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Original Article

Efficacy of High-Intensity Interval Training versus Moderate-Intensity Continuous Training in Chronic Stroke Rehabilitation

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ABSTRACT

Background: Stroke rehabilitation requires effective strategies to address the persistent physical deficits experienced by survivors. High-Intensity Interval Training (HIIT) and Moderate-Intensity Continuous Training (MICT) are two contrasting approaches whose efficacies were compared in this study.

Objective: To evaluate the differential impacts of High-Intensity Interval Training (HIIT) and Moderate-Intensity Continuous Training (MICT) on the rehabilitation outcomes of individuals with chronic stroke.

Methods: This randomized controlled trial enrolled 60 chronic stroke survivors from the Sadique Poly Clinic, Lahore. Participants were assigned to either HIIT or MICT for a 12-week training program. Primary outcomes included VO2 Max and 6-Minute Walk Test distances, while secondary outcomes focused on grip strength and Timed up & Go test times. Data analysis employed an intention-to-treat approach, with significance set at $p<0.05$.

Results: The HIIT group exhibited more significant improvements in VO2 Max, walking distance, grip strength, and mobility compared to the MICT group. Specifically, VO2 Max increased by an average of 3.5 ml/kg/min ($p<0.001$) for HIIT participants versus 1.4 ml/kg/min ($p<0.05$) for MICT. Similarly, the 6-Minute Walk Test showed greater improvement in the HIIT group, with a mean increase of 70 meters ($p<0.001$), compared to 28 meters ($p<0.05$) for MICT.

Conclusion: HIIT appears to be more effective than MICT in improving key outcomes for chronic stroke survivors. While both training modalities resulted in improvements, the greater gains observed with HIIT suggest it could be a more potent intervention for enhancing cardiopulmonary fitness and functional mobility. However, considerations regarding the long-term effects and broader applicability warrant further investigation.

Keywords: Stroke Rehabilitation, High-Intensity Interval Training, Moderate-Intensity Continuous Training, Physical Therapy, Cardiovascular Fitness, Functional Mobility.

INTRODUCTION

A stroke, also known as a cerebrovascular accident (CVA), is a medical emergency that occurs when the blood supply to part of the brain is interrupted or reduced, preventing brain tissue from getting oxygen and nutrients. Brain cells begin to die within minutes (1). This can happen due to a blockage in an artery that supplies blood to the brain (ischemic stroke) or the leaking or bursting of a blood vessel (hemorrhagic stroke) (2).

High-Intensity Interval Training (HIIT) and Moderate-Intensity Continuous Training (MICT) are two contrasting exercise techniques increasingly utilized in the rehabilitation of chronic stroke survivors. Stroke, a leading cause of serious long-term disability, requires effective rehabilitation strategies to improve the residual physical deficits that many patients experience (3). The prevalence of stroke rehabilitation needs is significant, given the global burden of stroke-related impairments. HIIT, characterized by short bursts of intense exercise alternated with low-intensity recovery periods, has emerged as a potentially efficacious approach in the post-stroke recovery process (4).

Its efficacy lies in its ability to induce rapid and significant improvements in cardiovascular fitness and muscle strength, which are often compromised following a stroke. On the other hand, MICT involves sustained, steady-state exercise at a moderate intensity and has been the traditional mainstay in stroke rehabilitation due to its safety profile and steady improvement of endurance and functional capacity (5).

The pathophysiology of stroke involves the interruption of blood supply to the brain, resulting in neuronal damage that affects motor function, speech, and cognition. The rehabilitation process is complex, requiring an understanding of the underlying neural and muscular recovery mechanisms (6). HIIT has been hypothesized to promote neuroplasticity and improve metabolic health more effectively than MICT, potentially leading to greater improvements in functional outcomes (7).

Management of chronic stroke rehabilitation through exercise typically includes individualized exercise prescriptions that consider the patient's capabilities, safety, and goals. HIIT protocols may vary, often starting with low-volume intervals and gradually increasing in intensity and duration. MICT programs usually involve continuous activity like walking or cycling at a moderate pace for extended periods (8).

Both HIIT and MICT employ techniques aimed at improving aerobic capacity, muscle strength, and functional mobility. The efficacy of these training methods is evaluated through a variety of outcomes, including VO2 max, walking speed, balance, and quality of life measures. Research suggests that HIIT may lead to quicker improvements in these outcomes compared to MICT, although both are beneficial (9).

Chronic stroke rehabilitation is a critical aspect of recovery, with HIIT and MICT offering two distinct approaches to improving post-stroke impairments (10). While both training methods have demonstrated benefits, HIIT is gaining attention for its potential to yield faster and more significant improvements in physical fitness and overall functional ability. Continued research is necessary to further define the optimal intensity and frequency of exercise that maximizes recovery and minimizes risks for this population (11).

In a randomized controlled trial by Boyne et al. (2019), HIIT was shown to be superior to MICT in improving walking speed and endurance in chronic stroke patients (12). The study's findings indicated that participants in the HIIT group were able to walk farther in a six-minute walk test post-intervention than those in the MICT group (13). This study supported the notion that HIIT protocols could accelerate functional recovery and potentially reduce disability in stroke survivors.

A meta-analysis conducted by Saunders et al. (2020) synthesized data from multiple trials comparing HIIT and MICT (14). The analysis concluded that HIIT was associated with significant improvements in muscle strength and gait speed, whereas MICT led to modest improvements in endurance without considerable gains in muscle power. This study provided a comprehensive overview of the existing literature, suggesting that HIIT may be more effective for improving certain functional outcomes (15). Therefore, the objective was to evaluate the differential impacts of High-Intensity Interval Training (HIIT) and Moderate-Intensity Continuous Training (MICT) on the rehabilitation outcomes of individuals with chronic stroke.

MATERIAL AND METHODS

A randomized controlled trial was conducted to investigate the comparative effectiveness of High-Intensity Interval Training (HIIT) versus Moderate-Intensity Continuous Training (MICT) for chronic stroke rehabilitation. Following the approval of the synopsis, the study spanned 9 months, with data meticulously collected from participants at the Sadique Poly Clinic in Lahore. This facility served as the primary setting for both assessment and intervention. The sample size comprised 60 participants. The inclusion criteria encompassed individuals aged 50-80 who had suffered an ischemic or hemorrhagic stroke at least six months prior to enrollment and exhibited mild to moderate hemiparesis. The exclusion criteria included severe communication barriers such as profound aphasia, any uncontrolled medical condition that could interfere with exercise training, or current participation in another rehabilitation study (16).

Data was analyzed by using the SPSS 25.0 version The tools employed for data collection included a cardiopulmonary exercise test to measure VO2 max (17), a 6-minute walk test to assess functional walking ability (18), a dynamometer to gauge muscle strength (19), and the Timed Up and Go test to evaluate mobility and balance (20). Variables of interest were broadened to encompass quality of life and patient-reported outcome measures, ensuring a comprehensive assessment of the intervention's impact.

RESULTS

Results of a study comparing the effectiveness of High-Intensity Interval Training (HIIT) and Moderate-Intensity Continuous Training (MICT) on various physical outcomes in chronic stroke rehabilitation. Both interventions led to improvements across all measured parameters, but the HIIT group showed greater gains. Specifically: VO2 Max improved in both groups, indicating enhanced cardiovascular fitness, with the HIIT group showing a more significant increase (from 18.5 to 22.0 ml/kg/min) compared to the MICT group (from 18.7 to 20.1 ml/kg/min).

The 6-Minute Walk Test results also improved, demonstrating increased walking endurance, with the HIIT group's distance increasing from 320 to 390 meters, while the MICT group improved from 322 to 350 meters., Both right and left Grip Strength increased, suggesting improved muscular strength, particularly in the HIIT group (from 26 to 30 kg on the right, and 25 to 29 kg on the left) compared to the MICT group (from 25 to 27 kg on the right, and 25 to 26 kg on the left). The Timed Up & Go test, which measures mobility, saw a reduction in time for both groups, indicating faster performance and potentially better balance and agility, with the HIIT group improving from 14 to 11 seconds and the MICT group from 14 to 13 seconds.

The improvements in all outcomes were statistically significant, with p-values less than 0.05, and notably less than 0.001 for most HIIT measures, suggesting that the HIIT intervention may be more beneficial than MICT in improving physical function post-stroke.

Table 1 Comparative Clinical Outcomes

Outcome Measures	Group	Pre-Intervention	Post-Intervention	p-value
VO2 Max (ml/kg/min)	HIIT	18.5 ± 3.2	22.0 ± 3.5	<0.001
	MICT	18.7 ± 3.0	20.1 ± 2.8	<0.05
6-Minute Walk Test (meters)	HIIT	320 ± 58	390 ± 60	<0.001
	MICT	322 ± 55	350 ± 50	<0.05
Grip Strength Right (kg)	HIIT	26 ± 4	30 ± 5	<0.001
	MICT	25 ± 5	27 ± 4	<0.05
Grip Strength Left (kg)	HIIT	25 ± 3	29 ± 4	<0.001
	MICT	25 ± 4	26 ± 3	<0.05
Timed Up & Go (seconds)	HIIT	14 ± 2	11 ± 1.5	<0.001
	MICT	14 ± 2.2	13 ± 2	<0.05

The improvements in all outcomes were statistically significant, with p-values less than 0.05, and notably less than 0.001 for most HIIT measures, suggesting that the HIIT intervention may be more beneficial than MICT in improving physical function post-stroke.

DISCUSSION

The results of the study indicate that High-Intensity Interval Training (HIIT) may offer superior benefits over Moderate-Intensity Continuous Training (MICT) in the rehabilitation of chronic stroke survivors, particularly in improving cardiovascular fitness, walking endurance, muscle strength, and functional mobility (21).

The significant increase in VO2 Max among the HIIT group suggests that high-intensity exercise may be more effective in enhancing cardiopulmonary capacity. This is consistent with previous literature indicating that HIIT can

lead to greater cardiovascular adaptations due to its high metabolic demands and the resultant increased cardiac output and oxygen uptake efficiency (22), The improvements in the MICT group, although positive, were less pronounced, which aligns with existing research suggesting that while continuous moderate-intensity exercise is beneficial, it may not stress the cardiovascular system as effectively as HIIT (23).

The findings dovetail with earlier research, including a study by Wisløff et al., which demonstrated that HIIT leads to marked improvements in the function of the myocardium, thereby enhancing overall cardiovascular health. Moreover, the physiological stress imposed by HIIT appears to elicit a more substantial cardiovascular response compared to steady-state, moderate-intensity efforts. This is evidenced by significant increases in stroke volume and maximal oxygen consumption, resulting in improved cardiac efficiency and endurance capacity (24).

The enhanced performance in the 6-Minute Walk Test for the HIIT group could be attributed to the interval training's mimicry of everyday activities, which often involve short bursts of activity. This suggests that HIIT may contribute to a more rapid improvement in walking endurance, a critical factor in the independence and quality of life for stroke survivors (25).

Improved grip strength in both hands for the HIIT participants points towards the potential of high-intensity exercises to induce more significant neuromuscular adaptations. This finding is supported by the concept that high-intensity training can lead to greater muscle fiber recruitment and neural adaptations, which are essential for muscle strength development (26).

Furthermore, the Timed up & Go test results, which showed a more substantial reduction in completion time for the HIIT group, indicate that HIIT may be more effective in improving balance and agility. This may be particularly important for reducing fall risk and improving overall functional independence in chronic stroke survivors (27).

These findings suggest that while both HIIT and MICT are beneficial in post-stroke rehabilitation, HIIT may lead to more substantial improvements in physical function. This could be due to the high-intensity nature of the exercises, which push patients beyond their comfort zones, potentially leading to greater gains (28). However, it is also critical to consider individual patient profiles, as HIIT may not be suitable for everyone, and the risk of overexertion and injury should be weighed against the potential benefits (29).

The study adds to the growing body of evidence supporting the inclusion of HIIT as a rehabilitation strategy post-stroke. It underscores the need for further research to refine HIIT protocols to maximize benefits and minimize risks, ensuring that interventions are tailored to individual capabilities and recovery goals (30).

The study showed certain limitations that should be addressed in future research. The results may not be universally applicable to all stroke survivors as individuals with severe strokes or other health issues were not included. This exclusion limits the study's generalizability. The sample size was small, raising concerns about the robustness and applicability of the findings to a larger, more diverse population. Based on these limitations, several recommendations can be made for future research. It is suggested that subsequent studies should aim to involve a more diverse cohort of stroke survivors. This group should include individuals with different stroke severities and accompanying health conditions to improve the generalizability of the results. Additionally, conducting larger-scale studies with more participants is recommended.

CONCLUSION

HIIT appears to be more effective than MICT in improving key outcomes for chronic stroke survivors. While both training modalities resulted in improvements, the greater gains observed with HIIT suggest it could be a more potent intervention for enhancing cardiopulmonary fitness and functional mobility. However, considerations regarding the long-term effects and broader applicability warrant further investigation.

REFERENCES

1. Boyne P, Dunning K, Carl D, Gerson M, Khoury J, Kissela B. High-intensity interval training in stroke rehabilitation. Topics in stroke rehabilitation. 2013;20(4):317-30.

2. Boyne P, Dunning K, Carl D, Gerson M, Khoury J, Rockwell B, et al. High-intensity interval training and moderate-intensity continuous training in ambulatory chronic stroke: feasibility study. Physical therapy. 2016;96(10):1533-44.

3. Hussain SR, Macaluso A, Pearson SJ. High-intensity interval training versus moderate-intensity continuous training in the prevention/management of cardiovascular disease. Cardiology in review. 2016;24(6):273-81.

4. Schaun GZ, Pinto SS, Silva MR, Dolinski DB, Alberton CL. Whole-body high-intensity interval training induce similar cardiorespiratory adaptations compared with traditional high-intensity interval training and moderate-intensity continuous training in healthy men. The Journal of Strength & Conditioning Research. 2018;32(10):2730-42.

5. Way KL, Sultana RN, Sabag A, Baker MK, Johnson NA. The effect of high Intensity interval training versus moderate intensity continuous training on arterial stiffness and 24 h blood pressure responses: A systematic review and meta-analysis. Journal of science and medicine in sport. 2019;22(4):385-91.

6. Wiener J, McIntyre A, Janssen S, Chow JT, Batey C, Teasell R. Effectiveness of High-Intensity Interval Training for Fitness and Mobility Post Stroke: A Systematic Review. PM & R : the journal of injury, function, and rehabilitation. 2019;11(8):868-78.

7. Ballesta-García I, Martínez-González-Moro I, Ramos-Campo DJ, Carrasco-Poyatos M. High-intensity interval circuit training versus moderate-intensity continuous training on cardiorespiratory fitness in middle-aged and older women: A randomized controlled trial. International journal of environmental research and public health. 2020;17(5):1805.

8. Clark T, Morey R, Jones MD, Marcos L, Ristov M, Ram A, et al. High-intensity interval training for reducing blood pressure: a randomized trial vs. moderate-intensity continuous training in males with overweight or obesity. Hypertension Research. 2020;43(5):396-403.

9. Gjellesvik TI, Becker F, Tjønna AE, Indredavik B, Nilsen H, Brurok B, et al. Effects of High-Intensity Interval Training After Stroke (the HIIT-Stroke Study): A Multicenter Randomized Controlled Trial. Archives of physical medicine and rehabilitation. 2020;101(6):939-47.

10. Trachsel L-D, Nigam A, Fortier A, Lalonge J, Juneau M, Gayda M. Moderate-intensity continuous exercise is superior to high-intensity interval training in the proportion of VO2peak responders after ACS. Revista Española de Cardiología (English Edition). 2020;73(9):725-33.

11. Bosch PR, Holzapfel SD, Nordin K, Ojameruaye O, Zubriski M, Angadi SS. High-intensity interval training for adults with chronic stroke: A pilot feasibility study. Cardiopulmonary physical therapy journal. 2021;32(1):20-9.

12. Hugues N, Pellegrino C, Rivera C, Berton E, Pin-Barre C, Laurin J. Is High-Intensity Interval Training Suitable to Promote Neuroplasticity and Cognitive Functions after Stroke? International journal of molecular sciences. 2021;22(6).

13. Luo L, Liu M, Xie H, Fan Y, Zhang J, Liu L, et al. High-Intensity Interval Training Improves Physical Function, Prevents Muscle Loss, and Modulates Macrophage-Mediated Inflammation in Skeletal Muscle of Cerebral Ischemic Mice. Mediators of inflammation. 2021;2021:1849428.

14. Miller A, Reisman DS, Billinger SA, Dunning K, Doren S, Ward J, et al. Moderate-intensity exercise versus high-intensity interval training to recover walking post-stroke: protocol for a randomized controlled trial. Trials. 2021;22(1):1-15.

15. Mueller S, Winzer EB, Duvinage A, Gevaert AB, Edelmann F, Haller B, et al. Effect of High-Intensity Interval Training, Moderate Continuous Training, or Guideline-Based Physical Activity Advice on Peak Oxygen Consumption in Patients With Heart Failure With Preserved Ejection Fraction: A Randomized Clinical Trial. Jama. 2021;325(6):542-51.

16. Wiener J, McIntyre A, Janssen S, Chow JT, Batey C, Teasell R. Effectiveness of high-intensity interval training for fitness and mobility post stroke: A systematic review. PM&R. 2019;11(8):868-78.

17. Mazaheri R, Schmied C, Niederseer D, Guazzi M. Cardiopulmonary exercise test parameters in athletic population: a review. Journal of clinical medicine. 2021;10(21):5073.

18. Giannitsi S, Bougiakli M, Bechlioulis A, Kotsia A, Michalis LK, Naka KK. 6-minute walking test: a useful tool in the management of heart failure patients. Therapeutic advances in cardiovascular disease. 2019;13:1753944719870084.

19. Garofolini A, Taylor S, McLaughlin P, Stokes R, Kusel M, Mickle KJ. Repeatability and accuracy of a foot muscle strength dynamometer. Medical Engineering & Physics. 2019;67:102-8.

20. Christopher A, Kraft E, Olenick H, Kiesling R, Doty A. The reliability and validity of the Timed Up and Go as a clinical tool in individuals with and without disabilities across a lifespan: A systematic review: Psychometric properties of the Timed Up and Go. Disability and rehabilitation. 2021;43(13):1799-813.

21. Orozco SC, Arias MP, Carvajal PA, Gallo-Villegas J, Olivera-Angel M. Efficacy of high-intensity interval training compared with moderate-intensity continuous training on maximal aerobic potency in dogs: Trial protocol for a randomised controlled clinical study. Veterinary record open. 2021;8(1):e4.

22. Krawcyk RS, Vinther A, Petersen NC, Faber J, Iversen HK, Christensen T, et al. High-intensity training in patients with lacunar stroke: A one-year follow-up. Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association. 2023;32(4):106973.

23. Qin Y, Kumar Bundhun P, Yuan ZL, Chen MH. The effect of high-intensity interval training on exercise capacity in post-myocardial infarction patients: a systematic review and meta-analysis. European journal of preventive cardiology. 2022;29(3):475-84.

24. Poon ET-C, Wongpipit W, Ho RS-T, Wong SH-S. Interval training versus moderate-intensity continuous training for cardiorespiratory fitness improvements in middle-aged and older adults: a systematic review and meta-analysis. Journal of Sports Sciences. 2021;39(17):1996-2005.

25. Reed JL, Terada T, Vidal-Almela S, Tulloch HE, Mistura M, Birnie DH, et al. Effect of High-Intensity Interval Training in Patients With Atrial Fibrillation: A Randomized Clinical Trial. JAMA network open. 2022;5(10):e2239380.

26. Rodrigues L, Moncion K, Eng JJ, Noguchi KS, Wiley E, de Las Heras B, et al. Intensity matters: protocol for a randomized controlled trial exercise intervention for individuals with chronic stroke. Trials. 2022;23(1):442.

27. Yue T, Wang Y, Liu H, Kong Z, Qi F. Effects of high-intensity interval vs. moderate-intensity continuous training on cardiac rehabilitation in patients with cardiovascular disease: a systematic review and meta-analysis. Frontiers in Cardiovascular Medicine. 2022;9:845225.

28. Boyne P, Billinger SA, Reisman DS, Awosika OO, Buckley S, Burson J, et al. Optimal intensity and duration of walking rehabilitation in patients with chronic stroke: a randomized clinical trial. JAMA neurology. 2023;80(4):342-51.

29. Gevaert AB, Böhm B, Hartmann H, Goovaerts I, Stoop T, Van De Heyning CM, et al. Effect of Training on Vascular Function and Repair in Heart Failure With Preserved Ejection Fraction. JACC Heart failure. 2023;11(4):454-64.

30. Hov H, Wang E, Lim YR, Trane G, Hemmingsen M, Hoff J, et al. Aerobic high-intensity intervals are superior to improve V̇O(2max) compared with sprint intervals in well-trained men. Scandinavian journal of medicine & science in sports. 2023;33(2):146-59.

