

Original Article

# Comparative Evaluation of High-Intensity Interval Training (HIIT) and Traditional Aerobic Exercise for Cardiovascular Health in Stroke Survivors: A Randomized Controlled Trial

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## ABSTRACT

**Background:** Stroke survivors often face significant challenges in regaining cardiovascular health, with exercise being a key component of rehabilitation. High-Intensity Interval Training (HIIT) and Traditional Aerobic Exercise are two prominent modalities aimed at improving cardiovascular outcomes in this population.

**Objective:** The study aimed to compare the effects of HIIT and Traditional Aerobic Exercise on cardiovascular health in stroke survivors.

**Methods:** This randomized clinical trial enrolled 46 stroke survivors, equally divided into HIIT and Traditional Aerobic Exercise groups. The study took place at Sadique Polly Clinic, Nawab Town, Lahore, Pakistan. Participants underwent baseline assessments for resting heart rate, systolic and diastolic blood pressure, and total cholesterol levels. Post-intervention, these parameters were re-evaluated. Data analysis involved using SPSS version 25 to compare the effects of the two exercise modalities on cardiovascular health outcomes.

**Results:** Both groups demonstrated improvements in cardiovascular health, but the HIIT group showed a more significant reduction in resting heart rate (change of  $-5.7 \pm 2.9$  bpm) compared to the Traditional Aerobic Exercise group (change of  $-3.9 \pm 2.4$  bpm), with a p-value of 0.03. Changes in systolic blood pressure ( $-9.2 \pm 4.3$  mmHg in HIIT vs.  $-7.6 \pm 3.8$  mmHg in Traditional), diastolic blood pressure ( $-4.3 \pm 2.1$  mmHg in HIIT vs.  $-3.7 \pm 1.9$  mmHg in Traditional), and total cholesterol levels ( $-11.1 \pm 5.2$  mg/dL in HIIT vs.  $-9.5 \pm 4.7$  mg/dL in Traditional) were observed in both groups but did not reach statistical significance ( $p > 0.05$ ).

**Conclusion:** Both HIIT and Traditional Aerobic Exercise are effective in enhancing cardiovascular health in stroke survivors. However, HIIT may offer a greater advantage in reducing resting heart rate compared to Traditional Aerobic Exercise.

**Keywords:** Stroke Rehabilitation, Cardiovascular Health, High-Intensity Interval Training, Traditional Aerobic Exercise, Randomized Clinical Trial.

## INTRODUCTION

The prevalence and impact of cerebrovascular accidents, commonly known as strokes, represent a significant global health concern. Strokes, which can be ischemic or hemorrhagic in nature, lead to neurological impairments due to inadequate cerebral blood flow (1, 2). The World Health Organization highlights stroke as the second leading cause of death worldwide, underscoring its role in contributing to disability (3). Geographical disparities in stroke prevalence are evident, with developing countries like Pakistan showing higher rates. Contributing factors include healthcare access, lifestyle, nutrition, and genetic predispositions. In Pakistan, the rise in cardiovascular diseases, diabetes, and hypertension plays a crucial role in the increasing incidence of strokes (4, 5). Recognized risk factors such as sedentary lifestyle, hypertension, smoking, diabetes, obesity, high cholesterol, age, and familial history further exacerbate the risk of stroke occurrence.

However, traditional stroke rehabilitation programs have been limited in providing opportunities for intense cardiovascular exercise, a key component in reducing the risk of subsequent strokes (6, 7). Stroke survivors are often recommended to engage in moderate-intensity continuous cardiovascular exercise (MICE) to improve cardiorespiratory fitness (CRF). This involves exercising at 40% to 70% of peak oxygen intake (VO<sub>2</sub>Peak) or heart rate reserve (HRR), or 80% of maximal heart rate (HR<sub>max</sub>). While moderate cardiovascular activity has been shown to benefit cognitive and motor recovery, increasing exercise intensity can be challenging for those with significant motor impairments, potentially limiting the ability to achieve optimal exercise benefits (8, 9).

Cardiovascular exercise is not only effective but also cost-efficient in enhancing various aspects of cognitive and motor recovery post-stroke. Although aerobic exercise is known to induce structural and functional changes in the brain in individuals without deficits, its effects post-stroke and the optimal training parameters for enhancing neuroplasticity and functional recovery remain uncertain (10, 11). High-Intensity Interval Training (HIIT), alternatively termed as moderate-intensity interval training (MICE), has gained popularity as a time-efficient exercise method. It is suitable for both clinical populations and those without disabilities. HIIT aims to increase exercise intensity while reducing overall duration and volume, interspersed with recovery periods. Studies have indicated that HIIT is more efficient and effective than traditional MICE, even with a reduced total exercise volume (12, 13). Particularly in individuals with heart disease, HIIT has shown greater benefits, including a more significant increase in VO<sub>2</sub>Peak, compared to MICE (14, 15). Recent research involving 261 individuals with heart failure demonstrated that both MICE and HIIT offer comparable benefits. However, issues like exercise intensity contamination in the MICE group and the failure of HIIT participants to meet intensity targets have complicated comparisons between the two, highlighting the need for further research (16, 17). HIIT, by elevating the moderate cardiovascular exertion typical in stroke rehabilitation, can achieve the higher intensities required for optimizing recovery. However, it is important to tailor HIIT parameters to the specific needs of different populations and training objectives. Despite its benefits, certain barriers prevent widespread adoption of HIIT among stroke survivors. These include cardiovascular deconditioning, neurological impairments such as motor and balance deficits, and the heightened cardiovascular strain experienced by stroke survivors compared to those engaging in MICE (18, 19). Ensuring safety requires thorough testing. HIIT programs post-stroke can be categorized based on recovery methods, rest period lengths, and the duration of high-intensity surges (22). HIIT maximizes time spent at a high percentage of VO<sub>2</sub>Peak through short, intense sprints, with low-volume HIIT involving hypoxic, maximal, absolute, or anaerobic workloads during brief high-intensity periods.

This study aims to conduct a Comparative Evaluation of High-Intensity Interval Training (HIIT) and Traditional Aerobic Exercise for Cardiovascular Health in Stroke Survivors. The objective is to ascertain the efficacy of HIIT compared to conventional aerobic exercises in improving cardiovascular health post-stroke, taking into account the unique challenges and needs of this population.

## MATERIAL AND METHODS

In the study's methodology, a randomized clinical trial design, recognized for its robustness in establishing causal relationships in medical research, was employed (1). This design involved the random allocation of stroke survivors into two groups: one subjected to High-Intensity Interval Training (HIIT) and the other to Traditional Aerobic Exercise. The study aimed to compare the efficacy of these exercise modalities in improving cardiovascular health among individuals who had experienced a stroke.

The trial recruited 46 participants, carefully divided into two equally sized groups to ensure a balanced comparison of the interventions. The study was conducted at the Sadique Polly Clinic in Nawab Town, Lahore, Pakistan, providing a controlled setting for data collection and intervention administration. The inclusion criteria focused on stroke survivors willing to participate, highlighting the importance of voluntary involvement. In contrast, exclusion criteria were set to omit individuals with contraindications to exercise or those physically unable to perform the prescribed activities, thus ensuring participant safety and enhancing the validity of the study's outcomes.

Data collection was meticulously carried out, encompassing comprehensive assessments both prior to and following the intervention phase. Baseline measurements were recorded to establish initial health parameters, and subsequent evaluations determined the impact of the exercise regimens on cardiovascular health. The interventions, tailored to each participant's assigned group, involved either HIIT or Traditional Aerobic Exercise, administered under controlled conditions.

Following the intervention, the collected data were subjected to a rigorous analysis using the Statistical Package for the Social Sciences (SPSS) version 25. This statistical approach facilitated a detailed comparison of the effects of HIIT and Traditional Aerobic Exercise on cardiovascular health in the stroke survivor cohort. The analysis aimed to yield insights into the relative effectiveness of these exercise modalities for improving cardiovascular outcomes in individuals recovering from stroke.

Overall, the study's methodology was carefully crafted to contribute meaningfully to the understanding of the comparative effectiveness of HIIT and Traditional Aerobic Exercise in enhancing cardiovascular health post-stroke. The careful selection of

participants, the randomized trial design, and the meticulous approach to data collection and analysis all played crucial roles in ensuring the study's reliability and relevance to stroke rehabilitation research.

## RESULTS

The study conducted a comparative analysis of High-Intensity Interval Training (HIIT) and Traditional Aerobic Exercise in stroke survivors, focusing on cardiovascular health outcomes. The baseline characteristics revealed similar demographics between the two groups, with no significant differences in age, gender distribution, or time since stroke. Baseline cardiovascular parameters, including resting heart rate, systolic and diastolic blood pressure, and total cholesterol levels, also demonstrated no statistically significant disparities. Post-intervention, both exercise modalities resulted in positive changes, indicating improvements in cardiovascular health. However, the HIIT group exhibited a more significant reduction in resting heart rate compared to the Traditional Aerobic Exercise group ( $p = 0.03$ ). While changes in systolic and diastolic blood pressure and total cholesterol were observed in both groups, the differences did not reach statistical significance ( $p > 0.05$ ). These findings suggest that both HIIT and Traditional Aerobic Exercise are effective in enhancing cardiovascular health in stroke survivors, with HIIT showing a notable advantage in reducing resting heart rate.

Table 1 Participant Demographics

Characteristic	HIIT Group (n=23)	Traditional Aerobic Exercise Group (n=23)
Age (years)	58.3 ± 7.2	57.8 ± 6.5
Gender (M/F)	12/11 (52%/48%)	11/12 (48%/52%)
Time Since Stroke (months)	14.6 ± 6.3	15.2 ± 5.8

This table presents key demographic characteristics of the study participants, including age, gender distribution, and time since stroke. The values represent means (± standard deviations) for age and time since stroke, while gender distribution is presented as counts with corresponding percentages.

Table 2 Baseline Cardiovascular Parameters

Parameter	HIIT Group (Baseline)	Traditional Aerobic Exercise Group (Baseline)	P-Value
Resting Heart Rate (bpm)	77.4 ± 9.2	78.1 ± 8.3	0.62
Systolic BP (mmHg)	129.8 ± 11.5	131.5 ± 10.2	0.48
Diastolic BP (mmHg)	81.6 ± 7.2	82.3 ± 7.8	0.74
Total Cholesterol (mg/dL)	197.5 ± 16.3	198.2 ± 15.7	0.85

This table displays baseline cardiovascular parameters for the HIIT and Traditional Aerobic Exercise groups. Values represent means (± standard deviations) for resting heart rate, systolic and diastolic blood pressure, and total cholesterol levels. The p-values indicate the statistical significance of any observed differences between the two groups at baseline.

Table 3 Comparison of Post-Intervention Cardiovascular Changes

Parameter	HIIT Group (Post-Intervention)	Traditional Aerobic Exercise Group (Post-Intervention)	P-Value
Resting Heart Rate Change (bpm)	-5.7 ± 2.9	-3.9 ± 2.4	0.03
Systolic BP Change (mmHg)	-9.2 ± 4.3	-7.6 ± 3.8	0.18
Diastolic BP Change (mmHg)	-4.3 ± 2.1	-3.7 ± 1.9	0.26
Total Cholesterol Change (mg/dL)	-11.1 ± 5.2	-9.5 ± 4.7	0.12

This table outlines the changes in cardiovascular parameters post-intervention for both the HIIT and Traditional Aerobic Exercise groups. Values represent means (± standard deviations) for the change in resting heart rate, systolic and diastolic blood pressure, and total cholesterol levels. The accompanying p-values indicate the statistical significance of observed differences between the two groups following the interventions.

## DISCUSSION

In this study, a thorough analysis of the effects of High-Intensity Interval Training (HIIT) and Conventional Aerobic Exercise on stroke survivors was conducted to evaluate their cardiovascular benefits. Both exercise modalities demonstrated favorable enhancements in key cardiovascular indicators post-intervention, reinforcing the potential effectiveness of structured exercise programs in stroke rehabilitation (22, 23). Participants engaging in HIIT exhibited a more notable decrease in resting heart rate compared to those in the aerobic exercise group ( $p = 0.03$ ), aligning with prior research underscoring the cardiovascular benefits of HIIT, such as improved endothelial function and heart rate recovery (24).

Despite observed improvements in systolic and diastolic blood pressure, total cholesterol levels, and other cardiovascular metrics, these did not reach statistical significance ( $p > 0.05$ ). This outcome necessitates consideration of individual variability and the relatively modest sample size, which could impact the statistical power to detect significant differences. However, the improvements noted in both groups suggest a positive trend in cardiovascular health following these exercise regimens (25, 26).

The results from this study are in agreement with previous research, supporting the notion that exercise, including HIIT and traditional aerobic exercise, significantly enhances cardiovascular rehabilitation in stroke survivors. Numerous studies have documented improvements in cardiovascular indicators like blood pressure, pulse rate, and lipid profiles following consistent exercise routines. This study extends this knowledge by comparing the effectiveness of conventional aerobic exercise and HIIT, highlighting the differences between these two modalities (27, 28).

It is important to acknowledge the diversity in methodologies, participant characteristics, and outcome measures across different studies, which might affect the direct comparability of results. Additionally, the duration and intensity of the exercise programs, as well as the timing of the interventions post-stroke, could have influenced the outcomes reported. Further research with larger sample sizes, longer intervention durations, and standardized outcome assessments would provide deeper insights into the optimal exercise regimen for stroke recovery (29, 30).

Our findings indicate that both conventional aerobic exercise and HIIT positively impact the cardiovascular health of stroke survivors, with HIIT showing a more pronounced effect on basal heart rate. This underscores the importance of personalized exercise programs tailored to the needs and preferences of individual patients during stroke rehabilitation. Further investigation is needed to understand the best implementation strategies and long-term benefits of various exercise methods in stroke rehabilitation (31, 32). The observed reduction in resting heart rate in the HIIT group, compared to the Traditional Aerobic Exercise group, was statistically significant ( $p = 0.03$ ). This supports other studies that have highlighted the benefits of HIIT on cardiovascular health, particularly in improving cardiac efficiency (33). However, the changes in total cholesterol, systolic and diastolic blood pressure were not statistically significant ( $p < 0.05$ ) in either group. These findings align with a body of research that presents varied effects of exercise on blood pressure and lipid profile. This variation, attributed to individual differences in fitness levels and stroke severity, highlights the complexity of stroke rehabilitation and the need for tailored exercise regimens (34).

While this study contributes significantly to the field of stroke rehabilitation by comparing HIIT and traditional aerobic exercises, it is imperative to conduct further extensive trials and meta-analyses. These future studies should aim to establish more comprehensive and customized exercise guidelines for individuals recovering from strokes, taking into account the diverse responses and needs of this population.

## CONCLUSION

Our Results indicates that both High-Intensity Interval Training (HIIT) and Traditional Aerobic Exercise benefit the cardiovascular health of stroke survivors. HIIT showed a stronger impact on reducing resting heart rate. While changes in blood pressure and cholesterol were positive but not statistically significant, individual differences highlight the importance of personalized exercise plans. Our study, with 46 participants, provides robust insights, but larger studies are needed for broader conclusions. Overall, exercise, especially HIIT, holds promise for improving the heart health of stroke survivors, emphasizing the need for tailored rehabilitation programs.

Our study's modest sample size and short intervention period may impact the generalizability and understanding of long-term effects. Individual variability in stroke recovery might not be fully accounted for. Future research should involve larger, more diverse samples, spanning longer durations. Further exploration of optimal exercise prescription, considering individual differences, is essential for refining targeted rehabilitation strategies for stroke survivors.

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