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Impact of Physiotherapy-Based Exercise Training on Cardiac Function and Quality of Life in Heart Failure Patients

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Abstract

Background: Exercise training based on physiotherapy has become a potential non-pharmacological treatment to enhance heart failure patients' quality of life and cardiac function.

Objective: To assess how exercise training determined by physical therapy affects heart failure patients' overall quality of life and heart function.

Methodology: A prospective, single-group pre–post interventional study was conducted at the Department of Cardiology and Physiotherapy Unit, Pakistan Institute of Medical Sciences (PIMS) in collaboration with Riphah International University, GGC Campus, Islamabad, Pakistan, from January to December 2024. A total of 126 clinically stable adult heart failure patients aged 30–70 years were enrolled using consecutive sampling. Participants underwent a 12-week structured physiotherapy-based exercise program incorporating aerobic, resistance, and breathing exercises, with sessions lasting 30–45 minutes, three to five times per week. Echocardiography (LVEF) was used to monitor cardiac function; the Minnesota Living with Heart Failure Questionnaire (MLHFQ) was used to measure quality of life; and the 6-minute walk test (6MWT) was used to measure functional capacity. Paired t-tests were used to compare the results before and after the intervention.

Results: Of 126 participants, 72 (57.14%) were male and 54 (42.86%) female. LVEF increased significantly from $38.72 \pm 6.54\%$ to $44.85 \pm 6.12\%$ ($p < 0.001$). MLHFQ

scores improved with physical domain decreasing from 28.45 ± 6.82 to 20.31 ± 5.97, emotional domain from 16.72 ± 4.65 to 11.89 ± 4.12, and total score from 45.17 ± 9.12 to 32.20 ± 8.35 (all $p < 0.001$). Functional capacity improved with 6MWT distance increasing from 310.45 ± 54.23 m to 365.78 ± 48.12 m ($p < 0.001$). Clinically meaningful improvements were observed in LVEF (≥5%) in 92 patients, 73.02%, MLHFQ (≥10-point reduction) in 85 patients, 67.46%, and 6MWT (≥50 m gain) in 78 patients, 61.90%.

Conclusion: Heart failure patients' cardiac function, quality of life, and functional ability are all markedly improved by physiotherapy-based exercise training.

Introduction

The incapacity of the heart to pump enough blood to fulfill the body's metabolic needs is the hallmark of heart failure, a complicated clinical disease [1]. Due to its high morbidity, mortality, and frequent hospitalizations, it continues to be a significant worldwide health burden [2]. Patients frequently suffer from symptoms such tiredness, dyspnea, decreased exercise tolerance, and fluid retention, all of which seriously hinder day-to-day activities and general health [3]. Many people nevertheless suffer from a steadily declining heart function and quality of life despite advancements in pharmaceutical and device-based treatments [4].

In recent years, there has been increasing recognition of the role of non-pharmacological interventions in the comprehensive management of heart failure [5]. Among these, physiotherapy-based exercise training has emerged as a promising strategy to improve both physiological and functional outcomes [6]. Structured exercise programs, including aerobic training, resistance exercises, and flexibility components, have demonstrated beneficial effects on cardiovascular efficiency, peripheral muscle strength, and endothelial function [7]. These adaptations contribute to improved oxygen utilization and reduced symptom burden in heart failure patients. Importantly, these physiological improvements are often reflected in measurable parameters such as left ventricular ejection fraction and validated quality of life indices [8].

Furthermore, exercise training has been shown to positively influence neurohormonal regulation and reduce systemic inflammation, both of which play critical roles in the pathophysiology of heart failure [9]. Beyond physiological improvements, participation in supervised physiotherapy programs can enhance psychological well-being by reducing symptoms of anxiety and depression, which are commonly observed in this patient population. Improved mental health, in turn, contributes to better adherence to treatment and lifestyle modifications [10].

Quality of life is an essential outcome measure in heart failure management, as it reflects the patient’s perception of their physical, emotional, and social functioning [11]. Traditional medical therapies often focus primarily on survival and symptom control, whereas physiotherapy interventions offer a more holistic approach by addressing functional capacity and independence [12]. However, variability in exercise protocols, patient characteristics, and clinical settings has led to inconsistent findings across studies, highlighting the need for further investigation, particularly using standardized outcome measures and structured intervention protocols.

Research Objective:

To assess how exercise training determined by physical therapy affects heart failure patients' overall quality of life and heart function.

Methodology

Study Design
The purpose of this prospective single-group pre-post interventional study was to assess how exercise training based on physiotherapy affected the quality of life and cardiac function of heart failure patients.

Study Setting
The study was conducted in partnership with Riphah International University, GGC Campus, Islamabad, Pakistan, at the Department of Cardiology and Physiotherapy Unit, Pakistan Institute of Medical Sciences (PIMS).

Study Duration
The research spanned from January 2024 to December 2024, for a total of one year. Assessments were carried out at baseline and at the end of the 12-week structured physiotherapy-based exercise program for each participant.

Study Population
Adult patients with heart failure who visited PIMS, Islamabad's outpatient and inpatient departments made up the research population. Inclusion was limited to clinically stable individuals who were judged fit to engage in a supervised exercise regimen.

Sample Size and Sampling Technique
The study used a non-probability sequential sampling strategy to enroll 126 patients in total. Until the required sample size was reached, eligible volunteers were recruited one after the other in accordance with predetermined inclusion and exclusion criteria.

Inclusion and Exclusion Crietria
The study comprised patients with a confirmed diagnosis of heart failure, including both decreased and maintained ejection fraction, who were between the ages of thirty and seventy. Hemodynamic stability and willingness to give informed permission were prerequisites for participation. The study excluded patients with advanced musculoskeletal and neurological conditions that could restrict exercise training participation, unstable angina, severe valvular heart disease requiring surgical intervention, uncontrolled hypertension, significant arrhythmias, or recent myocardial infarction. Patients with any medical condition deemed unsuitable for exercise intervention were also excluded.

Data Collection Procedure
Participants meeting the eligibility criteria were enrolled after obtaining written informed consent. Baseline data were collected, including demographic characteristics, clinical history, and physical examination findings. Cardiac function was assessed using echocardiography, and quality of life was measured using a validated questionnaire. Following enrollment, patients underwent the prescribed exercise training program and were reassessed after completion of the 12-week intervention period to evaluate changes in outcomes.

Intervention Protocol (Physiotherapy-Based Exercise Training)
A physiotherapy-based exercise training program that was supervised and structured and customized to each patient's functional ability made up the intervention. The regimen included physical training that targeted main muscle groups, cardiovascular activities like walking or stationary cycling, and breathing exercises like pursed-lip and diaphragmatic breathing. Three to five times a week, under the guidance of a licensed physiotherapist, each session lasted around thirty to forty-five minutes. To guarantee patient safety and the best possible training results, exercise intensity was tracked and gradually modified using the Borg Rating of Perceived Exertion (RPE) scale.

Outcome Measures

The study's main endpoint was cardiac function, which was determined by utilizing echocardiography to measure the left ventricular ejection fraction. The Minnesota Living with Heart Failure Questionnaire, a standardized and validated questionnaire, was used to measure quality of life, and the 6-minute walk test (6MWT) was used to assess functional ability.

Data Collection Tools

Data were collected using echocardiographic assessment for cardiac function and standardized questionnaires such as the Minnesota Living with Heart Failure Questionnaire for evaluating quality of life. Structured data collection forms were used to record demographic and clinical information.

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) version 26 was used to enter and evaluate all of the data that had been gathered. While categorical variables were displayed as frequencies and percentages, continuous variables were given as mean and standard deviation. Paired t-tests were used to compare cardiac function and quality of life before and after the intervention. To further improve the statistical analysis's robustness, effect sizes and 95% confidence intervals were computed. Statistical significance was defined as a p-value of 0.05 or below.

Ethical Considerations

The Institutional Review Board of Riphah International University, GGC Campus, Islamabad, granted ethical approval for the study. Before being included in the study, each subject provided written informed permission. All treatments were carried out in compliance with ethical standards, and patient data confidentiality was rigorously upheld. The freedom to leave the research at any time without affecting their regular medical treatment was explained to the participants.

Results

A total of 126 patients were included in the study, with 72 males (57.14%) and 54 females (42.86%), shown in table 1. The age distribution showed 20 patients (15.87%) aged 30–39 years, 36 patients (28.57%) aged 40–49 years, 38 patients (30.16%) aged 50–59 years, and 32 patients (25.40%) aged 60–70 years. Regarding heart failure type, 65 patients (51.59%) had HFrEF (EF <40%) and 61 patients (48.41%) had HFpEF (EF ≥50%). Most patients were classified as NYHA Class III (62 patients, 49.21%), followed by Class II (52 patients, 41.27%) and Class IV (12 patients, 9.52%). Common comorbidities included hypertension in 68 patients (53.97%), diabetes mellitus in 45 patients (35.71%), and dyslipidemia in 30 patients (23.81%).

Table 1: Baseline Demographic and Clinical Characteristics (n=126)

Characteristic	Category	Number of Patients (n)	Percentage (%)
Gender	Male	72	57.14
	Female	54	42.86
Age Group (years)	30–39	20	15.87
	40–49	36	28.57
	50–59	38	30.16
	60–70	32	25.40
Type of Heart Failure	HFrEF (EF <40%)	65	51.59

	HFpEF (EF ≥50%)	61	48.41
NYHA Functional Class	Class II	52	41.27
	Class III	62	49.21
	Class IV	12	9.52
Comorbidities	Hypertension	68	53.97
	Diabetes Mellitus	45	35.71
	Dyslipidemia	30	23.81

Cardiac function improved significantly after the 12-week physiotherapy-based exercise program (table 2). The mean left ventricular ejection fraction increased from 38.72 ± 6.54% at baseline to 44.85 ± 6.12% post-intervention, with a mean difference of 6.13% (95% CI: 4.98–7.28, Cohen's d = 0.94, $p < 0.001$), indicating a large effect size and clinically meaningful improvement in cardiac performance.

Table 2: Changes in Cardiac Function (LVEF) Pre- and Post-Intervention

Parameter	Pre-Intervention Mean ± SD	Post-Intervention Mean ± SD	Mean Difference	95% CI	Cohen's d	p-value
LVEF (%)	38.72 ± 6.54	44.85 ± 6.12	6.13	4.98 – 7.28	0.94	<0.001

Quality of life improved significantly following the intervention (table 3). The physical domain score decreased from 28.45 ± 6.82 to 20.31 ± 5.97 (mean difference -8.14, 95% CI -9.53 to -6.75, Cohen's d = 1.28, $p < 0.001$), the emotional domain score decreased from 16.72 ± 4.65 to 11.89 ± 4.12 (mean difference -4.83, 95% CI -5.81 to -3.85, Cohen's d = 1.08, $p < 0.001$), and the total MLHFQ score decreased from 45.17 ± 9.12 to 32.20 ± 8.35 (mean difference -12.97, 95% CI -14.63 to -11.31, Cohen's d = 1.47, $p < 0.001$), demonstrating substantial improvements across all domains.

Table 3: Changes in Quality of Life (MLHFQ Scores) Pre- and Post-Intervention

Domain	Pre-Intervention Mean ± SD	Post-Intervention Mean ± SD	Mean Difference	95% CI	Cohen's d	p-value
Physical	28.45 ± 6.82	20.31 ± 5.97	-8.14	-9.53 – -6.75	1.28	<0.001
Emotional	16.72 ± 4.65	11.89 ± 4.12	-4.83	-5.81 – -3.85	1.08	<0.001
Total Score	45.17 ± 9.12	32.20 ± 8.35	-12.97	-14.63 – -11.31	1.47	<0.001

Functional capacity improved markedly, with the 6-minute walk test distance increasing from 310.45 ± 54.23 meters at baseline to 365.78 ± 48.12 meters' post-intervention (table 4). The mean difference of 55.33 meters (95% CI: 47.21–63.45, Cohen's d = 1.06, $p < 0.001$) indicates a statistically significant and clinically meaningful improvement in exercise tolerance

Table 4: Functional Capacity (6-Minute Walk Test) Pre- and Post-Intervention

Parameter	Pre-Intervention Mean ± SD (meters)	Post-Intervention Mean ± SD (meters)	Mean Difference	95% CI	Cohen's d	p-value
6MWT Distance	310.45 ± 54.23	365.78 ± 48.12	55.33	47.21 – 63.45	1.06	<0.001

Among the participants, 92 patients (73.02%) achieved an LVEF increase of ≥5%, 85 patients (67.46%) showed a reduction in total MLHFQ score of ≥10 points, and 78 patients (61.90%) improved their 6MWT distance by ≥50 meters, highlighting the effectiveness of the exercise intervention in producing clinically relevant improvements (figure 1).

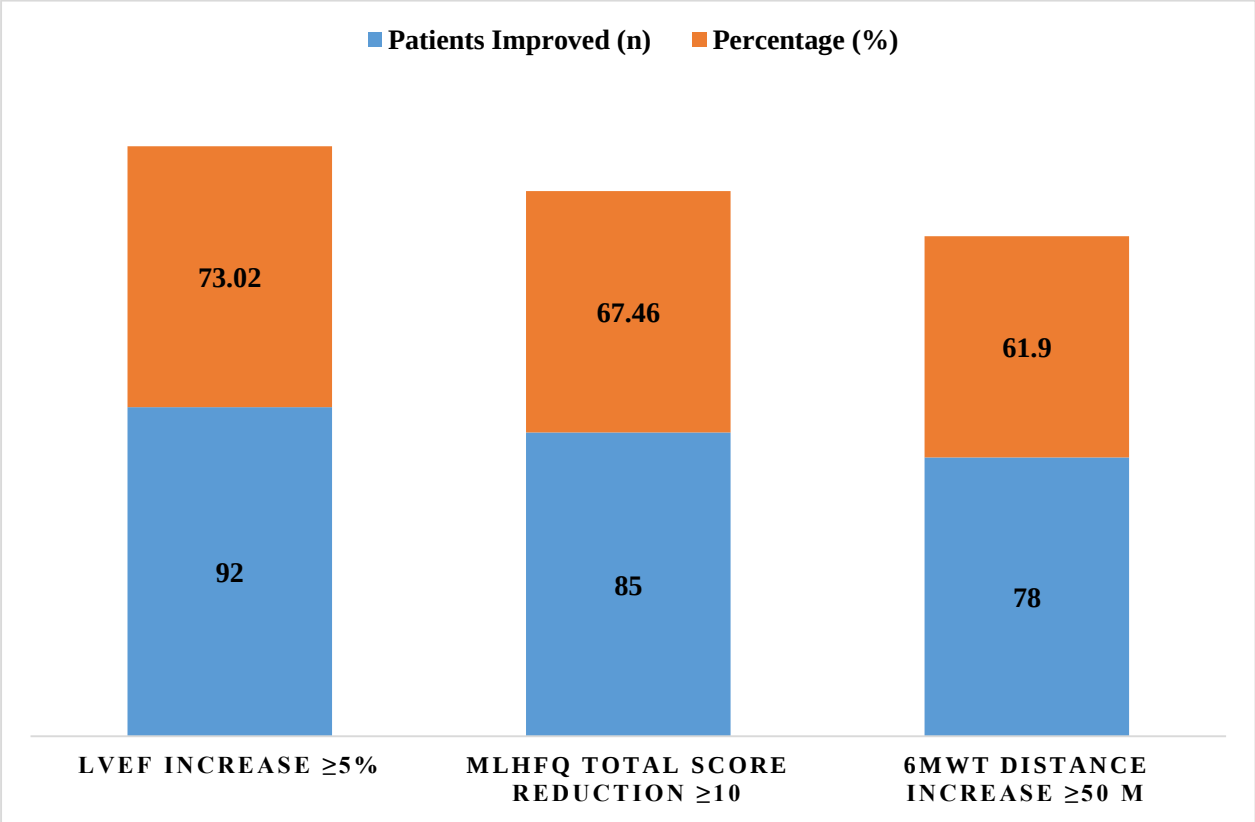

Figure 1: Distribution of Patients Showing Clinically Meaningful Improvement

Most participants adhered well to the intervention protocol (figure 2). A total of 98 patients (77.78%) completed ≥90% of prescribed sessions, 20 patients (15.87%) completed 75–89% of sessions, and only 8 patients (6.35%) completed less than 75%. The average session duration was 38 ± 4.52 minutes. Average perceived exertion (RPE) scores were 12.84 ± 1.41 for aerobic exercises, 13.26 ± 1.55 for resistance exercises, and 11.58 ± 1.29 for breathing exercises, indicating moderate intensity and good tolerability of the program.

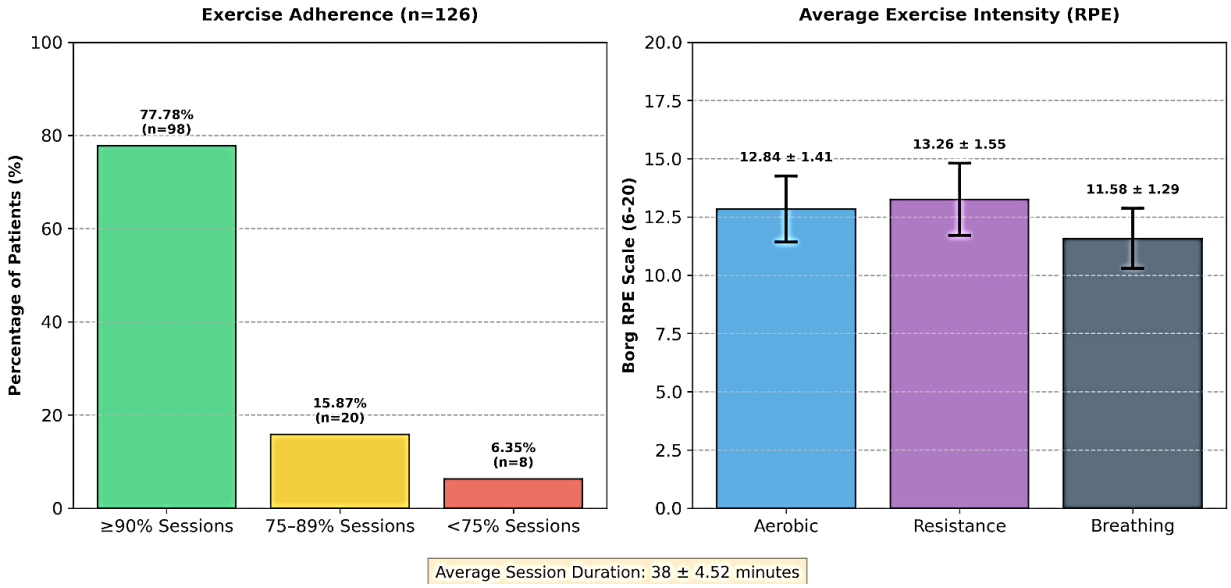

Figure 2: Exercise Adherence and Intensity During 12-Week Intervention

Discussion

In our study, physiotherapy-based exercise training resulted in a significant improvement in left ventricular ejection fraction (LVEF) from 38.72 ± 6.54 % to 44.85 ± 6.12 % (mean difference = 6.13 %, p < .001), indicating enhanced cardiac function post-intervention. Our findings align with recent systematic reviews showing that structured exercise programs can improve cardiac mechanics in heart failure patients. A meta-analysis reported that exercise training across both HFrEF and HFpEF populations was associated with favorable changes in left ventricular performance, although effects on hard outcomes like mortality were less consistent [13]. These consistent improvements suggest that exercise may promote beneficial cardiac remodeling and augment systolic performance, which parallels the significant LVEF gains observed in our cohort.

Our results demonstrated a robust effect on quality of life**,** with the total Minnesota Living with Heart Failure Questionnaire (MLHFQ) score improving from 45.17 ± 9.12 to 32.20 ± 8.35 (mean difference = –12.97, p < .001). This substantial improvement exceeds the clinically important difference identified in large meta-analyses, where pooled MLHFQ improvements averaged around –5.8 to –9.5 points with exercise-based cardiac rehabilitation [14]. Similarly, previous research found clinically meaningful enhancements in MLHFQ scores following chronic heart failure rehabilitation programs, with changes averaging around 8.5 points in many studies [15]. The magnitude of QoL gains in our study likely reflects the structured, supervised nature of the intervention and its emphasis on patient-centered progression, which may support better symptom control and psychological well-being compared to standard care.

Functional capacity also improved significantly in our cohort, as evidenced by the 6-minute walk test (6MWT) distance increasing from 310.45 ± 54.23 m to 365.78 ± 48.12 m (mean difference = 55.33 m, p < .001). This finding is consistent with chronic heart failure rehabilitation literature demonstrating meaningful increases in 6MWT distance, often averaging around 49.8 m post-intervention [15]. The observed gains in functional performance likely reflect improvements in peripheral conditioning and cardiovascular efficiency that accompany repeated exercise exposure, reinforcing similar conclusions from earlier comparative research.

When examining clinically relevant response rates**,** our study found that 73.02 % of patients achieved an LVEF increase ≥5 %**,** 67.46 % had ≥10-point reductions in MLHFQ scores**,** and 61.90 % improved their 6MWT distance by ≥50 m. These high proportions align with broader evidence showing that a majority of patients in

supervised exercise programs experience functional and perceptual benefits. A Cochrane review reported consistent improvements in health-related quality of life with exercise rehabilitation, albeit with minimal impact on short-term mortality, supporting the clinical significance of subjective and functional gains [16].

Exercise adherence in our study was strong, with 77.78 % completing ≥90 % of sessions and moderate perceived exertion, which mirrors other evidence highlighting the importance of adherence for maximizing benefit. For example, recent meta-analyses underscore that combining aerobic with resistance exercises yields greater enhancements in both physical function and quality of life compared to unimodal approaches [17]. This supports the comprehensive approach used in our physiotherapy protocol.

Overall, our results confirm that structured exercise training enhances multiple dimensions of health in heart failure patients, consistent with a growing body of evidence endorsing exercise as a key non-pharmacological intervention in this population.

Study Strengths and Limitations

Our study's major strengths include the prospective interventional design, structured and supervised physiotherapy-based exercise program, and comprehensive assessment of outcomes encompassing cardiac function (LVEF), quality of life (MLHFQ), and functional capacity (6MWT). High adherence rates (77.78% completing ≥90% of sessions) and use of validated measurement tools further enhance the reliability of our findings. Additionally, inclusion of both HFrEF and HFpEF patients across a broad age range increases the generalizability of results to diverse heart failure populations. However, the study has limitations, including the absence of a control group, which limits causal inference, and a single-center setting, which may reduce external validity. The 12-week intervention period, while sufficient to demonstrate short-term improvements, does not provide information on long-term sustainability of benefits. Lastly, the exclusion of patients with severe comorbidities or unstable cardiac conditions may limit applicability to higher-risk populations.

Conclusion

Our study demonstrates that a 12-week physiotherapy-based exercise training program significantly improves cardiac function, quality of life, and functional capacity in patients with heart failure. The observed increases in LVEF (mean 6.13%), reductions in MLHFQ scores (mean –12.97), and gains in 6MWT distance (mean 55.33 m) indicate both statistically significant and clinically meaningful benefits. These results support the integration of structured, supervised exercise interventions as a non-pharmacological strategy in comprehensive heart failure management, highlighting the importance of adherence and individualized program design to optimize patient outcomes.

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