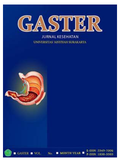

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Original Research

Physical Therapy Rehabilitation in Phase II Heart Failure After Mitral Valve Replacement: A Case Study

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ABSTRACT

***Introduction**: Congestive heart failure (CHF) due to rheumatic heart disease (RHD) frequently leads to impaired cardiac function following mitral valve replacement (MVR) and tricuspid valve repair (TVR). Phase II cardiac rehabilitation plays a crucial role in improving aerobic capacity, functional performance, and quality of life in postoperative cardiac patients.*

***Objective**: This study aimed to evaluate the effects of a phase II physical therapy–based cardiac rehabilitation program on aerobic capacity and functional tolerance in a patient with Class II CHF following MVR and TVR surgery.*

***Method**: This study employed a single-case study design involving a 43-year-old woman diagnosed with Class II CHF after MVR and TVR. The patient underwent 13 sessions of phase II cardiac rehabilitation consisting of aerobic exercises, including track walking, treadmill training, and stationary cycling, prescribed according to the FITT (Frequency, Intensity, Time, and Type) principle. Outcome measures included blood pressure, heart rate, oxygen saturation, Borg Rating of Perceived Exertion, metabolic equivalents (METs), and distance achieved in the Six-Minute Walking Test (6MWT).*

***Results**: The results demonstrated an improvement in functional capacity, as indicated by an increase in 6MWT distance from 355 meters to 446 meters. Aerobic capacity improved with METs increasing from 4.18 to 4.9 (moderate capacity), while perceived exertion decreased, as reflected by a reduction in Borg scale score from 6 to 7, accompanied by stable hemodynamic parameters throughout the intervention period.*

***Conclusion**: Phase II cardiac rehabilitation incorporating gradual aerobic exercise is safe and effective in improving aerobic capacity, exercise tolerance, and functional performance in patients with CHF following MVR and TVR, while maintaining hemodynamic stability and potentially contributes to reducing readmission risk.*

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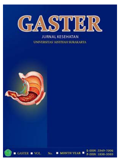


INTRODUCTION

Congestive Heart Failure (CHF) is a complex clinical syndrome caused by structural or functional impairment of the heart that leads to reduced cardiac output and exercise intolerance, significantly impacting quality of life and functional capacity (22). With a prevalence of 26 million people worldwide, CHF increases healthcare costs, reduces functional capacity, and significantly affects quality of life (22). Congestive Heart Failure is classified by the NYHA (New York Heart Association) as class II, meaning it shows symptoms with a normal level of activity. Congestive heart failure affects both sides of the heart, both right and left (21).

Cardiac rehabilitation (CR), particularly Phase II CR, is recommended internationally to improve exercise capacity, cardiorespiratory function, and functional tolerance in patients with heart failure and postoperative cardiac conditions (12). The main objectives of cardiac rehabilitation in this phase are to improve cardiorespiratory function, gradually increase the functional capacity of patients so that they can achieve independence and prevent worsening heart failure, prevent deconditioning, optimize activity tolerance, increase VO2peak, increase METs, and reduce the risk of recurrence and rehospitalization (14); (28). The principle that regular physical exercise influences aerobic capacity is highly relevant. In cases of post-valve CHF, phase II cardiac rehabilitation should include aerobic exercise with objective measurements such as 6MWT or METs. Both 6MWT and METs can be used as indicators of intervention effectiveness, as aerobic capacity is important for the prognosis and quality of life of CHF patients (24).

Unlike ischemic heart failure, patients with CHF secondary to rheumatic heart disease (RHD) who undergo mitral valve replacement (MVR) frequently present with persistent pulmonary vascular remodeling and residual pulmonary hypertension, even after successful surgical correction. This condition results from long-standing left atrial pressure overload that chronically elevates pulmonary arterial pressure and increases right ventricular (RV) afterload (11); (30).

Residual pulmonary hypertension after MVR confers an adverse prognosis, with mortality significantly higher among patients with pulmonary hypertension compared to those without. Furthermore, low TAPSE values combined with severe pulmonary hypertension are associated with increased early-term mortality and morbidity following MVR, indicating that right ventricular dysfunction represents a critical and distinct physiological barrier not commonly encountered in ischemic heart failure populations. These features impaired RV pulmonary artery coupling, reduced stroke volume augmentation during exertion, and blunted cardiac output reserve underpin the specific exercise limitations in post-MVR RHD patients and necessitate a tailored Phase II cardiac rehabilitation approach beyond conventional ischemic protocols (20); (31).

Three to five times a week is the suggested frequency. Depending on cardiac function tolerance, intensity is determined by Heart Rate (HR) using 40–70% Heart Rate Reserve (HRR) or 50–80% HRmax in certain patients. However, in patients with concomitant Atrial Fibrillation (AF) which is highly prevalent in RHD populations heart rate response to exercise is inherently irregular and non-linear due to impaired atrioventricular synchrony and variable ventricular filling intervals. When heart rate is inaccessible or inapplicable, such as in atrial fibrillation or with pacemaker usage, the RPE scale serves as a valid alternative intensity guide. Consequently, for patients who have difficulty obtaining a reliable exercise-related heart rate including those with atrial fibrillation, pacemakers, or chronotropic incompetence subjective measures such as the Borg RPE scale should be used as the primary monitoring tool in cardiac rehabilitation settings. Therefore, in this study, the Borg Rating of Perceived Exertion (target 11–13 on the 6–20 scale for moderate intensity) was applied as the primary intensity guide, with heart rate serving as a secondary safety parameter (5); (2).

This integrative FITT-based approach provides a physiologically justified and safety-oriented framework for exercise prescription in post-MVR patients with concomitant AF and residual pulmonary vascular burden. The duration of aerobic exercise sessions is 20–60 minutes, which includes 5–10 minutes for warm-up and cool-down. Starting at 20 to 30 minutes every session, the first phase progressively increases to 45 to 60 minutes based on tolerance. If there is intolerance, it can be divided into multiple short chunks (e.g., 2×10–15 minutes) (29). Walking on a treadmill, riding a stationary bike (ergoc arm cycle), and walking on a track are examples of aerobic exercise. If there are signs of an arrhythmia risk, an ECG monitor is utilized when exercising (5).

Although evidence supports the effectiveness of Phase II rehabilitation in improving functional outcomes in heart failure populations, most high-quality data pertain to ischemic heart disease and general CHF cohorts, whereas data specific to patients following surgical repair of valvular disorders such as mitral valve replacement (MVR) remain limited. Research has demonstrated that structured exercise-based cardiac rehabilitation can enhance aerobic capacity, increase walking distance in the six-minute walking test (6MWT), and improve quality of life in patients with heart failure, but standardized clinical evidence in patients with valvular surgery–related CHF is sparse (31). Although recent systematic reviews confirm the benefits of exercise-based cardiac rehabilitation after valve surgery, most high-quality trials predominantly include mixed or ischemic cohorts, with limited stratified analysis of RHD-related valve disease complicated by pulmonary hypertension and RV dysfunction (31); (20). Consequently, there remains a clinically relevant gap regarding the implementation of structured, physiologically tailored Phase II rehabilitation specifically in RHD patients after MVR and TVR who present with AF and residual right-sided hemodynamic burden.

Moreover, international guidelines emphasize that postoperative cardiac rehabilitation should be tailored to individual patient needs, yet there is a lack of detailed clinical reporting on the application of standardized exercise prescription frameworks—such as the Frequency, Intensity, Time, and Type (FITT) principle in Phase II CR for CHF patients after MVR (12).

This gap is particularly apparent in clinical literature, where few recent studies have evaluated the impact of Phase II physical therapy–based cardiac rehabilitation on functional outcomes in patients with CHF secondary to rheumatic heart disease (RHD) and valve surgery (22).

Accordingly, this case study aims to evaluate the effects of a Phase II physical therapy–based cardiac rehabilitation program on aerobic capacity and functional performance in a patient with Class II CHF following combined MVR and tricuspid valve repair (TVR), thereby addressing a critical gap in the current evidence base.

METHOD

This study employed a descriptive single-case study design aimed at systematically describing the implementation and outcomes of a Phase II physical therapy–based cardiac rehabilitation program in a patient with congestive heart failure (CHF) secondary to rheumatic heart disease (RHD) following mitral valve replacement (MVR) and tricuspid valve repair (TVR). A case study design was selected to allow in-depth clinical observation and detailed reporting of functional changes during the rehabilitation process.

The participant was selected using a purposive sampling technique based on predefined clinical eligibility criteria. The study involved one female patient aged 43 years diagnosed with Class II CHF according to the New York Heart Association (NYHA) classification following MVR and TVR due to rheumatic heart disease. The study was conducted at the Cardiac Rehabilitation Unit of Prof. Dr. I.G.N.G. Ngoerah General Hospital, Bali, Indonesia. The Phase II rehabilitation program was implemented over a six-week period from October to November 2024, comprising a total of 12 supervised exercise sessions.

At baseline, the patient presented with a resting heart rate of 102 bpm and blood pressure of 98/59 mmHg. Although these values may appear to indicate tachycardia with relative hypotension, further clinical assessment confirmed that this hemodynamic profile was consistent with a compensatory physiological response rather than a sign of acute decompensated heart failure. The elevated resting heart rate was interpreted as a compensatory response to reduced preload and diastolic underfilling associated with mechanical mitral valve dynamics and atrial fibrillation, rather than a sign of hemodynamic instability. As established in contemporary cardiac physiology, in patients with structural heart disease such as mitral valve replacement and concomitant AF, a mild degree of tachycardia may serve a beneficial compensatory role by maintaining cardiac output in the setting of reduced stroke volume; consequently, aggressive heart rate reduction to the "normal" range in such patients may paradoxically worsen hemodynamic status (17).

Clinical assessment confirmed the absence of peripheral congestion, pulmonary crackles, and signs of low-output state, supporting a determination of hemodynamic stability sufficient for Phase II rehabilitation initiation. Phase II rehabilitation was therefore commenced under strict supervision with continuous monitoring, consistent with contemporary cardiac rehabilitation safety frameworks emphasizing individualized hemodynamic assessment over isolated vital sign thresholds (5); (20).

Inclusion and Exclusion Criteria

Inclusion criteria were: (1) diagnosis of CHF NYHA Class II, (2) history of MVR with or without concomitant TVR, (3) clinical stability as indicated by stable vital signs, (4) medical clearance to participate in Phase II cardiac rehabilitation, and (5) ability to follow verbal instructions and participate in supervised exercise sessions.

Exclusion criteria included: (1) uncontrolled arrhythmias, (2) unstable angina, (3) decompensated heart failure, (4) severe musculoskeletal or neurological conditions limiting exercise participation, and (5) any acute postoperative complications contraindicating exercise training.

Anticoagulation Status and INR Monitoring

Given the presence of a mechanical St. Jude mitral valve prosthesis, the patient was on lifelong oral anticoagulation therapy with a vitamin K antagonist (warfarin). Baseline International Normalized Ratio (INR) prior to exercise initiation was 2.8, which was within the therapeutic target range of 2.5–3.5 recommended for mechanical mitral valve replacement according to current ACC/AHA valvular heart disease guidelines (18).

Exercise sessions were permitted only when INR values were within the therapeutic range, as supra-therapeutic INR increases bleeding risk during moderate-intensity aerobic training, whereas sub-therapeutic INR increases thromboembolic risk, particularly critical in patients with atrial fibrillation and a mechanical prosthetic valve (30); (20).

INR values were reviewed weekly in coordination with the supervising cardiologist throughout the rehabilitation program, consistent with best-practice anticoagulation monitoring protocols for mechanical prosthetic valve patients undergoing supervised exercise (18).

Intervention Procedure

The Phase II cardiac rehabilitation program consisted of structured aerobic exercise sessions conducted three times per week under the supervision of a licensed physical therapist. Exercise modalities included track walking, treadmill training, and stationary cycling, prescribed according to the FITT (Frequency, Intensity, Time, and Type) principle.

The Borg Rating of Perceived Exertion used in this study was the original 6–20 scale, not the modified 0–10 scale. The previously reported "6–10" range referred to early familiarization sessions only and has been corrected for clarity. The target training intensity during the main conditioning phase was RPE 11–13 ("somewhat hard"), corresponding to moderate intensity exercise recommended for Phase II cardiac rehabilitation in stable NYHA class II patients.

Exercise intensity was monitored using heart rate response, Borg Rating of Perceived Exertion (RPE), and patient symptoms, ensuring training was performed within a safe and moderate intensity range. Moderate intensity (RPE 11–13 on the 6–20 scale) was selected to stimulate central and peripheral adaptations, including improved stroke volume augmentation, enhanced skeletal muscle oxidative capacity, and increased arteriovenous oxygen difference—mechanisms known to contribute to improvements in VO_2peak and METs in heart failure populations (22); (31).

Each session included a warm-up phase, a main aerobic training phase, and a cool-down phase, with continuous monitoring of vital signs before, during, and after exercise. Warm-up and cool-down phases were performed at RPE 9–10, whereas the main conditioning phase was maintained within RPE 11–13 for 20–30 minutes during early sessions, progressively extended to 30–40 minutes as tolerated, consistent with contemporary valve-surgery rehabilitation recommendations (20).

Regarding the track walking protocol, the initial prescription of 2 × 400 m was completed at a self-selected walking speed of approximately 3.5–3.8 km/h, corresponding to 6–7 minutes per 400 m segment. The target distance of 1 × 1800 m was achieved progressively over several weeks and was completed in approximately 22–25 minutes, resulting in an average walking speed of 4.0–4.5 km/h.

This walking speed corresponds to an estimated metabolic demand of approximately 4.5–5.0 METs, which is consistent with the post-intervention MET value observed (4.9 METs), thereby supporting the physiological plausibility of the reported improvement (22).

Importantly, the 1800 m distance was not performed at high intensity but within the predefined moderate intensity zone (RPE 11–13), ensuring cardiovascular stimulus without exceeding safe hemodynamic thresholds in a patient with mild right ventricular dysfunction (20).

Considering the reduced tricuspid annular plane systolic excursion (TAPSE) value of 1.5 cm, indicating mild right ventricular systolic dysfunction, an expanded monitoring protocol for signs of right-sided heart failure was implemented throughout the rehabilitation program. Clinical signs of RV decompensation were systematically assessed before, during, and after each exercise session. These included inspection for peripheral edema of the lower extremities, jugular venous distension (JVD), hepatojugular reflux, and new-onset right upper quadrant discomfort all of which are recognized clinical markers of elevated right atrial pressure and systemic venous congestion associated with RV failure (25); (6).

Exercise was terminated immediately if any of these signs were present post-exercise, in conjunction with disproportionate heart rate rise without workload increment, systolic blood pressure drop >10 mmHg, or worsening oxygen desaturation. This expanded monitoring strategy aligns with recent valve-surgery rehabilitation recommendations emphasizing right ventricular–pulmonary circulation interaction as a critical determinant of exercise tolerance in post-MVR and TVR patients (20); (31).

Outcome Measures and Data Collection

Data collection was performed at baseline (pre-intervention), during each rehabilitation session for safety monitoring, and at the end of the intervention period (post-intervention). Primary outcome measures included functional exercise capacity assessed using the Six-Minute Walking Test (6MWT) and aerobic capacity estimated using metabolic equivalents (METs). Secondary outcome measures included blood pressure, heart rate, oxygen saturation, and perceived exertion measured using the Borg scale. All measurements were conducted following standardized clinical procedures to ensure reproducibility and consistency.

Ethical Approval

This study was approved by the Health Research Ethics Committee of the Faculty of Health Sciences, Muhammadiyah University of Surakarta (Approval No. 1606/KEPK-FIK/X/2025). Written informed consent was obtained from the participant prior to data collection, and all procedures were conducted in accordance with the Declaration of Helsinki. Patient confidentiality and anonymity were strictly maintained throughout the study.

RESULTS

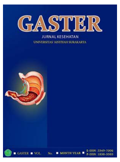
Clinical Findings

The physiotherapy examination focused on the subject's cardiopulmonary status. Initially, the patient was found to be fully conscious (compos mentis) and cooperative. Vital sign assessment revealed a stable but hypotensive and tachycardic state (98/59 mmHg; 102 bpm), while respiratory rate (18 breaths/min), body temperature (36.2 °C), and oxygen saturation (98%) remained within normal limits. Physical examination of the cardiovascular system showed no mitral murmurs, though a mechanical "click" was present. Pulmonary auscultation revealed normal vesicular breath sounds without adventitious sounds like rales or wheezing, ruling out acute heart failure or ventilation disorders at the time of examination. Post-intervention heart rate reached 140 bpm following the final exercise session. In a 43-year-old patient, the age-predicted maximum heart rate (HRmax) is approximately 177 bpm (220 − age), making 140 bpm equivalent to roughly 79% of predicted HRmax a value within the upper boundary of moderate-to-vigorous exercise intensity and not indicative of excessive cardiovascular stress per se.

Importantly, the patient did not exhibit signs of chronotropic incompetence, as heart rate increased proportionally to workload progression and was accompanied by stable systolic blood pressure (93/61→102/73 mmHg), absence of symptomatic deterioration, and maintained oxygen saturation, indicating appropriate cardiovascular adaptation rather than hemodynamic compromise. Chronotropic incompetence is classically defined as the failure to achieve 80% of predicted HRmax during exercise despite maximal effort; by this criterion, the achieved HR of 140 bpm (79% HRmax) falls at the boundary but was clinically interpreted as an appropriate adaptive response given the patient's concurrent AF, medication profile, and cardiac history (Joglar et al., 2024).

It is important to note, however, that in patients with concomitant atrial fibrillation (AF), heart rate during exercise is inherently variable due to irregular atrioventricular conduction, and ventricular rate may be disproportionately elevated relative to actual metabolic demand. Pulse oximetry commonly overestimates true arterial oxygen saturation, and heart rate responses in AF patients may not accurately reflect true exercise intensity Frontiers, reinforcing that subjective tolerance, blood pressure response, and symptom monitoring all of which remained within safe boundaries throughout should be weighted alongside absolute HR values when evaluating exercise safety in this population (5); (15)

Cardiac function tests indicated a mild reduction in Left Ventricular (LV) systolic function, with an Ejection Fraction (EF) of 59.7%. Additionally, LV diastolic underfilling was noted, secondary to the mechanical properties of the St. Jude prosthetic mitral valve. Despite this, the mechanical valve was confirmed to be functioning correctly without paravalvular leakage. Furthermore, the tricuspid valve with annuloplasty ring showed only mild regurgitation. The pulmonary artery systolic pressure (PASP), which measures blood pressure and flow, was 39 mmHg, indicating mild pulmonary hypertension. The mitral valve's transvalvular gradient was 5.4 mmHg, which is within the typical range for mechanical valves. TAPSE: 1.5 cm, which indicates somewhat reduced RV function and falls within the lower normal range. There was no risk of blood clots because there were no masses or thrombi in the atrium. The Six Minute Walking Test (6MWT) was then used to



evaluate the patient's functional capacity. The initial results indicated that the patient had walked 355 meters, with a Borg scale of 10/20, an HRWSI (Heart Rate Walking Speed Index) of 2.1 (severe category), and a value of 4.18 METs.

Pulse oximetry measurements were obtained immediately upon completion of the exercise bout (within 10–15 seconds after cessation of activity), rather than during peak treadmill speed. Therefore, the reported SpO_2 values reflect early post-exercise recovery readings rather than true peak-exercise saturation, which is an important methodological distinction.

Mild exercise-induced desaturation to 96–98% is physiologically common during moderate-to-vigorous exercise due to the rightward shift of the oxyhemoglobin dissociation curve caused by increased CO_2, decreased pH, elevated temperature, and accumulation of 2,3-bisphosphoglycerate (2,3-BPG) during muscular activity all of which reduce hemoglobin's oxygen affinity and promote oxygen release to working tissues (16). The absence of measurable desaturation below 97% in this patient is therefore plausible and attributable to two factors: first, the moderate exercise intensity employed (RPE 11–13, METs 4.5–5.0) which would not be expected to produce significant ventilation–perfusion mismatch; and second, the known positive measurement bias of pulse oximetry.

Bland-Altman analysis of pulse oximetry against arterial blood gas co-oximetry reveals a systematic bias of 3.8%, with SpO_2 consistently overestimating true SaO_2, Frontiers meaning SpO_2 readings of 97–100% likely correspond to true arterial saturations of approximately 93–97% values entirely consistent with moderate exercise physiology in a clinically stable cardiac patient (11); (16). Continuous monitoring during sessions did not reveal oxygen saturation below 97% at any time, further supporting adequate ventilation–perfusion matching and absence of clinically significant exercise-induced hypoxemia.

Table 1. Clinical Findings

Source: Primary Data (2025)

Examination	Results
Blood Pressure (BP)	98/59 mmHg
Heart Rate (HR)	102 beats/minute
Respiratory Rate (RR)	18 times/minute
Body Temperature	36.2 °C
SPO2	98
Heart Auscultation	Murmur (-)
Lung auscultation	Normal vesicular sounds, no rales or wheezing
Echocardiography	Left Atrium (LA) and Right Atrium (RA) dilated. EF 59.7%
ROM	Full independent without limitations
Six Minute Walk Test (6MWT)	355 meters
METs	2.1 4.18 → 4.9
Borg Scale	10/20
NYHA Functional Class	II
RV Systolic Function	Decreased
LV Systolic Function	Normal

Diagnostic Examination

Comprehensive diagnostic evaluations were conducted using a multi-modal approach, including echocardiography, 12-lead ECG, chest X-ray, biomarkers

(BNP/NT-proBNP), and functional assessments (6MWT). These examinations are crucial for establishing a baseline for exercise-based cardiac rehabilitation (CR), which has been shown to improve functional capacity and reduce hospital readmissions. Electrocardiogram (ECG) findings included atrial fibrillation (AF), bundle branch block, and signs of previous ischemia. Given that AF is prevalent in RHD patients, it significantly influences heart rate control and exercise intensity limits during rehabilitation. Furthermore, Transthoracic Echocardiography (TTE) identified key parameters for risk stratification, specifically Left Ventricular Ejection Fraction (LVEF) and tricuspid regurgitation (TR) severity. These values, along with the monitoring of mechanical prostheses for potential thrombus or obstruction, are essential for determining safe exercise targets.

The results of the chest X-ray showed symptoms of interstitial edema, pulmonary vascular congestion, and cardiomegaly. The Six-Minute Walk Test (6MWT) was used to assess functional aerobic capacity. The main instrument for determining exercise capacity and establishing exact training loads based on anticipated distance and Rating of Perceived Exertion (RPE) was the 6MWT. When available, cardiopulmonary exercise testing (CPET) offers the most precise VO2peak and anaerobic threshold (AT) for customized workout recommendations. For individuals with ventricular dysfunction and CHF, CPET aids in determining the appropriate level of activity. Daily functioning and changes after physical therapy intervention are evaluated using the NYHA/Functional Class scale and activities of daily living (ADL) assessment. Adherence to the CR program is frequently impacted by cognitive and psychosocial assessments, such as postoperative anxiety and depression; a quick screening is advised.

Table 2. ICF (International Classification of Functioning)

IMPAIRMENT				
	ICF Code	**Function Description**	**Patient Condition**	**Qualifier (impairment)**
Body Function	b410	Decreased heart function	Impaired heart function	2 (moderate)
	b415	Blood vessel function	Blood vessels impaired	1 (mild)
	b420	Blood pressure function	Stable with medication, no problems	1 (mild)
	b455	Tolerance to physical activity	Easily fatigued, able to walk 355 meters	2 (moderate)
Body Structure	s410	Heart structure	There is a functional abnormality due to post-op MVR with mechanical valve replacement.	2 (moderate)
	s420	Vascular structure	Relatively good, no peripheral edema, no obstruction	1 (mild)
	s450	Additional structures in the circulatory system	Mitral valve replacement (MVR) has been performed, function not yet fully normal	2 (moderate)
	s4302	Thoracic cage	There is an incision on the sternum, good	2 (moderate)
Activities and Participation	d450	Walk	The patient walks, able to walk independently	2 (moderate)
	d455	Moving around	The patient can climb stairs but experiences shortness of breath and tires quickly	3 (severe)
	d640	Performing household chores	Patients are advised to avoid heavy work	1 (mild)
Environmental Factors	e310	Immediate family	Fully support daily activities and medical control	1 (mild)
	e355	Healthcare services and systems	Supporting the rehabilitation process	1 (mild)

Patients exhibit a variety of impairments in bodily functions, body structures, activities, involvement, and environmental factors that impact the healing process, according to the International categorization of Functioning, Disability, and Health (ICF) categorization. In terms of bodily function, there are moderate to severe complaints of lower extremity and chest pain, reduced physical tolerance, diminished respiratory and aerobic muscle capacity, and issues with heart and blood flow. This shows residual damage following tricuspid surgery and mitral valve replacement, which is typical in patients with a history of heart failure. The sternal incision creates pain when deep breathing exercises are performed on body tissues and restricts breathing and thoracic mobility. Rapid exhaustion has prevented the patient from going back to work and has made it difficult for them to carry or lift goods.

Therapeutic Interventions

Patients with Congestive Heart Failure (CHF) Functional Class II due to Rheumatic Heart Disease (RHD) following mitral valve replacement and tricuspid valve repair, such as Mrs. J, are vulnerable to further functional deterioration without appropriate rehabilitation. The short-term objectives of physical therapy are to enhance activity tolerance, reduce dyspnea and fatigue during light activities, and improve cardiorespiratory muscle strength. Long-term goals include increasing functional capacity (6MWT distance), improving quality of life, and enabling safe and independent performance of daily activities. Interventions consist of aerobic exercise based on FITT principles, breathing exercises, and activity education. Current guidelines recommend moderate-intensity aerobic training (40–70% HRR or Borg 11–13) for 20–40 minutes, 3–5 times per week, in stable NYHA class II CHF patients (McDonagh et al., 2021; Heidenreich et al., 2022).

Table 3. FITT Walking Exercises Protocol on the Track

Parameters	Results
Frequency	3–5 times per week
Intensity	Borg Scale 6-10 (light)
Time	Initial 2×400 m, progressively increased at each session until reaching the target of 1×1800m. Target training dose: 2×400m→ 2×500m → 2×600m → 2×700m → 2×800m → 2×900m → 1×1800m
Type	Running on the track at a constant pace

Source: Primary Data (2025)

Table 4. FITT Walking Exercise Protocol on a Treadmill

Parameters	Results
Frequency	3–5 times per week
Intensity	Borg Scale 6–10 (light)
Time	Initial 2× (speed 4.2/1000 m) progressively increased to (speed 4.5/1100) each session Target: 2× (speed 4.8/1200 m) 2× (speed 5.1/1300 m)
Type	Walking on a treadmill at a predetermined speed

Source: Primary Data (2025)

Table 5. FITT Protocol for Stationary Bicycle

Parameters	Results
Frequency	3–5 times per week
Intensity	Initial 25 watts, 50–60 RPM, then increased progressively or according to patient tolerance (50–60 RPM) every session 25 watts
Time	10 minutes
Type	Aerobic exercise using a stationary bicycle, treadmill, or walking on a track

Source: Primary data (2025)

Safety Aspects of Phase II Cardiac Rehabilitation

Safety is a core component of phase II cardiac rehabilitation, particularly in patients with CHF FC II due to RHD after MVR. Prior to exercise, vital signs must be assessed to confirm safe hemodynamic status. Exercise is permitted only when systolic blood pressure is 140–160 mmHg, resting heart rate is ≤110 bpm, and oxygen saturation is ≥97% (23). Exercise intensity is monitored using the Borg Scale, targeting 11–13 (moderate intensity) as recommended by the American College of Sports Medicine (3). Exercise should be stopped immediately if signs of intolerance occur, including severe dyspnea (Borg >15), chest pain, dizziness, oxygen saturation <90%, or heart rate exceeding 85% of maximum (13). Continuous subjective assessment is essential to detect early fatigue.

Patients on anticoagulant therapy require additional precautions, with avoidance of high-risk activities to reduce bleeding risk (19). Exercise progression must be gradual and supervised, with workload increases limited to 0.5–1 METs per week, and vital signs monitored before, during, and after exercise (23). Exercise should be adjusted if abnormal heart rate responses, a blood pressure drop >10 mmHg, or excessive respiratory rate (>30 breaths/min) occur. When these safety principles are applied, exercise can be performed without cardiac decompensation or postoperative complications. Patient education plays a crucial role, including recognition of warning signs, self-monitoring of pulse and oxygen saturation, and adherence to graded activity progression (19).

The rehabilitation program resulted in a 17% improvement in aerobic capacity, reflected by increased METs (4.18 to 4.9), alongside stable blood pressure and appropriate heart rate responses, indicating good hemodynamic adaptation (13). These findings align with previous studies showing that moderate-intensity aerobic exercise improves functional capacity and quality of life without excessive cardiac stress (7).

Progressive walking and cycling exercises enhance endothelial function through increased nitric oxide release, improving peripheral perfusion and reducing ventricular afterload (7). A Borg score increase from 6 to 7 reflects improved exercise tolerance rather than intolerance, supported by stable oxygen saturation and proportional cardiovascular responses. Full adherence to the program contributed to improved fitness and reduced rehospitalization risk (3). Overall, this intervention improved ICF domains related to exercise tolerance (b455), cardiac function (b410), and walking ability (d450), consistent with evidence that structured lifestyle and rehabilitation programs enhance cardiorespiratory function and long-term exercise adherence (5).

Follow-up and Evaluation

Patients were able to complete all exercise sessions without complaints or exercise intolerance during phase II of the cardiac rehabilitation physiotherapy program. The program consisted of 13 sessions, each lasting approximately 45-60 minutes. All exercises were performed under the direct supervision of a physiotherapist. Before and after exercise, vital signs such as blood pressure, heart rate, respiratory rate, and oxygen saturation were monitored. The results after completing 13 sessions showed an increase in aerobic capacity as follows:

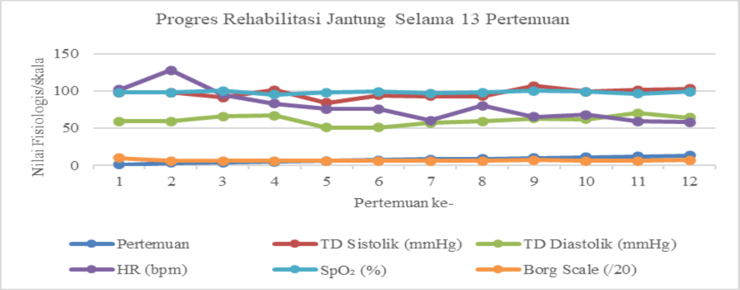


Figure 1. Follow-up graph of the 13-session rehabilitation program

At the start of the program, patients showed low aerobic capacity with a distance of 355 meters in the 6-Minute Walk Test (6MWT) and a Borg score of 10/20, indicating mild fatigue during activities below maximum level. The results of the evaluation after 13 training sessions combining walking and stationary cycling exercises showed an increase in distance, METs value, and hemodynamic efficiency in patients.

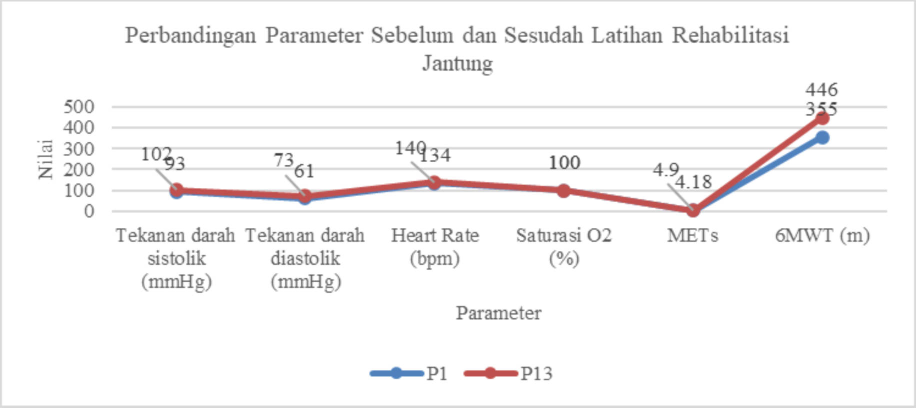


Figure 2. Follow-up graph of aerobic capacity (6MWT)

Structured aerobic exercise improves patients' aerobic capacity, as shown in the graph above. The 6MWT increased walking distance by 91 meters, from 355 meters to 446 meters. This improvement exceeded the threshold for clinically significant improvement (22). This indicates that the heart and peripheral muscles are working better and more efficiently. The increase in METs from 4.18 to 4.9 indicates an improvement in aerobic capacity from light to moderate activity. As a sign of physiological adaptation to a greater exercise load, the Borg score increased from 6 to 7. A slight increase in heart rate (134→140 bpm) and blood pressure (93/61→102/73 mmHg) indicates a normal hemodynamic response. Stable oxygen saturation (100%) indicates consistent ventilation and perfusion. Overall, these findings indicate that the exercise was safe, successful, and consistent with the Phase II rehabilitation goals.

DISCUSSION

The study's findings show that after completing 13 sessions of phase II cardiac rehabilitation that combined walking, treadmill, and stationary cycling, patients with Functional Class II congestive heart failure (CHF) following mitral valve replacement (MVR) and tricuspid valve repair had improved aerobic capacity. The six-minute walk test (6MWT), which measures walking distance, showed a 91-meter improvement in functional capacity, from 355 to 446 meters. This increase showed a clinically significant shift in functional performance in CHF patients, surpassing the minimal clinically significant difference (MCID) of 30–50 meters.

METs increased from 4.18 to 4.9 as a result of the roughly 17% increase in aerobic capacity, suggesting better oxygen transport efficiency and a larger cardiac stroke volume. These results are in line with earlier research showing that aerobic capacity and functional outcomes can be enhanced by moderate-intensity aerobic exercise, such as stationary cycling, without incurring undue ventricular stress (7).

Blood pressure and heart rate stayed within the physiological range throughout the rehabilitation program, with adaptive increases noted during activity sessions (93/61→102/73 mmHg and 134→140 bpm, respectively). In stable CHF patients, this hemodynamic stability supports the safety of supervised aerobic exercise and shows a suitable autonomic response (13).

Walking and cycling exercises that are gradual and repetitive are known to cause endothelial shear stress, which enhances vasodilation and triggers the production of nitric oxide. By increasing peripheral perfusion and tissue oxygen intake, this physiological adaptation can lower ventricular load and systemic vascular resistance (5). During phase II of rehabilitation, an increase in the Borg scale score from 6 to 7 demonstrates physiological adaptation rather than exercise intolerance and represents a shift from light to moderate effort.

Crucially, the patient showed excellent compliance by finishing all of the planned rehabilitation sessions. Consistent involvement in a supervised rehabilitation program is linked to increased cardiovascular fitness and a lower risk of rehospitalization, according to earlier research (3); (4). When compared to overground walking alone, treadmill-based exercise may result in higher increases in VO_2peak, provides for precise control over pace and exertion, and facilitates functional training akin to daily activities like walking and stair climbing (10).

Functionally speaking, gains were noted in ICF categories b455 (exercise tolerance), b410 (cardiovascular function), and d450 (walking ability), suggesting a greater capacity to tolerate physical activity without experiencing extreme exhaustion or dyspnea. These results are consistent with other research demonstrating that structured exercise and lifestyle modifications enhance endothelial function and cardiovascular fitness while encouraging sustained physical activity adherence (5).

However, there are a number of drawbacks to this study. The results' applicability is limited by the single-case design and the absence of a control group. Additionally, examination of long-term effects on functional ability, quality of life, and clinical outcomes such readmissions is not possible due to the relatively short duration of the intervention (20); 14). However, with the help of objective functional outcome measures, this study offers important clinical insights into the implementation of an organized, physiotherapist-supervised phase II cardiac rehabilitation program in patients with CHF following MVR and TVR.

Taken together, the hemodynamic profile—proportional heart rate rise, maintained systolic blood pressure, stable oxygen saturation, and absence of right-sided congestion—indicates appropriate cardiovascular stress within safe physiological limits for a supervised Phase II cardiac rehabilitation program (5); (20).

CONCLUSION

According to this study, participants in a structured phase II cardiac rehabilitation program that includes walking, treadmill, and stationary cycling exercises under the guidance of a physical therapist may see improvements in their aerobic capacity following mitral valve replacement and tricuspid valve repair for patients with Functional Class II congestive heart failure. Blood pressure, heart rate, and oxygen saturation stayed constant during the intervention, however improvements were seen in the 6MWT distance and METs.

Increased functional capacity, decreased fatigue, and better hemodynamic responses may result from graded aerobic exercise when properly monitored. These physiological changes are linked to enhanced cardiac pumping efficiency, skeletal muscle oxidative capacity, and endothelial function. To validate these results and assess long-term clinical outcomes, more research with bigger sample numbers and longer follow-up times is required.

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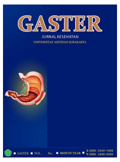

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