

The Impact of Continuous Cardiac Rehabilitation on the Psychological and Physiological Prognosis of Patients with Heart Failure—A Retrospective Study

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Objective: This study aimed to assess the impact of continued cardiac rehabilitation on cardiac function, psychological well-being, and prognostic outcomes in patients diagnosed with heart failure and improved ejection fraction (HFimpEF).

Methods: This study adopted a retrospective design, and a total of 150 patients with HFimpEF who experienced reduced ejection fraction after the first acute myocardial infarction were included. All patients underwent emergency percutaneous coronary intervention (PCI). Participants were categorized into a control group (n = 70) or an observation group (n = 80) based on their participation in ongoing cardiac rehabilitation. The follow-up period extended for one year. Comparative analyses were conducted to assess differences between the two groups in baseline characteristics, cardiac function, anxiety and depression scores, and the incidence of cardiovascular events.

Results: No statistically significant differences were observed between the groups in terms of sex, age, past medical history, blood lipid levels, blood glucose levels, or renal function. Similarly, pre-treatment assessments of cardiac function, six-minute walk test results, Self-Rating Anxiety Scale (SAS) scores, Self-Rating Depression Scale (SDS) scores, or the incidence of cardiovascular events showed no significant differences. Compared to the control group, the observation group demonstrated significantly better cardiac function and six-minute walk test performance, along with significantly lower SAS and SDS scores. Furthermore, the incidence of heart failure and rehospitalization was significantly lower in the observation group than in the control group.

Conclusion: Sustained cardiac rehabilitation in patients with HFimpEF was associated with significant improvements in cardiac function, enhanced six-minute walk test performance, reduced anxiety and depression levels, and a lower incidence of heart failure and rehospitalization. These findings highlight the key role of sustained cardiac rehabilitation in improving clinical outcomes for patients with HFimpEF.

Keywords: cardiac function, cardiac rehabilitation training, heart failure with improved ejection fraction, mood, prognosis

Introduction

Heart failure (HF) is a clinical syndrome characterized by structural or functional abnormalities of the heart, leading to impaired ventricular filling or ejection.¹ It represents the terminal stage of cardiovascular disease progression.² Common clinical manifestations include dyspnea, fatigue, and edema, which significantly compromise cardiac function and contribute to emotional and psychological distress, severely affecting the quality of life of patients.³

In 2022, the American Heart Association (AHA), American College of Cardiology (ACC), and Heart Failure Society of America (HFSA) introduced the term “heart failure with improved ejection fraction” (HFimpEF) in their guidelines for heart failure management.⁴ HFimpEF defined as a baseline LVEF $\leq 40\%$, with an absolute increase of at least 10% and

a follow-up LVEF above 40%.⁵ For patients with HFimpEF, it is crucial to maintain guideline-directed medical therapy (GDMT) to prevent the recurrence of heart failure and left ventricular dysfunction, even in patients who remain asymptomatic.⁴

The prognosis for patients with heart failure remains poor, underscoring the importance of effective cardiac rehabilitation interventions to improve outcomes in patients with chronic heart failure.⁶ Given the significant heterogeneity of heart failure, personalized intervention programs tailored to the specific etiologies and clinical conditions of individual patients may enhance recovery.⁷ Cardiopulmonary function, particularly cardiac function, serves as a key parameter for evaluating disease severity and prognosis in cardiovascular patients and is closely linked to their quality of life.⁸

Despite the recognized importance of cardiac rehabilitation, the potential benefits of continued rehabilitation interventions for patients with HFimpEF have not been comprehensively examined in previous research. To address this gap, a retrospective analysis was conducted to evaluate the effects of cardiac rehabilitation in patients with HFimpEF. Participants were categorized into a control group and an observation group, and differences in cardiac function, anxiety and depression levels between the two groups were assessed. This analysis aimed to further elucidate the potential advantages of sustained cardiac rehabilitation for patients with HFimpEF.

Research Materials and Methods

Study Patients and Data Collection

This study employed a retrospective approach. A total of 150 patients with first-time acute myocardial infarction and treated with emergency percutaneous coronary intervention (PCI) between January 2020 and December 2023 were included in this study. These patients were diagnosed with HFrEF 3 months after PCI, and were reclassified as HFimpEF after their LVEF increased to more than 40% after 6 months of treatment.⁹ Complete data were available for all patients included in the analysis.

The patients were allocated to a control group ($n = 70$, 46.67%) or an observation group ($n = 80$, 53.33%) based on their participation in ongoing cardiac rehabilitation. Standard treatment regimens, including anti-heart failure medications, antiplatelet agents, and lipid-lowering drugs, were administered to all participants.

Exclusion criteria included patients in the acute phase of a cardiovascular event; Patients with acute myocardial infarction without concurrent heart failure; those with severe hepatic, renal, or neurological conditions or requiring hemodialysis; patients with significant cognitive impairments or mental disorders that impaired communication;^{10–12} patients with congenital heart disease, pulmonary heart disease, cardiomyopathy, valvular heart disease, infective endocarditis, viral myocarditis, pericardial disease, or pulmonary artery stenosis; and patients diagnosed with advanced malignancies.

Materials and Methods

The diagnostic criteria for acute myocardial infarction were based on the expert consensus on the definition of myocardial infarction published in the Journal of the American College of Cardiology in 2018.¹³ All patients received standardized pharmacological treatment for heart failure in alignment with the 2018 Chinese Heart Failure Guidelines.¹⁴

The control group patients received conventional heart failure management, which included: ① Standard drug treatment: Following the standardized drug treatment plan in accordance with current heart failure guidelines (ARNI/ACEI/ARB, β -blockers, MRA, SGLT2 inhibitors quadruple therapy). ② Basic health education: Distributing heart failure self-management manuals, covering basic contents such as salt restriction and weight monitoring. ③ Outpatient follow-up: Regular outpatient follow-up at the cardiology department every 3 months, without including structured exercise prescriptions or supervised training. ④ Activity recommendations: Informing ‘Maintain daily activities’, but no individualized exercise guidance or intensity monitoring was provided.

On the basis of the treatment in the control group, patients in the observation group also received cardiac rehabilitation intervention and regular health education during the intervention period.

Cardiac Rehabilitation Program: A multidisciplinary cardiac rehabilitation team, comprising of cardiovascular specialists, nurses, and rehabilitation professionals (including physicians, nurses, and rehabilitation therapists), was established to dynamically assess patients' cardiac reserve and exercise tolerance. These assessments formed the basis for developing individualized exercise prescriptions and regularly coordinating synchronized cardiac rehabilitation training sessions. The trial process involved two independent experimenters collecting all the information on the patients' recovery process, which was ultimately verified by a third person.

Rehabilitation Content: The program primarily involved moderate-intensity cardiac rehabilitation exercises tailored for individuals with HFimpEF. During the training period, patients are scheduled for regular follow-ups every month, and they visit the designated community center for follow-ups every 1 to 2 weeks to receive personalized guidance and targeted advice. The follow-up period lasts for one year. During the follow-up period, detailed plans are made for patients to manage the duration dynamically: the basic rehabilitation cycle is 6 months (but can be extended to 9 months for patients whose LVEF does not reach the expected level or who need to consolidate the therapeutic effect), each training session lasts 20 to 40 minutes, with the specific duration determined by the individual's exercise capacity, and 3 to 4 training sessions are conducted per week. After 6 months, the maintenance period begins, with the exercise frequency reduced to twice a week. Family-based independent training is encouraged and continuous remote monitoring is maintained. If a serious cardiovascular event (such as acute heart failure or reinfarction) occurs or the patient voluntarily withdraws, they will be withdrawn from the program. If there is a temporary illness (such as infection) or abnormal physiological indicators (resting heart rate > 100 bpm, systolic blood pressure fluctuation > 20 mmHg), the program will be paused for no more than 2 weeks and then restarted.

Program Implementation: Patients visited designated community centers every one to two weeks for follow-ups, where they received personalized guidance and targeted recommendations. Additionally, hospital medical staff conduct monthly follow-ups and monitor patients' compliance.¹⁵ They use exercise logs and electronic devices for recording: patients are required to fill in standardized exercise logs daily (recording exercise type, duration, heart rate and subjective fatigue RPE score), and heart rate and exercise duration are simultaneously monitored through wearable devices (such as smart bracelets). Regular data verification: during community follow-ups, rehabilitation therapists check the consistency of the logs and device data. Patients with missing data for more than 3 days are reminded by phone. Compliance is evaluated based on the completion of planned exercise volume: high compliance (completing $\geq 80\%$ of planned exercise volume), medium compliance (completing 50%–79% of planned exercise volume), and low compliance (completing <50% of planned exercise volume). Patients with low compliance receive additional health education and individualized adjustments from the team. Patients who have compliance <30% for two consecutive months or experience serious adverse events are withdrawn.

Evaluation during the follow-up period: Comprehensive demographic and clinical data were collected for each patient, including age, sex, heart rate, blood pressure, New York Heart Association (NYHA) classification, laboratory test results, and prescribed heart failure medications. Data related to the implementation of the cardiac rehabilitation program, evaluations for anxiety and depression (The assessment was conducted using the Self-Rating Anxiety Scale (SAS) and the Self-Rating Depression Scale (SDS)),^{16,17} and cardiac function measurements were also obtained.

Cardiac Function Assessments: Cardiac function was evaluated using parameters such as left atrial dimension (LAd), left ventricular end-systolic dimension (LVESD), left ventricular end-diastolic dimension (LVEDD), and left ventricular ejection fraction (LVEF). The six-minute walk distance test (6MWD),¹⁸ a noninvasive exercise assessment, assessed cardiopulmonary functional status by measuring the maximum distance patients could walk in six minutes.¹⁴ The occurrence of major adverse cardiovascular events (MACE) was documented during the one-year follow-up period. MACE encompassed cardiovascular death, recurrent non-fatal myocardial infarction, stroke, heart failure, recurrent revascularization, and rehospitalization.¹⁹ For patients whose follow-up needs to be terminated due to adverse events, we take the results of the last follow-up before the occurrence of adverse events as the endpoint parameters.

Heart failure is judged based on the 2022 AHA/ACC/HFSA Guideline for the Management of Heart Failure: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines.

Rehospitalization refers to hospitalization due to cardiac events, such as worsening heart failure, recurrent ischemia, arrhythmia, or other cardiac causes.

Determining death due to cardiovascular events during follow-up: The data in the text refers to patients who experienced sudden changes in their condition during follow-up, were urgently sent to medical institutions for rescue, and ultimately died in medical institutions, with the death certificate issued by the medical institution recording the direct cause of death as a cardiovascular event, or medical records such as:

Medical history review: Past history of cardiovascular diseases (eg, coronary heart disease, heart failure, atrial fibrillation), risk factors (hypertension, diabetes, etc).

Record of terminal events: Symptoms before death (eg, chest pain, dyspnea, loss of consciousness), emergency measures (eg, cardiopulmonary resuscitation, defibrillation), and rescue outcomes.

Laboratory tests: Abnormal results of myocardial enzymes (eg, troponin), brain natriuretic peptide (BNP), D-dimer, etc.

Imaging evidence: Electrocardiogram (eg, ST-segment changes, ventricular fibrillation), echocardiography (eg, abnormal wall motion), coronary angiography (eg, vascular occlusion), CT/MRI (eg, stroke, aortic dissection).

Statistical Methods

Statistical analysis of the data was conducted using SPSS 20.0 statistical software. Continuous variables following a normal distribution are presented as mean \pm standard deviation, and comparisons between groups were conducted using *t*-tests. Variables not conforming to a normal distribution are expressed as median with interquartile ranges [M (Q25, Q75)], with group comparisons performed using the Mann–Whitney *U*-test. Categorical variables were analyzed using the chi-squared (χ^2) test. Time-to-event analyses were performed using the Kaplan–Meier method. A *p*-value of < 0.05 was considered statistically significant.

Results

Comparison of Baseline Data Between the Two Groups

The comparison of baseline data indicated no statistically significant differences between the observation group and the control group in terms of sex, age, past medical history (including hypertension, diabetes, and stroke), or the prevalence of smoking and alcohol consumption. Similarly, no significant differences were observed in baseline blood glucose levels, uric acid levels, serum creatinine levels, or blood lipid levels ($p > 0.05$), indicating that the baseline characteristics of the two groups were comparable. Further details are presented in [Table 1](#).

The Compliance of Patients in the Observation Group

In this study, 82.5% (66/80) of the patients in the observation group achieved high compliance ($\geq 80\%$ completion rate), 12.5% (10/80) had moderate compliance (50%–79%), and 5% (4/80) had low compliance ($< 50\%$). After the team provided additional health education and made individualized adjustments for the patients with low compliance, all of them improved to the moderate compliance level. Subgroup analysis showed that the improvement in LVEF in patients with high compliance was significantly greater than that in the medium compliance group (Δ LVEF 0.08 ± 0.03 vs 0.02 ± 0.01 , $P < 0.001$), suggesting a positive correlation between compliance and improvement in cardiac function.

Comparison of Cardiac Function and Exercise Tolerance Between the Two Groups

Both the control group and the observation group received standardized treatment protocols for heart failure and coronary heart disease and were monitored in accordance with the cardiac rehabilitation program. Prior to the initiation of continued cardiac rehabilitation, no significant differences were observed between the two groups in heart rate, systolic blood pressure, diastolic blood pressure, cardiac parameters (LAd, LVESD, LVEDD, LVEF), or 6MWD ($p > 0.05$).

The data after rehabilitation treatment indicated that the observation group demonstrated a significantly reduced heart rate and lower systolic and diastolic blood pressures compared to the control group. Additionally, cardiac function indicators, including LAd and LVEDD, were significantly reduced, while LVEF and 6MWD revealed significant

Table 1 Baseline Characteristics Before Cardiac Rehabilitation Between the Two Groups

	Control Group	Observation Group	p-Value
Male [n (%)]	56(80.00%)	62(77.50%)	0.709
Female [n (%)]	14(20.00%)	18(22.50%)	0.709
Age (year)	62.87±12.97	60.78±13.00	0.326
History of hypertension [n (%)]	41(58.57%)	53(66.25%)	0.332
History of diabetes [n (%)]	17(24.29%)	25(31.25%)	0.343
History of stroke [n (%)]	6(8.57%)	5(6.25%)	0.586
Smoking [n (%)]	45(64.29%)	46(57.50%)	0.396
Alcohol use [n (%)]	23(32.86%)	30(37.50%)	0.553
TC (mmol/L)	4.16±1.01	4.36±0.85	0.191
TG (mmol/L)	1.62±1.51	1.74±1.23	0.585
LDL-C (mmol/L)	2.26±0.70	2.19±0.64	0.478
HDL-C (mmol/L)	1.11±0.28	1.09±0.24	0.704
GLU (mmol/L)	5.77(4.95~6.67)	5.85(5.09~6.77)	0.687
UA (μmol/L)	353.61±115.38	343.11±0.64	0.597
Cr (μmol/L)	74.44±23.69	72.04±17.16	0.474

Abbreviations: TC, total cholesterol; TG, triglyceride; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; GLU, blood glucose; UA, uric acid; Cr, creatinine.

improvement, reflecting enhanced cardiac function in the observation group ($p < 0.05$). However, no statistically significant differences in LVESD values were identified between the two groups ($p > 0.05$).

These findings indicate that adherence to continued cardiac rehabilitation may contribute to heart rate reduction, improved blood pressure control, and enhanced cardiac reserve in patients. Further details are provided in [Table 2](#).

Comparison of Emotional Assessment Between the Two Groups

An analysis of anxiety and depression scores in the observation and control groups indicated no statistically significant differences in the SAS and SDS scores prior to the initiation of cardiac rehabilitation ($p > 0.05$). However, after the continuation of cardiac rehabilitation, the SAS and SDS score changes in the observation group were significantly higher than those in the control group ($p < 0.05$). These findings indicate that adherence to continued cardiac rehabilitation may effectively reduce anxiety and depression and contribute to stabilizing the emotional well-being of patients. Further details are provided in [Table 3](#).

Table 2 Comparison of Cardiac Function and Exercise Tolerance Before and After Cardiac Rehabilitation Between the Two Groups

	Before Treatment		After Treatment		Function Changes		P Values
	Control Group	Observation Group	Control Group	Observation Group	Control Group	Observation Group	
Heart Rate (bpm)	76.49±10.17	79.76±12.41	78.44±9.34	74.20±6.50	1.96±5.57	-5.56±9.2	<0.001*
Systolic blood pressure (mmHg)	128.96±18.35	132.28±16.28	129.70±16.54	124.81±10.44	0.74±4.78	-7.46±12.75	<0.001*
Diastolic Blood Pressure (mmHg)	82.00±13.77	82.51±11.44	82.40±13.77	75.60±8.68	0.40±4.22	-6.91±10.8	<0.001*
LAd (mm)	41.76±3.43	41.16±3.79	41.33±3.56	39.83±2.99	-0.43±2.35	-1.34±2.6	0.027*
LVESD (mm)	40.81±3.89	39.90±4.47	40.60±4.68	39.24±4.19	-0.21±2.01	-0.66±4.18	0.395
LVEDD (mm)	55.63±5.57	54.91±5.41	55.26±4.97	51.70±4.11	-0.37±3.26	-3.21±6.05	<0.001*
LVEF	0.45(0.45~0.47)	0.46(0.45~0.48)	0.46(0.45~0.51)	0.50(0.46~0.55)	0.01(0~0.03)	0.03(0~0.07)	0.048*
6MWD (m)	491.74±34.54	490.52±28.56	489.90±33.98	514.51±29.21	-1.84±8.19	23.99±3.23	<0.001*

Note: * The difference was statistically significant compared to the control group.

Abbreviations: LAd, left atrial dimension; LVESD, left ventricular end-systolic dimension; LVEDD, left ventricular end-diastolic dimension; LVEF, left ventricular ejection fraction; 6MWD, 6-minute walk test.

Table 3 Comparison of Emotional Scores Before and After Cardiac Rehabilitation Between the Two Groups

	Before Treatment		After Treatment		Score Changes		P Value
	Control Group	Observation Group	Control Group	Observation Group	Control Group	Observation Group	
SAS	58.33±8.04	56.29±6.74	50.76±8.15	44.09±5.72	7.57±1.92	12.2±5.49	<0.001*
SDS	56.09±8.33	57.05±7.31	49.70±7.36	42.49±6.55	6.39±4.97	14.56±6.79	<0.001*

Note: * The difference was statistically significant compared to the control group.

Comparison of Prognosis Between the Two Groups During Follow-Up

The incidence of cardiovascular events during the follow-up period was analyzed for the observation and control groups. Rates of cardiovascular death, recurrent non-fatal myocardial infarction, stroke, and revascularization were lower in the observation group compared to the control group, although these differences did not reach statistical significance ($p > 0.05$, Table 4). However, further analysis indicated that the incidence of heart failure events and rehospitalization was significantly reduced in the observation group compared to the control group ($p < 0.05$, Table 4). Kaplan-Meier analysis demonstrated that the observation group had significantly longer median time to heart failure [hazard ratio (HR) = 0.373, $p = 0.033$] and rehospitalization (HR = 0.355, $p = 0.035$) compared with the control group (Figure 1). However, median time to cardiovascular death ($p = 0.558$), recurrent non-fatal myocardial infarction ($p = 0.311$), stroke ($p = 0.921$), and revascularization ($p = 0.557$) did not significantly differ between the groups (Figure 1). These results indicate that adherence to continued cardiac rehabilitation may effectively decrease the occurrence of heart failure and rehospitalization, thereby enhancing patient prognosis.

Discussion

Heart failure is a common complication following acute myocardial infarction, with approximately 17–21% of patients exhibiting symptoms of heart failure and 13–32% developing left ventricular systolic dysfunction.²⁰ Despite advancements in treatment, including PCI, the incidence of heart failure remains high among patients with acute myocardial infarction.²¹ Cardiac rehabilitation is typically categorized into three stages: Stage I (in-hospital rehabilitation), Stage II (early outpatient rehabilitation), and Stage III (long-term outpatient rehabilitation).²² This structured approach provides comprehensive training during the acute, recovery, and maintenance phases of cardiovascular disease management, providing substantial benefits for the treatment and recovery of cardiac diseases.²² Cardiac rehabilitation is broadly applicable to patients with acute myocardial infarction, chronic heart failure, patients undergoing PCI, cardiac surgery, and those managing other chronic cardiac conditions.²³ This study highlights the importance of continued cardiac rehabilitation for patients with HFimpEF following acute myocardial infarction.

Evidence from previous research highlights the benefits of cardiac rehabilitation in this population. For instance, a study exploring the impact of early cardiac rehabilitation on the prognosis of patients with acute myocardial infarction

Table 4 Comparison of Major Adverse Cardiovascular Events Between the Two Groups. [n (%)]

	Control Group	Observation Group	P Value
Cardiovascular death	4(5.71%)	3(3.75%)	0.856
Recurrent non-fatal myocardial infarction	4(5.71%)	2(2.50%)	0.559
Stroke	1(1.43%)	1(1.25%)	0.924
Heart failure	13(18.57%)	6(7.50%)	0.042*
Recurrent revascularization	5(7.14%)	4(5.00%)	0.836
Rehospitalization	12(17.14%)	5(6.25%)	0.036*

Note: The difference was statistically significant compared to the control group.

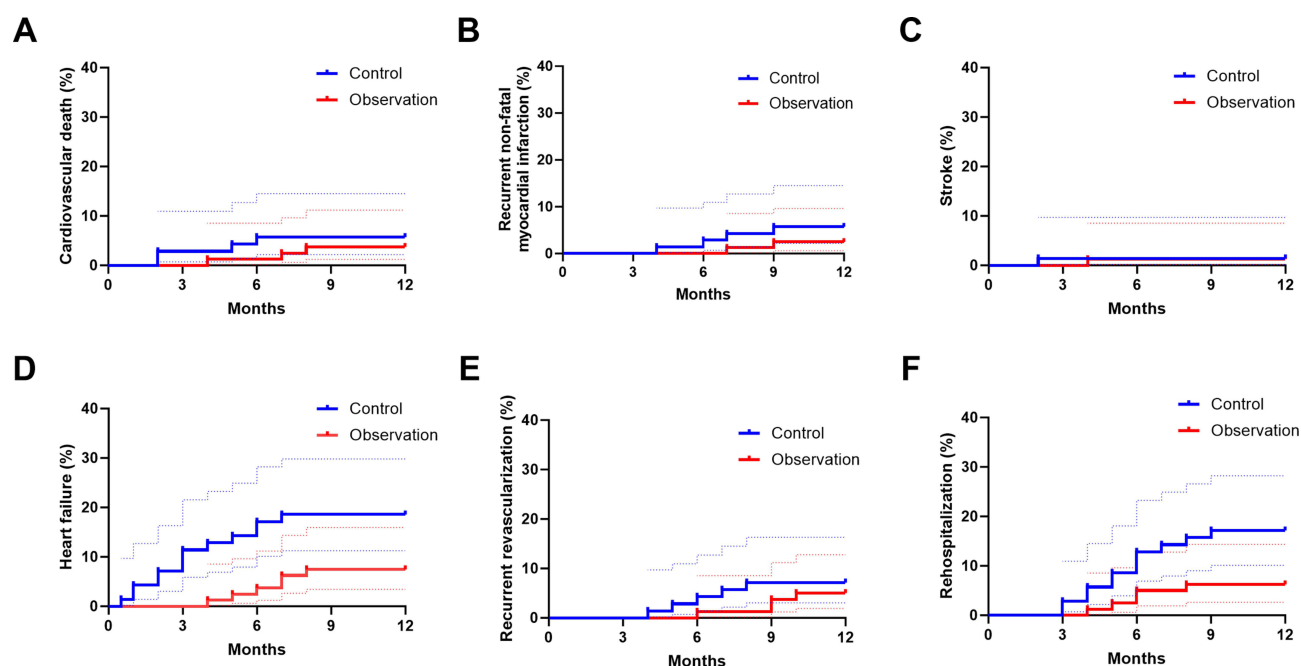


Figure 1 Kaplan-Meier analysis of major adverse cardiovascular events. (A) Cardiovascular death; (B) Recurrent non-fatal myocardial infarction; (C) Stroke; (D) Heart failure; (E) Recurrent revascularization; (F) Rehospitalization.

undergoing interventional therapy reported no significant differences in heart rate post-intervention.²³ However, mean arterial pressure was significantly reduced in the cardiac rehabilitation group compared to the control group. This finding indicates that cardiac rehabilitation enhances cardiac reserve and stress tolerance, contributing to improved blood pressure regulation.²⁴ Exercise-based rehabilitation has been shown to improve prognosis by increasing vagal activity and reducing sympathetic tone, thereby improving resting heart rate, systolic blood pressure, and cardiopulmonary function.²⁵

In this study, the effects of continued cardiac rehabilitation were examined in patients with HFimpEF, indicating that such interventions effectively reduce heart rate, improve blood pressure control, and enhance cardiac functional reserve. These findings highlight the critical role and clinical value of sustained cardiac rehabilitation in improving outcomes for patients with HFimpEF following myocardial infarction.

Edelmann et al demonstrated that exercise not only improves exercise tolerance and quality of life but also reverses atrial remodeling and enhances diastolic function in patients with HFpEF.²⁶ Building on these findings, the present study implemented continued cardiac rehabilitation training in patients with HFimpEF following myocardial infarction. The results revealed significant improvements in cardiac function, particularly in parameters such as left atrial size, left ventricular end-diastolic diameter, and left ventricular ejection fraction, aligning with the outcomes reported by Edelmann et al.²⁶ Furthermore, the six-minute walk test demonstrated that cardiac rehabilitation significantly enhanced cardiac reserve capacity and exercise performance in these patients, contributing to improved exercise tolerance and quality of life.

Analysis of cardiovascular event incidence demonstrated that continued cardiac rehabilitation significantly reduced the occurrence of cardiovascular events in patients with HFimpEF. Notably, a significant reduction in heart failure events and rehospitalization rates was observed in the rehabilitation group compared to the control group. These findings indicate that sustained cardiac rehabilitation plays a key role in reducing the incidence of heart failure and rehospitalization, thereby significantly improving clinical outcomes in this patient population. The observed clinical benefits are closely associated with improvements in both cardiac function and exercise tolerance.

Previous studies have further demonstrated that cardiac rehabilitation can lower all-cause and cardiovascular mortality in patients following myocardial infarction.²⁷ Additional benefits include slowing and inhibiting the

progression of atherosclerosis, preventing the development of cardiovascular and coronary artery diseases, reducing cardiac-related events, and enhancing patient prognosis.²²

Patients with chronic heart failure often experience recurrent symptoms, leading to repeated hospitalizations, significant financial burdens on families, and considerable psychological distress. Many individuals also face severe anxiety, depression, and insomnia.²⁸ Previous studies have demonstrated that early cardiac rehabilitation training can positively impact the mental health of patients with chronic heart failure by improving cardiac function, alleviating anxiety and depression, and enhancing overall quality of life.²⁹

In the present study, patients with HFimpEF following myocardial infarction who participated in continued cardiac rehabilitation training initially exhibited no significant differences in anxiety and depression scores between the observation and control groups. However, post-treatment assessments revealed a significant reduction in anxiety and depression scores in the observation group, indicating that continued cardiac rehabilitation effectively improves these adverse emotional states in patients with HFimpEF.

Anxiety and depression exacerbate heart failure symptoms, increase rehospitalization rates, and elevate the incidence of cardiovascular events, thereby negatively impacting patient prognosis.³⁰ Additionally, this intervention significantly reduced the occurrence of heart failure episodes and rehospitalizations.

This study has certain limitations. Firstly, grouping is based on patients' autonomous choice rather than random allocation, which may introduce selection bias. Although the baseline characteristics were balanced and known confounding factors were controlled through multivariate analysis, the influence of unmeasured variables (such as patient compliance and social support level) could still not be completely excluded. Future studies can adopt randomized controlled designs or prospective cohort studies to further verify the conclusions. Secondly, there may be individual differences in the actual implementation intensity of cardiac rehabilitation (such as exercise duration and frequency), but this study minimized such biases through regular follow-up and standardized protocols.

Overall, cardiac rehabilitation after myocardial infarction in patients with HFimpEF may bring positive effects, including improved regulation of heart rate and blood pressure, enhanced cardiac function and reserve capacity, and enhanced cardiac adaptability. Additionally, related interventions can help alleviate psychological burdens such as anxiety and depression, potentially reducing the risk of cardiovascular events, especially heart failure episodes and rehospitalizations. These findings suggest the importance and clinical relevance of continuous cardiac rehabilitation in this patient population.

Abbreviations

HFimpEF, Heart failure and improved ejection fraction; HFpEF, Heart failure with preserved ejection fraction; HFrEF, Heart failure with reduced ejection fraction; LVEF, Left ventricular ejection fraction; GDMT, Guideline-directed medical therapy; SAS, Self-Rating Anxiety Scale; SDS, Self-Rating Depression Scale; HF, Heart failure; AHA, American Heart Association; HFSA, Heart Failure Society of America.

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author, Li Lu, upon reasonable request.

Ethics Approval

This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethics Committee of Nantong First Peoples' Hospital. A written informed consent was obtained from all participants.

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Disclosure

None of the authors have any conflicts of interest to report for this work.

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