

Assessing the Long-Term Impact of Cardiac Rehabilitation Programs on Morbidity and Mortality in Patients with HFrEF: A One Year Study in Egypt

GHADA SELIM, M.D. *; YOUSSEF TAMARA, MB B .Ch. *; MAHMOUD TANTAWY, MD. ** and AHMED TAMARA, MD.*

The Department of Cardiology, Faculty of Medicine, Ain Shams University* and Misr University for Science & Technology**

Abstract

Background: Cardiovascular disease (CVD) poses a substantial public health challenge in Egypt, contributing to a significant proportion of reported deaths and prevalent risk factors in the population. The increasing incidence of CVD not only strains healthcare resources but also impedes economic productivity, posing a significant developmental barrier.

Aim of Study: This study is to assess the influence of cardiac rehabilitation on mortality and cardiovascular events in patients with heart failure with reduced ejection fraction (HFrEF). Furthermore, the research scrutinizes the correlation between patient experience and clinical outcomes, aiming to elevate comprehension of how the synergistic impact of cardiac rehabilitation and comprehensive patient satisfaction leads to enhanced management outcomes in HFrEF.

Patients and Methods: This prospective study, conducted at Ain Shams University Hospital from January 2021 to January 2022, involved 96 patients with HFrEF who completed a 12-week cardiac rehabilitation program (Group A) and 101 HFrEF patients without CR enrollment (Group B). Patients in Group A underwent medical assessment, tailored exercise regimens, risk factor modification, medication optimization, and psychological support. Both cohorts were followed-up for one year for all-cause mortality and re-hospitalization.

Results: Demonstrate a re-hospitalization rate of 5.2% among Group A and a significantly higher rate of 39.6% among Group B. One-year mortality was 1.04% in Group A compared to 8.9% in Group B. Patient satisfaction scores were notably higher in Group A, indicating the program's effectiveness in addressing physical and psychological needs.

Conclusion: This study highlights the tangible benefits of cardiac rehabilitation in reducing re-hospitalization and mortality rates among HFrEF patients. The program's multifaceted approach, encompassing exercise, risk factor modification,

medication optimization, and psychological support, contributes to these outcomes. Furthermore, patients' satisfaction scores underscore the positive impact of CR on enhancing patient experience. Cardiac rehabilitation stands as a cost-effective intervention that significantly improves patient outcomes, making it a valuable pillar in the management of HFrEF and potentially serving as a model for similar contexts worldwide.

Key Words: Cardiovascular disease — Cardiac rehabilitation — Heart failure with reduced ejection fraction (HFrEF) — Re-hospitalization — Mortality — Patient satisfaction.

Introduction

CARDIOVASCULAR disease (CVD) stands as a significant health challenge within Egypt, contributing to 39% of all reported deaths and presenting a substantial prevalence of risk factors among the population [1]. The escalating incidence of CVD not only exerts a direct burden on healthcare resources but also impairs economic productivity by sidelining individuals from the active workforce, thereby posing a formidable obstacle to development. Addressing the toll of morbidity, disability, and premature mortality linked to cardiovascular ailments necessitates the effective implementation of preventive measures. This imperative calls for a holistic and cross-disciplinary approach that spans diverse domains such as health policies, agriculture, food industry, trade, and education.

Embedding secondary prevention programs for cardiovascular diseases within the continuum of care assumes a paramount role in addressing this multifaceted challenge. The complexity amplifies in the context of a developing nation like Egypt, where low education levels and inadequate living conditions act as substantial impediments to patients' health awareness, risk-factor modification, and adherence to prescribed medications. Given this context, individuals afflicted with coronary heart

Correspondence to: Dr. Ghada Selim,
[E-Mail: ghadaselim23@yahoo.com](mailto:ghadaselim23@yahoo.com)

disease are profoundly in need of an encompassing rehabilitation service that empowers their return to daily activities and fosters a safe level of physical exertion [2].

Cardiac rehabilitation (CR) emerges as a pivotal secondary prevention initiative, encompassing a multidisciplinary program that optimizes the physical, psychological, and social well-being of cardiac patients. Beyond its clinical efficacy, CR demonstrates its worth as an exceptionally cost-effective intervention, surpassing other therapeutic avenues. By mitigating the need for recurrent hospitalization, and diminishing the likelihood of disability or mortality-related workforce with drawals, CR effectively curtails health-related expenses.

Aim of the work:

The core objective of this study is to assess the influence of cardiac rehabilitation on mortality and cardiovascular events in patients with HFrEF. Furthermore, the research aims to meticulously scrutinize the correlation between patient experience and clinical outcomes. Ultimately, the overarching ambition is to elevate our comprehension of how the synergistic impact of cardiac rehabilitation and comprehensive patient satisfaction, encompassing both physical and psychological aspects, leads to enhanced outcomes in the management of HFrEF.

Patients and Methods

This is a prospective study preformed at Ain Shams University Hospital in the period from January, 2021 to January 2022. Ninety Six (96) patients with HFrEF who completed a 12 week cardiac rehabilitation program in for HFrEF were classified as "Group A". One hundred and one patients with HFrEF without enrollment into a CR program were classified as "Group B" (control group).

The following patients were excluded from the study: Patients with decompensated HF, hemodynamically unstable arrhythmia (frequent extra systoles, atrial fibrillation, ventricular arrhythmia), chronic obstructive pulmonary disease, uncontrolled hypertension, musculoskeletal disease that prevent the patient from exercise, co morbidities (severe renal failure, severe liver failure, malignancy), and patients with incomplete cardiac revascularization with residual ischemic symptoms.

Patients in Group A underwent a comprehensive cardiac rehabilitation program. It began with a detailed medical assessment, which included a thorough review of their medical history and screenings for factors like smoking, high blood pressure, diabetes, high cholesterol, and obesity. They also received a comprehensive physical examination, which involved measuring their weight, body mass index (**BMI**), resting heart rate, and blood pressure. Additionally, the medical team assessed for any

signs of heart failure and abnormal heart sounds. An essential aspect of this program was the use of 2D echocardiography to evaluate the heart's pumping efficiency, specifically the left ventricular ejection fraction (LVEF), using the biplane Simpson's method [3].

Both patients cohorts received anti-failure medical therapy consisting of a combination of "four pillars" of heart failure therapy, these medications are beta blockers, angiotensin receptor-neprilysin inhibitors (ARNIs), mineralcorticoid receptor antagonists (MRAs) and sodium-glucose co-transporter 2 Inhibitors (SGLT2i) titrated to maximally tolerated doses defined by heart rate and blood pressure-lowering criteria unless limited by side effects. Both groups of patients were followed up for one year for all-cause mortality, and for re-hospitalization.

Under the supervision of cardiac rehabilitation experts, patients in Group A participated in a supervised moderate-intensity exercise plan. This program was explained to the patients, and they gave their consent to participate. It involved exercising three times a week for three months. The goal of the exercise plan was to reach a target heart rate between 40% and 60% of their heart rate reserve. This reserve was determined based on a previous stress test using the modified Bruce protocol. Each exercise session lasted for 30 minutes and began with a 5-minute warm-up routine. To gauge how hard the exercise should be, the Borg scale of rate of perceived exertion (RPE) was used. The aim was to maintain an RPE of 11-13 without experiencing any symptoms [4]. A trained cardiac rehabilitation nurse closely watched over the patients during these sessions, monitoring their heart rates, blood pressure, and any signs of discomfort or symptoms.

A crucial part of the program focused on reducing health risks. A cardiologist at the program site regularly evaluated patients to improve their medical care whenever possible. The program strongly emphasized education and motivation. A trained nurse provided intensive counseling, supported by motivational videos and specific tools.

As part of the program, patients had their average blood pressure, cholesterol levels, blood sugar, and hemoglobin A1c measured before and after completing the program. To manage weight, obese patients (those with a BMI of 30 or higher) were advised to cut back on their daily calorie intake by 500 calories. Patients with a BMI between 25 and 30 were encouraged to make dietary adjustments. Everyone received guidance to reduce saturated fat intake and increase their consumption of fish, grains, fruits, and vegetables.

Recognizing the crucial link between psychological well-being and recovery, the program inte-

grated psychological education and counseling, facilitated by a trained nurse.

The program meticulously tracked major adverse cardiac events, encompassing occurrences such as death and re-hospitalization and both patient cohorts were asked to fill in a (Patient satisfaction & Quality of care experience) questionnaire structured by the investigator (Appendix 1).

Statistical methods:

The collected data was revised, coded, tabulated and introduced to a PC using statistical package for social science: IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.

Quantitative data e.g. age were presented as mean ± standard deviation. Independent t-test is used to compare such data between two groups. ANOVA test was used in comparing more than two groups. In case of non parametric data Mann Whitney U-test was used in comparing two groups.

p-value was considered significant (S) if p<0.05 and highly significant (HS) if p<0.001.

Results

Patients demographics:

In the period from January 2021 to January 2022, 96 patients (mean age ± SD was 53±10.8 year) completed the CR program, of which 83.3% were males, 16.7% were females. In the same period, 101 patients with HFrEF diagnosis (55.66 mean age ± 6.8 SD) were referred for follow-up in the outpatient clinics and were not enrolled in CR program, of which 75.2% were males, 24.8% were females. There was no statistically significant difference between both groups regarding gender, or age Chi-square=1.95 p43.16 and 1.6 p=0.1, respectively.

In 96 patients who completed CR: 46 patients (48%) were illiterate, and 52% received different levels of education: 3 (3.1%) received primary education, 34 (35.4%) received middle school education, and 13 (13.5%) received university education.

Whereas in the other group: 55 patients (54.5%) were illiterate, while 45.6% received different levels of education: 3 (3%) received primary education, 34 (33.7%) received middle school education and 9 (8.9%) received university education.

There was no statistically significant difference between both groups regarding level of education. Chi-square=1.54 p43.67.

Clinical outcome:

A comprehensive one-year follow-up of patients who successfully completed a CR program revealed a re-hospitalization rate of merely 5.2%, contrast-

ing remarkably with the significantly higher rate of 39.6% observed among non-enrolled individuals. This distinction proved to be statistically profound (p43.00), underscored by a Chi-square value of 28.9.

One year Follow-up of patients who completed a CR program showed a death rate of 1.04% vs 8.9% among those who were not enrolled. This was statistically significant (p=0.036), Chi-square=4.3.

Satisfaction score:

The CR patients group shows a statistically significant higher satisfaction scores than the patients group that was not enrolled in CR. p=0.00 (HS).

Table (1): Shows one year re-hospitalization rate follow-up in both patients groups.

Rehospitalization	CR Program		Total
	Not enrolled N=101	Enrolled N=96	
No:			
Count	64	91	155
%	63.30%	94.70%	78.60%
Yes:			
Count	37	5	42
%	39.60%	5.20%	21.30%

Table (2): Shows one year mortality follow-up in both patients groups.

Mortality	CR Program		Total
	Not enrolled N=101	Enrolled N=96	
No:			
Count	94	95	189
%	91.1%	98.9%	95.9%
Yes:			
Count	7	1	8
%	8.9%	1.04%	4.06%

Table (3): Shows the score of satisfaction with the quality of care in both patients groups.

	t	p-value
- To what extent the program served your physical needs	8.528	.000
- To what extent the program served your psychological needs	8.700	.000
- Are you happy with the level of health service supplied	6.803	.000
- To what extent did the medical team answers your inquiries and decrease your fear	5.094	.000
- From your point of view what is your evaluation of the service	5.457	.000

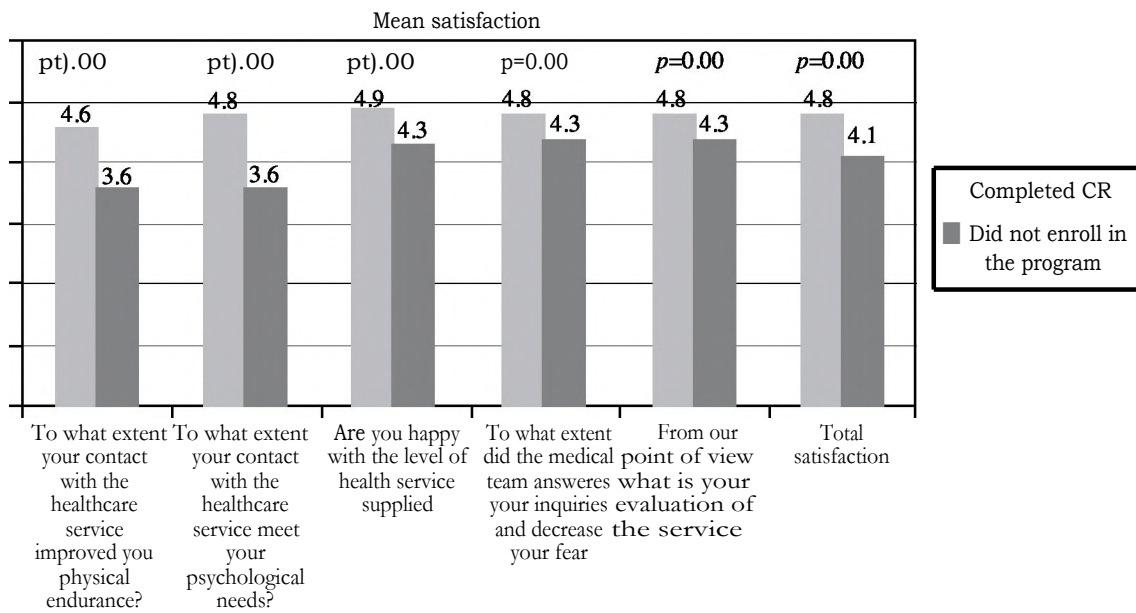


Fig. (1): Shows the score of satisfaction with the quality of care in both patients groups.

Discussion

In this study, we aimed to quantify the benefits of the CR program at Ain Shams University Hospital with an emphasis on patient-relevant outcomes such as morbidity and mortality rather than surrogate outcomes such as blood pressure and serum cholesterol levels.

1- Morbidity & Mortality benefit:

The results of the one-year follow-up study involving 96 patients with HFrEF who successfully completed a cardiac rehabilitation (CR) program demonstrated notably low re-hospitalization and mortality rates of 5.2% and 1.0%, respectively. In stark contrast, the study's comparison group of 101 patients who did not participate in CR exhibited significantly higher re-hospitalization and mortality rates of 39.6% and 6.9%, respectively. These findings suggest a clear benefit of CR in reducing both re-hospitalization and mortality rates.

Our study aligns with a multicenter retrospective cohort investigation conducted among patients hospitalized for acute heart failure (HF) across 15 hospitals in Japan between 2007 and 2016 [5]. The exercise protocol consisted of moderate-intensity aerobic exercise with heart rate calculated using the Karvonen formula, or intensity of 12 to 13 on the Borg scale and the study focused on assessing the primary outcome, which was a composite measure of all-cause mortality and HF rehospitalization post-discharge. Additionally, secondary outcomes, including all-cause mortality and HF rehospitalization, were evaluated, specifically comparing participants engaged in outpatient cardiac rehabilitation (CR) programs with nonparticipants with a median follow-up of 2.4 years. Within a cohort of 3,277 pa-

tients, 26% (862 individuals) engaged in outpatient CR. Results showed that all-cause mortality and risk of hospital readmission because of HF were lower in CR participants even after Propensity Score matching according to factors related to HF prognosis. This study adds to the increasing evidence confirming the positive effects of multidisciplinary cardiac rehabilitation programs on long-term outcomes for patients with heart failure.

Another study conducted by Rengo et al. [6] provide valuable insights into the improvement of functional capacity in patients with HFrEF. The research addresses the question of how exercise training and cardiac rehabilitation (CR) impacted this specific patient population in a clinical setting. The results showed that patients who completed the CR program experienced notable improvements in their aerobic capacity, as measured by both estimated METs and VO2 peak leading to tangible symptomatic improvement.

On the other hand, a 2022 update of the Cochrane systematic review and meta-analysis provides a comprehensive and contemporary review of randomized trial evidence of 60 trials comparing exercise-based cardiac rehabilitation to no exercise control in 8728 patients with median of 6-month follow-up, the majority in patients with heart failure with reduced ejection fraction (HFrEF) (mean left ventricular ejection fraction: 32%) with a mean age of 63 years, and the majority of patients with New York Heart Association (NYHA) Class II or III. Although this latest analysis shows that participation in cardiac rehabilitation has no clear benefit in terms of overall mortality, it shows 25%-30% relative reduction in the risk of all-cause and heart failure hospitalization and concomitant reduction in

healthcare costs and improvement in health-related quality of life [7].

Our study demonstrated a notable decrease in one year re-hospitalization and mortality rates observed among patients who completed the cardiac rehabilitation (CR) program. This can be attributed to multiple factors. This CR program, overseen by on-site attending cardiologists at Ain Shams University, distinguishes itself by facilitating medication up-titration twice a week, a practice that accelerates the optimization of medical treatment and achievement of target blood pressure and heart rate within a remarkably brief 6-8 week timeframe. This distinctive feature harbors immense potential in substantially limiting complications and the need for re-hospitalizations. Additionally, the CR program likely played an instrumental role in developing patients' skill in self-management, equipping them with the knowledge to promptly recognize symptoms and adhere to prescribed medication regimens.

Furthermore, the exercise likely yielded improvements in physical fitness and symptoms, and the program's focus on modifying risk factors, such as addressing smoking habits, sedentary lifestyles, and unhealthy dietary choices, could have contributed to the reduction in rehospitalization. The inclusion of psychological support services may have tangibly augmented mental well-being, indirectly affecting cardiovascular health positively. The intensified frequency of monitoring and check-ups during the course of the program might have facilitated the early identification and proactive management of potential concerns. The active involvement and education of patients, combined with the comprehensive approach of cardiac rehabilitation, most likely played a role in encouraging lifestyle changes and an overall enhancement in cardiac health.

It is noteworthy to acknowledge that the financial landscape in Egypt plays a pivotal role in the program's effectiveness. In contexts where physician pay and compensation per hour are comparatively lower, as seen in many low-income countries, initiatives like this CR program become a beacon of opportunity. The program's exceptional benefits and outcomes make it an invaluable option for regions with limited healthcare resources, offering a cost-effective solution that can alleviate the burden on healthcare systems while significantly enhancing patient care and outcomes.

2- Patients satisfaction:

Capturing patient's satisfaction is a complex and intricate undertaking, encompassing a multifaceted array of dimensions that challenge a definitive delineation. Among these dimensions, the interactions between patients and physicians, care expectations, and attitudes hold profound significance to patients. In this study, we aimed to investigate whether the Cardiac Rehabilitation (CR) program, compared with the conventional monthly outpatient follow-up

approach, yielded greater satisfaction among patients struggling with heart disease. Our questionnaire aimed to measure the program's efficacy in addressing their physical and psychological needs while also addressing their concerns.

Upon examination, the group of patients participating in the CR program showed notably higher satisfaction scores across all domains of the questionnaire compared to the group not engaged in CR ($p=0.00$). These findings carry statistical significance and illuminate the tangible impact of the CR program on enhancing patient fulfillment. Validating these results, Doyle 1 C et al. [8] affirm that patient's experience has a positive correlation with clinical effectiveness and patient's safety. This further highlights the rationale for embracing patient's experience as a pivotal cornerstone of healthcare quality.

To enrich the experience, patients were actively encouraged to invite their caregivers, who could be family members or friends, to partake in CR sessions. This inclusive approach might have synergistically contributed to empowering patients to actively participate in their treatment journey, potentially fostering a more conducive healing environment. This facet introduces an intriguing angle, whereby the presence of caregivers acts as a catalyst in the patient's journey towards empowerment and engagement in their care.

Conclusion:

Cardiac Rehabilitation intervention has yielded tangible enhancements in patients' clinical trajectories. The program's core strength lies in its ability to foster patients' active participation in self-management behaviors, leading to tangible improvements in risk factors and subsequently, overall health status. The consequential impact is evident through the noteworthy reductions in one-year mortality and re-hospitalization rates.

Although a quantitative assessment of the program's cost-effectiveness remains absent from this study, the substantial reductions witnessed in both morbidity and mortality, as compared to standard treatment, bear the promise of a potentially highly cost-effective intervention. This becomes particularly pivotal in contexts where substantial increments in healthcare expenditures pose challenges, making such interventions that effectively curtail health costs while concurrently enhancing care quality and clinical outcomes an indispensable necessity. In nations where the need to bolster healthcare funding is both urgent and impractical, interventions of this nature arise as essential pillars of support. Their capacity to lighten the load on healthcare systems while simultaneously enhancing care quality and patient outcomes highlights their pivotal role in advancing enduring and influential healthcare solutions.

References

- 1- HASSANIN A., HASSANEIN M., BENDARY A., et al.: "Demographics, clinical characteristics, and outcomes among hospitalized heart failure patients across different regions of Egypt." *Egypt Heart J*, 72 (1): 49. [DOI: 10.1186/s43044-020-00082-0](https://doi.org/10.1186/s43044-020-00082-0). PMID: 32789717; PMCID: PMC7426340, 2020.
- 2- SELIM G.: "Cardiac Rehabilitation in Egypt."Lancet Global Health, 1 (2): E72, 2013.
- 3- KOSARAJU A., GOYAL A., GRIGOROVA Y., et al.: "Left Ventricular Ejection Fraction." [Updated 2023 Apr 24]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; Jan-. [Available from https://www.ncbi.nlm.nih.gov/books/NBK459131](https://www.ncbi.nlm.nih.gov/books/NBK459131), 2023.
- 4- KHORSHID HR., ADELHADY Y.A. et al.: "Effect of Cardiac Rehabilitation Program on Heart Rate Recovery in Diabetic Patients Post Myocardial Infarction Treated by Primary Percutaneous Coronary Intervention." MJMR, 31 (3): 153-166, 2020.
- 5- KAMIYA K., SATO Y., TAKAHASHI T., TSUCHIHASHI-MAKAYA, et al.: "Multidisciplinary Cardiac Rehabilitation and Long-Term Prognosis in Patients With Heart Failure." Circulation: Heart Failure, 13 (10). [DOI: 10.1161/CIRCHEARTFAILURE.119.006798](https://doi.org/10.1161/CIRCHEARTFAILURE.119.006798). 2020.
- 6- RENGO J.L., SAVAGE PD., BARRETT T., et al.: "Cardiac Rehabilitation Participation Rates and Outcomes for Patients With Heart Failure." J. Cardiopulm Rehabil Prev., Jan. 38 (1): 38-42. [DOI: 10.1097/HCR.000000000000252](https://doi.org/10.1097/HCR.000000000000252) . PMID: 28671938; PMCID: PMC5741463, 2018.
- 7- TAYLOR R.S., DALAL H.M. and ZWISLER A.D.: "Cardiac rehabilitation for heart failure: 'Cinderella' or evidence-based pillar of care?" *Eur Heart J*. May 1; 44 (17): 1511-1518. [DOI: 10.1093/eurheartj/ehad118](https://doi.org/10.1093/eurheartj/ehad118) . PMID: 36905176; PMCID: PMC10149531, 2023.
- 8- DOYLE C. and LENNOX L.: "A systematic review of evidence on the links between patient experience and clinical safety and effectiveness." BMJ Open, 3: e001570, 2013.

Appendix (1)

Patients' Satisfaction & Quality of service:

A weighted score was calculated based on five points for each patient; the responses for each question were totaled and averaged. Five points for those who said "excellent," four points for "very good," three points for "good" and so on. The weighted responses for each question were totaled and averaged to get the score as follows.

Below are some questions about the quality of care you received after hospital discharge. Please indicate how much you agree or disagree with each statement as it applies to you personally by circling your answer.

	Very poor	Poor	Fair	Good	Very good
	1	2	3	4	5

- To what extent did your contact with the healthcare service improve your physical endurance ?
- To what extent did your contact with the healthcare service fulfill your psychological needs?
- To what extent are you happy with the standard of care you receive?
- To what extent did the staff respond to your questions, and worries?
- Overall rating of care received during your visits?

Conclusion:

The study titled "Assessing the Long-Term Impact of Cardiac Rehabilitation Programs on Morbidity and Mortality in Patients with HFrEF: A One-Year Study in Egypt" aimed to investigate the influence of cardiac rehabilitation (CR) on patients with heart failure with reduced ejection fraction (HFrEF). Conducted at Ain Shams University Hospital from 2021 to 2022, the study involved 96 patients completing a 12-week CR program (Group A) and 101 HFrEF patients without CR (Group B).

Results showed that the CR group had a re-hospitalization rate of 5.2% compared to 39.6% in the non-CR group. One-year mortality was significantly lower in the CR group (1.04% vs. 8.9%). Patient satisfaction scores were higher in the CR group, indicating program effectiveness in addressing physical and psychological needs.

The study highlights CR's benefits in reducing re-hospitalization and mortality rates among HFrEF patients. The CR program's holistic approach, including exercise, risk factor modification, medication optimization, and psychological support, contributed to these outcomes. The findings emphasize the program's cost-effectiveness and potential as a model for managing HFrEF in various contexts.

الدراسة المعنونة تقييم تأثير برامج التأهيل القلبي على المرضى المصابين بضعف فى عضلة القلب على المضاعفات والوفيات

هدفت إلى استقصاء تأثير التأهيل القلبي على مرضى يعف عضلة القلب أظهرت النتائج أن المجموعة التي خضعت لبرنامج التأهيل القلبي كانت نسبة حدوث المضاعفات ٥,٢% مقارنة بـ ٣٩,٦% في المجموعة غير التي لم تتبع برنامج التأهيل. وكان معدل الوفيات على مدى عام واحد أقل بشكل ملحوظ في المجموعة التي خضعت لبرنامج التأهيل (١,٠٤% مقابل ٨,٩%). وكانت درجات رضا المرضى أعلى في المجموعة التي خضعت لبرنامج التأهيل، مما يشير إلى فعالية البرنامج في تلبية الاحتياجات الجسدية والنفسية.

شملت الدراسة ٩٦ مريضاً مصابين بقصور فى القلب أكملوا برنامج تأهيل قلبي لمدة ١٢ أسبوعاً (المجموعة أ) و ١٠١ مريضاً بدون برنامج تأهيل (المجموعة ب).

تسلط الدراسة الضوء على فوائد التأهيل القلبي في تقليل معدلات إعادة التحت المرضية ومعدلات الوفيات بين مرضى.

القلب، بما فى ذلك ممارسة الرياضة، وتعديل عوامل الخطر، وتحسين الدواء، والدعم النفسى، فى تحقيق هذه النتائج. فى سياقات مختلفة.