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Effectiveness of a community-based cardiac rehabilitation program on functional independence and physical activity among patients with heart failure: a quasi-experimental study

Eficacia de un programa comunitario de rehabilitación cardíaca sobre la independencia funcional y la actividad física en pacientes con insuficiencia cardíaca: un estudio cuasiexperimental

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SUMMARY

Introduction: *Heart failure (HF) is a leading cause of disability and mortality worldwide, especially in low-resource settings where access to hospital-based rehabilitation is limited. Community-based cardiac rehabilitation (CBCR) offers a practical and affordable model to enhance self-care and daily functioning among patients with HF. Objective: To determine the effectiveness of a six-week CBCR program in improving functional independence and physical activity in patients with chronic heart failure.* **Methods**: *A quasi-experimental pretest–posttest control-group study was conducted at two primary healthcare centers in Bulukumba, Indonesia, involving 252 stable HF patients (126 in the intervention group, 126 in the control group). The intervention group participated in a structured CBCR program comprising supervised aerobic and functional exercises, self-care education, and behavioral reinforcement. The control group received usual care. Outcomes were assessed using the Functional Independence Measure (FIM) and Short-Form International Physical Activity Questionnaire (IPAQ-SF). Data were analyzed with ANCOVA, adjusting for demographic and clinical covariates.* **Results**: *The intervention significantly improved FIM scores (106.02 ± 12.63 vs. 98.10 ± 20.80; $p < 0.001$) and physical activity levels ($\chi^2 = 13.98$; $p < 0.001$). The adjusted ANCOVA remained significant ($F(1,246) = 10.03$; $p = 0.002$; partial $\eta^2 = 0.039$).* **Conclusion**: *CBCR effectively enhances functional independence and activity levels among patients with heart failure, supporting its integration into community health systems.*

Keywords: *Heart failure; cardiac rehabilitation; functional independence; physical activity; community-based intervention*

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RESUMEN

Introducción*: La insuficiencia cardíaca (IC) es una de las principales causas de discapacidad y mortalidad en todo el mundo, especialmente en entornos con escasos recursos, donde el acceso a la rehabilitación hospitalaria es limitado. La rehabilitación cardíaca comunitaria (CBCR) ofrece un modelo práctico y asequible para mejorar el autocuidado y el funcionamiento diario de los pacientes con insuficiencia cardíaca.* **Objetivo***: Determinar la efectividad de un programa de CBCR de seis semanas para mejorar la independencia funcional y la actividad física en pacientes con insuficiencia cardíaca crónica.* **Métodos***: Se realizó un estudio cuasiexperimental de pretest-postest con un grupo de control en dos centros de atención primaria de salud en Bulukumba, Indonesia, con 252 pacientes estables con insuficiencia cardíaca (126 en intervención, 126 en control). El grupo de intervención participó en un programa estructurado de CBCR que incluía ejercicios aeróbicos y funcionales supervisados, educación en autocuidado y refuerzo conductual. El grupo de control recibió atención habitual. Los resultados se evaluaron mediante la Medida de Independencia Funcional (FIM) y el Cuestionario Internacional de Actividad Física de Forma Breve (IPAQ-SF). Los datos se analizaron mediante ANCOVA, ajustando por covariables demográficas y clínicas. Resultados: La intervención mejoró significativamente las puntuaciones de FIM (106,02 ± 12,63 vs. 98,10 ± 20,80; p <0,001) y los niveles de actividad física (χ^2 = 13,98; p < 0,001). El ANCOVA ajustado se mantuvo significativo (F(1,246) = 10,03; p = 0,002; η^2 parcial = 0,039).* **Conclusión***: El CBCR mejora de manera efectiva la independencia funcional y los niveles de actividad en pacientes con insuficiencia cardíaca, lo que respalda su integración en los sistemas de salud comunitarios.*

Palabras clave: *Insuficiencia cardíaca, rehabilitación cardíaca, independencia funcional, actividad física, intervención comunitaria*

INTRODUCTION

Heart failure (HF) remains a worldwide public health issue and a main contributor to morbidity, hospital readmissions, and premature mortality (1). The World Health Organization (WHO) estimates that more than 64 million people worldwide are impacted by heart failure (HF), with increasing prevalence due to demographic changes and improved survival rates from ischemic and hypertensive heart diseases (2). Despite advances in pharmacological therapy, many patients experience persistent functional limitations, reduced exercise capacity, and diminished quality of life (3). These results are primarily attributable to physical deconditioning, muscular weakness, and inadequate adherence to self-care guidelines, underscoring the importance of non-pharmacological strategies that complement conventional medical treatment (4).

Cardiac rehabilitation (CR) is a multidisciplinary approach demonstrated to enhance exercise capacity, psychological health, and long-term survival in individuals with heart failure (5). Evidence from meta-analyses and international guidelines, including the American Heart Association (AHA, 2025) (6) and the European Society of Cardiology (ESC, 2023) (7), indicates that exercise-based cardiac rehabilitation reduces all-cause mortality and hospitalization by 20–30%, whilst enhancing functional ability and quality of life. Nevertheless, in numerous low- and middle-income nations, the implementation of formal hospital-based cardiac rehabilitation programs is constrained by insufficient facilities, labor shortages, and financial barriers (8). In Indonesia and other resource-limited settings, less than 10% of eligible HF patients have access to structured rehabilitation programs.

Community-based cardiac rehabilitation (CBCR) has emerged as a feasible, cost-effective alternative that decentralizes cardiac rehabilitation services to primary care and community settings (9). CBCR combines supervised physical activity, patient education, and behavioral support to enhance accessibility for a broader population while preserving therapeutic efficacy. Prior research in Europe, Latin America, and Southeast Asia has shown that CBCR can yield outcomes comparable to those of hospital-based programs when established protocols and trained personnel are employed (10). However, the evidence from Indonesia, particularly within community and primary healthcare contexts, remains scarce.

Functional independence is a vital measure of the effectiveness of rehabilitation. The Functional Independence Measure (FIM) is widely used to assess an individual's capacity to perform activities of daily living (ADLs) autonomously, encompassing both motor and

cognitive rehabilitation (11). Improvements in FIM scores in patients with heart failure indicate greater autonomy and improved integration into social and occupational activities. Similarly, the International Physical Activity Questionnaire (IPAQ-SF) provides a standardized assessment of patients' physical activity level, which correlates strongly with cardiovascular prognosis and overall health status (12). The integration of these two variables for a thorough assessment of the effects of community-based therapies on both physiological and functional aspects of rehabilitation.

Despite growing global interest in CBCR, there is limited empirical evidence on its implementation and outcomes in Indonesia's primary healthcare system (13). Prior local research has predominantly concentrated on pharmaceutical adherence or health education, with minimal incorporation of scheduled physical activity or assessment of functional outcomes. This study aims to address the existing gap by implementing a comprehensive six-week community-based cardiac rehabilitation program that includes aerobic and functional exercises, education, and behavioral reinforcement, specifically designed for heart failure patients in a low-resource setting.

This study assessed the hypothesis that a structured CBCR program can markedly enhance functional independence and physical activity compared with usual care, even after adjusting for confounding demographic and physiological factors. The results are expected to provide evidence for policymakers and healthcare practitioners to incorporate CBCR as a sustainable component of primary cardiovascular care in Indonesia and similar resource-constrained settings.

METHODS

The study employed a quasi-experimental design with ANCOVA to control for baseline differences in age, gender, blood pressure, and body weight, thereby ensuring a rigorous review, and was implemented at two basic healthcare centers in Bulukumba Regency, Indonesia. The study sought to assess the efficacy of a community-based cardiac rehabilitation (CBCR) program in enhancing functional independence and physical activity in individuals with chronic heart failure. Participants were randomly assigned to two groups: an intervention group that received the CBCR program and a control group that received routine treatment. The intervention lasted six weeks. A total of 252 clinically stable heart failure patients participated, with 126 in the intervention group and 126 in the control group. Eligibility requirements encompassed: diagnosed heart failure class II–III (NYHA classification), clinical stability for a minimum of two weeks, capability to communicate and execute fundamental mobility tasks, and willingness to furnish informed permission. Individuals experiencing acute decompensation, cognitive deficits, or significant comorbidities (e.g., renal failure, stroke) were excluded. Baseline comparability across groups was assessed using independent t-tests for continuous data and Mann–Whitney U tests for categorical data.

The intervention phase comprised a six-week community-based cardiac rehabilitation program incorporating three elements:

1. *Aerobic and Functional Exercise*: Moderate-intensity walking (50–70% HRmax), respiratory regulation, and limb mobilization, conducted thrice weekly for 30–45 minutes under the supervision of a nurse or physiotherapist.

2. *Self-Care Education*: Weekly 45-minute sessions focusing on fluid balance, medication compliance, symptom surveillance, and stress alleviation.

3. *Behavioral Reinforcement*: Implementation of goal-setting, diary-based activity monitoring, and motivational interviews to improve compliance.

The control group got routine medical management and brief counseling according

to clinical guidelines, but lacked a systematic rehabilitative component.

Statistical Analysis

Data analysis was conducted using SPSS version 25.0. Descriptive statistics included participant attributes. Baseline differences were assessed using t-, U-, or χ^2 tests, with significance set at $p < 0.05$. An Analysis of Covariance (ANCOVA) was used to compare post-intervention FIM scores between groups, adjusted for age, gender, systolic blood pressure (SBP), diastolic blood pressure (DBP), and body weight. Adjusted means and 95% confidence intervals (CI) were calculated. Partial eta-squared (η^2) was employed to assess effect size (0.01 = minor, 0.06 = moderate, 0.14 = big). Effect sizes for pairwise comparisons were represented as Cohen's d for continuous data and Cramer's V for categorical data.

The institutional ethics committee of STIKES Panrita Husada Bulukumba approved the study protocol (approval No. 001927/KEP/2024). All participants furnished written informed consent. The research complied with the Declaration of Helsinki.

RESULTS

Table 1 shows the baseline characteristics of the two groups. Both groups were comparable in most sociodemographic and clinical characteristics, indicating sufficient baseline equivalence. The average age of participants was 59.07 ± 10.35 years in the intervention group and 56.54 ± 13.60 years in the control group ($p = 0.098$). No notable disparities were detected in educational attainment, employment status, marital condition, or duration of hypertension.

Notable disparities were observed in weight ($p = 0.022$), systolic blood pressure (SBP) ($p < 0.001$), diastolic blood pressure (DBP) ($p < 0.001$), and gender distribution ($p = 0.034$), with a marginally higher proportion of females in the control group. These factors were subsequently included as covariates in the ANCOVA model to mitigate potential confounding.

As shown in Table 2, post-intervention Functional Independence Measure (FIM) scores were significantly higher in the intervention group than in the control group (106.02 ± 12.63 vs. 98.10 ± 20.80; $t(250) = 3.66$; $p < 0.001$). The mean difference (95% CI) was 8.04 (3.65 to 11.19), corresponding to a medium effect size (Cohen's $d = 0.46$).

This finding indicates a clinically meaningful improvement in functional independence among participants who received the community-based rehabilitation program.

Table 3 shows the changes in physical activity levels. At baseline, no significant differences in activity categories were observed between the two groups ($\chi^2 = 5.64$, $p = 0.06$). After six weeks, a considerable increase in activity levels was noted in the intervention group, with the percentage of participants partaking in moderate-to-vigorous activity rising from 58.7% to 77.0%. The alteration was statistically significant ($\chi^2 = 13.98$, $p < 0.001$; Cramer's $V = 0.26$, signifying a moderate correlation).

After controlling for age, gender, blood pressure, and weight using ANCOVA (Table 4), the difference between groups remained statistically significant ($F(1,246) = 10.03$; $p = 0.002$; partial $\eta^2 = 0.039$). None of the covariates had a significant effect on post-intervention FIM, confirming that the improvement was attributable to the intervention.

DISCUSSION

This study assessed the efficacy of a community-based cardiac rehabilitation (CBCR) program on functional independence and physical activity in individuals with chronic heart failure. The results indicated that the intervention markedly improved Functional Independence Measure (FIM) scores and physical activity levels compared with conventional care. After controlling for

Table 1. Baseline Characteristics of Patients with Heart Failure (n = 252)

Variable	Intervention Group (n = 126)	Control Group (n = 126)	Test statistic	p-value	Effect size (95% CI)
Age (years)	59.07 ± 10.35	56.54 ± 13.60	t = 1.66	0.098	d = 0.20 (–0.03 to 0.44)
Weight (kg)	60.77 ± 11.96	56.54 ± 9.28	U = 6610	0.022*	r = 0.19 (0.02 to 0.35)
SBP (mmHg)	144.2 ± 20.04	152.4 ± 15.01	t = –3.67	<0.001**	d = 0.53 (0.27 to 0.79)
DBP (mmHg)	84.67 ± 9.49	90.44 ± 10.13	t = –4.67	<0.001**	d = 0.66 (0.39 to 0.93)
Gender					
Male	35 (27.8%)	21 (16.7%)	χ^2 = 4.50	0.034*	V = 0.13
Female	91 (72.2%)	105 (83.3%)			(0.01 to 0.26)
Marital status					
Married	123 (97.6%)	124 (98.4%)	χ^2 = 0.20	0.651	V = 0.03
Single	3 (2.4%)	2 (1.6%)			(0.00 to 0.09)
Occupation					
Housewife	88 (69.8%)	88 (69.8%)	χ^2 = 0.07	0.995	V = 0.02
Entrepreneur	14 (11.1%) 1	15 (11.9%)			(0.00 to 0.05)
Farmer	5 (11.9%)	14 (11.1%)			
Civil Servant	9 (7.1%)	9 (7.1%)			
Education level					
Literate					
Primary	20 (15.9%)	24 (20.2%)	χ^2 = 2.72	0.436	V = 0.08
Middle	25 (19.8%)	15 (12.6%)			(0.00 to 0.18)
High	58 (46.0%)	56 (47.1%)			
	23 (18.3%)	24 (20.2%)			
Duration of Hypertension (years)	20 (15.9%)	30 (23.8%)	χ^2 = 2.50	0.114	V = 0.10
≤1 year	106 (84.1%)	96 (76.2%)			(0.00 to 0.21)
>1 year					

Note: t = Independent t-test; U = Mann–Whitney U; χ^2 = Chi-square. $p < 0.05$*; $p < 0.001$** = significant. Effect sizes: Cohen's d for continuous data, r for Mann–Whitney, Cramer's V for categorical data, SBP=Systolic Blood Pressure, DBP=Diastolic Blood Pressure

Table 2. Functional Independence Measure (FIM) Scores After Intervention

Outcome	Intervention (X ± SD)	Control (X ± SD)	t (df)	95% CI of Mean Difference	p-value	Effect size (d)
Post-intervention FIM	106.02 ± 12.63	98.10 ± 20.80	3.66 (250)	3.65 to 11.19	<0.001**	0.46 (0.23 to 0.69) – medium

Table 3. Secondary Outcome: Physical Activity Level (IPAQ-SF)

Activity Level	Intervention Group n (%)	Control Group n (%)	χ^2 (2)	p-value	V (95% CI)
Pre-test					
Light	52 (41.3%)	35 (27.8%)	5.64	0.060	0.15 (0.00 to 0.29)
Moderate	30 (23.8%)	24 (19.1%)			
Vigorous	44 (34.9%)	67 (53.2%)			
Post-test					
Light	29 (23.0%)	40 (31.7%)	13.98	<0.001**	0.26 (0.12 to 0.39) – medium
Moderate	21 (16.7%)	27 (21.4%)			
Vigorous	76 (60.3%)	59 (46.8%)			

potential confounders—age, gender, systolic and diastolic blood pressure, and body weight—the intervention effect remained significant, with a partial η^2 of 0.039, indicating a small-to-moderate yet clinically relevant enhancement.

These results are consistent with previous studies emphasizing the importance of structured rehabilitation and exercise-based interventions for patients with heart failure (14,15). Indeed, Dribben et al. (2023) reported in a Cochrane review that exercise-based cardiac rehabilitation reduces hospital readmissions and improves quality of life by enhancing exercise tolerance and physical autonomy. In a comparable manner, McMillan Boyles (16) stated that community-based rehabilitation is as successful as hospital-based programs when appropriately designed and supervised. This work contributes to the expanding evidence base by presenting data from a resource-constrained population in Indonesia, where access to conventional cardiac rehabilitation is restricted.

The inclusion of FIM as a primary outcome provides a functional perspective that reflects daily living abilities rather than merely physiological metrics. Improvements in FIM scores indicate that individuals not only increased their exercise capacity but also regained independence in activities such as ambulation, bathing, and stair climbing. This aligns with the findings of Brown et al. (2024), who emphasized that rehabilitation therapies focusing on functional and behavioral elements provide superior real-world benefits compared to aerobic-only regimens (17). The observed mean difference of approximately 8 points in FIM exceeds the commonly used least clinically important difference (MCID) for functional recovery in patients with chronic cardiac disease.

Table 4. ANCOVA Results for Post-intervention FIM

Source	SS (Type III)	df	MS	F	p-value	Partial η^2
Group (Intervention vs control)	2933.41	1	2933.1	10.030	0.002	0.039
Age (years)	3.098	1	3.098	0.010	0.919	4.187
Gender (male=1)	202.577	1	202.577	0.692	0.406	0.003
SBP (mmHg)	1.082	1	1.082	0.006	0.938	2.435
DBP (mmHg)	1071	1	1070.7	3.655	0.057	0.014
Weight (kg)	548.1	1	548.1	1.858	0.174	0.007
Error	7192.46	246	292.45	—	—	—
Total	—	252	—	—	—	—

Notes: SS = Sum of Squares; MS = Mean Square; η^2 = eta squared (partial). $p < 0.05$*; $p < 0.001$**. Coding: Group (Intervention=1, Control=0); Gender (Male=1, Female=0)

The observed improvements may be attributable to increased peripheral muscle perfusion, improved cardiac efficiency, and enhanced energy-conservation strategies implemented during the program (17). The combination of moderate-intensity aerobic exercise, functional strength training, and self-management education likely facilitated both physiological and behavioral changes (18). The absence of significant effects of age, gender, blood pressure, or weight indicates that the intervention's benefits extend beyond demographic and physiological differences, rendering it widely applicable across diverse patient populations (19).

The increase in physical activity levels (IPAQ-SF) within the intervention group enhances the sustainability of exercise habits and self-efficacy (20). Behavioral reinforcement measures, including goal setting, weekly follow-up calls, and symptom self-monitoring, were essential for sustaining adherence. Previous studies corroborate this process; Kroesen et al. (21) demonstrated that adherence-focused methods improve long-term engagement and diminish relapse in sedentary behavior among cardiac patients. The present data confirm that behavioral support is a crucial component of effective cardiac rehabilitation, particularly in community-based settings.

Although the partial η^2 value of 0.039 indicates a moderate effect, its clinical impact is considerable given the chronic nature of heart failure and the challenges of patient adherence. Small but sustained functional gains can meaningfully reduce dependency and hospital readmissions. Moreover, the simplicity and cost-effectiveness of the community-based model offer strong potential for scalability in low- and middle-income settings. Trained nurses and physiotherapists led the program, which required minimal equipment and incorporated family and peer support factors known to enhance long-term outcomes.

However, the study possesses drawbacks. The lack of randomization introduces a risk of selection bias, despite the use of ANCOVA to adjust for baseline differences. The follow-up period was limited to six weeks; the long-term sustainability of functional improvement required further study. Third, the absence of biochemical or echocardiographic information hinders the assessment of the underlying physiological mechanisms. Subsequent research should

incorporate longer follow-up periods and objective assessments of cardiac function to strengthen causal inferences.

Despite these limitations, this study provides robust evidence supporting the feasibility and effectiveness of CBCR in primary care and community settings. It aligns with global cardiac rehabilitation frameworks by the World Health Organization (2024) (22) and the American Heart Association (2021), which emphasize the decentralization of rehabilitation services and their integration into community-based healthcare (23).

The findings possess multiple implications for clinical practice and health policy. Integrating structured community-based rehabilitation into primary healthcare could markedly enhance patient outcomes in resource-limited areas. The noted improvement in FIM underscores that even minimal-intensity, supervised exercise, coupled with education, can restore independence in daily tasks, alleviate caregiver strain, and improve overall quality of life.

Finally, given the increasing prevalence of heart failure in aging populations, integrating community-based rehabilitation into national health policies could offer a sustainable and scalable solution. Using primary care networks and digital follow-up tools could reduce hospitalizations and associated healthcare costs.

CONCLUSION

The six-week community-based cardiac rehabilitation (CBCR) program markedly enhanced functional independence and physical activity among patients with heart failure, even after controlling for demographic and clinical factors. This intervention is a clinically successful and cost-effective addition to medical management, as it improves self-care, physical function, and exercise adherence. CBCR can mitigate functional deterioration and avert hospital readmissions by engaging a multidisciplinary team of nurses, physiotherapists, and community health workers.

From a policy standpoint, integrating CBCR into primary healthcare systems is a scalable, sustainable approach to improving cardiovascular outcomes in resource-constrained environments. Integrating this strategy with national non-communicable disease (NCD) control initiatives and WHO guidelines would enhance the accessibility and continuity of cardiac care. In conclusion, CBCR is clinically advantageous and policy-relevant, offering an effective framework for improving heart failure management in the community.

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Conflict of Interest

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Ethical Approval

Approved by the Research Ethics Committee of STIKES Panrita Husada Bulukumba (Approval No. 001927/KEP/2024) All participants provided written informed consent before enrollment.

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