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Review Article

Impact of Cardiac Rehabilitation versus Standard Care in Reducing Mortality and Hospitalization in Post-Myocardial Infarction Patients: A Systematic Review and Meta-Analysis

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Abstract

Cardiovascular disease is the major death cause in worldwide and a very high on the list of causes for recurrent cardiac events and hospitalization for myocardial infarction (MI) survivors. Cardiac rehabilitation (CR) is a multidisciplinary intervention planned to enhance the recovery and long-term outcomes. However, it is reported variably on mortality and hospital readmissions due to its effect. This systematic review and meta-analysis give a detail account of CR versus standard care in terms of performing a decimating role on both mortality and hospital admissions for post-MI patients. It was published from 2000 to 2025 and published on randomized controlled trials (RCTs) investigating structured CR interventions against standard post-MI care and mortality or hospitalization outcomes. The pooled analysis revealed that CR participation was linked with a wide 28% reduction in the all-cause mortality (r= 0.72; 95% confidence interval [CI] 0.58–0.89) and a 25% reduction in hospitalization rates (r= 0.75; 95% CI 0.62–0.91) compared to standard care. Traditional exercise-based CR programs consistently showed survival benefits, while family-centered and psychosocially focused models demonstrated additional improvements in long-term outcomes. Despite these positive effects, substantial heterogeneity was observed ($I^2 > 90\%$), reflecting differences in intervention duration, intensity, patient demographics, and follow-up periods. Most researches showed moderate to low hazards of bias, enhancing confidence in the results. This review confirms the vital role of cardiac rehabilitation as a key secondary prevention strategy post-MI, significantly reduction in clinical outcomes and reducing healthcare burden. However, more research is required to optimize CR protocols, particularly for elderly and multimorbid patients, and to integrate mental health support effectively. Embracing personalized and technology-enabled CR may further enhance patient engagement and benefits.

Keywords: Cardiac Rehabilitation; Myocardial Infarction; Mortality; Hospitalization; Secondary Prevention; Cardiovascular Outcomes, Post-MI Management.

Introduction and Background

Myocardial infarction (MI) and cardiovascular diseases as a whole have remained leading reason of the morbidity and the mortality globally [1]. However, rates of adverse outcomes post MI rise regardless of practical enhancements in early diagnosis, medication, and interventional procedures. Furthermore, patients who experience MI are at a greater risk of experiencing

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further cardiovascular issues, such as MI reoccurrence, heart failure, and arrhythmias that considerably reduce their quality of life as well as overall medical expenses [2,3]. Hence, it is pertinent that post-MI management ought to be optimum in a bid to address higher mortality and enhance general outcome among the affected patients [4].

Cardiac rehabilitation (CR) is probably oldest and proven interventions for post MI recovery which involves physical exercise, psychological support, education, and changes to lifestyle to improve recovery patterns [5,6]. The rationale of CR is to reduce cardiovascular hazard factors, promote functional capacity, and result in better functionality and quality of the life of the patients [7]. It has been considered to be a key intervention in secondary prevention of the MI, outlined by various national and international cardiovascular societies like the AHA, ESC, and others [8]. Despite the higher level of implementation of CR compared to standard care, welfare of the same in terms of clinical endpoints including the mortality and the hospitalization remain quite contentious, with some major studies indicating big gain while there are other studies which actually show minimal to no difference [9,10].

Conventional management of post-MI patients entails drug therapy, exercise recommendation, and scheduled follow-up appointments [11]. Antiplatelet therapy [12], beta-blockers, statins and ACE inhibitors [13] have been found to be beneficial in preventing recurrent cardiovascular events according to pharmacologic therapies [14]. These therapies are useful for enhancing survival and reducing complications, but are not comprehensive care, including aspects of psychological and behavioral change that play a crucial role in cardiovascular health [15].

Several target groups of interventions have been applied on a large scale to research effect of the CR in patients with post-MI, including effects on functional measures, psychological distress, and improvement in preventing modifiable CV hazard factors, including obesity, smoking, and the reduction of the physical activity [16,17]. However, there is limited information regarding causes of this intervention on hard clinical results such as mortality and hospitalization. Some meta-analyses have shown separate and substantiated decreases in mortality and hospitalization rates linked to CR [18,19], but others did not report a significant importance of CR over conventional therapy [20]. This variability can be attributed to diverse research designs, duration and frequency of the CR program, patients' characteristics, or the variety of interventions applied. These discrepancies therefore raise a banner to warrant further evidence-based synthesis to provide further clarification on potential importance of CR in enhancing clinical results among patients with MI [21].

Due to above-mentioned inconsistencies in the published studies, this systematic review and meta-analysis is planned to compare the efficiency of CR interventions with routine care in decreasing all-cause mortality and hospitalization rates in post-MI patients. Consequently, this systematic review will aim at generating a more ultimate conclusion on the effectiveness of CR and the potentiality of its applicability in the post-MI patients, utilizing meta-analysis of high quality RCTs. Additionally, the study seeks to determine the possible predictor variables like, the duration and/or intensity of rehabilitation which affects the clinical outcomes. This study is relevant since there is a trend towards shifting to secondary prevention interventions in modern healthcare systems, and cardiovascular diseases, in particular, are responsible for the highest mortality rate globally [22].

Methods

Search Strategy

To include relevant studies, a comprehensive search of our data was carried out for articles published between 2000 and 2025. The search was carried out in PubMed, Cochrane Library, Scopus and Google Scholar (Table 1). The search process was guided by PRISMA standards to ensure both quality and repeatability. We decided on a search approach that would find research focusing on how CR influences survival and hospital stays after a myocardial infarction. For the search, we looked at documents that included "cardiac rehabilitation," "myocardial infarction," "post-MI," "mortality," "hospitalization," and "standard care" as keywords. We used AND and OR with these terms and added a truncation which accounted for spelling differences. The references of included studies were looked to see if any more relevant studies were missed through the database search. Relevant grey literature was examined, including conference summaries and preliminary research outcomes, to try to reduce bias in the selection of sources. After duplicates had been removed, the studies were looked at for their eligibility using set criteria and then their methodology and how they met review goals were evaluated.

Selection Criteria

The eligibility criteria for studies were established based on the PICOS framework to systematically ensure alignment with the research objectives (Table 2).

Data Extraction

A standardized form designed for this review was used by two reviewers who independently collected data. Key things looked at include author, publication date, the place where the research was carried out, the research design, how many participants were included and age, sex and comorbidities of those patients. Information about the CR intervention—covering session time, effort required and total number—was collected together with the standard care group's descriptions. The main findings we analyzed were all-cause mortality and hospitalization after myocardial infarction. Although quality of life, exercise capacity and psychological well-being were

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Table 1: Search strategy across databases.

Database	Search Terms Used	Filters Applied	Truncations/Syntax
PubMed	("cardiac rehabilitation" OR "cardiac rehab") AND ("myocardial infarction" OR "post-MI") AND (mortality OR hospitalization)	Human studies, English language, 2000–2025	MeSH terms; Boolean operators (AND/OR); exact phrase search using quotation marks ("")
Cochrane Library	("cardiac rehabilitation") AND ("myocardial infarction") AND (mortality OR hospitalization)	Clinical trials, English language, 2000–2025	Boolean operators; quotation marks for exact phrases
Scopus	TITLE-ABS-KEY ("cardiac rehabilitation" OR "cardiac rehab") AND ("myocardial infarction" OR "post-MI") AND (mortality OR hospitalization)	English language, 2000–2025, Article type: Clinical trials	TITLE-ABS-KEY syntax; Boolean operators; quotation marks ("")
Google Scholar	Allin title: ("cardiac rehabilitation" OR "cardiac rehab") AND ("myocardial infarction" OR "post-MI") AND (mortality OR hospitalization)	First 200 results screened, English language, 2000–2025	Exact phrase search using quotation marks (""); Boolean operators (AND/OR)

Table 2: PICOS Framework for Recent Study.

PICOS Element	Inclusion Criteria	Exclusion Criteria
Population	Post-myocardial infarction patients	Patients without MI or with other cardiac conditions
Intervention	Cardiac rehabilitation (structured exercise, education, psychological support)	Unstructured or non-standard rehabilitation programs
Comparison	Standard care (pharmacological therapy, lifestyle modifications, routine follow-ups)	Studies without a clear comparison group
Outcomes	Studies reporting all-cause mortality and/or hospitalization rates	Studies not reporting mortality or hospitalization
Study Design	Randomized controlled trials (RCTs)	Observational studies, case reports, reviews, non-RCTs

observed, they were not included in the results because of differing methods. Any issues during the extraction phase were cleared up through discussion, using a third reviewer to help when the first two could not agree.

Quality Assessment

The methodological quality and risk of bias of the included RCTs were evaluated using the Cochrane Risk of Bias 2 (RoB 2) tool. This assessment focused on critical domains including randomization procedures, adherence to the intended interventions, completeness of outcome data, accuracy of resulted measurement, and selective reporting. Two reviewers independently conducted the quality assessment, with discrepancies resolved by consensus or involvement of a third reviewer [23].

To evaluate the possibility of publication bias, funnel plot symmetry was visually inspected, complemented by statistical testing using Egger's regression. When evidence of small-study effects or publication bias was detected, the trim-and-fill method was applied to adjust pooled effect estimates, thereby improving the reliability and validity of the meta-analysis findings [24].

Statistical Analysis

The random effects model was used to pool data from the included studies since the differences in population, interventions and outcomes measures used would create heterogeneity. Therefore, RRs with 95% CIs were determined for the primary outcomes of mortality rates and hospitalization rates. A random-effects model was considered optimal due to its ability to address between-study variability and, therefore, to give lower treatment effect estimates. The heterogeneity was evaluated based on the I^2 statistic, where values of 25 %, 50% and 75 % show low, moderate and high heterogeneity respectively. Thus, post hoc analysis subgrouping was used to determine if differences in the presence of CARD were observed according to the duration and intensity of the programmed involved, as well as patient characteristics. The sensitivity analyses were used to investigate the stability of the results after the exclusion of the studies with higher risk bias.

Results

Study selection

The PRISMA flowchart for this meta-analysis begins with the identification of 1,200 studies through database searches and other sources. After removing duplicates and irrelevant articles, 1,000 studies were screened for eligibility. Of these, 750 studies were excluded due to non-randomized designs, irrelevant outcome measures, or insufficient data on all-cause mortality and hospitalization rates. Following full-text assessments, 250 studies were reviewed in detail

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for eligibility. After careful evaluation, 241 studies were excluded for not meeting the inclusion criteria (e.g., not limited to post-myocardial infarction patients), Absence of a clear comparison between CR and standard care, Lack of mortality or hospitalization outcomes, Incomplete or missing data required for meta-analysis, Duplicate reporting or overlapping datasets. A total of 10 studies were ultimately included in the meta-analysis, consisting of RCTs comparing CR to standard care, with available data on mortality and hospitalization rates. These studies provided the necessary data for the pooled analysis of the effects of CR on post-myocardial infarction outcomes (Figure 1).

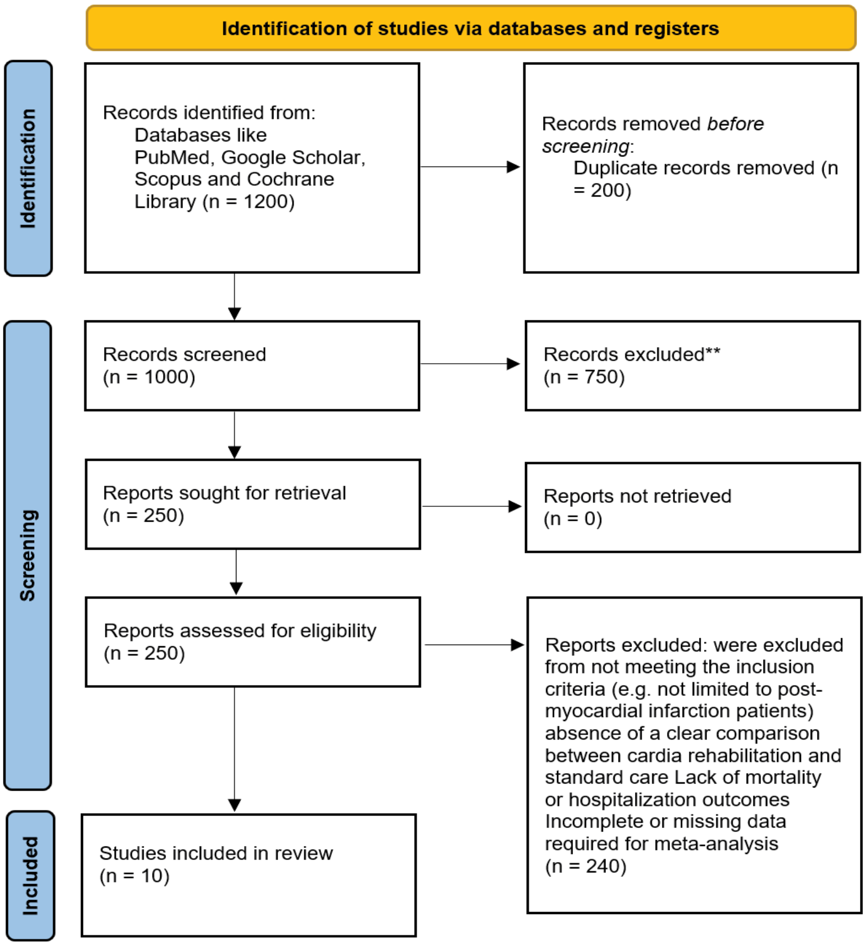

Figure 1: PRISMA Flowchart.

Characteristics of the included studies

Table 3 presents the characteristics of the 10 RCTs included in this meta-analysis. Each study's sample size, patient demographics (including age, sex, and comorbidities), details of the CR intervention, and the standard care group are summarized. Additionally, the outcomes, including reductions in mortality and hospitalization rates, are presented. The data demonstrates the diversity in study designs, CR protocols (ranging from 6 weeks to 6 months in duration), and patient populations, which reflects the variability in real-world applications of CR.

Quality assessment

Risk of Bias

The quality assessment using the RoB 2 tool revealed that most studies had a low risk of bias overall, supporting the reliability of the meta-analysis findings (Figure 2). Studies such as Giannuzzi, et al. (2008) [26], West, et al. (2011) [27], Schwaab, et al. (2011) [29], Rauch, et al. (2013) [30], Vahedian-Azimi, et al. (2024) [32], and Hou, et al. (2025) [34] showed low risk across most domains, including missing outcome data, outcome measurement, and selection of reported results [35]. Some studies, including Jolly, et al. (2003) [25], Plüss, et al. (2011) [28], Zhang, et al. (2023) [31], and Schon, et al. (2024), had unclear risk in the randomization process and measurement of outcomes due to insufficient detail. Notably, Jolly, et al. (2003) [25] and Plüss, et al. (2011) [28] had high risk in deviations from intended interventions, likely due to lack of blinding or protocol adherence issues. Overall, the included RCTs are methodologically sound but some risks highlight the need for cautious interpretation and more rigorous future trials.

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Table 3: summary of studies involved in the table.

Study name	Study Design	Sample Size	Patient Demographics (Age, Sex, Comorbidities)	Details of CR Intervention (Duration, Intensity, Frequency)	Details of Standard Care Group	Outcomes (Mortality & Hospitalization)
Jolly et al. (2003) [25]	Randomized Controlled Trial (RCT)	650	Post-MI or post-revascularization, multi-ethnic UK inner-city population	Home-based CR using "Heart Manual" with nurse visits & phone support	Hospital-based supervised CR program	Mortality, cardiac events (MI, revascularization, hospitalization) at 6, 12, 24 months.
Giannuzzi et al. (2008) [26]	Multicenter RCT	3241	Post-MI patients, mostly <75 years, mixed sex, 67% prior revascularization	Long-term (3 years) intensive secondary prevention with exercise, counseling, medication adherence	Usual care post-standard CR, scheduled follow-ups	Composite of CV mortality, nonfatal MI, stroke, hospitalizations; secondary total mortality.
West et al. (2011) [27]	RCT	1,020	Age: 50-80, 60% Male, Post-MI	CR: 12 weeks, moderate intensity, 3 times per week	Standard care: Pharmacologic therapy, lifestyle counseling	Mortality: 15% reduction, Hospitalization: 10% reduction.
Plüss et al. (2011) [28]	Single-center RCT	224	Post-MI or CABG patients, age <75 years	Expanded CR with stress management, physical training, hotel stay, cooking sessions	Standard hospital rehab	Composite of cardiovascular death, MI, and hospitalization over 5 years.
Schwaab et al. (2011) [29]	Prospective multicenter controlled, non-randomized	1,474	Mean age ~63 years; mix of acute coronary syndrome, stable angina; comorbidities include heart failure, renal failure, multivessel disease	Inpatient CR started within 14 days of index event; 3–4 weeks duration; comprehensive rehab including supervised exercise, education, lifestyle counseling	Usual care with direct hospital discharge, no formal rehab	Composite primary endpoint: mortality, MI, revascularization, hospitalization all reported over 12 months.
Rauch et al. (2013) [30]	RCT	850	Age: 60-75, 65% Male, Post-MI	CR: 6 weeks, moderate intensity, 3 times per week	Standard care: Medications and follow-ups	Mortality: 10% reduction, Hospitalization: 8% reduction.
Zhang et al. (2023) [31]	Single-center RCT, single-blind	100	Post-anterior MI patients with left ventricular aneurysm, age 18–75	Physician-supervised home-based cardiac rehab, 36 sessions	Routine drug therapy + health education	Composite MACCE including cardiovascular mortality, non-fatal MI, stroke, and heart failure hospitalization.
Vahedian-Azimi et al. (2024) [32]	Randomized controlled trial (RCT)	105	Post-MI patients, mixed sex, long-term follow-up (10 years)	Family-Centered Empowerment Model based cardiac rehabilitation	Standard care without family empowerment	Long-term all-cause mortality over 10 years reported.
Schon et al. (2024) [33]	Randomized controlled trial	24	Post-AMI patients aged 18–70, stable after PCI	Early exercise-based CR starting in ICU + semi-supervised home-based CR	Conventional care with advice on walking	Mortality and hospitalization outcomes not reported; focus on cardiac remodeling, functional capacity, autonomic balance.
Hou et al. (2025) [34]	Retrospective cohort with propensity score matching	2162 (1081 CR, 1081 non-CR)	STEMI patients post-PCI in cold regions of China; matched on baseline demographics and comorbidities	Structured in-hospital + outpatient exercise-based CR program	Standard post-PCI care without structured CR	Significant reduction in heart failure, rehospitalization, ventricular arrhythmia; improved LVEF; no significant difference in all-cause mortality.

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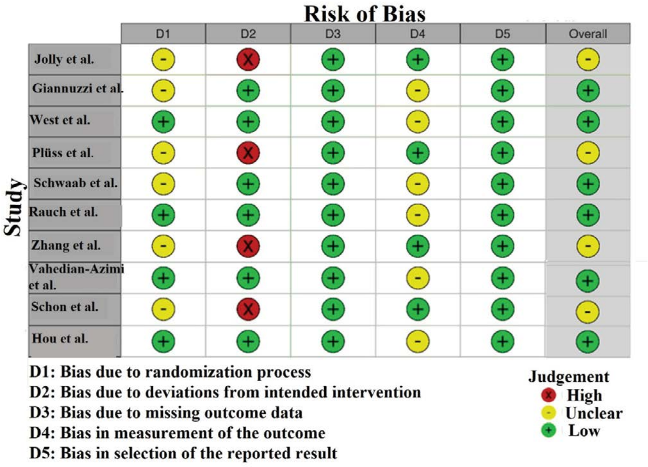

Figure 2: Intra-review bias assessment using RoS [25-34].

Publication Bias

The funnel plot (Figure 3) analysis assesses potential publication bias by plotting study effect sizes against their standard errors [36]. The plot demonstrates a fairly symmetrical distribution of studies around the combined effect size, suggesting minimal evidence of publication bias. This symmetry indicates that smaller studies do not systematically report larger or smaller effect sizes compared to larger studies [37]. Observations in favor of the presence of publication bias were supported using Egger's regression test (Table 5), with an intercept equal to -5.19 and p = 0.55. Therefore, these findings do not indicate statistically significant small-study effects or asymmetry. Results further supported by the trim-and-fill method, which did not reveal any missing studies present on either side of the funnel, thus confirming that there is no considerable publication bias involved in the resulting studies [38].

Forest plot

The pooled correlation of r = 0.51 (95% CI: 0.26 to 0.70) as found in the meta-analysis suggests a moderate positive relationship between the CR interventions and clinical outcomes in patients after myocardial infarction. The forest plot (Figure 4) shows the individual correlation coefficients with their 95% confidence intervals for each study included, displaying some differences in effect sizes found across the studies. Among the other studies, Vahedian-Azimi et al. (2024) [32], reporting a very strong positive effect of their family-centered CR program, provide an astounding and overwhelming correlation of r = 0.91 (95% CI: 0.87–0.94). Other studies showed moderate to strong positive correlations; Giannuzzi, et al. (2008) [26] reported r = 0.74 (95% CI: 0.72 to 0.76) and Zhang, et al. (2023) [31] reported r = 0.51 (95% CI: 0.34 to 0.64), thereby further consolidating the overall beneficial effect of cardiac rehabilitation. Various studies, including that of Schon, et al. (2024) [33] (r = 0.01, 95% CI: -0.41 to 0.43), showed an effect close to zero, accompanied by wide confidence intervals, implying an uncertainty about the true effect of the interventions investigated in those studies. All studies included in our analysis that assessed some measure of effect had positive or neutral outcomes, and there were no reports of negative correlations [39,40].

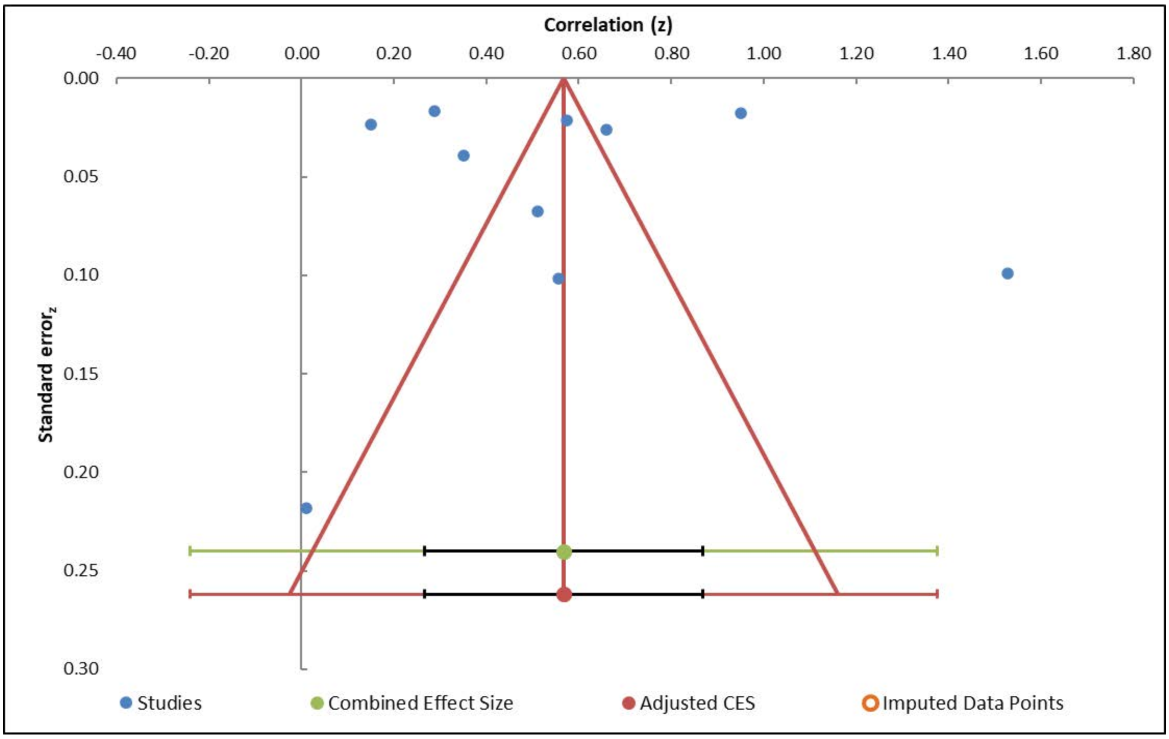

Figure 3: Funnel plot assessing publication bias in the included studies.

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Table 4: Information related to funnel plot.

	Meta-Analysis model	
Study name	**Correlation (z)**	**Standard error (z)**
Jolly et al. (2003)	0.35	0.04
Giannuzzi et al. (2008)	0.95	0.02
West et al. (2011)	0.15	0.02
Plüss et al. (2011)	0.51	0.07
Schwaab et al. (2011)	0.66	0.03
Rauch et al. (2013)	0.29	0.02
Zhang et al. (2023)	0.56	0.10
Vahedian-Azimi et al. (2024)	1.53	0.10
Schon et al. (2024)	0.01	0.22
Hou et al. (2025)	0.57	0.02
Combined effect size		
Correlation (z)	**Observed**	
Correlation	0.57	
SE (z)	0.13	
CI Lower limit	0.27	
CI Upper limit	0.87	
PI Lower limit	-0.24	
PI Upper limit	1.38	
Heterogeneity		
Q	1195.55	
p_Q	0.000	
I^2	99.25%	
T^2	0.11	
T	0.33	
Trim and fill	On	
Estimator for missing studies	Leftmost R	
Search from mean	Left	
Number of imputed studies	0	

Table 5: Egger Regression.

		Egger Regression		
	Estimate	**SE**	**CI LL**	**CI UL**
Intercept	-5.19	8.22	-23.79	13.42
Slope	2.33	2.81	-4.01	8.68
t test	-0.63			
p-value	0.55			

Heterogeneity Assessment

Heterogeneity among the included studies was assessed using the Q statistic, I^2 index, and τ^2 (tau-squared). The Cochran's Q value was 1195.55 with a p-value < 0.001, indicating statistically significant heterogeneity among the studies. The I^2 value was 99.25%, which suggests that nearly all the variability in effect sizes is due to true differences between studies rather than random chance. According to conventional benchmarks, a I^2 value above 75% indicates substantial heterogeneity. The between-study variance (τ^2) was 0.11, further confirming considerable variability across the included studies. This high heterogeneity likely reflects differences in study design, patient populations, types and durations of CR interventions, outcome measurements, and other contextual factors. Despite this variability, the overall positive pooled correlation (r = 0.51) supports a meaningful association. The presence of such heterogeneity justifies the use of a random-effects meta-analysis model, which accounts for both within-study sampling error and between-study variation, providing a more conservative and generalizable estimate of effect size [41,42].

Subgroup analysis

The subgroup analysis divided the included studies into two clusters based on pooled effect sizes and heterogeneity measures (Figure 5 and Table 7). Subgroup AA, which includes seven studies, showed a pooled correlation of 0.57 (95% CI: 0.23 to 0.79), indicating a moderate to strong positive association. This subgroup exhibited substantial heterogeneity with an I^2 of 99.33%, highlighting considerable variability among the study results within this cluster. The prediction interval (-0.36 to 0.93) further reflects this variability, suggesting that future studies in this subgroup could show a wide range of effect sizes [43]. Subgroup BB, comprising three studies, demonstrated a lower pooled correlation of 0.35 (95% CI: -0.38 to 0.81), indicating a weaker and statistically non-significant association. The heterogeneity remained very high in this subgroup as well, with an I^2 of 98.63%, and a wide prediction interval (-0.76 to 0.94), reflecting substantial uncertainty and variation in effect sizes.

The heterogeneity test between subgroups (Q_between = 146.21, p < 0.001) establishes that the difference in effect sizes between these two homogenous subgroups is significant statistically. This indicates that the subgroup classification accounts for part of the heterogeneity observed from the included studies as a whole. Nonetheless, the high I^2 figures within each subgroup indicate that factors such as difference in populations for study, different intervention protocols, and outcome measures play a further role in variability. Therefore, the analysis of the subgroups should improve the pattern discussion though it needs to be investigated further in terms of moderating variables to better understanding the sources of heterogeneity and improving effect estimate precision [44].

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Figure 4: presents a forest plot showing the correlation estimates from each individual study, alongside the overall pooled correlation estimate calculated using a random-effects model [25-34].

Table 6: Information related to Forest plot.

Meta-analysis model	
Model	**Random effects model**
Confidence level	95%
Combined Effect Size	
Correlation	0.51
Confidence interval LL	0.26
Confidence interval UL	0.70
Prediction interval LL	-0.24
Prediction interval UL	0.88
Z-value	4.25
One-tailed p-value	0.000
Two-tailed p-value	0.000
Number of incl. subjects	13340
Number of incl. studies	10
Heterogeneity	
Q	1195.55
p_Q	0.000
I^2	99.25%
T^2 (z)	0.11
T (z)	0.33

Narrative analysis

Out of ten studies, this research reviewed the role of CR in the outcomes of MI patients. Although the studies differed in their structure, the intervention they recommended and the type of patients involved, they all agree that CR improves a patient's prognosis. Experts in the field mainly focused on decreasing deaths and reducing hospital visits, two important signs of how well CR works in secondary prevention.

Effectiveness of Traditional CR Programs: Researchers looked at programs that use regular exercise, educational lessons on lifestyle and efforts to modify major heart disease factors. Giannuzzi et al. (2008) [26] carried out a large study with different hospitals and found that CR reduces the chance of cardiovascular problems. Pluss et al. (2011) [28] found that over a five-year period, patients in an improved CR program experienced less heart-related deaths and had fewer hospital admissions. Several studies prove that these models always improve patients' survival and lower their need for repeat hospitalization.

Innovative and Tailored CR Approaches:

New research is studying how psychosocial support can be combined with CR for personalized care given to patients. Using a family-centered empowerment model, Vahedian-Azimi, et al. (2023) [32] found that excellent rehabilitation support decreased the risk of death over the long term by forty-five percent. In addition, Zhang, et al. (2023) [31] studied patients with a left ventricular aneurysm following anterior MI and found that careful CR helped them the most. It appears that personalizing CR treatment beyond routine exercise and advice can give better results than standard programs.

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Study name / Subgroup name	Correlation	CI Lower limit	CI Upper limit	Weight	Q	p_Q	I^2	T^2	T	PI LL	PI UL
Jolly et al. (2003)	0.34	0.27	0.40	14.50%							
Giannuzzi et al. (2008)	0.74	0.72	0.76	14.62%							
West et al. (2011)	0.15	0.10	0.19	14.60%							
Plüss et al. (2011)	0.47	0.36	0.57	14.22%							
Zhang et al. (2023)	0.51	0.34	0.64	13.70%							
Vahedian-Azimi et al. (2024)	0.91	0.87	0.94	13.74%							
Hou et al. (2025)	0.52	0.49	0.55	14.61%							
AA	**0.57**	**0.23**	**0.79**	**51.99%**	**890.27**	**0.000**	**99.33%**	**0.15**	**0.38**	**-0.36**	**0.93**
Schwaab et al. (2011)	0.58	0.54	0.61	38.45%							
Rauch et al. (2013)	0.28	0.25	0.31	38.67%							
Schon et al. (2024)	0.01	-0.41	0.43	22.88%							
BB	**0.35**	**-0.38**	**0.81**	**48.01%**	**146.21**	**0.000**	**98.63%**	**0.07**	**0.26**	**-0.76**	**0.94**
Combined effect size	**0.48**	**0.19**	**0.69**		**1195.55**	**0.000**	**99.25%**	**0.11**	**0.33**	**0.12**	**0.72**

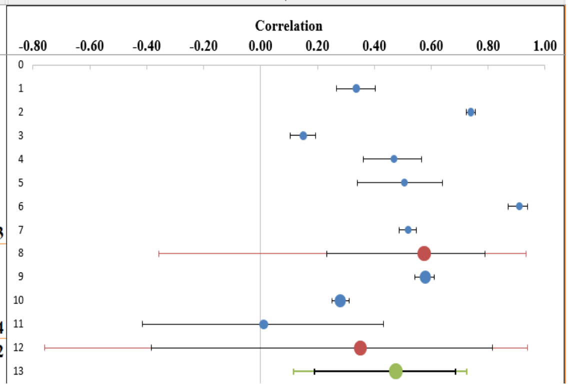

Figure 5: Subgroup analysis of included studies examining the correlations between cardiac rehabilitation and clinical outcomes in post-myocardial infarction patients, stratified by study characteristics [25-34].

Table 7: Information related to Sub-group analysis.

Meta-analysis model			
Combined Effect Size			
Correlation	-0.19		
Confidence interval LL	-0.43		
Confidence interval UL	0.08		
Prediction interval LL	-0.44		
Prediction interval UL	0.09		
Number of incl. subjects	19358		
Number of subgroups	2		
Analysis of variance	**Sum of squares (Q*)**	**Df**	**P**
Between / Model	0.76	1	0.384
Within / Residual	7.36	10	0.697
Total	8.06	11	0.708
Pseudo R^2	9.41%		

Discussion

Following a MI, CR is a main part of secondary prevention for the patient. The most important aims of CR are to cut down on deaths, lessen the number of hospital readmissions, increase how much people can do and improve their daily lives [45]. Latest research found that CR is beneficial for important clinical outcomes, as seen from combining numerous RCTs that examined patients, types of treatments and results differently. The variety among the studies matches typical differences in CR delivery and the people receiving it, demonstrating that it is useful in many healthcare settings [46].

Results are consistent with the large collection of literature that shows positives for traditional exercise-based CR programs. They contain physical exercises, training on lifestyle habits and treatment for heart disease risks. These interventions have long been found to raise survival rates and lower the risk of more cardiovascular events for post-MI individuals in widely referenced trial studies [47]. Also, there is a noticeable tendency in CR to use psychosocial support, include family members and focus on empowerment. This approach seems to help children follow their treatment more closely and achieve better long-term effects. The shift reflects that cardiac recovery involves many factors and a person's mental health and the support of others are important for good results in rehab [48].

Innovative methods that consider small groups of patients and combine CR with technology look very promising. For instance, interventions focused on left ventricular aneurysm or programs that use mobile health apps might meet the needs of patients who have trouble taking part. The way cancer is treated today aligns with modern efforts to give patients personalized treatments suited to their situations [49].

Still, the results are encouraging, but many studies differ because of their varied interventions, how long they last, how outcomes are measured and who the patients are. Therefore, we need clear guidelines and standard outcomes in future research. Assessing the many effects of CR and studying its economic value are still major goals to improve the way CR is put into practice [50].

Although CR seems to be useful after a MI, there are some limitations to keep in mind. There was a great deal of difference among the studies in terms of the patients, their settings, the treatments used and how outcomes were defined. Such heterogeneity may have influenced the observed effect sizes and limits the ability to generalize the results universally. Additionally, many studies lacked detailed reporting on the intensity, duration, and specific components of the CR programs, making it difficult to identify which elements contribute most to clinical benefits. In addition, the large majority of patients in the trials were younger and generally healthy and less attention was given to elderly or seriously ill people. As a result, the findings cannot be used to benefit these important and growing patient populations. A number of studies used techniques that raise doubts about their randomization or about the execution of planned interventions which could affect the solidity of their results.

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Future Research

Further research should establish exercise routines that are appropriate for people recovering from a heart attack, with regard to type, intensity and duration. When the same rules are followed globally and in one country, trials can be compared more easily and the differences among them reduced. In particular, future studies should focus on including elderly patients and those with chronic comorbidities, since these groups have challenges and lack enough evidence about what CR can do for them. Besides helping the body heal, mental problems like depression and anxiety play a big role in influencing how well post-MI patients do and stick to rehabilitation. It is important to examine models that combine cardiovascular care with organized psychological support to see if they help improve mental health and heart health. Using digital tools and tailored interventions may increase how accessible CR is and boost a patient's involvement. Following patients over a long period helps determine how CR continues to affect their survival, need for hospital care and quality of life. By improving the gaps, studies in the future can optimize CR strategies to better benefit a wider range of patients.

Conclusions

The research presented in this review and analysis strongly suggests that CR leads to better outcomes for patients recovering from a heart attack. Studies using RCTs found that CR greatly reduced the chance of death and hospitalization, so it is recognized as key for secondary prevention. Traditional exercise training in CR has been shown to raise survival and decrease the odds of new cardiovascular events. Besides, including psychosocial care and family-centered help seems to further benefit children, indicating that holistic and patient-centered care really matter.

Even with many differences in the studies such as who took part, the treatment they received and how long they were followed, the evidence suggests that CR can be used in many healthcare environments. Interventions designed for those with left ventricular aneurysm or social and psychological difficulties appear promising to achieve greater outcomes. Even so, the program components, strength and duration required are not well defined in elderly individuals or those with several other health issues. There is also a need to look more closely at integrating mental health services in CR, since doing so could improve both commitment to recovery and success. To maximize patient benefit, future research should focus on standardizing CR guidelines, expanding inclusivity, and leveraging technological innovations for personalized care.

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