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THE EFFECTIVENESS OF PHASE III CARDIAC TELEREHABILITATION ON FUNCTIONAL CAPACITY, ADHERENCE, REHOSPITALIZATION, AND QUALITY OF LIFE: A SYSTEMATIC REVIEW AND META-ANALYSIS

Wini Widia Maulanie[1], Cecep Eli Kosasih[2], Hikmat Rudyana[3]
Universitas Jenderal Achmad Yani
winienurse49@gmail.com

Abstract

Cardiovascular disease remains the leading cause of global morbidity and mortality. Phase III cardiac rehabilitation plays a crucial role in long-term maintenance and secondary prevention; however, patient adherence and program sustainability remain suboptimal due to limited access, geographical barriers, and resource constraints. Phase III cardiac telerehabilitation has been developed as a digital-based alternative to support patient engagement and continuity of rehabilitation. This study aimed to analyze the effectiveness of phase III cardiac telerehabilitation on functional capacity, adherence, rehospitalization, and quality of life compared with conventional cardiac rehabilitation or standard care. This study was a systematic review and meta-analysis of 15 randomized controlled trials published between 2015 and 2025. The study population included adult patients with cardiovascular disease who had completed phase II cardiac rehabilitation and participated in phase III cardiac telerehabilitation programs. Outcomes assessed included functional capacity (VO_2peak, Six-Minute Walk Test, and metabolic equivalents), program adherence, rehospitalization, and quality of life. Data were analyzed using Review Manager (RevMan) version 5.3 with fixed-effect or random-effect models according to heterogeneity levels. The meta-analysis demonstrated that phase III cardiac telerehabilitation significantly improved functional capacity measured by VO_2peak with low heterogeneity ($I^2 = 0\%$), as well as quality of life (SMD = 0.16; 95% CI 0.04–0.28; p = 0.01) and patient adherence to rehabilitation programs. However, no significant differences were observed in the Six-Minute Walk Test, metabolic equivalents, or rehospitalization compared with control groups. Based on these findings, phase III cardiac telerehabilitation is recommended as an effective and safe strategy to support the long-term sustainability of cardiac rehabilitation and improve patients' quality of life.

Keywords: Cardiac Telerehabilitation, Phase III Rehabilitation, Functional Capacity, Adherence, Quality Of Life, Meta-Analysis

* Corresponding author :
Address : Universitas Jenderal Achmad Yani
Email : winienurse49@gmail.com

INTRODUCTION

Cardiovascular disease (CVD) remains the leading cause of morbidity and mortality worldwide, accounting for approximately 17.9 million deaths annually. The global burden of CVD continues to increase due to population aging, lifestyle changes, and the rising prevalence of metabolic risk factors. Beyond mortality, CVD significantly contributes to long-term disability, decreased quality of life, and escalating healthcare expenditures, making it a major public health concern across both developed and developing countries (World Health Organization, 2023).

Cardiac rehabilitation is widely recognized as an effective multidisciplinary intervention for secondary prevention of cardiovascular disease. It integrates structured exercise training, health education, risk factor management, psychological support, and pharmacological adherence monitoring to improve functional capacity and reduce recurrent cardiovascular events. Cardiac rehabilitation is typically delivered in three phases: phase I (inpatient), phase II (structured outpatient), and phase III (long-term maintenance). Among these, phase III plays a crucial role in sustaining the clinical gains achieved during earlier phases and promoting long-term lifestyle modification.

Despite strong clinical evidence supporting cardiac rehabilitation, patient participation and adherence remain suboptimal, particularly during phase III. Common barriers include limited access to rehabilitation facilities, geographical constraints, transportation costs, time limitations, and reduced supervision after discharge from structured programs. As a result, many patients experience a decline in exercise adherence and lifestyle changes once they transition to home-based self-management. This decline may lead to reduced functional capacity, increased rehospitalization risk, and poorer long-term quality of life outcomes.

The rapid advancement of digital health technologies has introduced new opportunities to address these challenges through cardiac telerehabilitation. This approach allows patients to participate in rehabilitation programs remotely using digital platforms such as mobile health applications, wearable monitoring devices, telecoaching, and real-time telemonitoring systems. Telerehabilitation has the potential to improve accessibility, flexibility, and continuity of care, particularly for patients living in remote areas or those with limited mobility.

Previous studies have demonstrated that cardiac telerehabilitation can produce outcomes comparable to center-based rehabilitation in improving functional capacity and quality of life, especially during phase II rehabilitation. However, evidence specifically focusing on phase III telerehabilitation remains limited, despite this phase being essential for long-term maintenance and secondary prevention. More than half of the long-term success of cardiac rehabilitation depends on sustained adherence to lifestyle modification, exercise, and risk factor management during the maintenance phase.

Furthermore, there remains a significant gap between scientific evidence and healthcare policy implementation. Policymakers require robust, comprehensive, and clearly interpretable evidence to support the integration of digital health innovations into national healthcare systems. Systematic reviews and meta-analyses of randomized controlled trials (RCTs) represent the highest level of evidence for evaluating intervention effectiveness and guiding evidence-informed policymaking.

Therefore, this study aims to analyze the effectiveness of phase III cardiac telerehabilitation on functional capacity, adherence, rehospitalization, and quality of life among patients with cardiovascular disease compared with conventional rehabilitation or standard care. The findings are expected to provide strong evidence to support the development and integration of digital-based cardiac rehabilitation programs that are accessible, sustainable, and adaptable to modern healthcare systems.

METHODS

Study Design

This study employed a systematic review and meta-analysis design to evaluate the effectiveness of phase III cardiac telerehabilitation on functional capacity, adherence, rehospitalization, and quality of life. The review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines to ensure methodological transparency, reproducibility, and scientific rigor.

Search Strategy

A comprehensive literature search was conducted to identify relevant randomized controlled trials (RCTs) published between January 2015 and December 2025. Electronic databases searched included PubMed, Scopus, ScienceDirect, Cochrane Library, and Google Scholar. Search terms were developed using a combination of Medical Subject Headings (MeSH) and keywords, including:

- "cardiac telerehabilitation"
- "phase III cardiac rehabilitation"
- "home-based cardiac rehabilitation"
- "functional capacity"
- "quality of life"
- "adherence"
- "rehospitalization"
- "randomized controlled trial"

Boolean operators (AND/OR) were applied to refine search results. Reference lists of selected articles were also screened manually to identify additional relevant studies.

Eligibility Criteria

Inclusion Criteria

Studies were included if they met the following criteria:

1. Randomized controlled trial design.
2. Adult participants diagnosed with cardiovascular disease.
3. Participants had completed phase II cardiac rehabilitation.
4. Intervention involved phase III cardiac telerehabilitation delivered through digital platforms.
5. Comparator included conventional cardiac rehabilitation or standard care.
6. Reported at least one of the following outcomes:
   - Functional capacity (VO_2 peak, Six-Minute Walk Test, or METs)
   - Adherence to rehabilitation programs
   - Rehospitalization
   - Quality of life
7. Published in peer-reviewed journals between 2015 and 2025.

Exclusion Criteria

Studies were excluded if they:

- Were non-randomized or observational studies.
- Focused only on phase I or phase II rehabilitation.
- Included pediatric populations.
- Did not provide sufficient quantitative outcome data.

Study Selection

All retrieved articles were imported into a reference management software to remove duplicates. Titles and abstracts were independently screened by two reviewers based on eligibility criteria. Full-text articles were then assessed for inclusion. Disagreements were resolved through discussion or consultation with a third reviewer to ensure selection consistency and minimize bias.

Data Extraction

Data extraction was conducted independently by two reviewers using a standardized extraction form. The following information was collected from each study:

- Author and year of publication
- Country of study
- Sample size and participant characteristics
- Type and duration of telerehabilitation intervention
- Comparator intervention
- Outcome measures (VO_2 peak, 6MWT, METs, adherence, rehospitalization, quality of life)
- Follow-up duration

Quality Assessment and Risk of Bias

The methodological quality of included studies was assessed using the Cochrane Risk of Bias Tool. The following domains were evaluated:

- Random sequence generation
- Allocation concealment
- Blinding of participants and personnel
- Blinding of outcome assessment
- Incomplete outcome data
- Selective reporting

Each study was classified as having low, unclear, or high risk of bias.

Outcome Measures

Primary Outcome

- Functional capacity measured using VO_2 peak, Six-Minute Walk Test (6MWT), or metabolic equivalents (METs).

Secondary Outcomes

- Adherence to rehabilitation programs
- Rehospitalization rates
- Quality of life assessed using validated instruments (e.g., SF-36, EQ-5D, or disease-specific scales)

Data Synthesis and Statistical Analysis

Meta-analysis was conducted using Review Manager (RevMan) version 5.3. Continuous outcomes were analyzed using standardized mean differences (SMD) with 95% confidence intervals (CI), while dichotomous outcomes were analyzed using risk ratios (RR).

Statistical heterogeneity was assessed using the I^2 statistic:

- $I^2 < 25\%$: low heterogeneity
- I^2 25–50%: moderate heterogeneity
- $I^2 > 50\%$: high heterogeneity

A fixed-effect model was used when heterogeneity was low, and a random-effect model was applied when heterogeneity was moderate to high. Publication bias was evaluated using funnel plot analysis.

RESULTS AND DISCUSSION

Study Identification and Selection Process

This systematic review and meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines to ensure methodological transparency, reproducibility, and high reporting standards. The use of PRISMA 2020 enabled a structured approach in defining the research question, developing the search strategy, selecting studies, assessing methodological quality, and synthesizing findings.

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Prior to the literature search, the study protocol was formally registered to enhance transparency and minimize reporting bias. Due to technical constraints encountered during registration in PROSPERO, the protocol was registered in the International Platform of Registered Systematic Review and Meta-analysis Protocols (INPLASY), an internationally recognized registry that complies with PRISMA reporting standards. The study was registered under INPLASY Protocol Number INPLASY2025120028 with DOI: 10.37766/inplasy2025.12.0028, published on December 9, 2025.

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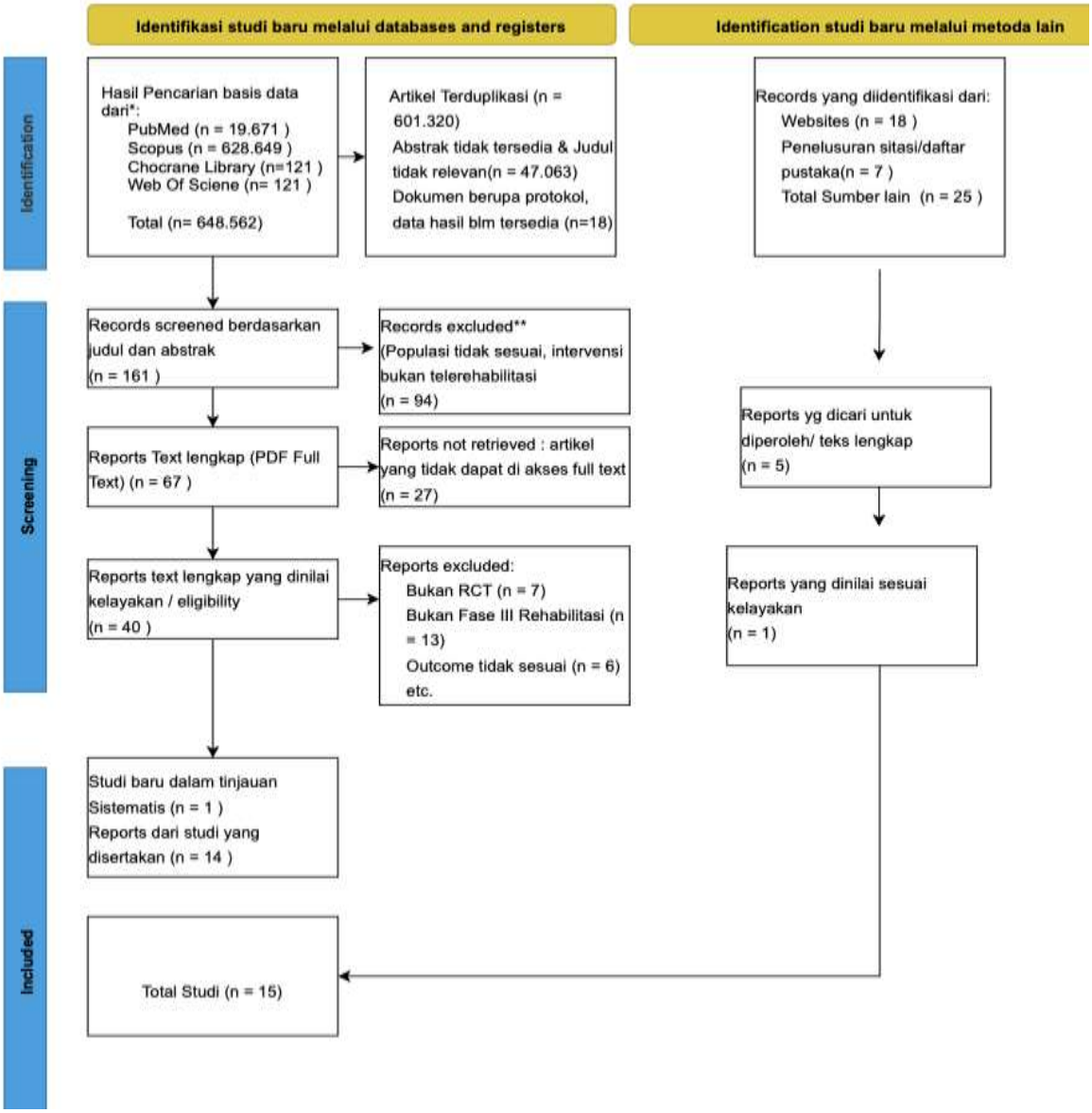
A comprehensive literature search was conducted across multiple electronic databases, including PubMed/MEDLINE, Scopus, Cochrane Library, and Web of Science. The search was performed between December 20 and December 23, 2025. Keywords and Medical Subject Headings (MeSH) terms were combined using Boolean operators to maximize sensitivity and specificity. The search terms included combinations of:

- Intervention terms: “telerehabilitation”, “remote cardiac rehabilitation”, “home-based cardiac rehabilitation”, “digital health”, “mHealth”, “telemonitoring”, “wearable devices”, “digital coaching”
- Population terms: “cardiac rehabilitation”, “coronary artery disease”, “ischemic heart disease”, “heart failure”, “post-PCI”, “post-CABG”
- Outcome terms: “functional capacity”, “VO_2 peak”, “VO_2 max”, “6-minute walk test”, “exercise tolerance”, “quality of life”, “HRQoL”, “adherence”, “compliance”, “rehospitalization”, “hospital readmission”

Advanced syntax (e.g., Ti, Ab, Tiab, truncation symbols, and parentheses) was used to refine the search strategy. Filtering criteria included publication year (2015–2025), English-language articles, and randomized controlled trials.

The study selection process followed the PRISMA flow framework. First, all records identified from databases were compiled and duplicate entries were removed. Second, titles and abstracts were screened based on inclusion and exclusion criteria. Third, full-text articles were assessed for eligibility. The final PRISMA flow diagram is presented in Figure 1.



Study Characteristics

A total of 15 studies were included in this meta-analysis, representing diverse geographic regions including Japan, Spain, Germany, Portugal, Finland, Australia, the United States, Belgium, Ireland, Norway, Poland, the Czech Republic, and Israel. The studies were published between 2017 and 2025 and involved patients diagnosed primarily with coronary artery disease and heart failure who had completed phase II cardiac rehabilitation and were transitioning into phase III maintenance programs.

NO	Penulis (Tahun)	Judul Penelitian	Lokasi Penelitian	Populasi *Jenis penyakit*	Jumlah Partisipan	Jenis Studi	Intervensi Komponen Teknologi Telerehabilitasi Fase III	Comparison/ Pembanding	*Outcome* Primer	Sekunder

1	*Nishio et al. (2025)*	*Wearable Devices in Remote Cardiac Rehabilitation With and Without Weekly Online Coaching for Patients With Coronary Artery Disease*	Jepang	*Coronary Artery Disease*	Total= 50 (Intervensi = 25, Kontrol = 25)	*Randomized controlled trial*	*Wearable-based remote cardiac rehabilitation*	*Wearable-based rehabilitation without coaching* (Tanpa pelatihan daring)	Kapasitas Fungsional : *VO_2 peak*	Aktivitas fisik dan kualitas hidup
2	*Cruz-Cobo et al. (2024)*	*Efficacy of a Mobile Health App (eMOTIVA)*	Spanyol	*Coronary Artery Disease*	Total= 300 (Intervensi = 150, Kontrol = 150)	*Randomized controlled trial*	*Mobile app–based cardiac rehabilitation*	*Standard cardiac rehabilitation* (Rehabilitasi Standar)	Kepatuhan Rehabilitasi	Kapasitas Fungsional (6MWT, METs)
3	*Yamashita et al. (2024)*	*Effects of Small Community Walking*	Jepang	*Coronary Artery Disease*	Total= 55 (Intervensi = 29, Kontrol = 26)	*Randomized controlled trial*	*Small-group community walking programme*	I*ndividual walking* (program Standar)	Aktivitas fisik	Kapasitas Fungsional : *Six Minute Walking Test* (6MWT)
4	*Nabutovsky et al. (2024)*	*Enhanced Strength Training in Remote Cardiac Rehabilitation*	Israel	*Coronary Artery Disease*	Total= 50 (Intervensi = 23, Kontrol = 27)	*Pilot randomized controlled trial*	*Remote cardiac rehabilitation with strength training*	*Standard rehabilitation* (Rehabilitasi Standar)	Kekuatan Otot	Kapasitas Fungsional : METs
5	*Bretschneider et al.(2024)*	*Results of a Digital Multimodal Motivational and Educational Program*	Jerman	*Coronary Artery Disease*	Total = 354 (Intervensi = 190, Kontrol = 164)	*Randomized controlled trial*	*Digital multimodal aftercare programme*	*No digital aftercare* (Tanpa program digital)	Kualitas Hidup	Risiko Kardiovaskular
6	*Vieira et al. (2023)*	*Home-Based Virtual Reality Exercise Program*	Portugal	*Coronary Artery Disease*	Total= 33 (Intervensi = 22, Kontrol = 11)	*Randomized controlled trial*	*Virtual reality–based home exercise cardiac rehabilitation*	*Booklet-based exercise* (latihan berbasis booklet /standa	Kapasitas Fungsional	Kapasitas Fungsional : METs dan Aktivitas Fisik

							r)		
7	*Lahtio et al. (2023)*	*The Added Value of Remote Technology in Cardiac Rehabilitation on Physical Function, Anthropometrics, and Quality of Life*	Finlandia	*Coronary Artery Disease*	Total= 59 (Intervensi = 29, Kontrol = 30)	*Cluster randomized controlled trial*	*Remote technology–assisted cardiac rehabilitation*	*Conventional cardiac rehabilitation* (rehabilitasi jantung konvensional)	Kapasitas Fungsional : *Six Minute Walking Test* (6MWT)	Kualitas Hidup & Antropometri
8	*Indraratna et al. (2022)*	*A Smartphone-Based Model of Care to Support Patients With Cardiac Disease*	Australia	*Coronary Artery Disease and Heart Failure*	Total= 164 (Intervensi = 81, Kontrol = 83)	*Randomized controlled trial*	*Smartphone-based transitional cardiac care model*	*Standard discharge care* (Perawatan pulang standar)	Readmisi Rumah Sakit (Rehospitalilsasi)	Kualitas Hidup
9	*Park et al. (2021)*	*Mobile Health Intervention Promoting Physical Activity*	Amerika Serikat	*Coronary Artery Disease*	Total= 60 (Intervensi = 26, Kontrol = 25)	*Randomized controlled trial*	*Mobile health intervention after cardiac rehabilitation*	*Standard post-cardiac rehabilitation care* (perawatan paska rehabilitasi standar)	Aktivitas Fisik	Kapasitas Fungsional : *Six Minute Walking Test* (6MWT)
10	*Claes et al. (2020)*	*Feasibility and Effectiveness of the PATHway Platform*	Belgia & Irlandia	*Coronary Artery Disease*	Total = 120 (Intervensi = 60, Kontrol = 60)	*Pilot randomized controlled trial*	*Digital platform–enabled home-based cardiac rehabilitation*	*Usual care* (perawatan standar)	Aktivitas Fisik	Kapasitas Fungsional : VO_2 *peak* & Kualitas Hidup
11	*Lunde et al. (2020)*	*Long-Term Follow-up With a Smartphone Application Improves Exercise Capacity Post Cardiac Rehabilitation*	Norwegia	*Coronary Artery Disease*	Total = 113 (Intervensi = 57, Kontrol = 56)	*Randomized controlled trial*	*Smartphone-based follow-up after cardiac rehabilitation*	*Usual post-cardiac rehabilitation follow-up* (tindak lanjut rehabilitasi jantung standar	Kapasitas Fungsional : VO_2 *peak*	Kualitas Hidup

								)		
12	*Piotrowicz et al. (2020)*	*Long-Term Outcomes of Hybrid Telerehabilitation in Patients With Heart Failure: The TELEREH-HF Trial*	Polandia	*Heart Failure*	Total = 850 (Intervensi = 425, Kontrol = 425)	*Randomized controlled trial*	*Hybrid comprehensive cardiac telerehabilitation*	*Standard heart failure care* (perawatan gagal jantung standar)	Mortalitas dan Rehospitalisasi	(-)
13	*Batalik et al. (2020)*	*Wrist Heart Rate Monitor as a Telerehabilitation Device*	Republik Ceko	*Coronary Artery Disease*	Total = 56 (Intervensi = 28, Kontrol = 28)	*Randomized controlled trial*	*Heart rate monitor–based cardiac telerehabilitation*	*Conventional outpatient cardiac rehabilitation* (rehabilitasi jantung konvensional)	Kapasitas Fungsional : *VO_2 peak*	Kualitas Hidup
14	*Pekmezaris. et al (2019)*	*Telehealth Self-Management in Underserved Heart Failure Patients*	Amerika Serikat	*Heart Failure*	Total = 104 (Intervensi = 46, Kontrol = 58)	*Randomized controlled trial*	*Telehealth-based self-management programme*	*Standard outpatient management* (perawatan rawat jalan standar)	Rehospitalisai	Kualitas Hidup
15	*Hwang et al. (2017)*	*Home-Based Telerehabilitation in Chronic Heart Failure*	Australia	*Gagal Jantung*	Total= 53 (Intervensi = 24, Kontrol = 29)	*Randomized controlled trial*	*Home-based video-conference cardiac telerehabilitation*	*Centre-based cardiac rehabilitation* (rehabilitasi berbasis fasilitas)	Kapasitas Fungsional : *Six Minute Walking Test* (6MWT)	Kualitas Hidup

Discussion

This systematic review and meta-analysis evaluated the effectiveness of phase III cardiac telerehabilitation on functional capacity, adherence, rehospitalization, and quality of life among patients with cardiovascular disease. The findings indicate that digital-based maintenance rehabilitation offers clinically meaningful benefits, particularly in improving VO_2 peak, enhancing adherence, and increasing quality of life, while demonstrating comparable outcomes to conventional rehabilitation in terms of 6-minute walk test (6MWT), metabolic equivalents (METs), and rehospitalization.

Functional Capacity Outcomes

One of the most important findings of this study is the significant improvement in functional capacity measured by VO_2 peak among patients who participated in phase III cardiac telerehabilitation. VO_2 peak is considered the gold standard indicator of cardiorespiratory fitness and a strong predictor of long-term cardiovascular outcomes. The low heterogeneity observed across studies suggests that the effect of telerehabilitation on VO_2 peak is consistent and reproducible across different populations and technological modalities.

This improvement can be explained by the ability of digital platforms to support sustained exercise participation beyond structured clinical rehabilitation. Continuous monitoring through wearable devices, mobile applications, and telecoaching allows patients to maintain regular physical activity levels, which are essential for preserving aerobic capacity. In phase III rehabilitation, where patients transition to self-managed exercise, digital supervision appears to bridge the gap between structured care and independent lifestyle maintenance.

In contrast, pooled results showed no statistically significant difference in 6MWT and METs between intervention and control groups. This finding may reflect variability in exercise intensity, program duration, and outcome measurement timing across studies. It is also possible that both telerehabilitation and conventional rehabilitation are equally effective in maintaining functional mobility and endurance once patients have completed phase II programs.

Adherence to Rehabilitation

Another key finding of this study is the positive impact of telerehabilitation on patient adherence. Adherence is a critical determinant of long-term rehabilitation success, particularly during phase III when patients are no longer under continuous clinical supervision. Digital platforms provide structured reminders, self-monitoring tools, performance feedback, and remote interaction with healthcare providers, all of which may reinforce behavioral motivation and long-term engagement.

Behavioral theory suggests that consistent feedback, goal-setting, and remote support can strengthen self-efficacy and sustain lifestyle changes. Telerehabilitation programs often incorporate motivational coaching, activity tracking, and personalized monitoring, which may help patients maintain exercise routines and healthy behaviors over extended periods. This mechanism likely explains the higher adherence levels observed in digital rehabilitation groups compared with standard care.

Quality of Life Improvements

This study also found that phase III cardiac telerehabilitation significantly improved quality of life outcomes. Although the pooled effect size was modest, it remained statistically meaningful and clinically relevant. Quality of life in cardiac patients is influenced not only by physical function but also by psychological well-being, social participation, and perceived independence.

Telerehabilitation may enhance quality of life through several pathways. First, remote programs reduce the burden of travel and scheduling constraints, allowing patients to integrate rehabilitation into daily routines. Second, digital platforms may provide a sense of security through continuous monitoring and professional support. Third, increased autonomy in managing health behaviors may improve confidence and psychological resilience. These combined factors may contribute to improved patient satisfaction and perceived well-being.

Rehospitalization Outcomes

In contrast to functional and behavioral outcomes, this study did not find a significant reduction in rehospitalization rates among patients receiving telerehabilitation compared with control groups. Several factors may explain this finding. Rehospitalization is influenced by multiple clinical variables, including disease severity, comorbid conditions, medication adherence, and healthcare system factors, which may not be fully addressed by rehabilitation interventions alone.

Additionally, follow-up durations across studies varied, and some trials may not have been sufficiently powered to detect differences in hospitalization outcomes. It is also possible that phase III telerehabilitation primarily supports functional maintenance and behavioral adherence rather than directly preventing acute clinical deterioration. Therefore, longer-term studies may be required to evaluate its impact on clinical endpoints such as hospitalization and mortality.

Clinical and Nursing Implications

The findings of this study have important implications for clinical practice and healthcare delivery. Phase III cardiac rehabilitation is widely

recognized as the most challenging phase in terms of sustaining patient engagement. Telerehabilitation offers a scalable and accessible model to support long-term disease management, particularly in regions with limited access to rehabilitation facilities.

From a nursing perspective, the integration of digital health technologies expands the role of nurses beyond traditional clinical settings. Nurses can function as care coordinators, digital health navigators, and remote coaches who monitor patient progress, provide education, and support behavior change. This shift aligns with modern patient-centered care models that emphasize continuity, accessibility, and long-term self-management.

Interpretation in the Context of Global Healthcare Trends

Globally, participation rates in conventional cardiac rehabilitation remain low due to geographical, economic, and logistical barriers. Telerehabilitation has emerged as a promising strategy to address these gaps by enabling home-based care delivery supported by digital technologies. The consistency of positive findings across multiple countries in this study suggests that telerehabilitation is adaptable to diverse healthcare settings and populations.

In developing countries, where rehabilitation infrastructure may be limited, digital approaches could significantly expand access to secondary prevention services. The use of mobile technology, wearable devices, and remote monitoring platforms may help reduce disparities in rehabilitation participation and improve long-term cardiovascular outcomes.

CONCLUSION

This systematic review and meta-analysis of 15 randomized controlled trials demonstrates that phase III cardiac telerehabilitation is an effective and safe maintenance strategy after completion of phase II rehabilitation, showing significant improvements in functional capacity (VO_2 peak), adherence to rehabilitation programs, and health-related quality of life compared with conventional rehabilitation or standard care, while yielding no statistically significant differences in Six-Minute Walk Test (6MWT), metabolic equivalents (METs), or rehospitalization; overall, these findings suggest that the main added value of phase III telerehabilitation lies in sustaining long-term engagement and self-management, supporting functional maintenance, and expanding access to secondary prevention services—particularly for patients facing geographic or logistical barriers—although further research is needed to clarify long-term clinical endpoints and identify the most effective program components

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