Physiotherapy-led Interventions in Cardiac Rehabilitation Programs for Individuals with Heart Disease: A Scoping Review

Master in Health Promotion

Raquel Inês Simões Gomes de Oliveira

October 2025

Physiotherapy-led Interventions in Cardiac Rehabilitation Programs for Individuals with Heart Disease: A Scoping Review

Dissertation presented to fulfil the requirements for the Master's degree in Health Promotion, developed under the scientific supervision of Professor Marta Moreira Marques and Alexandre Moniz

October 2025

ACKNOWLEDGEMENTS

This master's journey has challenged me in many ways, but each difficulty has been an opportunity for growth, reflection, and transformation, both personally and academically.

I would like to express my deepest gratitude to my supervisor, Marta Moreira Marques, for her guidance and valuable contributions throughout this academic journey.

I am sincerely grateful to my co-supervisor, Alexandre Moniz, my deepest thanks for his availability, constant support, dedication, and patience at every stage of this work.

I would like to express my sincere gratitude to Professor Ana Rita Goes for her coordination of the master's program, her constant availability, and her encouraging words throughout this journey.

I would also like to thank librarians Isabel Andrade and Silvana Roque de Oliveira for their availability, kindness, professionalism, and competence in assisting me throughout this work.

I am deeply indebted to my classmates, in particular Lúcia Parreira and Filipa Garvão, for their presence, encouragement, and help whenever I needed it most.

I would like to express my heartfelt appreciation to my parents, and especially to my mother, for who I am, what I have become, and what I have achieved, I also owe to them.

I thank my children, for always believing in me and for their understanding of the time I had to take away from them.

Finally, I would like to thank my husband, to whom I owe my greatest gratitude, for being my anchor, my safe haven, and my greatest strength over these past two years. Your unwavering support and love were my foundation; without your patience and presence, this journey would not have been possible.

ABSTRACT

Introduction: Cardiovascular diseases are the leading cause of death worldwide, with associated disability creating significant economic and social burden. Following a cardiac event, Cardiac Rehabilitation (CR) - a comprehensive multidisciplinary program combining physical exercise, health behavioral changes, risk factor management, and psychological support – is the recommended treatment. Physiotherapists play a key role in exercise prescription and monitoring, but their interventions must be integrated with other healthcare professionals. However, there is a lack of clarity regarding the specific characteristics of physiotherapy-led interventions, the Behavior Change Techniques (BCTs) employed, the implementation strategies - that support their adoption in different contexts.

Objective: To map the existing literature on physiotherapy-led interventions within CR programs, identifying their characteristics, the BCTs employed, the implementation strategies used, and the patient-level primary outcomes evaluated.

Methods: A scoping review was conducted according to the Joanna Briggs Institute methodology and reported following the PRISMA-ScR checklist. A systematic search of peer-review papers reporting randomized controlled trials was performed in PubMed, SCOPUS, Web of Science, and CINAHL, complemented by manual reference screening. Two reviewers independently conducted study selection, data extraction, and synthesis. Intervention characteristics were described using the Template for Intervention Description and Replication (TIDieR) checklist, BCTs were coded through the Behavior Change Technique Ontology (BCTO), and implementation strategies were classified according to the Expert Recommendations for Implementing Change (ERIC) taxonomy. Findings were synthesized narratively and presented in tables according to the review objectives.

Results: Twenty-three studies were included, involving populations with heart disease or patients undergoing cardiac surgery or percutaneous procedures, among others. Most studies involved patients with heart failure (K = 10), cardiac surgery (K = 7), or percutaneous coronary interventions (K = 6). Physiotherapy interventions were highly diverse, with a predominance of hybrid programs (K=8) combining initial in-person phases with continued home-based formats, often supported by digital technologies. The most common components were aerobic exercise combined with resistance training (K=12), mostly prescribed at moderate to vigorous intensity (K=11). Several BCTs were identified, most frequently *instruct how to perform behavior*, *self-monitor behavior* and *set graded tasks*. Implementation strategies were mainly focused on patient adherence

(*intervene with patients/consumers to enhance uptake and adherence*). The main patient-level primary outcomes evaluated were functional capacity (K = 6), exercise capacity (K = 5), and quality of life (K = 3).

Conclusion: This study enhances the understanding of physiotherapy's role in CR by mapping the characteristics of interventions described in the literature. The findings highlight the diversity of physiotherapy-led programs and the growing integration of behavioral and implementation components. This evidence may support the development of more sustainable, accessible, and equitable CR programs and guide future research towards greater standardization and effectiveness of physiotherapy practice.

Keywords: Cardiac Rehabilitation; Physiotherapy; Heart Disease; Behavior Change Techniques; Implementation Strategies; Scoping Review.

RESUMO

Introdução: As doenças cardiovasculares são a principal causa de morte no mundo, sendo a incapacidade associada a estas condições responsável por um elevado impacto económico e social. Após um evento cardíaco, a reabilitação cardíaca - um programa multidisciplinar abrangente que combina exercício físico, mudança de comportamentos de saúde, controlo de fatores de risco e apoio psicológico — constitui o tratamento recomendado. O fisioterapeuta desempenha um papel fundamental na prescrição e monitorização do exercício, mas as suas intervenções devem estar integradas com as de outros profissionais de saúde. Contudo, existe anda falta de clareza quanto às características específicas das intervenções conduzidas por fisioterapeutas, às técnicas de mudança comportamental utilizadas e às estratégias de implementação que apoiam a sua adoção em diferentes contextos.

Objetivo: Mapear a literatura existente sobre intervenções conduzidas por fisioterapeutas em programas de reabilitação cardíaca, identificando as suas características, as técnicas de mudança comportamental empregues, as estratégias de implementação utilizadas e os desfechos primários avaliados ao nível do utente.

Métodos: Foi conduzida uma *scoping review* de acordo com a metodologia da Joanna Briggs Institute e reportada segundo a checklist PRISMA-ScR. Efetuou-se uma pesquisa sistemática de artigos *peer-reviewed* que relataram ensaios clínicos aleatorizados nas bases de dados nas bases de dados PubMed, SCOPUS, Web of Science e CINAHL, complementada por uma triagem manual de referências. Dois revisores conduziram de forma independente a seleção dos estudos, a extração e a síntese de dados. As características das intervenções foram descritas com base na checklist Template for Intervention Description and Replication (TIDieR), as técnicas de mudança comportamental codificadas através da Behaviour Change Technique Ontology (BCTO), e as estratégias de implementação classificadas segundo a taxonomia Expert Recommendations for Implementing Change (ERIC). Os achados foram sintetizados narrativamente e apresentados em tabelas, de acordo com os objetivos da revisão.

Resultados: Foram incluídos 23 ensaios clínicos randomizados envolvendo populações com doença cardíaca, ou submetidas a cirurgia cardíaca ou procedimentos percutâneos. A maioria dos estudos incluiu doentes com insuficiência cardíaca (k = 10), cirurgia cardíaca (k = 7) ou intervenções coronárias percutâneas (k = 6). As intervenções de fisioterapia revelaram grande diversidade, com predomínio de programas híbridos (k = 8) que combinaram fases iniciais presenciais com acompanhamento continuado em formato domiciliário, frequentemente suportado por tecnologias digitais. Os componentes mais comuns foram o exercício aeróbio combinado com treino de

resistência (k = 12), geralmente prescrito a intensidade moderada a vigorosa (k = 11). Foram identificadas várias técnicas de mudança comportamental, sendo mais frequentes *instruct how to perform behavior*, *self-monitor behavior* and *set graded tasks.* As estratégias de implementação centraram-se sobretudo na adesão dos utentes (*intervene with patients/consumers to enhance uptake and adherence*). Os principais desfechos primários avaliados ao nível do utente foram a capacidade funcional (K = 6), a capacidade de exercício (K = 5) e a qualidade de vida (K = 3).

Conclusão: Este estudo contribui para uma melhor compreensão do papel da fisioterapia na reabilitação cardíaca, ao mapear as características das intervenções descritas na literatura. Os resultados obtidos evidenciam a diversidade dos programas conduzidos por fisioterapeutas e a crescente integração de componentes comportamentais e de implementação. Esta evidência pode apoiar o desenvolvimento de programas mais sustentáveis, acessíveis e equitativos, bem como orientar futuras investigações para uma maior padronização e eficácia da prática na fisioterapia.

Palavra-chave: Reabilitação Cardíaca; Fisioterapia; Doença cardíaca; Técnicas de mudança comportamental; Estratégias de Implementação; Scoping Review.

INDEX

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BCT – Behavior Change Techniques

BCTO - Behavior Change Techniques Ontology

CR – Cardiac Rehabilitation

CHAPTER I

Introduction

Definition and key points about cardiovascular diseases and heart disease

Cardiovascular disease is a broad term encompassing a group of disorders that affect the heart or blood vessels, including heart disease and cerebro vascular disease (stroke). These conditions may result from a combination of behavioral, metabolic, environmental, and socio-economic risk factors[1,2].

Behavioral factors are strongly associated with lifestyle including physical inactivity, unhealthy dietary habits, excessive alcohol consumption, smoking, and psychosocial stress[1,3,4]. These behaviors can contribute to metabolic and physiological changes such as high blood pressure (hypertension), obesity, elevated blood sugar levels (diabetes), and abnormal blood lipid levels (dyslipidemia)[5]. These risk factors are considered modifiable, in contrast to non-modifiable factors such as genetics or family history[1,5]. Cardiovascular health can also be influenced by social determinants, including income distribution, educational level, and living conditions[5].

Heart disease is a broad term used to describe a range of conditions that affect the heart, including diseases of the heart's blood vessels (coronary artery disease), heart failure, heart rhythm disorders (arrhythmias), valvular diseases, heart infections, and congenital heart defects[3,5,6].

Coronary artery disease is the most common type of ischemic heart disease and can present in an acute stage, such as Acute Coronary Syndrome[6], which includes Acute Myocardial Infarction and unstable angina[7]. It is the leading cause of Heart Failure, a complex syndrome resulting from any structural or functional impairment of ventricular filling or blood ejection[6].

Epidemiological Data and Impact

Cardiovascular diseases are considered the leading cause of mortality and one of the most significant causes of disability worldwide[8], accounting for approximately 19.8 million deaths in 2022, which represents around 31% of global deaths. These figures correspond to 396 million years of life lost (YLL) and 44.9 million years lived with disability (YLD)[9].

The disability caused by these conditions has a significant economic impact, not only due to the direct costs of treatment but also because of productivity losses, affecting

individuals, families, healthcare systems, public institutions, governments, and society as a whole[10]. Cardiovascular diseases are considered the most costly health condition in terms of both direct and indirect costs, representing a substantial economic burden on the European Union, estimated at €210 billion annually[11]. In 2021, indirect costs, including productivity losses and informal care, amounted to €140 billion[2].

Ischemic heart disease was responsible for 9.24 million deaths in 2022[9], remaining the leading cause of death worldwide[12]. In terms of disability-adjusted life years (DALYs), ischemic heart disease had a global rate of 2,275.9 DALYs per 100,000 inhabitants, making it the most burdensome among cardiovascular diseases[9].

Patients with ischemic heart disease and heart failure experience significant reductions in exercise capacity, which impairs functionality, daily living activities, and health-related quality of life. This decline also contributes to increased hospitalization rates and mortality[13,14]. Work capacity and social life are further limited by frequent and debilitating symptoms such as fatigue and shortness of breath[15].

Recommendations for the Treatment of Individuals with Heart Disease

Given the complexity and impact of these conditions on patients' health and quality of life, the effective management of cardiovascular diseases requires a multidisciplinary approach[16–23].

International guidelines prioritize a collaborative and integrated approach to the treatment of individuals with heart disease, combining medical and invasive therapies, pharmacological treatments, behavioral interventions, and the active involvement of a multidisciplinary, patient-centered team. This approach aims not only to reduce mortality and hospitalizations but also to ensure that every aspect of treatment is tailored to the individual needs and characteristics of each patient[18–21].

A continuous, structured follow-up with biomarker monitoring and the use of telemonitoring is recommended to detect early signs of decompensation and promptly adjust treatment as needed[20].

International guidelines strongly recommend the promotion of sustainable lifestyle changes to reduce cardiovascular risk and prevent recurrence in individuals with heart disease[2,19–22]. The recommendations include:

- Smoking cessation, alcohol consumption reduction, adoption of a healthy diet, and salt intake reduction[2,19,21].
- Management of blood pressure and cholesterol levels[19,21].

- Regular exercise: Engaging in supervised physical activity contributes to improved cardiovascular function and symptom reduction. Hospital readmission and mortality rates can be significantly reduced if individuals with heart disease engage in regular physical activity[19–21,24].

Given that multidisciplinary involvement is a key recommendation, it is important to highlight that each professional within the multidisciplinary team plays a specific role in the care and management of individuals with heart disease[17,25]. Typically, teams should include cardiologists (responsible for clinical management, coordination, and treatment decisions, sometimes in collaboration with cardiothoracic surgeons in advanced cases)[17,21,25], cardiothoracic surgeon (responsible for preoperative and postoperative management of procedures)[17], specialist nurses (providing coordination, education, and follow-up)[17,21,25], nutritionist (providing education on nutrition and dietary adjustments)[17,25,26], clinical pharmacist (optimizing pharmacological therapy)[17], psychologists (responsible for assessing psychosocial and cognitive barriers, managing mental health, and supporting treatment adherence)[17,25], social workers (addressing social and financial factors) [17,25], and physiotherapists [17,25,26].

As movement specialists, physiotherapists contribute throughout the continuum of care by assessing, evaluating, and delivering treatment and rehabilitation [17,25,26]. Their role includes prescribing exercise and physical activity to improve exercise capacity, quality of life, and prognosis, as well as providing education on preventive behaviors. As a member of the multidisciplinary team, the physiotherapist should also incorporate education on preventive behaviors, provide appropriate nutritional counseling, and offer guidance on medication management, aiming to reduce hospitalizations and optimize patient outcomes[26.] In acute phases, such as after myocardial infarction or cardiac surgery, they also help prevent secondary complications, including pulmonary and thromboembolic events[24]. Physiotherapists are also actively involved in comprehensive, supervised interventions delivered by a multidisciplinary team such as Cardiac Rehabilitation (CR) programs [27].

Secondary prevention after an acute event is crucial to improving quality of life and reducing mortality and morbidity, and it should begin as early as possible after the index event[27]. CR is a strong recommendation by scientific societies for various cardiac conditions, as highlighted in the guidelines of the Portuguese Society of Cardiology[25], the American Heart Association (AHA)/American College of Cardiology (ACC)[21], and the European Society of Cardiology (ESC)[20].

Cardiac Rehabilitation

CR is a cost-effective intervention, with formal endorsement in the guidelines of major international scientific societies[25]. It is defined as an intervention aimed at helping patients recover or improve their physical, psychological, social, and vocational functioning following an acute cardiac event or in the context of chronic cardiovascular disease[23]. CR is an integrated multidisciplinary process that combines components such as physical exercise, behavioral changes toward healthier lifestyles, risk factor management, and psychological interventions[23]. It is considered a complex intervention that incorporates Behavior Change Techniques (BCTs) within its structure, to enhance adherence to healthy behaviors, promoting modifications in modifiable risk factors[28], and slowing the progression of underlying cardiovascular disease[23].

The key components of CR include patient assessment, management and control of cardiovascular risk factors, physical activity counseling, exercise prescription, dietary counseling, smoking cessation support, patient education, psychosocial management, and vocational support[23]. CR programs aim to improve functional capacity, reduce risk factors, and prevent future cardiac events[29].

Studies have demonstrated that these programs are effective in reducing both cardiovascular and all-cause mortality, as well as lowering hospitalization rates[27]. Evidence also indicates that CR improves exercise capacity, health-related quality of life, depression, and anxiety in individuals with heart disease, with these benefits being consistent across different cardiac conditions and intervention types[27,30].

Based on this evidence, CR has received the highest recommendation class (Class I) with Level of Evidence A in international guidelines, including those from the European Society of Cardiology (ESC), the American Heart Association (AHA), and the American College of Cardiology (ACC), following hospital admission due to a cardiac event. Exercise-based therapy has been consistently identified as a central component of these programs[18,20,27,31].

Phases of Cardiac Rehabilitation

CR is a treatment modality structured into three main phases: Phase I, which takes place during the acute hospitalization of inpatients; Phase II, traditionally delivered in an outpatient setting; and Phase III, which focuses on the long-term maintenance of lifestyle changes[32].

Prolonged bed rest and physical activity limitations may occasionally be necessary for patients with severe complications to achieve clinical stabilization. However, early mobilization and ambulation (e.g., getting out of bed on day 1) are recommended for most patients in the acute phase, such as those with acute coronary syndrome[19], following coronary artery bypass grafting, valve replacement, heart transplantation, or percutaneous coronary intervention[33].

This phase is considered Phase I of CR, also referred to as the Hospital Phase, due to its inpatient setting. It can be further subdivided into Phase Ia, conducted in the Intensive Care Unit, and Phase Ib, carried out in the general ward[25].

Phase I focuses on early mobilization, low-intensity exercises, educational interventions aimed at promoting a healthy lifestyle and risk factor control, encouragement of therapy adherence, and engagement in subsequent phases of CR[29,34].

As heart disease progresses to the subacute and chronic phases, the intervention for these patients focuses on Phases II and III of CR[25,29].

Phase II begins immediately after hospital discharge and consists of a structured, intensive, and supervised outpatient program lasting between three and six months, aimed at initial recovery and functional rehabilitation[32,33].

Interventions can take place in various settings, depending not only on the stage of the disease but also on factors such as the patient's age, frailty, risk stratification results, prognosis, and comorbidities, which help determine the most appropriate environment for CR[27].

Phase III is a lifelong phase focused on maintaining cardiovascular health, with reduced supervision and less intensive monitoring, promoting patient autonomy and self-management[27,32]. This phase consists of home-based or community-based exercises, such as gym programs, aimed at sustaining risk factor modification and long-term health benefits[32].

Delivery Models of Cardiac Rehabilitation Programs

Traditional center-based CR programs, conducted in specialized facilities, provide structured and intensive patient follow-up[35]. However, they have certain limitations, such as often being located far from the patient’s residence, fixed schedules and days, standardized activities for all participants, and group-based sessions, which may present barriers to patient adherence[36].

Given the low adherence to traditional programs, along with the impact of the pandemic, alternative models have been explored[37]. To expand access and participation, home-based CR programs have been increasingly implemented[6]. These programs are particularly beneficial for low-risk patients, as they eliminate the need for travel to specialized centers and scheduling challenges, allowing treatment to continue in the patient's familiar home environment[25].

Home-based programs, whether implemented independently or in combination with center-based programs - within a hybrid CR approach - represent a viable alternative that can enhance the delivery of CR programs to eligible patients[35].

The proliferation of information and communication technologies has enabled the development of Digital CR, utilizing smartphones, web-based applications, and wearable devices. Several studies have concluded that these programs can achieve positive outcomes, comparable to or even superior to those of center-based programs in some cases[38]. Flexible and innovative behavior change interventions targeting cardiovascular risk factors, such as physical inactivity and sedentary behavior, are essential for secondary prevention[39]. Digital CR can serve as a suitable complement to traditional healthcare services, which are not always accessible or feasible[40].

Home-based programs, facilitated by technological tools, have the potential to expand the reach of CR, improving patient acceptance and adherence compared to traditional approaches[35].

The European guidelines on cardiovascular disease prevention state that "home-based rehabilitation, with or without telemonitoring, is promising for increasing participation and supporting behavior change"[31].

Although clear recommendations exist for the treatment of individuals with heart disease, several gaps remain, including: lack of studies investigating effective strategies to improve adherence to exercise, medication, and behavioral changes[41]; limited knowledge on which interventions lead to the effective implementation of guidelines in clinical practice[21]; lack of clarity regarding the most effective physiotherapy strategies or interventions for different subgroups of patients with cardiac conditions, such as heart failure[26]; uncertainty regarding the most appropriate exercise parameters (intensity, frequency, duration, type) for specific populations of individuals with heart disease[26].

This highlights the need for studies focused on characterizing physiotherapy interventions described in the literature, identifying existing practices, knowledge gaps, and implementation opportunities. Such research would provide a comprehensive and structured overview of the approaches used in CR across different settings.

Physiotherapy involves complex interventions such as CR, which comprise multiple interactive components. These components may include exercise training, educational activities, BCTs, psychosocial support, or remote monitoring. Interventions of this nature require detailed descriptions of their components and careful consideration of their content and context to ensure they can be effectively structured, delivered, replicated, and adapted across different settings while supporting evidence-based practice[42]. Furthermore, identifying BCTs used within these interventions can facilitate the replication of successful components, thereby improving health outcomes in individuals with cardiovascular disease[40].

It is equally important to understand how these interventions are put into practice. Implementation strategies, defined as methods or techniques used to enhance the adoption, implementation, and sustainability of a clinical program or practice[43], may help address current challenges such as low adherence[44], inequities in access[11,44], and variability in program delivery[11,27] in the context of interventions such as CR. By mapping the implementation strategies used alongside physiotherapy interventions, this review aims to provide insights that may guide a more consistent and effective integration of CR programs into clinical practice.

A scoping review of the existing literature enables the mapping and characterization of these interventions, helping to identify their key components, describe how they are implemented in different contexts, and highlight gaps in knowledge that may inform future research[45].

Dissertation rationale, aims and structure

This master's dissertation provides an important contribution to the field of Health Promotion, as it focuses on one of the most significant public health challenges – cardiovascular disease. It highlights the relevance of prevention, education, and multidisciplinary rehabilitation in improving cardiovascular health and quality of life. The work also seeks to reinforce the integration of health promotion principles into clinical practice and to encourage a more comprehensive view of how these approaches can support individual and community well-being. In addition, it aligns with the Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-being), by contributing to efforts aimed at reducing the burden of non-communicable diseases, and SDG 10 (Reduced Inequalities), by emphasizing the importance of equitable access to effective cardiovascular care.

By identifying, describing, and mapping physiotherapy interventions applied within CR programs for individuals with heart disease, this study contributes to a clearer understanding of how these interventions are structured and implemented in different contexts. It supports the development of more consistent and comprehensive physiotherapy practices, promoting greater alignment with international recommendations, and strengthen the integration of physiotherapy within multidisciplinary CR teams. Furthermore, by summarizing existing evidence on BCTs and implementation strategies, this dissertation contributes to evidence-based interventions that enhance patient adherence, and continuity of care in CR.

In light of the rationale presented above, this dissertation is guided by the following research question:

"What physiotherapy-led CR interventions have been developed and implemented for the treatment of individuals with heart disease?"

To further explore this topic, the following sub-questions were formulated: what are the characteristics of physiotherapy interventions for individuals with heart disease within CR programs? Which BCTs have been used within these interventions? What implementation strategies have been adopted to support their delivery? What patient-level primary outcomes have been reported?

To address this question, this dissertation has the following objectives:

- The overall aim is to map the existing literature on physiotherapy interventions for the treatment/rehabilitation of individuals with heart disease within CR Programs.
- The specific aims are to describe the characteristics (e.g., intensity, frequency, duration, content, and mode of delivery, as well as the BCTs used) of physiotherapy interventions for individuals with heart disease across different contexts; to identify the implementation strategies adopted in different programs; and to describe the patient-level primary outcomes reported in these interventions.

This dissertation follows the article model type and is divided into two chapters. The first chapter provides an extended introduction to cardiovascular diseases and CR, outlining the role of physiotherapy, and presenting the rationale, objectives, and structure of the dissertation.

The second chapter presents the scoping review conducted within this project, in full manuscript form, prepared for submission to a peer-reviewed journal.

References

1. Cesare M, Bixby H, Gaziano T, Hadeed L, Kabudula C, McGhie D, et al. World heart report 2023: confronting the world's number one killer. World Heart Federation. Geneva; 2023.
2. Timmis A, Aboyans V, Vardas P, Townsend N, Torbica A, Kavousi M, et al. European Society of Cardiology: the 2023 Atlas of Cardiovascular Disease Statistics. Eur Heart J. 2024;45(38):4019–62.
3. Martin SS, Aday AW, Almarzooq ZI, Anderson CAM, Arora P, Avery CL, et al. 2024 Heart disease and stroke statistics: a report of US and global data from the American Heart Association. Circulation. 2024;149(8):e347–913.
4. Christiaans I, Birnie E, Bonsel GJ, Mannens MMAM, Michels M, Majoor-Krakauer D, et al. Manifest disease, risk factors for sudden cardiac death, and cardiac events in a large nationwide cohort of predictively tested hypertrophic cardiomyopathy mutation carriers: determining the best cardiological screening strategy. Eur Heart J. 2011;32(9):1161–70.
5. Mendis Shanthi, Puska Pekka, Norrving Bo, editors. Global atlas on cardiovascular disease prevention and control. World Health Organization; 2011.
6. Anderson L, Taylor RS. Cardiac rehabilitation for people with heart disease: an overview of Cochrane systematic reviews (protocol). Cochrane Database of Systematic Reviews. 2014;12(8):1–9.
7. Ferreira R, Macedo M, Pinto F, Neves R. Programa Nacional para as Doenças Cérebro-Cardiovasculares 2017. Direção-Geral da Saúde. Lisboa; 2017.
8. Kaptoge S, Pennells L, De Bacquer D, Cooney MT, Kavousi M, Stevens G, et al. World Health Organization cardiovascular disease risk charts: revised models to estimate risk in 21 global regions. Lancet Glob Health. 2019;7(10):1332–45.
9. Mensah GA, Habtegiorgis Abate Y, Abbasian M, Abd-Allah F, Abdollahi A, Abdollahi M, et al. Global burden of cardiovascular diseases and risks, 1990-2022. J Am Coll Cardiol. 2023;82(25):2350–473.
10. Gheorghe A, Griffiths U, Murphy A, Legido-Quigley H, Lamptey P, Perel P. The economic burden of cardiovascular disease and hypertension in low- and middle-income countries: a systematic review. BMC Public Health. 2018;18(1):975.
11. Abreu A, Pesah E, Supervia M, Turk-Adawi K, Bjarnason-Wehrens B, Lopez-Jimenez F, et al. Cardiac rehabilitation availability and delivery in Europe: how does it differ by region

and compare with other high-income countries? Eur J Prev Cardiol. 2019;26(11):1131–46.

12. World Health Organization. The top 10 causes of death [Internet]. Geneva: WHO; 2024 [cited 2024 Oct 13]. Available from: https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death

13. Go AS, Mozaffarian D, Roger VL, Benjamin EJ, Berry JD, Blaha MJ, et al. Heart disease and stroke statistics - 2014 update: a report from the American Heart Association. Circulation. 2014;129(3):1–536.

14. Gravely-Witte S, De Gucht V, Heiser W, Grace SL, Van Elderen T. The impact of angina and cardiac history on health-related quality of life and depression in coronary heart disease patients. Chronic Illn. 2007;3(1):66–76.

15. Passantino A, Dalla Vecchia LA, Corrà U, Scalvini S, Pistono M, Bussotti M, et al. The future of exercise-based cardiac rehabilitation for patients with heart failure. Front Cardiovasc Med. 2021;8:709898.

16. Riojas RA, Lawton JS, Metkus TS. The heart team: the multidisciplinary approach to coronary artery disease. Vessel Plus. 2024;8(6):1–16.

17. Sokos G, Kido K, Panjrath G, Benton E, Page R, Patel J, et al. Multidisciplinary care in heart failure services. J Card Fail. 2023;29(6):943–58.

18. Heidenreich PA, Bozkurt B, Aguilar D, Allen LA, Byun JJ, Colvin MM, et al. 2022 AHA/ACC/HFSA guideline for the management of heart failure: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Circulation. 2022;145(18):e895–1032.

19. Byrne RA, Rossello X, Coughlan JJ, Barbato E, Berry C, Chieffo A, et al. 2023 ESC guidelines for the management of acute coronary syndromes. Eur Heart J. 2023;44(38):3720–826.

20. McDonagh TA, Metra M, Adamo M, Baumbach A, Böhm M, Burri H, et al. 2021 ESC guidelines for the diagnosis and treatment of acute and chronic heart failure. Eur Heart J. 2022;24(36):3599–726.

21. Virani SS, Newby LK, Arnold S V., Bittner V, Brewer LPC, Demeter SH, et al. 2023 AHA/ACC/ACCP/ASPC/NLA/PCNA guideline for the management of patients with chronic coronary disease: a report of the American Heart Association/American College of Cardiology Joint Committee on Clinical Practice Guidelines. Circulation. 2023;148(9):e9–119.

22. Price KJ, Gordon BA, Bird SR, Benson AC. A review of guidelines for cardiac rehabilitation exercise programmes: Is there an international consensus? Eur J Prev Cardiol. 2016;23(16):1715–33.

23. Dalal HM, Doherty P, Taylor RS. Cardiac rehabilitation. BMJ . 2015;351:h5000.

24. Zheng YT, Zhang JX. Preoperative exercise and recovery after cardiac surgery: a meta-analysis. BMC Cardiovasc Disord. 2020;20(2):1–7.

25. Abreu A, Mendes M, Dores H, Silveira C, Fontes P, Teixeira M, et al. Mandatory criteria for cardiac rehabilitation programs: 2018 guidelines from the Portuguese Society of Cardiology. Revista Portuguesa de Cardiologia. 2018;37(5):363–73.

26. Shoemaker MJ, Shoemaker MJ, Dias KJ, Lefebvre KM, Heick JD, Collins SM. Physical therapist clinical practice guideline for the management of individuals with heart failure. Physical Therapy. 2020;100(1):14–43.

27. Ambrosetti M, Abreu A, Corrà U, Davos CH, Hansen D, Frederix I, et al. Secondary prevention through comprehensive cardiovascular rehabilitation: from knowledge to implementation. 2020 update. A position paper from the Secondary Prevention and Rehabilitation Section of the European Association of Preventive Cardiology. Eur J Prev Cardiol. 2021;28(5):460–95.

28. Heron N, Kee F, Donnelly M, Cardwell C, Tully MA, Cupples ME. Behaviour change techniques in home-based cardiac rehabilitation: a systematic review. Br J Gen Pract . 2016;66(651):e747–57.

29. Piepoli MF, Corrà U, Benzer W, Bjarnason-Wehrens B, Dendale P, Gaita D, et al. Secondary prevention through cardiac rehabilitation: from knowledge to implementation: a position paper from the cardiac rehabilitation section of the European Association of Cardiovascular Prevention and Rehabilitation. Eur J Cardiovasc Prev Rehabil. 2010;17(1):1–17.

30. Zheng X, Zheng Y, Ma J, Zhang M, Zhang Y, Liu X, et al. Effect of exercise-based cardiac rehabilitation on anxiety and depression in patients with myocardial infarction: a systematic review and meta-analysis. Heart & Lung. 2018;48(1):1–7.

31. Piepoli MF, Hoes AW, Agewall S, Albus C, Brotons C, Catapano AL, et al. 2016 European guidelines on cardiovascular disease prevention in clinical practice. Eur Heart J. 2016;37(29):2315–81.

32. Mampuya WM. Cardiac rehabilitation past, present and future: an overview. Cardiovasc Diagn Ther. 2012;2(1):38–49.

33. Simon M, Korn K, Cho L, Blackburn GG, Raymond C. Cardiac rehabilitation: a class 1 recommendation. Cleve Clin J Med. 2018;85(7):551–8.

34. Macedo RM de, Faria-Neto J, Costantini CO, Casali D, Muller A, Costantini CR, et al. Phase I of cardiac rehabilitation: a new challenge for evidence based physiotherapy. World Journal of Cardiologyy. 2011;3(7):248–55.

35. Thomas RJ, Beatty AL, Beckie TM, Brewer LPC, Brown TM, Forman DE, et al. Home-based cardiac rehabilitation: a scientific statement from the American Association of Cardiovascular and Pulmonary Rehabilitation, the American Heart Association, and the American College of Cardiology. J Am Coll Cardiol. 2019;74(1):133–53.

36. Nabutovsky I, Nachshon A, Klempfner R, Shapiro Y, Tesler R. Digital cardiac rehabilitation programs: the future of patient-centered medicine. Telemedicine and e-Health. 2020;26(1):34–41.

37. Ramachandran HJ, Jiang Y, Tam WWS, Yeo TJ, Wang W. Effectiveness of home-based cardiac telerehabilitation as an alternative to Phase 2 cardiac rehabilitation of coronary heart disease: A systematic review and meta-analysis. Eur J Prev Cardiol. 2022;29(7):1017–43.

38. Kenny E, Coyne R, McEvoy JW, McSharry J, Taylor RS, Byrne M. Behaviour change techniques and intervention characteristics in digital cardiac rehabilitation: a systematic review and meta-analysis of randomised controlled trials. Health Psychol Rev. 2024;18(1):189–228.

39. El Kirat H, van Belle S, Khattabi A, Belrhiti Z. Behavioral change interventions, theories, and techniques to reduce physical inactivity and sedentary behavior in the general population: a scoping review. BMC Public Health. 2024;24(2099):1–36.

40. Patterson K, Davey R, Keegan R, Kunstler B, Woodward A, Freene N. Behaviour change techniques in cardiovascular disease smartphone apps to improve physical activity and sedentary behaviour: systematic review and meta-regression. International Journal of Behavioral Nutrition and Physical Activity. 2022;19(1):81.

41. Beatty AL, Beckie TM, Dodson J, Goldstein CM, Hughes JW, Kraus WE, et al. A new era in cardiac rehabilitation delivery: research gaps, questions, strategies, and priorities. Circulation. 2023 Jan 17;147(3):254–66.

42. Skivington K, Matthews L, Simpson SA, Craig P, Baird J, Blazeby JM, et al. A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance. BMJ. 2021;374:n261.

43. Powell BJ, Waltz TJ, Chinman MJ, Damschroder LJ, Smith JL, Matthieu MM, et al. A refined compilation of implementation strategies: results from the Expert Recommendations for Implementing Change (ERIC) project. Implementation Science. 2015;10(21):1–14.

44. Iyngkaran P, Appuhamilage PY, Patabandige G, Sarathchandra Peru Kandage PS, Usmani W, Hanna F. Barriers to cardiac rehabilitation among patients diagnosed with cardiovascular diseases: a scoping review. International Journal of Environmental Research and Public Health. 2024;21(3):3339.

45. Peters M, Godfrey C, McInerney P, Munn Z, Tricco A, Khalil H. Chapter 11: Scoping reviews (2020 version). In: Aromataris E, Munn Z, editors. JBI Manual for Evidence Synthesis. Adelaide, Australia: JBI; 2020. p. 406–86.

CHAPTER II

MANUSCRIPT

Physiotherapy-led Interventions in Cardiac Rehabilitation Programs for Individuals with Heart Disease: A Scoping Review

Raquel Oliveira[1,2], Alexandre Moniz[3], Marta Moreira Marques[3]

[1]NOVA National School of Public Health, NOVA University Lisboa, Lisbon, Portugal

[2]Medicine Area, Physical Medicine and Rehabilitation Service, Hospital de Santa Marta, Unidade Local de Saúde de São José, Lisbon, Portugal

[3]National School of Public Health, Comprehensive Health Research Centre (CHRC), NOVA University Lisboa, Lisbon, Portugal

ABSTRACT

Introduction: Cardiovascular diseases are the leading cause of death worldwide, creating significant economic and social burden. Cardiac rehabilitation (CR) is a multidisciplinary program combining exercise and lifestyle modification, recommended after a cardiac event. Physiotherapists play a key role in exercise prescription and monitoring; however, there is limited clarity about the characteristics of physiotherapy-led interventions, the behavior change techniques (BCTs) used, and the implementation strategies supporting their adoption.

Objective: To map the literature on physiotherapy-led interventions within CR programs, identifying their characteristics, employed BCTs, implementation strategies, and the patient-level primary outcomes evaluated.

Methods: A scoping review was conducted following the Joanna Briggs Institute methodology and PRISMA-ScR checklist. Randomized controlled trials were searched in PubMed, SCOPUS, Web of Science, and CINAHL, complemented by manual reference screening. Two reviewers independently selected studies and extracted data. Interventions were described using the Template for Intervention Description and Replication (TIDieR) checklist, BCTs coded through the Behavior Change Technique Ontology (BCTO), and implementation strategies classified according to the Expert Recommendations for Implementing Change (ERIC) taxonomy. Findings were synthesized narratively and presented in tables.

Results: Twenty-three studies were included, mostly involving patients with heart failure (K = 10), cardiac surgery (K = 7), or percutaneous coronary interventions (K = 6). Most physiotherapy interventions were hybrid (K = 8). Common elements included aerobic and resistance training (K = 12), typically at moderate-to-vigorous intensity (K = 11). Frequent BCTs included *instruct how to perform behavior*, *self-monitor behavior* and *set graded tasks*. Implementation strategies mainly focused on patient adherence. Main patient-level primary outcomes were functional capacity (K = 6), exercise capacity (K = 5), and quality of life (K =3).

Conclusion: This review clarifies physiotherapy's contribution to CR and support the design of more sustainable and effective physiotherapy-led CR models.

Keywords: Cardiac Rehabilitation; Physiotherapy; Heart Disease; Behavior Change Techniques; Implementation Strategies; Scoping Review.

Introduction

Cardiovascular diseases, including heart disease, are a group of disorders affecting the heart and blood vessels, often resulting from behavioral, metabolic, environmental, and socio-economic risk factors[1,2]. Cardiovascular diseases caused 19.8 million deaths in 2022, making them the leading global cause of mortality[3] and a major source of disability[4]. Their economic impact in the European Union is estimated at €210 billion annually[2,5,6]. Ischemic heart disease is the primary contributor[4,7], associated with reduced functional capacity, poorer quality of life, and higher hospitalization and mortality rates[8–10].

Effective cardiovascular disease management requires a multidisciplinar, patient-centered approach that combines pharmacological, medical, and behavioral interventions[11–18]. International guidelines strongly recommend the promotion of sustainable lifestyle changes, such as smoking cessation, alcohol reduction, dietary changes[2,14,16], management of blood pressure and cholesterol levels[14,16] and regular exercise[2,14–17].

Multidisciplinary involvement is a key recommendation, and each professional within the team plays a specific role in the care and management of individuals with heart disease[12,19]. Physiotherapists are integral to this approach[12,19,20]: they prescribe physical activities to improve exercise capacity and quality of life, provide education on preventive behaviors to reduce hospitalizations and optimize patient outcomes[20], and are actively involved in supervised, multidisciplinary interventions like Cardiac Rehabilitation (CR) programmes[21].

CR is a Class I, Level A recommendation in international guidelines, including those of the American Heart Association (AHA)/American College of Cardiology (ACC)[13,16] and the European Society of Cardiology (ESC)[15].

CR combines components such as physical exercise, behavioral changes toward healthier lifestyles, risk factor management, and psychological interventions[18]. CR programs aim to improve functional capacity, reduce risk factors, prevent future cardiac events[22] and slow disease progression[18]. Evidence shows that CR programs reduces cardiovascular and all-cause mortality, lowers hospitalizations[21], and improves exercise capacity, health-related quality of life, depression, and anxiety across different cardiac populations[21,23].

Despite its benefits, adherence to traditional center-based CR is low due to logistical barriers, such as travel distance and rigid schedules[24,25]. To expand access, home-based

CR programs have been increasingly implemented[26], particularly for low-risk patients, allowing treatment to continue in the patient's familiar home environment[19].

Home-based programs, whether implemented independently or in combination with center-based programs—within a hybrid CR approach—represent a viable alternative that can enhance the delivery of CR programs to eligible patients[24].

Digital CR using mobile technologies is also effective and improves patient engagement[27,28]. Home-based programs, facilitated by technological tools, have the potential to expand the reach of CR, improving patient acceptance and adherence[24].

Although clear recommendations exist for the treatment of individuals with heart disease, several gaps remain, including: lack of clarity regarding the most effective physiotherapy strategies or interventions for different subgroups of patients with cardiac conditions, such as heart failure[20]; uncertainty regarding the most appropriate exercise parameters (intensity, frequency, duration, type) for specific populations of individuals with heart disease[20]; lack of studies investigating effective strategies to improve adherence to exercise, medication, and behavioral changes[29]; limited knowledge on which interventions lead to the effective implementation of guidelines in clinical practice[16].

This highlights the need for studies focused on characterizing physiotherapy interventions described in the literature, identifying existing practices, knowledge gaps, and implementation opportunities. Such research would provide a comprehensive and structured overview of the approaches used in CR across different settings.

Physiotherapy involves complex interventions such as CR, which comprises multiple interactive components. These components may include exercise training, educational activities, Behavioral Change Techniques (BCTs) to change health-related behaviors, psychosocial support, or remote monitoring. Interventions of this nature require detailed descriptions of their components and careful consideration of their content and context to ensure they can be effectively structured, delivered, replicated, and adapted across different settings while supporting evidence-based practice[30]. The Behavior Change Technique Ontology (BCTO) further refines this concept, defining a BCT as a planned process that represents the smallest part of behavior change intervention content that is observable, replicable, and, on its own, has the potential to bring about behavior change in oneself or other people[31]. Additionally, the BCTO provides a structured and standardized system for defining, classifying, and labelling BCTs in a transparent and machine-readable format, facilitating the systematic identification and comparison of intervention components across studies[31]. Identifying BCTs used within these

interventions can facilitate the replication of successful components, thereby improving health outcomes in individuals with cardiovascular disease[28].

It is equally important to understand how these interventions are put into practice. Implementation strategies, defined as methods or techniques used to enhance the adoption, implementation, and sustainability of a clinical program or practice[32], may help address current challenges such as low adherence[33], inequities in access[6,33], and variability in program delivery[6,21] in the context of interventions such as CR. By mapping the implementation strategies used alongside physiotherapy interventions, this review aims to provide insights that may guide a more consistent and effective integration of CR programs into clinical practice.

A scoping review of the existing literature enables the mapping and characterization of these interventions, helping to identify their key components, describe how they are implemented in different contexts, and highlight gaps in knowledge that may inform future research[34].

To our knowledge, and after a search in relevant databases, no prior review was identified that explored, described, and characterized the interventions of physiotherapists in individuals with heart disease across different contexts. Moreover, no review was found that mapped the BCTs and implementation strategies used in these interventions, highlighting the innovation and the need to map and synthesize the available evidence.

Aim of the study

The overall aim of this study was to map the existing literature on physiotherapy-led interventions for the treatment/rehabilitation of individuals with heart disease within CR programs.

The specific objectives were:

- To describe the characteristics (e.g. intensity, frequency, duration, BCTs, and mode of delivery) of these physiotherapy-led interventions across different contexts.
- To identify the implementation strategies used in physiotherapy-led interventions.
- To describe the patient-level primary outcomes reported in these interventions.

Methods

This scoping review was conducted following the methodology of the Joanna Briggs Institute framework[34] and was reported in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist[35] (see Appendix 1 for the completed checklist). The protocol for this review was previously published in Open Science Framework (available at: https://doi.org/10.17605/OSF.IO/5M8ZS).

Eligibility criteria

Eligibility criteria were defined according to the Participants, Concept, Context (PCC) framework recommended by the Joanna Briggs Institute for Scoping Reviews.

Participants

This study will include adult participants (≥18 years) with any form of heart disease (e.g., acute coronary syndrome, heart failure, valvular disease, congenital heart disease), including those who have undergone cardiac surgery or percutaneous interventions, and patients with clinically stable pulmonary hypertension. Participants were required to be enrolled in CR programs. Studies were excluded if participants presented contraindications for CR, such as unstable angina, decompensated heart failure, complex ventricular arrhythmias, pulmonary hypertension >60 mmHg, intracavitary thrombus, recent thrombophlebitis with or without pulmonary embolism, severe obstructive cardiopathies, severe or symptomatic aortic stenosis, uncontrolled inflammatory or infectious pathologies, or musculoskeletal conditions preventing exercise.

Concept

The review included any type of evidence-based physiotherapy intervention targeting adults with heart disease. The intervention was physiotherapy-led, and the study explicitly mentioned the inclusion of a physiotherapist in the delivery team and clarified their role in the implementation.

Context

Settings where physiotherapy interventions are applied to individuals with heart disease, with or without digital support. These settings may vary depending on the stage of the disease, the overall health status of the patient[19], and access to and participation in CR programs.

- Hospital-based context: Interventions performed in hospital settings, usually in the early stages following an acute cardiac event (Phase I of CR).
- Center-based context: Interventions conducted in CR centers.
- Home-based context: CR programs carried out at the patient's home, where interventions may or may not be supported by digital technologies, such as smartphones and web platforms, to remotely monitor and guide exercise practice and behavior changes (digital CR).
- Hybrid context: Interventions combining home-based and center-based approaches.

Type of evidence sources

Only quantitative primary studies (e.g., randomized controlled trials, non-randomized controlled trials, before-and-after studies, interrupted time-series, pilot studies, or feasibility studies, prospective, retrospective, cross-sectional, or case-control designs) published from 2010 onwards in Portuguese, English, or Spanish were included.

Although CR was formally recommended in major international guidelines from the early 2000s[36], this review will include studies published from 2010 onwards, as this period reflects the publication of updated international guidelines and the integration of more contemporary evidence-based practices in CR[37,38].

Studies were excluded if they did not specify the physiotherapist's involvement or role, or if they were systematic reviews, meta-analyses, scoping reviews, books, conference proceedings, policy documents, opinion articles, research reports, dissertations, theses, editorials, or any other type of grey literature. The review focused exclusively on primary studies published in peer-reviewed journals.

Information Sources

The literature search was conducted in four electronic databases: PubMed, SCOPUS, Web of Science, and CINAHL.

The search was performed on the same day (9 May 2025) across all four databases, applying the pre-developed search strategy.

Search Strategy

The search strategy was developed in collaboration with an experienced librarian and adapted for each database. It was performed in three phases: (1) the initial search was

developed and applied to the PubMed electronic database. The search results were analyzed, keywords from retrieved articles were screened, and the PubMed MeSH thesaurus was consulted for broader terms; (2) in the second phase, the final search query was applied to the four electronic databases previously mentioned, incorporating MeSH thesaurus terms for “heart disease,” “physical therapy modalities,” and “CR.” Due to the diversity of search functionalities across electronic databases, a different set of filters was applied to each database to limit search results according to the eligibility criteria previously established. Complete search queries, applied filters, and obtained results were explicitly detailed to ensure a transparent, replicable, and unbiased search strategy. Complete and final search strategies for all databases, including applied filters and the number of records retrieved from each, are presented in Appendix 2.; (3) the third phase involved manual searching through retrospective citation tracking, reviewing the reference lists of all included studies. References of systematic and scoping reviews on the theme of interest were also examined to identify other potentially eligible studies.

Selection of Sources of Evidence

Search results were exported in RIS format and uploaded to Rayyan software for duplicate removal, followed by manual verification. After that, two reviewers (RO and AM) independently screened all identified studies in a two-phase process using the predefined eligibility criteria. The first phase involved screening titles and abstracts, while the second phase consisted of full-text screening. A standardized screening form was developed to ensure consistency in the selection of evidence sources, as presented in Appendix 3.

The review team conducted a pilot test on a random sample of 25 titles/abstracts. The two reviewers screened this sample using the eligibility criteria, discussed discrepancies, and made necessary adjustments to the screening form. The pilot test was only considered successful, and the screening process only began, when an agreement of 75% (or higher) was achieved[39].

After completion of the first phase, the reviewers proceeded to the second phase, which involved full-text screening. Selected references were imported into Covidence for full-text screening, data extraction, and synthesis. “Two reviewers (RO and AM) independently screened all titles and abstracts using the predefined eligibility criteria. For full-text screening, RO reviewed all studies, and AM independently verified 20% of them, again using the developed screening form to ensure consistency in the selection process. A pilot test on a random sample of five full-text articles was undertaken to

ensure consistency in applying the eligibility criteria. Any discrepancies between reviewers were discussed, and the inclusion/exclusion criteria were refined, if necessary, before proceeding with the full-text screening phase. Any disagreements between the reviewers at any stage of the selection process were resolved through discussion. If consensus could not be reached, a third reviewer (MM) settled disagreements.

Data charting

Data extraction was first conducted independently by both reviewers (RO and AM) for 20% of the included studies to ensure consistency and refine the standardized data extraction form developed specifically for this review. Discrepancies were discussed and resolved by consensus, after which the remaining studies were extracted by one reviewer (RO) using the finalized form. This form, which was pilot tested in advance and is presented in Appendix 4, included fields for general study information, intervention characteristics (using the TIDieR checklist[40], BCTs (coded according to the BCTO[31]), implementation strategies (classified using the ERIC taxonomy[32]), and patient-level outcomes and results.

Data analysis and synthesis of results

We conducted a descriptive analysis of the qualitative content, aligned with the objectives of this scoping review. Data was organized and summarized narratively, with results presented in tables to facilitate comparison across studies.

Intervention content was systematically charted using the TIDieR checklist[40] to capture key elements such as provider, materials, procedures, mode of delivery, setting, dose, and tailoring. BCTs were identified and coded according to the BCTO[31], with their frequencies calculated across studies. Implementation strategies were classified using the Expert Recommendations for Implementing Change (ERIC)[32] taxonomy and similarly summarized through frequency counts.

Missing or unclear information was reported as “not specified.”

Results

Literature search

A total of 1821 studies were identified from the databases search. After removing duplicates, 1,295 records were screened by title and abstract, leading to the exclusion

of 1,110 records. An additional 61 records were identified through citation searching (41 from the reference lists of excluded systematic reviews and 20 from the reference lists of included studies). A total of 201 records proceed to full text screening; 3 could not be retrieved despite attempts to obtain them, which included contacting the corresponding authors by email, and 175 were excluded because they did not meet the eligibility criteria. Finally, 23 studies were included in the review[41–63]. Figure 1 provides the flowchart for the study selection process[64]. A complete list of studies assessed for full-text eligibility, along with the reasons for exclusion, is provided in Appendix 5.

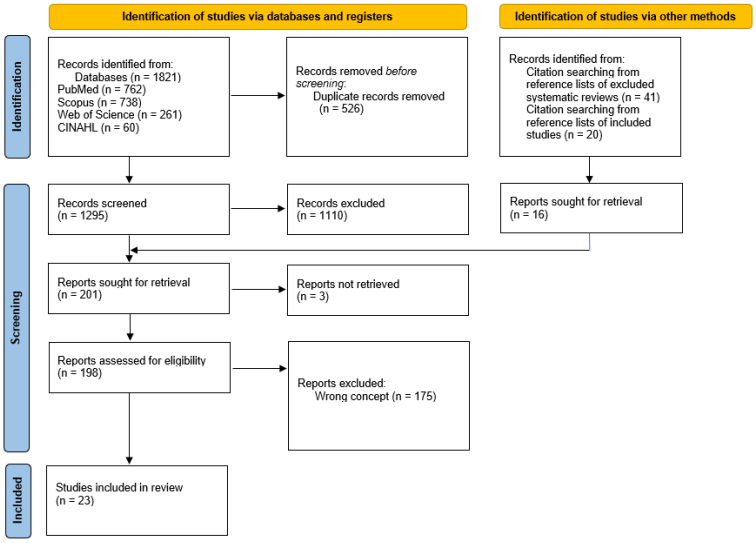

Figure 1. Flow diagram of study selection

Characteristics of the included studies

All included studies were Randomized Controlled Trials, some of them with different designs.

The studies mainly involved populations with chronic heart failure[42,45,50,51,53,54,61], coronary artery disease[41,56,57,62], or patients undergoing surgical procedures[44,47,56,63]. More recent studies expanded the focus to patients with pulmonary hypertension[46] or combined cardiac disease with other conditions, such as COPD[48] or obesity[52].

Usual care was the most frequent comparator[42,44,45,49–51,53–60,63], followed by standard care[46–48,62].

The characteristics of the included studies are listed in Table 1.

Table 1. Studies characteristics

Author, Year, Country	Study design	Population	Groups	Primary outcome	Assessment Metric	Timepoints
Astengo, 2010, Sweden	RCT	Stable angina; advanced atherosclerosis; elective PCI (n=62)	CG: usual care; IG: training	Maximal exercise capacity	Maximal exercise test	2mo pre-PCI; 1wk pre-PCI; 3mo post-PCI; 6mo post-PCI
Pozehl, 2010, USA	RCT	Chronic HF (n=42)	CG: education only; IG: HEART CAMP	Cardiac exercise self-efficacy	CESEI	wk 0; wk 12
Babu, 2011, India	Prospective RCT	Congestive HF, NYHA II–IV (n=30)	CG: physician advice/usual care; IG: in-patient rehab + HB	Functional capacity	6MWT	Discharge; FU: wk 8
Chien, 2011, Taiwan	RT	Chronic HF, NYHA I–III (n=51)	CG: usual activity; IG: HB exercise;	HRQoL	MLHFQ	wk 0; wk 8
Cowie, 2011, Scotland	RCT	HF (n=60)	usual HF care/daily routine; IG-1: HB; IG-2: Hospital-based	Physical activity	ActivPALPhysical activity (steps/d, upright hours, walking pattern, cadence)	wk 0; wk 8; FU: 6mo
Oerkild, 2011, Denmark	RCT	CHD, ≥65 yrs (n=75)	CG: usual care; IG: HB	Exercise capacity	Peak VO_2, 6MWT	0mo; 3mo; FU: 12mo

Author, Year, Country	Study design	Population	Groups	Primary outcome	Assessment Metric	Timepoints
Oerkild, 2012, Denmark	RCT	CHD (n=40)	CG: usual care; IG: HB CR	Exercise capacity	6MWT	0mo; 3mo; FU: 12mo
Aamot, 2014, Norway	RCT	CAD (n=90)	TE; GE; HE	Peak VO_2	CPET	0wk; wk 12 (HIT)
Kraal, 2014, The Netherlands	RCT	Low–moderate risk patients entering CR (n=55)	CG: usual care IG: HB Training	Exercise capacity	Maximal exercise test + respiratory gas analysis	0wk; wk 12
Hwang, 2017, Australia	RT	Stable Chronic HF (n=53)	CG: CB usual care; IG: telerehab	Functional capacity	6MWT	wk 0; wk 12; FU: wk 24
Kraal, 2017, The Netherlands	Prospective RCT	Post-ACS, PCI or CABG entering CR (n=90)	CG: usual care; IG: HB	Physical fitness	Peak VO_2	Wk 12; FU: 12mo
Bernocchi, 2018, Italy	Open, multicentre RCT	Patients with COPD + chronic HF	CG: Standard care IG: Telerehab-HB	Exercise tolerance	6MWT	Discharge; 4mo; 6mo
Peng, 2018, China	RCT	Patients with HF + caregivers (n=98)	CG = usual care; IG = usual care + telehealth ex training	QoL	MLHFQ	wk 0; 2mo; FU: 6mo

Author, Year, Country	Study design	Population	Groups	Primary outcome	Assessment Metric	Timepoints
Sunamura, 2018, The Netherlands	Open RCT, superiority trial	Patients with ACS referred to for CR (n=914)	CG: Standard CR; IG1: CR + face-to-face sess.; IG2: CR + telephone sess.	SCORE 10-year CV mortality risk	Estimated 10-year CV mortality risk of CV death	wk 0; 3mo; FU: 18mo
Babu, 2019, India	Prospective nonblind RCT	Pulmonary hypertension patients (n=84)	CG = standard care; IG = HB ex training	Functional capacity	6MWT	wk 0; wk 12
AlvesdaCruz, 2020, Brazil	Cluster randomized crossover trial	Patients with CVD or CV risk factors (n=27)	VRBT CR (conventional rehab sess.);	Acute hemodynamic response	SBP, DBP, HR, RR, SpO_2, RPE	5' initial rest; Conditioning: every 5' Recovery: 1', 3', 5', 10', 20', 30'
Beigiene, 2021, Lithuania	RCT, single-center, 3-arm, parallel design	Elderly post-PCI/CABG after ACS, referred to CR (n=79)	CG: CR only; IG1 (CR + traditional ex); IG2 (CR + mechanical ex)	Functional capacity	6MWT	Admission; Post-CR
Tamuleviciute-Prasciene, 2021, Lithuania	RCT	Older patients post-valve intervention (n=116)	CG: Usual care GI: Usual care + extra resistance & balance sess.	Functional capacity & physical performance	6MWT; SPPB; 5MWT	CR start; Post-CR; FU: 3mo
Meslet, 2022, France	RCT	ACS patients, stable clinical status (n=60)	CG: CB (usual care); IG: hybrid rehab	Cardiorespiratory fitness	Peak VO_2	0wk; 3wk

Author, Year, Country	Study design	Population	Groups	Primary outcome	Assessment Metric	Timepoints
Ahmad, 2023, Egypt	RCT	Hospitalized acute HF patients (n=79)	CG: Usual medical care; IG: Supervised mobilization program	Functional capacity	6MWT	Discharge only
denUijl, 2023, The Netherlands	Multicentre RCT	Patients with cardiac disease and obesity (n=201)	CG: usual care; IG: OPTICARE XL CR	HRQoL	MacNew Heart Disease questionnaire	0mo; FU: 6mo post-CR (18M OPTICARE XL; 9M standard CR)
Chair, 2024, China	RCT	Coronary HD patients, regional CR center, Hong Kong (n=130)	CG: Usual care; IG: HB, music-paced PA program	Exercise capacity	ISWT	0mo; 3mo; 6mo
DiLeone, 2024, Brazil	RCT	Patients with HF decompensation (n=28)	CG: AE and NIV protocols separately IG: AE + NIV	Length of ICU stay	days from ICU admission to discharge, medical records	ICU discharge

Abbreviations: 5MWT: 5-Metre Walk Test; 6MWT: 6-Minute Walk Test; ACS: acute coronary syndrome; AE: aerobic exercise; CABG: coronary artery bypass graft; CAD: coronary artery disease; CB: center-based; CESEI: Cardiac Exercise Self-Efficacy Instrument; CHD: coronary heart disease; CG: control group; COPD: chronic obstructive pulmonary disease; CPET: cardiopulmonary exercise test; CR: cardiac rehabilitation; CV: cardiovascular; CVD: cardiovascular disease; DBP: diastolic blood pressure; Ex: exercise; FU: follow-up; GE: group exercise; GP: general practitioner; HB: home-based; HE: home exercise; HF: heart failure; HIT: high-intensity training; HR: heart rate; HRQoL: health-related quality of life; ICU: intensive care unit; IG: intervention group; ISWT: 10-metre Incremental Shuttle Walk Test; MLHFQ: Minnesota Living with Heart Failure Questionnaire; mo: month(s); NIV: non-invasive ventilation; NYHA: New York Heart Association Class; OPTICARE XL: Optimizing Cardiac Rehabilitation in Obese Patients XL; PA: physical activity; PCI: percutaneous coronary intervention; Peak VO_2: peak oxygen uptake; Post: post-intervention; pre: before / pre-intervention; QoL: quality of life; RCT: randomized controlled trial; RPE: rating of perceived exertion; RR: respiratory rate; SBP: systolic blood pressure; SCORE: Systematic COronary Risk Evaluation; SDT: Self-Determination Theory; SPPB: Short Physical Performance Battery; SpO_2: peripheral oxygen saturation; TE: treadmill exercise; VRBT: virtual reality-based therapy; wk: week.

Characteristics of the interventions

The interventions analyzed ranged from home-based programs[44,46,48,50,58–60], often complemented by periodic contacts such as home visits or telephone calls, to center-based programs[43,52,62,63], with hospital-based programs being less represented[42,47,53]. A strong presence of hybrid approaches was observed[41,45,49,54–57,61], which combined initial in-person phases (in hospital or rehabilitation centers) with home-based continuation. One study directly compared home- and hospital-based programes[51].

Face-to-face delivery was predominant in most included studies[42–45,47,49,51–53,57–63], but several studies also reported the use of telemonitoring[41,48,54–56,60], either as a stand-alone modality or as part of hybrid programs that combined in-person and home-based delivery.

Most studies included aerobic exercise combined with resistance training[42–45,47,52,54,55,57,60–62]. Some studies added balance training[42,47,63], while others incorporated behavioral change strategies[55,61,62]. Innovative modalities were also reported, such as music-paced training[49], or virtual reality[43].

Program frequency and duration varied considerably across studies, but most protocols lasted 8–12 weeks[41,45,46,49–52,54–56,60–62] with 2–7 sessions per week[41,43,44,46–63]. Intensity was generally prescribed at moderate-to-vigorous levels (40–70% HRR)[43,44,47–49,55–57,60,61,63].

In terms of resources and materials, the interventions used both simple equipment (elastic bands, pedometers, water bottles, exercise diaries)[43–46,48,50,54,60–63] and digital technologies (mobile applications, real-time telemonitoring, videoconferencing)[41,43,48,51,54–56,60,61].

Most of the included studies described the general structure of CR programs, particularly regarding frequency, intensity, and duration, and the main exercise type. However, in some cases, interventions descriptions were brief and specific details were limited. Under-reporting was also observed with respect to exercise progression - although the target training intensity was specified in most cases[41–45,47–49,51,53–61,63], only two[47,63] clearly described progression criteria, both restricted to resistance and balance training. In other studies, full intervention details were available only in supplementary materials[46] or previously published protocols [62].

Most CR programs reported the inclusion of educational or counselling components, generally related to nutrition, risk factor management, medication adherence, or lifestyle promotion[47–49,54,56,58,59,62,63]; however, this information was often presented superficially. The intervention characteristics are presented in Table 2.

Table 2. Intervention characteristics

Study	Procedures	Setting (S)/ Mode of delivery (MoD)	Dose Frequency (F)/Duration (D)/Itensity(I)
Astengo, 2010	Bicycle ergometer + resistance with elastic bands.	**S:** HB **MoD:** face-to-face Pt visits	**F:** 5×/wk **D:** ≥30'/sess.; 2 mo pre-PCI to 6 mo post-PCI **I**: ~70% max capacity (submax test)
Pozehl, 2010	Aerobic (hospital with ECG 3 wk, then self-scheduled in facility), resistance (1 supervised + 1 home sess./wk), self-monitoring (HR, RPE, symptoms, diaries), behavioral support (group sessions, Bandura-based strategies), education (demos, peer sharing, problem-solving, goal setting, relapse management).	**S**: Hybrid **MoD**: group face-to-face sess. + individual sess. in hospital outpatient; maintenance centre; home unsupervised training	**F:** aerobic 3×/wk; resistance 2×/wk; education wkly/biwkly; **D:** 12 wks; 60'/sess. **I:** Aerobic 40–70% HRR
Babu, 2011	Phase 1 (in-patient): breathing, ankle/AROM, progressive exercises, walking. Phase 2 (home): walking (progressive), strengthening, breathing/relaxation + weekly phone FU; daily exercise logbook.	**S:** Hybrid; Phase 1 hospital-based; Phase 2 HB **MoD:** Phase 1 individual; Phase 2 weekly phone support.	**F:** Phase 1 daily (during admission); Phase 2 walking 2×/day + exercises **D:** 8 wks **I:** Phase 1: progressive, RPE 3-4/10; Phase 2: RPE 4-6/10
Chien, 2011	Pt interview with instructions for walking + limb strengthening; safety brochure; phone support every 1–2 wks for adherence.	**S**: Initial (1) hospital-based individual sess.; (2) HB **MoD**: (1) individual + (2) phone FU	**F:** 3×/wk; 30'/sess. **D**: 8 wks **I:** moderate intensity
Cowie, 2011	Warm-up + aerobic circuit (10 exercises with active recovery) + cool-down; intensity via HR and RPE; education on unstable HF symptoms; biweekly Pt phone calls (home group).	**S:** (1) Hospital-based; (2) HB **MoD**: (1) group face-to-face Pt-led classes (rehab center); (2) individual with DVD/booklet + Pt phone FU	**F:** 2×/wk **D**: 1 h/session; 8 wks **I:** 40–60% HRR (shuttle test peak HR); RPE 12–13

Study	Procedures	Setting (S)/ Mode of delivery (MoD)	Dose Frequency (F)/Duration (D)/Itensity(I)
Oerkild, 2011	Individualized home/outdoor program by Pt (walking/cycling); 2 home visits + 1 phone call; optional counselling (diet, smoking).	**S:** HB **MoD:** individual, face-to-face Pt visits + phone call	**F:** 6 ds/wk **D:** 30'/d; 6 wks; PT contact: 2 home visits + 1 phone call **I:** Borg 11–13 (moderate)
Oerkild, 2012	2 Pt home visits to develop personalized program (incl. warm-up/cool-down); shorter sess. for very disabled; home/outdoor exercises; FU calls (Pt + cardiologist); medical consultations 0, 3, 6, 12 mo; optional dietary counselling & smoking cessation.	**S:** HB **MoD**: individual; face-to-face Pt visits + phone call	**F:** 6 ds/wk **D:** 30'/sess.; 12 mo; PT 2 home visits (1^{st} 6 wks); FU calls (mo 4-5); cardiologist consults 0, 3, 6, 12 mo **I:** Borg 11-13 (moderate); shorter sess. if needed for highly disabled patients
Aamot, 2014	Warm-up + 4×4' high-intensity intervals with active recovery + cool-down; circuit (treadmill, running, cycling, squats, steps); feedback via HR monitor; after 2 supervised sess., continued HB in preferred mode.	**S:** Hybrid; hospital-based + HB **MoD:** face-to-face group sessions (TE, GE) + HB remotely monitored sess. (HE)	**F:** 2×/wk **D:** 12 wks **I:** Interval training 85–95% HRpeak
Kraal, 2014	Exercise training per ESC recommendations; behavior change with goal-setting theory + motivational interviewing.	**S:** Hybrid **MoD:** 3 initial face-to-face sess.; then HB with online monitoring + weekly phone coaching	**F**: ≥2×/wk **D:** 45–60'/sess.; 12 wks **I:** 70–85% HRmax
Hwang, 2017	Real-time telerehabilitation via videoconference; group sess. (warm-up + aerobic/strength + cool-down) led by Pt with feedback; 15-min group discussion pre-session; education (pre-recorded presentations); support with equipment familiarization, manual, technical help.	**S:** HB **MoD:** group telerehabilitation via real-time videoconferencing (supervised) + asynchronous educative (pre-recorded presentations).	**F:** 2×/wk supervised (60') + 3×/wk unsupervised **D:** 12 wks **I**: RPE 9 → 13 (progressive)

Study	Procedures	Setting (S)/ Mode of delivery (MoD)	Dose Frequency (F)/Duration (D)/Itensity(I)
Kraal, 2017	Both: standard CR (continuous training with warm-up/cool-down). Home group: 3 supervised familiarization sess., then independent home training with HR monitor + Garmin Connect; weekly Pt phone feedback, then self-maintained.	**S:** Hybrid - (1) CR + (2) HB **MoD:** (1) face-to-face sess.; (2) individual sess. + weekly phone FU with telemonitoring.	**F:** 3 initial supervised sess.; then ≥2×/wk **D:** HB (45–60'); 12 wks **I:** 70–85% HRmax.
Bernocchi, 2018	Education + personalized exercise program; Basic: (mini-ergometer + calisthenics + walking); High: (mini-ergometer + resistance + walking); weekly phone call to set/adjust targets.	**S:** HB telerehabilitation; hospital-based assessments **MoD:** real-time telemonitoring + weekly phone calls	**F:** Basic: 2-3×/wk; High: 3-7×/wk **D:** 4 mo **I:** moderate to high dyspnoea/fatigue (Borg)
Peng, 2018	Discharge education (HF management, exercise, self-care) + brochure; Stage1: aerobic (walking/jogging); Stage 2: resistance (calisthenics, squats, elastic bands); all with warm-up/cool-down; Pt monitored HR/reports; support via weekly calls/QQ/WeChat (4 mo) + on-demand consultation.	**S:** (1) hospital sess. at discharge; (2) HB **MoD:** (1) face-to-face; (2) individual exercise supervised via QQ/WeChat (video/text) + weekly FU (calls/messages) + on-demand support (≤48h).	**F:** Stage 1: 3×/wk; Stage 2: 5×/wk; **D:** 60' discharge education; Stage 1:12 sess.(20'/sess.); Stage 2: 20 sess. (30'/sess.) **I:** 40-70% HRR
Sunamura, 2018	OPTICARE-Basic: standard CR with supervised Pt-led exercise; optional education; additional support if required (smoking, nutrition, stress, psychological). CR+F (OPTICARE-CAPRI): standard CR + mandatory lifestyle/risk factor management (supervised exercise + behavioral counselling with motivational strategies). CR+T (OPTICARE-COACH): Standard CR + 5-6	CR+F: outpatient CB group face-to-face. CR+T: HB individual via phone. Standard CR: outpatient CB group face-to-face.	Standard CR: **F**: 2×/wk **D:** 90'/sess.; 12 wks **I:** moderate intensity CR+F: **F:** As Standard CR + 3 group counselling (monthly during CR) + 3 post-CR (mo 4, 6, 12). **D**: Each post-CR session ~ 2h

Study	Procedures	Setting (S)/ Mode of delivery (MoD)	Dose Frequency (F)/Duration (D)/Itensity(I)
	individual telephone coaching sess., delivered by specialized nurses.		**I:** moderate intensity CR+T **F:** As Standard CR + 5-6 phone coaching (every 5-6 wks) **D:** CR = 12 wks; FU: 6 mo **I:** moderate intensity
Babu, 2019	Program + standard care + PulHMan education; warm-up (active limb) + walking + cool-down; biweekly progression; phone monitoring; exercise logbook for adherence.	**S:** HB **MoD**: individual (unsupervised) + phone FU.	**F:** 3–5 d/wk; **D**: 12 wks; sess. progressed 10'-20' → 30'-40' **I:** RPE 4–6/10; 12–13/20
AlvesdaCruz, 2020	Weekly VRBT + CR on nonconsecutive days; sess.: rest + warm-up + conditioning + recovery. VRBT: sensor-based games with virtual therapist-led exercises + free weights; combined exercises (1×15 reps). CR: stretching/resistance warm-up + treadmill walking;	**S:** CB **MoD:** outpatient; face-to-face in pairs with interactive wall-projected games (motion sensors).	**F:** 2×/wk (1 VRBT + 1 CR), nonconsecutive; **D:** 85'/sess. **I:** 40-70% HRR (CVD) or 60–80% HRR (risk factors)
Beigiene, 2021	All: standard inpatient CR (aerobic + breathing). IG1: balance + resistance with physiotherapy tools — warm-up (coordination/ROM) + strength (UL/LL progressive) + balance (bodyweight → unstable platforms) + cool-down (stretching). IG2: balance + resistance with mechanical devices — warm-up + balance (Biodex) + strength (HUR 30–50% 1RM) + cool-down (stretching).	**S:** Hospital-based, in-patient CR; **MoD:** face-to-face in small supervised groups	**F:** Aerobic 6 d/wk (≤30'); resistance/balance (IG1, IG2) 3×/wk; **D:** 14–20 d **I:** Aerobic 60–70% HRmax; Borg 11–15

Study	Procedures	Setting (S)/ Mode of delivery (MoD)	Dose Frequency (F)/Duration (D)/Itensity(I)
Tamuleviciute-Prascienė, 2021	CG: 20-day inpatient CR — aerobic endurance (warm-up, main, cool-down) + aerobic gymnastics (seated/standing) + respiratory muscle training. IG: CG program + resistance (LL) + progressive balance (wk1 uneven surfaces/heel-to-toe; wk2 one-leg/position changes/eyes closed; wk3 dual tasks/tiptoe reach). Small-group (3 pts) PT-led from day 3; biweekly calls + home exercise encouragement.	**S:** Hospital-based, inpatient CR; **MoD:** CG: face-to-face groups. IG: additional small-group sess. + biweekly telephone FU post-discharge.	**F:** Endurance 6×/wk (~40'); gymnastics 5×/wk (30'); RMT 7×/wk (15'); IG: +3×/wk resistance & balance; **D:** 20 d total **I:** Endurance 60–70% HRmax; resistance ≤60% 1RM; Borg ≤13
Meslet, 2022	Initial phase (5 days, center-based): clinical evaluation, education, supervised exercise — 2 aerobic (cycle ergometer + 1-h walk) + 1 resistance; all with warm-up/cool-down. Hybrid phase (3 wks, sport centers): cycling + resistance, supervised by activity professionals (1st with cardiac staff); warm-up/cool-down included. Additional: daily 1h walk encouraged, GP FU (wk 2), booklet with plan + recommendations.	**S:** Hybrid; initial phase CB (outpatient CR); second phase community-based in local sport centers. **MoD:** face-to-face sessions	**F:** CB: 2 aerobic + 1 resistance sess./d. Sport center: 3×/wk + 1h/d walk **D:** CB: 5d. Sport center: 3 wks **I:** Aerobic (VTh1–150% VTh1) + resistance 40–60% 1RM; Borg ≤8/10
Ahmad, 2023	Mobilization ≤3 days post-admission; 5 stages: Stage 1-2 limb/strength/balance; Stage 3-4 walking; Stage 5 walking + stair climbing; intensity guided by HR increase and RPE.	**S:** Hospital-based in-patient; **MoD:** face-to-face individual sessions.	**F:** daily or 2×/d; **D:** from clinical stability until discharge **I**: Stage 1-4: HRrest+20, RPE 11–12; Stage 5: HRrest+ 20-30, RPE ≤13
denUijl, 2023	Supervised 2×/wk endurance (cycling, rowing) + resistance, tailored for obesity. Behavioral modules: weekly “Healthy Weight” (dietician) + “Active	**S:** Outpatient CB; **MoD:** face-to-face group sess.; after-care with optional mobile group chat.	**F**: Part I: 2×/wk supervised exercise; Part II: 6 booster sess. **D**: Part I: 60'-90'; 12 wks; Part II: 9-mo

Study	Procedures	Setting (S)/ Mode of delivery (MoD)	Dose Frequency (F)/Duration (D)/Itensity(I)
	Lifestyle" every 3 wks (Pt). Support: activity tracker, 6 booster sess. (9 mo), optional peer-support chat.		after-care **I**: NR
Chair, 2024	Post-CR IG: 4 Pt-led face-to-face sess. (wks 7-8) on music-paced home PA (warm-up + brisk walking + cool-down) using MP3 with verbal cues; FU with 5 biweekly + 3 monthly nurse phone calls (SDT-based).	**S:** Hybrid: (1) CB → (2) HB **MoD:** (1) 4 face-to-face group sess.; (2) individual + phone FU	**F:** 2×/wk supervised exercise sess + 6 weekly group education; HB PA 3×/wk; **D:** 8 wks total **I:** Aerobic 60–75% HRmax; music-tempo individualized;
DiLeone, 2024	IG (AE+NIV): daily in ICU — aerobic cycling with warm-up + intervals + cool-down performed simultaneously with NIV; continuous monitoring (HR, BP, SpO_2, Borg). CG: same AE and NIV but performed separately (≥15 min apart).	**S:** Hospital-based inpatient (ICU); **MoD:** face-to-face individual sess.	**F:**1×/d; **D:** from 48h post-ICU admission until discharge; 13-15' active time/sess. **I:** Cycling intervals (Borg 3–5/10); load adjusted daily

Abbreviations: AE: aerobic exercise; AROM: active range of motion; BP: blood pressure; Borg: Borg Rating of Perceived Exertion Scale; CB: center-based; CG: control group; CR: cardiac rehabilitation; CR+F: standard CR extended with group counselling sessions; CR+T: standard CR extended with individual telephone counselling sessions; CV: cardiovascular; CVD: cardiovascular disease; d: day; ds/wk: days per week; ECG: electrocardiographic; ESC: European Society of Cardiology; Ex: exercise; FU: follow-up; GE: group exercise; HB: home-based; HE: home-based exercise; HF: heart failure; HR: heart rate; HRmax: maximum heart rate; HRpeak: peak heart rate; HRR: heart rate reserve; h: hour; ICU: intensive care unit; IG: intervention group; LL: lower limbs; min: minute(s); mo: month(s); MP3: digital audio file; NIV: non-invasive ventilation; NR: not reported; PA: physical activity; Pt: physiotherapist; reps: repetitions; RM: repetition maximum; RMT: respiratory muscle training; ROM: range of motion; RR: respiratory rate; RPE: rating of perceived exertion; SDT: Self-Determination Theory; sess.: session(s); SpO_2: peripheral oxygen saturation; SPPB: Short Physical Performance Battery; TE: treadmill exercise; UUL: upper limbs; VTh1: first ventilatory threshold; VRBT: virtual reality-based therapy; wk: week

Use of Behavior Change Techniques

Our scoping review identified the use of 29 distinct BCTs across the included studies, with a total of 138 BCTs coded. The highest number of BCTs identified in a single study was 14[61], while the lowest was 2[42,58,59].

The most frequently identified BCTs were *instruct how to perform behavior*, coded 13 times across several studies[41,43,45,46,48–50,54–57,59,60] *self-monitor behavior*, coded 12 times[45,46,49–52,54–57,61,62], *set graded tasks*, also coded 12 times[41–47,51,53,60,61,63], *deliver informational support*, coded 11 times[45,46,48–52,57,60–62], and *deliver support*, also coded 11 times[44,47,52,54,55,58–63]. The least frequently coded BCTs, each reported only once, were *substitute behaviour*[44], *context-specific non-enactment of behaviour*[51], *goal setting*[52], *create behavioral contract* [57], *self-monitor outcome of behaviour*[52], *guide how to perform behaviour*[54], *provide positive consequences for outcome of behavior* [61], and *increase awareness of behaviour*[62]. In relative terms, more than half of the studies included *instruct how to perform behavior* (57%), *deliver informational support* (52%), and *self-monitor behavior* (52%). Approximately half of the studies applied *set graded tasks* (48%), while the remaining BCTs were identified in fewer than 50% of the studies, most appearing only sporadically (≤13%).

These BCTs were implemented in different contexts and in multiple ways across the studies. The BCT *instruct how to perform behavior* was recurrently applied in hybrid programs or those involving telemonitoring[41,54–56,60], and was operationalized by therapists providing detailed guidance on the correct execution of prescribed exercises, as exemplified by *"patients were instructed by a therapist to perform combined exercises"*[43]. Other BCTs, such as *self-monitor behavior*, were frequently observed in home-based programs supported by technology[46,54,60], where participants recorded their activities or were remotely monitored, as illustrated by "f*or monitoring of adherence and exercise intensity, the home group completed a diary detailing every session completed"*[51]. The BCT *set graded tasks* was most frequently observed in home-based[44,46,60], hospital-based[47,53,63], and hybrid programs[41,45,61], often involving gradual progression of exercise load, as in *"all exercises were introduced and started at minimal number of repetitions… the loads were gradually increased by the addition of 0.5 to 1 kg as tolerated"*[46].The BCT *deliver informational support* was applied across a wider range of settings, appearing in center-based programs[50,52,61,62], hybrid programs[49,57] and home-based interventions supported by technology[46,48,60]. In practice, this usually involved offering patients additional advice and reinforcement on lifestyle and exercise, as exemplified by "…*gave extra reinforcement on the value of lifestyle changes and the importance of exercise*"[48]. *Deliver support* was mainly identified in hospital or center-

based contexts[47,52,63], and was operationalized by professionals offering direct assistance and encouragement to patients, as exemplified by "*a physiotherapist met with the patients monthly to… adjust the intensity of home exercise, and provide motivation*"[44].

Table 3 presents the BCTs coded in the studies.

Table 3. Frequency of BCTs used in the studies

BCT	Studies																							Total N=23 (100%)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Instruct how to perform behavior BCT (BCIO: 007058)			✓	✓			✓	✓	✓	✓	✓	✓	✓		✓	✓			✓			✓		13 (57%)
Self-monitor behavior BCT (BCIO: 007024)		✓	✓	✓	✓				✓	✓	✓			✓	✓				✓		✓	✓		12 (52%)
Set graded tasks BCT (BCIO: 007100)	✓	✓	✓		✓			✓					✓		✓	✓	✓	✓		✓			✓	12 (52%)
Deliver informational support BCT (BCIO: 007042)		✓	✓	✓	✓							✓	✓	✓	✓				✓		✓	✓		11 (48%)
Deliver support BCT (BCIO: 007039)	✓	✓				✓	✓		✓	✓			✓	✓			✓	✓			✓			11 (48%)
Add objects to the environment BCT (BCIO:007156)	✓	✓								✓		✓	✓	✓		✓	✓	✓					✓	10 (44%)
Provide biofeedback BCT (BCIO: 007026)		✓			✓			✓		✓		✓	✓				✓			✓	✓		✓	10 (44%)
Goal strategizing BCT (BCIO: 007008)		✓		✓					✓				✓	✓							✓	✓		7 (30%)

BCT	Studies																							Total N=23 (100%)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Demonstrate the behavior BCT (BCIO: 007055)		✓								✓			✓		✓	✓			✓					6 (26%)
Set measurable behavior goal BCT (BCIO: 007300)	✓			✓		✓									✓				✓			✓		6 (26%)
Monitoring BCT (BCIO: 007017)		✓		✓								✓	✓	✓								✓		6 (26%)
Provide feedback BCT (BCIO: 007022)		✓		✓										✓							✓	✓		5 (22%)
Set behavior goal BCT (BCIO: 007003)		✓							✓			✓												3 (13%)
Review behavior goal BCT (BCIO: 007011)		✓							✓			✓												3 (13%)
Provide feedback on behavior BCT (BCIO: 007023)									✓	✓	✓													3 (13%)
inform about positive health consequences BCT (BCIO: 007183)		✓												✓										2 (9%)
Record behavior without feedback BCT(BCIO: 007019)															✓		✓							2 (9%)

BCT	Studies																							Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	N=23 (100%)
Observe outcome of behavior by another without feedback BCT (BCIO: 007020)															✓			✓						2 (9%)
Social support BCT (BCIO: 007028)										✓											✓			2 (9%)
Action planning BCT (BCIO: 007010)														✓							✓			2 (9%)
Advise specific behavior BCT (BCIO: 007168)									✓					✓										2 (9%)
Substitute behavior BCT (BCIO: 007095)	✓																							1(4%)
Context-specific non-enactment of behavior BCT (BCIO: 007169)					✓																			1(4%)
Goal setting BCT (BCIO: 007002)																					✓			1(4%)
Create behavioral contract BCT (BCIO: 007014)																			✓					1(4%)

BCT	Studies																							Total N=23 (100%)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Self-monitor outcome of behavior BCT (BCIO: 007025)																					✓			1(4%)
Guide how to perform behavior BCT (BCIO: 007050)										✓														1(4%)
Provide positive consequences for outcome of behavior BCT (BCIO: 007264)		✓																						1(4%)
Increase awareness of behavior BCT (BCIO: 007173)														✓										1(4%)

1) Astengo, 2010; 2) Pozehl, 2010; 3) Babu, 2011; 4) Chien, 2011; 5) Cowie, 2011; 6) Oerkild, 2011; 7) Oerkild, 2012; 8) Aamot, 2014; 9) Kraal, 2014; 10) Hwang, 2017; 11) Kraal, 2017; 12) Bernocchi, 2018; 13) Peng, 2018; 14) Sunamura, 2018; 15) Babu, 2019; 16) AlvesdaCruz, 2020; 17) Beigienė, 2021; 18) Tamuleviciute-Prasciene, 2021; 19) Meslet, 2022; 20) Ahmad, 2023; 21) denUijl, 2023; 22) Chair, 2024; 23) DiLeone, 2024

Use of Implementation strategies

Of the 23 included studies, one did not report any specific implementation strategies[47]. The number of strategies identified ranged from one[47] to eight[57], with a mean of 2.6 per study.

In total, 59 implementation strategies were reported across the included studies. Of these, 20 belonged to the *engage consumers*[44–46,48–52,54–63] cluster, which was therefore the most represented. This was followed by *adapt and tailor to context* (n=13)[41,42,44–46,49,54–56,58–61], *change infrastructure* (n=12)[41,48,51,54–60], and *use evaluative and iterative strategies* (n=6)[42,43,45,48,57]. The remaining clusters were represented by only a few strategies each.

The most frequently applied strategy was *intervene with patients/consumers to enhance uptake and adherence* (n=17; 74%)[44–46,48–52,55–63], observed across different contexts, including hybrid programs[55,57], home-based programs[46,58,60], and center-based programs[50,52]. In practice, this strategy included, for example, providing telephone calls or home visits to encourage participation and adherence to prescribed exercise programs (e.g., "*A physiotherapist telephoned the home group every two weeks to modify their exercise prescription where appropriate"*)[51]. The strategy *promote adaptability* was used 13 times (57%)[41,42,44–46,49,54–56,58–61], and was operationalized by tailoring interventions to local needs and patient characteristics while maintaining fidelity to core components, for example by modifying program intensity and progression to ensure safety[46], allowing substitution of exercise modalities of equivalent intensity[44], or incorporating patients' preferred training modalities into the home programme[55]. *Change service sites* (n=10; 44%) [41,48,51,54–60] was operationalized by moving rehabilitation delivery outside hospital or specialized centers to settings that facilitated patient access. In most cases, this was achieved through telerehabilitation programes[41,48,54–56,60], but it also included home-based training programs that could be performed indoors or in the surrounding outdoor environment[58,59], as well as exercise sessions conducted in local sport centers near patients' homes[57]. The strategy *prepare patients/consumers to be active participants* (n=3; 13%)[52,54,55] was operationalized by creating opportunities for patients to engage actively in their care, for example through discussions focusing on training progress, barriers, and facilitators[55]. The strategy *obtain and use patients/consumers and family feedback* (n=3; 13%)[45,48,55], was operationalized by systematically collecting patient feedback on satisfaction with the intervention, for example through structured questionnaires evaluating service quality, clarity of guidance, and perceived support[48]. *Conduct educational meetings* (n=3; 13%)[48,53,57] was

operationalized by conducting joint training of staff, organizational meetings and planning before commencing patient enrolment.

The least frequently reported strategies were *conduct local need assessment* (n=2; 9%)[42,43], *change physical structure and equipment* (n=2,)[57,60], *promote network weaving* (n=2; 9%)[57,60], *provide ongoing consultation* (n=1; 4%)[49], *provide local technical assistance* (n=1; 4%)[54], identified only in a home-based telerehabilitation program, *assess for readiness and identify barriers and facilitators* (n=1; 4%)[57], reported in a hybrid study conducted in a community setting, and *create new clinical teams* (n=1; 4%)[57], reported in the same study.

Figure 2 outlines the strategies employed for the implementation of the interventions.

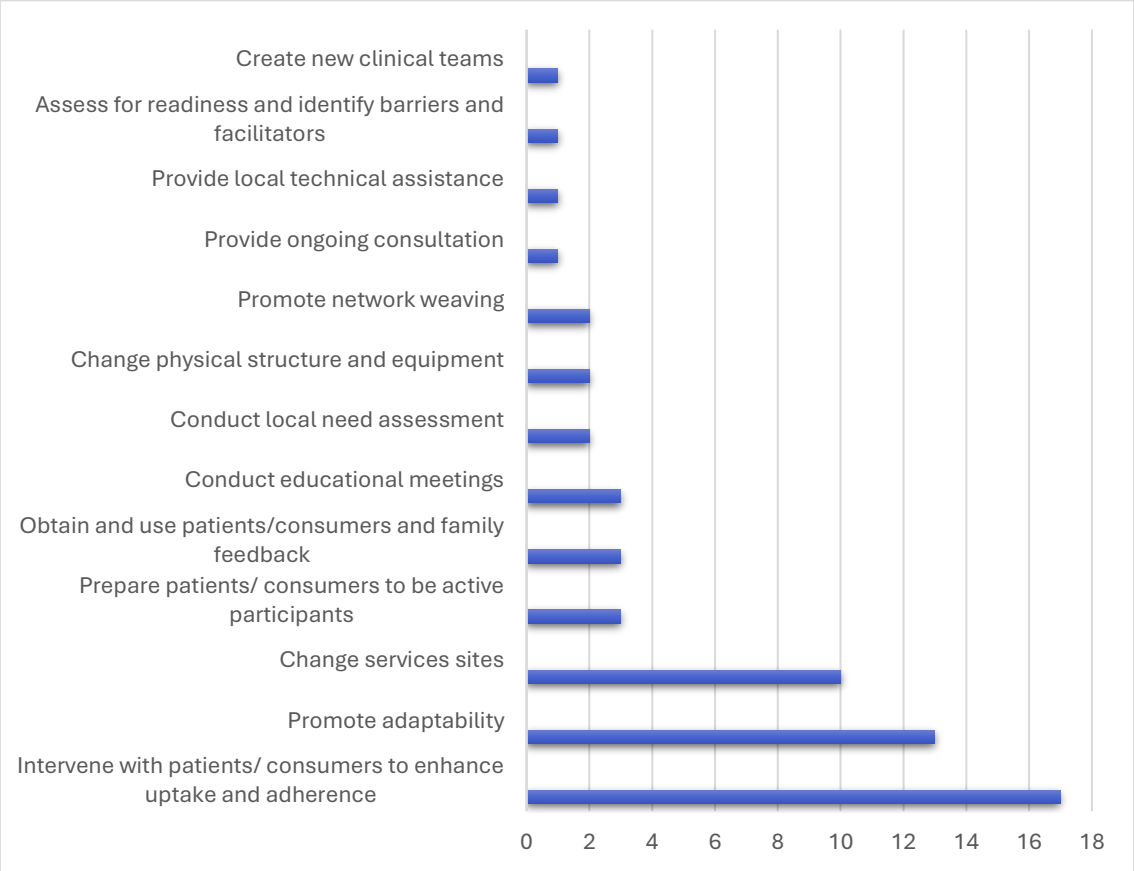

Figure 2. Strategies employed for the implementation of the interventions

Patient-level primary outcomes and measures

Regarding the patient-level primary outcomes, the assessment of functional capacity was predominant[42,45–47,54,63], most frequently measured using the *6-Minute Walk Test (6*

MWT)[42,45–47,54,63]. Exercise capacity was also a commonly reported outcome [48,49,55,58,59] primarily assessed with the *6MWT*[48,58,59], but also through other tests such as the *Maximal Exercise Test*[44], *Peak* VO_2[58], *Maximal Test with Gas Analysis*[55], and the *Incremental Shuttle Walk Test (ISWT)*[49]. Other aspects, such as quality of life, were also evaluated[50,52,60], with the *Minnesota Living with Heart Failure Questionnaire (MLHFQ)* being the most frequently used instrument[50,60].

Some studies also relied on clinical indicators, including hemodynamic recordings[43] and the length of stay in the intensive care unit[53].

Regarding to the timepoints of assessment, most studies included a baseline evaluation, usually conducted before the start of the CR program[41,44,46,47,49–52,54,55,57–59,61–63] or at hospital discharge[42,45,48,53,60]. In many cases, this was followed by an immediate post-intervention assessment, usually conducted at the end of the rehabilitation program[41,45–47,49–52,54–59,61,63].

Several studies also incorporated medium-term follow-up assessments, between 3 and 6 months after the intervention[44,48,49,51,54,60,63], others extended the follow-up to 12 months[56,58,59] or even 18 months[52,62]. In specific cases, assessment was performed only at hospital discharge[42] or intensively during the rehabilitation phase, with repeated hemodynamic measurements every 5–10 minutes[43]. These findings are summarized in Table 1.

Discussion

This study aimed to map the existing literature on physiotherapy-led interventions directed at the treatment and rehabilitation of individuals with heart disease within the scope of CR programs.

The results of this review show that CR programs exhibit significant diversity, dominance of hybrid programs seems to reflect a trend towards combining initial face-to-face supervision with ongoing support in a home-based format. This mode of delivery ensures safety in the early stages and encourages greater long-term adherence. These findings align with previous studies, which state that hybrid or home-based programs, often supported by digital technologies, are not inferior to solely face-to-face models in enhancing functional capacity and quality of life, representing a feasible and essential alternative to overcome geographical, work-related, or social barriers[33,65,66].

Face-to-face delivery, however, continues to be predominant in CR programs, especially in hospital settings, remaining the most studied and reported mode of delivery. Previous

studies have shown that face-to-face delivery is the most investigated and documented approach, and that in-person interventions, carried out mainly in hospital settings, are the most effective in promoting the enrollment and retention of patients in CR programs[67].

At the same time, the use of telemonitoring also showed a strong presence in this review, reinforcing the already described trend towards a “new era” in CR delivery modes, in which telerehabilitation emerges as an effective and safe alternative to face-to-face models, a process accelerated by the COVID-19 pandemic[15,29].This delivery mode is accepted by the majority of patients, including older populations; however, its future development should take into account the technological limitations associated with aging, investing in simple and attractive platforms that integrate health promotion content[25]. Technological adaptation will be essential to ensure equity, in order to prevent digital literacy from becoming a new barrier to access[29].

Regarding exercise component, most interventions included in this review combined aerobic and resistance training [42–45,47,52,54,55,57,60–62], prescribed at moderate to vigorous intensities to balance safety and effectiveness. These findings align with evidence showing that such modalities improve functional capacity, quality of life, and reduce cardiovascular events, thus reflecting international guidelines for CR programs[14–16,21]. Moreover, they are consistent with recent international recommendations that recognize aerobic training as a core component of CR, to be performed three to five times per week, at moderate to vigorous intensity, for 20 to 60 minutes[68–70]. The same sources further recommend combining aerobic and resistance training, prescribed two to three times per week, using machines, free weights, elastic bands, or body weight.

Several studies included in this review provided limited reporting of key exercise parameters, particularly regarding progression criteria, and individualization of intensity; only two studies[47,63] clearly described progression criteria. This underreporting has also been noted in recent reviews[71], which highlight the ongoing challenge of reproducibility in CR research. These reviews similarly point out that, although intensity and duration are usually described, details on exercise progression, monitoring, and safety criteria remain inconsistently reported, hindering translation into clinical practice.

As for BCTs, the most frequently identified in this review were *instruct how to perform behavior*, *deliver informational support*, *self-monitor behavior*, *set graded tasks*, and *deliver support*, in different implementation contexts. These findings are consistent with previous reviews, which highlight these BCTs as commonly used in interventions directed at cardiac populations[27,72–74], although their frequency varies according to the different contexts or modes of delivery of CR programs.

The BCT *instruct how to perform behavior* emerged mainly in hybrid and technology-mediated programs, in which the absence of face-to-face supervision requires clear guidance to ensure the correct execution of target behaviors, such as physical exercise or self-management strategies. This finding is consistent with other reviews. Heron et al. identified this technique in seven of the eleven home-based CR trials included[72]. Duff et al. reported it in 43% of digital programs aimed at promoting physical activity in people with cardiovascular diseases[73]. Kenny et al., on the other hand, observed it in only 20% of the digital CR programs analyzed, but it was mainly used to provide practical instructions on how to perform physical exercise[27].

Another frequently observed technique was *self-monitor behavior*, predominant in home-based programs with technological support, in which participants recorded their activities or were monitored remotely. This pattern is consistent with previous studies, which reported its high prevalence in digital CR programs[27,74]. Heron et al. identified it in six of the eleven home-based trials[72]; Duff et al. in 48% of digital programs for people with cardiovascular diseases[73]; and Kenny et al. in 84% of the digital CR programs analyzed, confirming its widespread use in this context[27]. Other studies further confirm that this is the most commonly used BCT in mobile applications directed at cardiovascular populations[28].

The BCT *set graded tasks* also stand out, being associated with the increase of physical activity through the prescription of gradual tasks that start at accessible levels and progress step by step. This strategy reduces the risk of frustration and facilitates sustained adherence to exercise[28,74], a relevant aspect in cardiac populations that often present fear of excessive effort after an acute cardiac event[18]. Although it is not among the most frequently reported in previous CR reviews, it has been described as promising: Douma et al. identified evidence of its effectiveness in promoting physical activity in technology-mediated CR programmes[74]; Patterson et al. observed it in 58% of cardiovascular diseases apps, associated with improvements in physical activity[28]; Kenny et al. reported its presence in digital CR programs, particularly in studies focusing on the promotion of physical activity[27].

The BCT *deliver support* was also among the most frequently identified in this review, appearing mainly in hospital or center-based programs. Although it was likewise reported in previous reviews, the mode of delivery was not the same. Heron et al. observed it in all eleven home-based trials included[72]; Duff et al. in 48% of digital health programs targeting people with cardiovascular diseases[73]; and Kenny et al., on the other hand, reported it less frequently in digital CR programmes[27]. These results suggest that,

although it is a cross-cutting technique, it tends to manifest more consistently in face-to-face programs, where support occurs directly and immediately.

It is also important to note that comparability with previous studies is limited by differences in taxonomy. While the previous literature used the BCTTv1 taxonomy[75], the present review relied on the BCTO[31]. Some BCTs underwent changes in designation or conceptual subdivisions, which may have influenced the perception of their frequency. This is the case of the BCT *deliver informational support*, frequent in this review but absent in the previous taxonomy, or of the BCT *goal setting (behavior)*, common in past reviews[27,73], but which in the BCTO appears fragmented into different categories.

Other BCTs were rarely used, such as *create behavioral contract*, *substitute behavior*, or *self-monitor outcome of behavior*. This finding is consistent with previous reviews based on the BCTTv1[72,73,76,77].

With regard to implementation strategies, the most frequent was *intervene with patients/consumers to enhance uptake and adherence*, observed in different contexts. Since low adherence is one of the main barriers to the effectiveness of CR programs[33], this strategy includes measures ranging from educational support to regular follow-up contacts, with the aim of improving patient participation in these programs[78]. Best practices include gathering information about the patient, providing culturally and linguistically appropriate education and guidance, establishing a therapeutic relationship with the patient, and facilitating their pathway[79].

The second most frequently observed strategy, *promote adaptability*, reflects the need to adjust programs to the needs and realities of patients, as well as to the contexts in which they are applied. Recent evidence shows that adaptive models, such as home-based programs or those with flexible scheduling, facilitate participation and increase patient satisfaction[80].

The strategy *change service sites*, identified in ten studies, reflects the trend of adapting CR programs to different contexts, exploring community or home-based settings, which is consistent with the evolution towards hybrid and telerehabilitation models already described in the literature[66].

On the other hand, organizational strategies such as *provide ongoing consultation*, *provide local technical assistance*, or *assess for readiness and identify barriers and facilitators* were rarely reported. This absence is consistent with studies that identify that the delivery of CR programs is hindered by deficits in training and continuous support for teams[78,81], technological limitations and lack of local resources[78], as well as insufficient

structured planning, referral, and adaptation to the specific needs of services and populations[82].

Thus, the results of this review suggest that implementation strategies in CR remain strongly focused on the individual and their adherence behavior, but invest little in organizational and community mechanisms that could strengthen the sustainability and continuity of the programs.

In terms of primary outcomes, functional capacity and exercise capacity were the most frequently assessed, followed by quality of life. This result is consistent with international guidelines, which identify functional capacity as one of the main prognostic predictors in cardiac patients, being strongly associated with mortality and risk of hospitalization[13,15,21]. The inclusion of quality of life, although less frequent, reveals a growing trend towards valuing patient-centered measures[13,14]. However, the absence of primary psychosocial outcomes such as anxiety, depression, or treatment adherence suggests a relevant gap, given their direct impact on overall recovery and on the active participation of patients in the programs[18].

Strengths and limitations

This review presents as its main strength the comprehensive mapping of physiotherapy interventions in CR programs, integrating different implementation contexts, BCTs, and their implementation strategies. The use of the BCTO was an added value, allowing for an updated classification of the techniques, as well as the identification of new or different findings compared to previous reviews.

However, some limitations must be acknowledged. The heterogeneity of the included studies made direct comparison between programs difficult and limited the possibility of quantitative synthesis. In addition, this review did not aim to assess the effectiveness of the interventions, either through meta-analysis or qualitative synthesis, nor to explore the impact of specific BCTs or implementation strategies on patient outcomes. These aspects were beyond the scope of this review, which focused on mapping and characterizing the physiotherapy components of CR programs. The exclusion of grey literature may also have led to the omission of potentially relevant studies. It is also important to note that this review included only patient-level primary outcomes, without considering secondary outcomes or outcomes at other levels (organizational or systemic), which constitutes a relevant limitation.

Overall, this review reinforces the role of physiotherapy in CR, highlighting its contribution to the implementation of effective programs adapted to patients' needs. By systematically

mapping intervention characteristics, BCTs, and implementation strategies, this work provides a solid foundation for developing more person-centered and adaptable rehabilitation programs. The findings may support physiotherapists in designing evidence-based interventions and assist policymakers in creating sustainable models of rehabilitation that address current demographic and technological challenges. Moreover, the identification of knowledge gaps highlights relevant priorities for future research.

Future investigations should consider not only patient-level primary outcomes, but also explore additional outcomes, including organizational, professional, and systemic dimensions. A broader approach would allow for a more complete understanding of the impact of CR, not only on the patient's clinical condition, but also on the sustainability of programs and the quality of health services.

Conclusions

This study provides a relevant contribution to understanding the role of physiotherapy in CR by offering an integrated overview of the interventions reported in the literature and their main characteristics. The mapping conducted helps identify patterns and knowledge gaps, guiding future research and supporting the development of more sustainable and equitable rehabilitation programs.

Beyond summarizing the existing evidence, this review underscores the need to strengthen the visibility and standardization of physiotherapy practice within multidisciplinary CR. It also reinforces the importance of incorporating BCTs and implementation strategies to enhance patient engagement and long-term adherence. Future research should focus on evaluating the effectiveness of these components, exploring their interaction with contextual and organizational factors, and testing models that can be adapted to different healthcare systems.

References

1. Cesare M, Bixby H, Gaziano T, Hadeed L, Kabudula C, McGhie D, et al. World heart report 2023: confronting the world's number one killer. World Heart Federation. Geneva; 2023.
2. Timmis A, Aboyans V, Vardas P, Townsend N, Torbica A, Kavousi M, et al. European Society of Cardiology: the 2023 Atlas of Cardiovascular Disease Statistics. Eur Heart J. 2024;45(38):4019–62.
3. Kaptoge S, Pennells L, De Bacquer D, Cooney MT, Kavousi M, Stevens G, et al. World Health Organization cardiovascular disease risk charts: revised models to estimate risk in 21 global regions. Lancet Glob Health. 2019;7(10):1332–45.
4. Mensah GA, Habtegiorgis Abate Y, Abbasian M, Abd-Allah F, Abdollahi A, Abdollahi M, et al. Global burden of cardiovascular diseases and risks, 1990-2022. J Am Coll Cardiol. 2023;82(25):2350–473.
5. Gheorghe A, Griffiths U, Murphy A, Legido-Quigley H, Lamptey P, Perel P. The economic burden of cardiovascular disease and hypertension in low- and middle-income countries: a systematic review. BMC Public Health. 2018;18(1):975.
6. Abreu A, Pesah E, Supervia M, Turk-Adawi K, Bjarnason-Wehrens B, Lopez-Jimenez F, et al. Cardiac rehabilitation availability and delivery in Europe: how does it differ by region and compare with other high-income countries? Eur J Prev Cardiol. 2019;26(11):1131–46.
7. World Health Organization. The top 10 causes of death [Internet]. Geneva: WHO; 2024 [cited 2024 Oct 13]. Available from: https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death
8. Go AS, Mozaffarian D, Roger VL, Benjamin EJ, Berry JD, Blaha MJ, et al. Heart disease and stroke statistics - 2014 update: a report from the American Heart Association. Circulation. 2014;129(3):1–536.
9. Gravely-Witte S, De Gucht V, Heiser W, Grace SL, Van Elderen T. The impact of angina and cardiac history on health-related quality of life and depression in coronary heart disease patients. Chronic Illn. 2007;3(1):66–76.
10. Passantino A, Dalla Vecchia LA, Corrà U, Scalvini S, Pistono M, Bussotti M, et al. The future of exercise-based cardiac rehabilitation for patients with heart failure. Front Cardiovasc Med. 2021;8:709898.

11. Riojas RA, Lawton JS, Metkus TS. The heart team: the multidisciplinary approach to coronary artery disease. Vessel Plus. 2024;8(6):1–16.

12. Sokos G, Kido K, Panjrath G, Benton E, Page R, Patel J, et al. Multidisciplinary care in heart failure services. J Card Fail. 2023;29(6):943–58.

13. Heidenreich PA, Bozkurt B, Aguilar D, Allen LA, Byun JJ, Colvin MM, et al. 2022 AHA/ACC/HFSA guideline for the management of heart failure: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Circulation. 2022;145(18):e895–1032.

14. Byrne RA, Rossello X, Coughlan JJ, Barbato E, Berry C, Chieffo A, et al. 2023 ESC guidelines for the management of acute coronary syndromes. Eur Heart J. 2023;44(38):3720–826.

15. McDonagh TA, Metra M, Adamo M, Baumbach A, Böhm M, Burri H, et al. 2021 ESC guidelines for the diagnosis and treatment of acute and chronic heart failure. Eur Heart J. 2022;24(36):3599–726.

16. Virani SS, Newby LK, Arnold S V., Bittner V, Brewer LPC, Demeter SH, et al. 2023 AHA/ACC/ACCP/ASPC/NLA/PCNA guideline for the management of patients with chronic coronary disease: a report of the American Heart Association/American College of Cardiology Joint Committee on Clinical Practice Guidelines. Circulation. 2023;148(9):e9–119.

17. Price KJ, Gordon BA, Bird SR, Benson AC. A review of guidelines for cardiac rehabilitation exercise programmes: Is there an international consensus? Eur J Prev Cardiol. 2016;23(16):1715–33.

18. Dalal HM, Doherty P, Taylor RS. Cardiac rehabilitation. BMJ . 2015;351:h5000.

19. Abreu A, Mendes M, Dores H, Silveira C, Fontes P, Teixeira M, et al. Mandatory criteria for cardiac rehabilitation programs: 2018 guidelines from the Portuguese Society of Cardiology. Revista Portuguesa de Cardiologia. 2018;37(5):363–73.

20. Shoemaker MJ, Shoemaker MJ, Dias KJ, Lefebvre KM, Heick JD, Collins SM. Physical therapist clinical practice guideline for the management of individuals with heart failure. Physical Therapy. 2020;100(1):14–43.

21. Ambrosetti M, Abreu A, Corrà U, Davos CH, Hansen D, Frederix I, et al. Secondary prevention through comprehensive cardiovascular rehabilitation: from knowledge to implementation. 2020 update. A position paper from the Secondary Prevention and Rehabilitation Section of the European Association of Preventive Cardiology. Eur J Prev Cardiol. 2021;28(5):460–95.

22. Piepoli MF, Corrà U, Benzer W, Bjarnason-Wehrens B, Dendale P, Gaita D, et al. Secondary prevention through cardiac rehabilitation: from knowledge to implementation: a position paper from the cardiac rehabilitation section of the European Association of Cardiovascular Prevention and Rehabilitation. Eur J Cardiovasc Prev Rehabil. 2010;17(1):1–17.

23. Zheng X, Zheng Y, Ma J, Zhang M, Zhang Y, Liu X, et al. Effect of exercise-based cardiac rehabilitation on anxiety and depression in patients with myocardial infarction: a systematic review and meta-analysis. Heart & Lung. 2018;48(1):1–7.

24. Thomas RJ, Beatty AL, Beckie TM, Brewer LPC, Brown TM, Forman DE, et al. Home-based cardiac rehabilitation: a scientific statement from the American Association of Cardiovascular and Pulmonary Rehabilitation, the American Heart Association, and the American College of Cardiology. J Am Coll Cardiol. 2019;74(1):133–53.

25. Nabutovsky I, Nachshon A, Klempfner R, Shapiro Y, Tesler R. Digital cardiac rehabilitation programs: the future of patient-centered medicine. Telemedicine and e-Health. 2020;26(1):34–41.

26. Anderson L, Taylor RS. Cardiac rehabilitation for people with heart disease: an overview of Cochrane systematic reviews (protocol). Cochrane Database of Systematic Reviews. 2014;12(8):1–9.

27. Kenny E, Coyne R, McEvoy JW, McSharry J, Taylor RS, Byrne M. Behaviour change techniques and intervention characteristics in digital cardiac rehabilitation: a systematic review and meta-analysis of randomised controlled trials. Health Psychol Rev. 2024;18(1):189–228.

28. Patterson K, Davey R, Keegan R, Kunstler B, Woodward A, Freene N. Behaviour change techniques in cardiovascular disease smartphone apps to improve physical activity and sedentary behaviour: systematic review and meta-regression. International Journal of Behavioral Nutrition and Physical Activity. 2022;19(1):81.

29. Beatty AL, Beckie TM, Dodson J, Goldstein CM, Hughes JW, Kraus WE, et al. A new era in cardiac rehabilitation delivery: research gaps, questions, strategies, and priorities. Circulation. 2023 Jan 17;147(3):254–66.

30. Skivington K, Matthews L, Simpson SA, Craig P, Baird J, Blazeby JM, et al. A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance. BMJ. 2021;374:n261.

31. Marques MM, Wright AJ, Corker E, Johnston M, West R, Hastings J, et al. The Behaviour Change Technique Ontology: transforming the Behaviour Change Technique Taxonomy v1. Wellcome Open Res. 2024;8(308):3–36.

32. Powell BJ, Waltz TJ, Chinman MJ, Damschroder LJ, Smith JL, Matthieu MM, et al. A refined compilation of implementation strategies: results from the Expert Recommendations for Implementing Change (ERIC) project. Implementation Science. 2015;10(21):1–14.

33. Iyngkaran P, Appuhamilage PY, Patabandige G, Sarathchandra Peru Kandage PS, Usmani W, Hanna F. Barriers to cardiac rehabilitation among patients diagnosed with cardiovascular diseases: a scoping review. International Journal of Environmental Research and Public Health. 2024;21(3):3339.

34. Peters M, Godfrey C, McInerney P, Munn Z, Tricco A, Khalil H. Chapter 11: Scoping reviews (2020 version). In: Aromataris E, Munn Z, editors. JBI Manual for Evidence Synthesis. Adelaide, Australia: JBI; 2020. p. 406–86.

35. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. Ann Intern Med. 2018 Oct 2;169(7):467–73.

36. Mampuya WM. Cardiac rehabilitation past, present and future: an overview. Cardiovasc Diagn Ther. 2012;2(1):38–49.

37. Cowie A, Buckley J, Doherty P, Furze G, Hayward J, Hinton S, et al. Standards and core components for cardiovascular disease prevention and rehabilitation. Heart. 2019;105:510–5.

38. Smith SC, Benjamin EJ, Bonow RO, Braun LT, Creager MA, Franklin BA, et al. AHA/ACCF secondary prevention and risk reduction therapy for patients with coronary and other atherosclerotic vascular disease: 2011 update: a guideline from the American Heart Association and American College of Cardiology Foundation. Circulation. 2011;124:2458–73.

39. Lefebvre C, Glanville J, Briscoe S, Featherstone R, Littlewood A, Metzendorf MI, et al. Chapter 4: Searching for and selecting studies. In: Julian Higgins, James Thomas, Jacqueline Chandler, Miranda Cumpston, Tianjing Li, Matthew Page, et al., editors. Cochrane Handbook for systematic reviews of interventions version 6,0. London, U.K.: Cochrane; 2019.

40. Hoffmann TC, Glasziou PP, Boutron I, Milne R, Perera R, Moher D, et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. BMJ . 2014;348:g1687.

41. Aamot IL, Forbord SH, Gustad K, Lockra V, Stensen A, Berg AT, et al. Home-based versus hospital-based high-intensity interval training in cardiac rehabilitation: a randomized study. Eur J Prev Cardiol. 2014;21(9):1070–8.

42. Ahmad AM, Elshenawy AI, Abdelghany M, Elghaffar HAA. Effects of early mobilisation program on functional capacity, daily living activities, and N-terminal prohormone brain natriuretic peptide in patients hospitalised for acute heart failure. a randomised controlled trial. Hong Kong Physiotherapy Journal. 2023;43(1):19–31.

43. Alves da Cruz MM, Ricci-Vitor AL, Bonini Borges GL, Fernanda da Silva P, Ribeiro F, Marques Vanderlei LC. Acute hemodynamic effects of virtual reality–based therapy in patients of cardiovascular rehabilitation: a cluster randomized crossover trial. Arch Phys Med Rehabil. 2020;101(4):642–9.

44. Astengo M, Dahl A, Karlsson T, Mattsson-Hultén L, Wiklund O, Wennerblom B. Physical training after percutaneous coronary intervention in patients with stable angina: effects on working capacity, metabolism, and markers of inflammation. Eur J Prev Cardiol. 2010;17(3):349–54.

45. Babu A, Maiya A, George Mm, Padmakumar R, Guddattu V. Effects of combined early in-patient cardiac rehabilitation and structured home-based program on function among patients with congestive heart failure: a randomized controlled trial. Heart Views. 2011;12(3):99–103.

46. Babu AS, Padmakumar R, Nayak K, Shetty R, Mohapatra AK, Maiya AG. Effects of home-based exercise training on functional outcomes and quality of life in patients with pulmonary hypertension: a randomized clinical trial. Indian Heart J. 2019;71(2):161–5.

47. Beigiene A, Petruseviciene D, Barasaite V, Kubilius R, Macijauskiene J. Cardiac rehabilitation and complementary physical training in elderly patients after acute coronary syndrome: a pilot study. Medicina . 2021;57(6):529–38.

48. Bernocchi P, Vitacca M, La Rovere MT, Volterrani M, Galli T, Baratti D, et al. Home-based telerehabilitation in older patients with chronic obstructive pulmonary disease and heart failure: a randomised controlled trial. Age Ageing. 2018;47(1):82–8.

49. Chair SY, Cheng HY, Lo SWS, Sit JWH, Wong EML, Leung KC, et al. Effectiveness of a home-based music-paced physical activity programme on exercise-related outcomes

after cardiac rehabilitation: a randomized controlled trial. Eur J Cardiovasc Nurs. 2024;23(5):510–20.

50. Chien CL, Lee CM, Wu YW, Wu YT. Home-based exercise improves the quality of life and physical function but not the psychological status of people with chronic heart failure: a randomised trial. J Physiother. 2011;57(3):157–63.

51. Cowie A, Thow MK, Granat MH, Mitchell SL. A comparison of home and hospital-based exercise training in heart failure: immediate and long-term effects upon physical activity level. European Journal of Cardiovascular Prevention & Rehabilitation. 2011;18(2):158–66.

52. den Uijl I, ter Hoeve N, Sunamura M, Stam HJ, Boersma E, Lenzen MJ, et al. Cardiac rehabilitation designed for patients with obesity: OPTICARE XL RCT results on health-related quality of life and psychosocial well-being. Disabil Rehabil. 2023;45(6):1046–55.

53. Di Leone CN, Diniz CP, Vieira de Araújo TM, Sant' Anna M de, Lamas C da C, Mediano MFF, et al. Aerobic exercise simultaneous with non-invasive ventilation reduces the length of stay in intensive care in patients with heart failure: a randomised clinical trial. Eur J Physiother. 2024;26(3):176–84.

54. Hwang R, Bruning J, Morris NR, Mandrusiak A, Russell T. Home-based telerehabilitation is not inferior to a centre-based program in patients with chronic heart failure: a randomised trial. J Physiother. 2017;63(2):101–7.

55. Kraal JJ, Peek N, Van Den Akker-Van Marle ME, Kemps H mc. Effects of home-based training with telemonitoring guidance in low to moderate risk patients entering cardiac rehabilitation: short-term results of the FIT@Home study. Eur J Prev Cardiol. 2014;21(2):26–31.

56. Kraal JJ, Elske Van Den Akker-Van Marle M, Abu-Hanna A, Stut W, Peek N, Kemps HMC. Clinical and cost-effectiveness of home-based cardiac rehabilitation compared to conventional, centre-based cardiac rehabilitation: results of the FIT@Home study. Eur J Prev Cardiol. 2017;24(12):1260–73.

57. Meslet JB, Dugué B, Brisset U, Pianeta A, Kubas S. Evaluation of a hybrid cardiovascular rehabilitation program in acute coronary syndrome low-risk patients organised in both cardiac rehabilitation and sport centres: a model feasibility study. Int J Environ Res Public Health. 2022;19(15):9455–65.

58. Oerkild B, Frederiksen M, Hansen JF, Simonsen L, Skovgaard LT, Prescott E. Home-based cardiac rehabilitation is as effective as centre-based cardiac rehabilitation among

elderly with coronary heart disease: results from a randomised clinical trial. Age Ageing. 2011;40(1):78–85.

59. Oerkild B, Frederiksen M, Hansen JF, Prescott E. Home-based cardiac rehabilitation is an attractive alternative to no cardiac rehabilitation for elderly patients with coronary heart disease: results from a randomised clinical trial. BMJ Open [Internet]. 2012;2(6):e001820. Available from: http://bmjopen.bmj.com

60. Peng X, Su Y, Hu Z, Sun X, Li X, Dolansky MA, et al. Home-based telehealth exercise training program in Chinese patients with heart failure a randomized controlled trial. Medicine . 2018;97(35):1–9.

61. Pozehl B, Duncan K, Hertzog M, Norman JF. Heart failure exercise and training camp: effects of a multicomponent exercise training intervention in patients with heart failure. Heart and Lung. 2010;39(6 Suppl):1–13.

62. Sunamura M, Ter Hoeve N, Van Den Berg-Emons RJG, Geleijnse ML, Haverkamp M, Stam HJ, et al. Randomised controlled trial of two advanced and extended cardiac rehabilitation programmes. Heart. 2018;104(5):430–7.

63. Tamuleviciute-Prasciene E, Beigiene A, Thompson MJ, Balnė K, Kubilius R, Bjarnason-Wehrens B. The impact of additional resistance and balance training in exercise-based cardiac rehabilitation in older patients after valve surgery or intervention: randomized control trial. BMC Geriatr. 2021;21(1):23–35.

64. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71.

65. Keteyian SJ, Ades PA, Beatty AL, Gavic-Ott A, Hines S, Lui K, et al. A review of the design and implementation of a hybrid cardiac rehabilitation program an expanding opportunity for optimizing cardiovascular care. J Cardiopulm Rehabil Prev. 2022;42(1):1–9.

66. Imran HM, Baig M, Erqou S, Taveira TH, Shah NR, Morrison A, et al. Home-based cardiac rehabilitation alone and hybrid with center-based cardiac rehabilitation in heart failure: a systematic review and meta-analysis. J Am Heart Assoc. 2019;8(16):e012779.

67. Rasmussen B, Maribo T, Skovsby Toft B. The content and characteristics of face-to-face interventions to encourage patients' enrollment in cardiac rehabilitation; a scoping review. Disabil Rehabil. 2024;46(13):2734–46.

68. Brown TM, Pack QR, Aberegg E, Brewer LC, Ford YR, Forman DE, et al. Core components of cardiac rehabilitation programs: 2024 update: a scientific statement from

the American Heart Association and the American Association of Cardiovascular and Pulmonary Rehabilitation. Circulation. 2024;150(18):e328–47.

69. Dibben G, Faulkner J, Oldridge N, Rees K, Thompson DR, Zwisler AD, et al. Exercise-based cardiac rehabilitation for coronary heart disease. Cochrane Database of Systematic Reviews. 2021;2021(11):1–264.

70. Dibben GO, Faulkner J, Oldridge N, Rees K, Thompson DR, Zwisler AD, et al. Exercise-based cardiac rehabilitation for coronary heart disease: a meta-analysis. Eur Heart J. 2023;44:452–69.

71. McGrath A, McHale S, Hanson CL, McLelland C, Hamilton DF. Completeness of intervention reporting in randomised trials of technology-enabled remote or hybrid exercise-based cardiac rehabilitation: a systematic review using the TIDieR framework. Vol. 46, Disability and Rehabilitation. Taylor and Francis Ltd.; 2024. p. 4350–8.

72. Heron N, Kee F, Donnelly M, Cardwell C, Tully MA, Cupples ME. Behaviour change techniques in home-based cardiac rehabilitation: a systematic review. Br J Gen Pract . 2016;66(651):e747–57.

73. Duff OM, Walsh DMJ, Furlong BA, O'Connor NE, Moran KA, Woods CB. Behavior change techniques in physical activity eHealth interventions for people with cardiovascular disease: systematic review. Med Internet Res. 2017;19(8):e281.

74. Douma ER, Roovers T, Habibovic M, de Bruijn GJ, Bosch JA, Schmitz B, et al. Effectiveness of behavior change techniques in eHealth-based cardiac rehabilitation in patients with coronary artery disease: a systematic review: effective behavior change techniques in eHealth CR. Am J Prev Cardiol. 2024;20:100892.

75. Michie S, Richardson M, Johnston M, Abraham C, Francis J, Hardeman W, et al. The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. Annals of Behavioral Medicine. 2013;46(1):81–95.

76. El Kirat H, van Belle S, Khattabi A, Belrhiti Z. Behavioral change interventions, theories, and techniques to reduce physical inactivity and sedentary behavior in the general population: a scoping review. BMC Public Health. 2024;24(2099):1–36.

77. Nadal IP, Angkurawaranon C, Singh A, Choksomngam Y, Sadana V, Kock L, et al. Effectiveness of behaviour change techniques in lifestyle interventions for non-communicable diseases: an umbrella review. BMC Public Health. 2024 Dec 1;24(1):3082.

78. Ferrel-Yui D, Candelaria D, Pettersen TR, Gallagher R, Shi W. Uptake and implementation of cardiac telerehabilitation: a systematic review of provider and system barriers and enablers. Int J Med Inform. 2024;184:105346.

79. Santiago de Araújo Pio C, Beckie TM, Varnfield M, Sarrafzadegan N, Babu AS, Baidya S, et al. Promoting patient utilization of outpatient cardiac rehabilitation: a joint international council and Canadian Association of Cardiovascular Prevention and Rehabilitation position statement. Int J Cardiol. 2020;298:1–7.

80. Wright CX, Fournier S, Deng Y, Meng C, Hiller S, Oen-Hsiao JM, et al. Implementation of an appointment-based cardiac rehabilitation approach: a single-center experience. J Am Heart Assoc. 2022;11(9):e024066.

81. Daw P, Withers TM, van Zanten JJCSV, Harrison A, Greaves CJ. A systematic review of provider-and system-level factors influencing the delivery of cardiac rehabilitation for heart failure. BMC Health Serv Res. 2021;21:1267.

82. Babu AS, Bhat V, Jose P, Padickaparambil S, Padmakumar R, Jeemon P. Challenges and solutions to implementing cardiac rehabilitation in a low- and middle-income country. Expert Rev Cardiovasc Ther. 2024;22(8):421–8.

APPENDIX

APPENDIX 1 - Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM		REPORTED ON PAGE #
	TITLE			
Title	1	Identify the report as a scoping review.		p.14
	ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable) background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.		p.14-15
	INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.		p.18-18
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.		p.18
	METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.		p.19

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM		REPORTED ON PAGE #
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.		p. 19-20
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.		p. 20
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.		Appendix 2
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.		p. 21
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.		p. 22
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.		Appendix 4
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).		NA

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM		REPORTED ON PAGE #
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.		p. 22
	RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.		p.23
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.		p.24-44
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).		NA
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.		p.24-44
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.		p.24-44
	DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.		p. 44-47
Limitations	20	Discuss the limitations of the scoping review process.		p. 47-48

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM		REPORTED ON PAGE #
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.		p.48
	FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.		NA

APPENDIX 2 – Final Search Strategies and Results

Pubmed (Medline)

("Coronary Disease"[MeSH] OR "coronary disease"[tiab] OR "coronary heart disease"[tiab] OR "myocardial ischaemia"[tiab] OR "Myocardial Ischemia"[MeSH] OR "Coronary Artery Disease"[MeSH] OR "coronary artery disease"[tiab] OR "Myocardial Infarction"[MeSH] OR "myocardial infarction"[tiab] OR "heart attack"[tiab] OR "Heart Diseases"[MeSH] OR "heart diseases"[tiab] OR "heart disease"[tiab] OR "Heart Failure"[MeSH] OR "heart failure"[tiab] OR "Heart Valve Diseases"[MeSH] OR "heart valve diseases"[tiab] OR "Cardiovascular Diseases"[MeSH] OR "cardiovascular diseases"[tiab] OR "Heart Transplantation"[MeSH] OR "heart transplantation"[tiab])

AND

("Physical Therapy Modalities"[MeSH] OR "physical therapy"[tiab] OR "Physical Therapy Specialty"[MeSH] OR "physiotherapy"[tiab] OR "Physical and Rehabilitation Medicine"[MeSH] OR "Cardiac Rehabilitation"[MeSH] OR "cardiac rehabilitation"[tiab] OR "Physical Education and Training"[MeSH] OR "Patient Education as Topic"[MeSH] OR "Health Education"[MeSH] OR "health education"[tiab] OR "Exercise"[MeSH] OR "exercise"[tiab] OR "Exercise Therapy"[MeSH] OR "exercise therapy"[tiab] OR "Physical Fitness"[MeSH] OR "physical fitness"[tiab] OR "behaviour therapy"[tiab] OR "Behavior Therapy"[MeSH])

AND

("Tertiary Healthcare"[MeSH] OR "tertiary healthcare"[tiab] OR "Hospitals, Rehabilitation"[MeSH] OR "rehabilitation hospitals"[tiab] OR "rehabilitation centre"[tiab] OR "Rehabilitation Centers"[MeSH] OR "rehabilitation center"[tiab] OR "home-based care"[tiab] OR "home care service"[tiab] OR "home care program"[tiab])

Filters: from 2010 – 2025

Results: 762

Web of Science (Elsevier)

("Coronary Disease" OR "coronary disease" OR "coronary heart disease" OR "myocardial ischaemia" OR "Myocardial Ischaemia" OR "Coronary Artery Disease" OR "coronary artery disease" OR "Myocardial Infarction" OR "myocardial infarction" OR "heart attack" OR "Heart Diseases" OR "heart diseases" OR "heart disease" OR "Heart Failure" OR "heart failure" OR "Heart Valve Diseases" OR "heart valve diseases" OR "Cardiovascular Diseases" OR "cardiovascular diseases" OR "Heart Transplantation" OR "heart transplantation")

AND

("Physical Therapy Modalities" OR "physical therapy" OR "Physical Therapy Specialty" OR physiotherapy OR "Physical and Rehabilitation Medicine" OR "Cardiac Rehabilitation" OR "cardiac rehabilitation" OR "Physical Education and Training" OR "Patient Education as Topic" OR "Health Education" OR "health education" OR Exercise OR exercise OR "Exercise Therapy" OR "exercise therapy" OR "Physical Fitness" OR "physical fitness" OR "behaviour therapy" OR "Behavior Therapy")

AND

("Tertiary Healthcare" OR "tertiary healthcare" OR "Hospitals, Rehabilitation" OR "rehabilitation hospitals" OR "rehabilitation centre" OR "Rehabilitation Centers" OR "rehabilitation center" OR "home-based care" OR "home care service" OR "home care program")

Filters: from 2010 – 2025

Results: 261

Scopus (clarivate)

("Coronary Disease" OR "coronary disease" OR "coronary heart disease" OR "myocardial ischaemia" OR "Myocardial Ischaemia" OR "Coronary Artery Disease" OR "coronary artery disease" OR "Myocardial Infarction" OR "myocardial infarction" OR "heart attack" OR "Heart Diseases" OR "heart diseases" OR "heart disease" OR "Heart Failure" OR "heart failure" OR "Heart Valve Diseases" OR "heart valve diseases" OR "Cardiovascular Diseases" OR "cardiovascular diseases" OR "Heart Transplantation" OR "heart transplantation")

AND

("Physical Therapy Modalities" OR "physical therapy" OR "Physical Therapy Specialty" OR physiotherapy OR "Physical and Rehabilitation Medicine" OR "Cardiac Rehabilitation" OR "cardiac rehabilitation" OR "Physical Education and Training" OR "Patient Education as Topic" OR "Health Education" OR "health education" OR Exercise OR exercise OR "Exercise Therapy" OR "exercise therapy" OR "Physical Fitness" OR "physical fitness" OR "behaviour therapy" OR "Behavior Therapy")

AND

("Tertiary Healthcare" OR "tertiary healthcare" OR "Hospitals, Rehabilitation" OR "rehabilitation hospitals" OR "rehabilitation centre" OR "Rehabilitation Centers" OR "rehabilitation center" OR "home-based care" OR "home care service" OR "home care program")

Filters: from 2010 – 2025

Results: 738

CINAHL (EBSCOhost)

((MH "coronary disease+") OR (TI "coronary disease" OR AB "coronary disease") OR (TI "coronary heart disease" OR AB "coronary heart disease") OR (TI "myocardial ischaemia" OR AB " myocardial ischaemia") OR (MH "myocardial ischaemia+") OR (MH "coronary artery disease+") OR (TI "coronary artery disease" OR AB "coronary artery disease" OR (MH "myocardial infarction+") OR (TI "myocardial infarction" OR AB "myocardial infarction" OR (TI "heart attack" OR AB "heart attack") OR (MH "heart diseases+") OR (TI "heart diseases OR AB "heart diseases) OR (TI "heart disease" OR AB "heart disease) OR (MH "heart failure+") OR (TI "heart failure" OR AB "heart failure") OR (MH "heart valve diseases+") OR (TI "heart valve diseases" OR AB "heart valve diseases") OR (MH "cardiovascular diseases+") OR (TI "cardiovascular diseases" OR AB "cardiovascular diseases" OR (MH "heart tranplantation+") OR (TI "heart tranplantation" OR AB "heart tranplantation"))

AND

((MH "physical therapy modalities+") OR (TI ("physical therapy modalities" OR AB "physical therapy modalities") OR (TI "physical therapy" OR AB "physical therapy") OR (MH "physical therapy specialty+" OR (TI "physical therapy specialty" OR AB "physical therapy specialty") OR (TI physiotherapies OR AB physiotherapies) OR (TI physiotherapY OR AB physiotherapy) OR (MH "physical and rehabilitation medicine+") OR (TI "physical and rehabilitation medicine" OR AB "physical and rehabilitation medicine") OR (MH "cardiac rehabilitation+") OR TI "cardiac rehabilitation" OR AB "cardiac rehabilitation") OR (MH "physical education and training+") OR (TI "physical education and training" OR AB "physical education and training") OR (MH "patient education as topic+") OR (MH health education"+) OR (TI "health education" OR AB "health education") OR (MH exercise+) OR (TI exercise OR AB exercise) OR (TI exercises OR AB exercises) OR (MH "exercise therapy+") OR (TI "exercise therapy" OR AB "exercise therapy") OR (MH "physical fitness+") OR (TI "physical fitness" OR AB "physical fitness") OR (TI "behaviour therapy" OR AB "behaviour therapy") OR (MH "behaviour therapy+"))

AND

((MH "tertiary healthcare+") OR (TI "tertiary healthcare" OR AB "tertiary healthcare) OR (MH "hospitals, rehabilitation+) OR (TI "rehabilitation hospitals" OR AB "rehabilitation hospitals") OR (TI "rehabilitation centre" OR AB "rehabilitation centre") OR (MH "rehabilitation centres+") OR (TI "rehabilitation centres" OR AB "rehabilitation centres") OR (TI "home care services" OR AB "home care services") OR (TI "home care service"

OR AB "home care service") OR (TI "domiciliar care" OR AB "domiciliar care") OR (TI "home health care" OR AB "home health care") OT (TI "home care" OR AB "home care") OR (TI "domestic health care" OR AB "domestic health care") OR (TI "domestic healthcare" OR AB "domestic healthcare") OR (TI "domiciliary health care" OR AB "domiciliary health care") OR (TI "home care program" OR AB "home care program") OR (TI "home care programme" OR AB "home care programme") OR (TI "home healthcare" OR AB "home healthcare"))

Filters: from 2010 – 2025

Results: 60

Note: the final search was completed on 9th May 2025. All retrieved results were exported in RIS format for screening and duplicate removal in Rayyan software.

APPENDIX 3 - Screening form and screener instructions

Study Title					
Criteria		**Yes**	**No**	**Maybe**	**Additional comments**
1. Population	1. Individuals diagnosed with any type of heart disease or have undergone cardiac surgery, including: • Acute coronary disease • Heart failure. • Patients with left ventricular assist devices, resynchronization therapy devices, defibrillators, or pacemakers; Patients who have undergone coronary artery bypass surgery or percutaneous coronary intervention. • Patients who have undergone valvular heart surgery or percutaneous valve implantation. • Patients who have undergone surgery to correct congenital heart disease.				
	1.2. Participants aged 18 years or older				
	1.3. Individuals that are included in Cardiac Rehabilitation Programs				

	1.4. Does not include individuals present contraindications to participating in Cardiac Rehabilitation programs, such as: Unstable angina; Decompensated heart failure; Complex ventricular arrhythmias; Pulmonary hypertension greater than 60 mmHg; Intracavitary thrombus; Recent thrombophlebitis with or without pulmonary embolism; Severe obstructive cardiopathies; Severe or symptomatic aortic stenosis; Uncontrolled inflammatory or infectious pathologies; Any musculoskeletal conditions that prevent exercise				
2. **Concept**	2.1. Interventions performed by physiotherapists in individuals with heart disease within Cardiac Rehabilitation Programs;				
3. Context	3.1. Hospital-based context;				
	3.2. Centre-based context;				
	3.3. Home-based context (with or without digital support);				
	3.4. Hybrid context.				
	4.2. It is not a systematic reviews, meta-analysis, scoping reviews, books, conference proceedings, policy documents, texts and opinion articles, research reports, dissertations and theses, editorials, or any type of grey literature.				
5. Restrictions	Published after 2010				
	Articles published in Portuguese, English, or Spanish.				

Screener instructions

Population

Include if:

- Individuals over 18 years old
- Individuals diagnosed with any type of heart disease or have undergone cardiac surgery, including:
- Acute coronary disease;
- Heart failure;
- Patients with left ventricular assist devices, resynchronization therapy devices, defibrillators, or pacemakers; Patients who have undergone coronary artery bypass surgery or percutaneous coronary intervention;
- Patients who have undergone valvular heart surgery or percutaneous valve implantation;
- Patients who have undergone surgery to correct congenital heart disease.
- Individuals that are included in Cardiac Rehabilitation Programs

Exclude if:

- Individuals present contraindications to participating in Cardiac Rehabilitation programs, such as:
- Unstable angina;
- Decompensated heart failure;
- Complex ventricular arrhythmias;
- Pulmonary hypertension greater than 60 mmHg;
- Intracavitary thrombus;
- Recent thrombophlebitis with or without pulmonary embolism;
- Severe obstructive cardiopathies;
- Severe or symptomatic aortic stenosis;
- Uncontrolled inflammatory or infectious pathologies;
- Any musculoskeletal conditions that prevent exercise

Concept

Include if:

- Interventions are performed by physiotherapists in individuals with heart disease within Cardiac Rehabilitation Programs. The intervention was physiotherapy-led,

and the study explicitly mentioned the inclusion of a physiotherapist in the delivery team and clarified their role in the implementation;

Context

Include if:

- Physiotherapy interventions are delivered in:
- Hospital-based context;
- Centre-based context;
- Home-based context (with or without digital support);
- Hybrid context.

Types of studies

Include if:

- **Experimental or quasi-experimental designs**, such as:
  - Randomized controlled trials
  - Non-randomized controlled trials
  - Before and after studies
  - Interrupted time-series studies
  - Pilot studies or feasibility studies
- **Observational studies**, including:
  - Prospective
  - Retrospective
  - Cross-sectional
  - Case-control designs

Exclude if:

- Studies published before 2010.
- Systematic reviews, meta-analyses, scoping reviews, books, conference proceedings, policy documents, texts and opinion articles, research reports, dissertations and theses, editorials, or any type of grey literature.

APPENDIX 4 – Extraction Form

1. GENERAL INFORMATION	
Reference *Full reference of the study*	
Title *Title of the included study*	
Authors *Name of the authors of the study.*	
Corresponding author's contact details *Name and contact details of the corresponding author*	
Publication date *Date in which in the study was published*	

2. CHARACTERISTICS OF THE INCLUDED STUDIES	
METHODOLOGY	
Study objectives *Objectives of the study*	
Study design *Type of study design*	
PARTICIPANTS	
Population description *General description of the population included in the study*	
Inclusion criteria *Inclusion criteria defined for the study*	

Exclusion criteria *Exclusion criteria defined for the study*	
Sample size *Number of participants in the study;* (Intervention vs. control, when applicable)	
Time points	

3. INTERVENTION CHARACTERISTICS *(coding based on the TIDIER checklist)*	
3.1. IDENTIFICATION	
Name of the intervention *Provide the name or a phrase that describes the intervention.*	
Country *Identify the country where the intervention was developed and implemented.*	
Other available references *Identify other existing studies about this intervention (e.g., protocols, follow-up studies).*	

3.2. **INTERVENTION COMPONENTS/DESCRIPTION** *(coding based on the TIDIER checklist*	
WHY IS CARE PROVIDED?	
Rationale *Describe any rationale, theory or goal of the elements essential to the intervention*	
WHAT CARE IS PROVIDED	
Procedures *Description of the characteristics of the interventions. Describe each of the procedures, activities, and/or processes used in the intervention, including any enabling or support activities*	
Materials used *Describe any physical or informational materials used in the intervention, including those provided to participants or used in intervention delivery or in training of intervention providers. Provide information on where the materials can be accessed (e.g. online appendix, URL).*	
WHO PROVIDES CARE	
Health professionals involved	

Identify each healthcare professional who delivers care, as well as their expertise, background and any specific training given.	
HOW	
Modes of delivery *Describe the modes of delivery (e.g. face-to-face or by some other mechanism, such as internet or telephone, group vs. individual) of the intervention and whether it was provided individually or in a group.*	
WHERE	
Setting *Description of the setting(s) in which the model of service delivery was develop, implemented and/or evaluated. Also describe the type(s) of locations where the intervention occurred, including any necessary infrastructure or relevant features or changes in where care is provided (e.g., home vs. healthcare facility, inpatient vs. outpatient).*	
WHEN AND HOW WUCH	
Frequency, duration and dosage	

Describe the number of times the intervention was delivered and over what period of time including the number of sessions, their schedule, and their duration, intensity or dose.	
TAILORING	
If the intervention was planned to be personalized, titrated or adapted, then describe what, why, when, and how.	
MODIFICATIONS	
If the intervention was modified during the course of the study, describe the changes (what, why, when, and how).	

4. **BEHAVIOR CHANGE TECHNIQUES** (according to BCTOntology)	
Description	**BCTO**

5. **IMPLEMENTATION STRATEGIES** *(description of the implementation strategy)*	
1. **Use evaluative and iterative strategies**	
1.1. Assess for readiness and identify barriers and facilitators *Assess various aspects of an organization to determine its degree of readiness to implement, barriers that may impede implementation, and strengths that can be used in the implementation effort.*	
1.2. Audit and provide feedback *Collect and summarize clinical performance data over a specified time period and give it to clinicians and administrators to monitor, evaluate, and modify provider behaviour.*	
1.3. Purposefully reexamine the implementation *Monitor progress and adjust clinical practices and implementation strategies to continuously improve the quality of care.*	
1.4. Develop and implement tools for quality monitoring	

Develop, test, and introduce into quality-monitoring systems the right input – the appropriate language, protocols, algorithms, standards, and measures (of processes, patient/consumer outcomes, and implementation outcomes) that are often specific to the innovation being implemented.	
1.5. Develop and organize quality monitoring systems *Develop and organize systems and procedures that monitor clinical processes and/or outcomes for the purpose of quality assurance and improvement.*	
1.6. Develop a formal implementation blueprint *Develop a formal implementation blueprint that includes all goals and strategies. The blueprint should include the following: 1) aim/purpose of the implementation; 2) scope of the change (e.g., what organizational units are affected); 3) timeframe and milestones; and 4) appropriate performance/progress measures. Use and update this plan to guide the implementation effort over time.*	
1.7. Conduct local need assessment *Collect and analyse data related to the need for the innovation.*	
1.8. Stage implementation scale up *Phase implementation efforts by starting with small pilots or demonstration projects and gradually move to a system wide rollout.*	
1.9. Obtain and use patients/consumers and family feedback *Develop strategies to increase patient/consumer and family feedback on the implementation effort.*	

1.10. Conduct cyclical small tests of change *Implement changes in a cyclical fashion using small tests of change before taking changes system-wide. Tests of change benefit from systematic measurement, and results of the tests of change are studied for insights on how to do better. This process continues serially over time, and refinement is added with each cycle.*	
2. Provide interactive assistance	
2.1. Facilitation *A process of interactive problem solving and support that occurs in a context of a recognized need for improvement and a supporting interpersonal relationship.*	
2.2. Provide local technical assistance *Develop and use a system to deliver technical assistance focused on implementation issues using local personnel.*	
2.3. Provide clinical supervision *Provide clinicians with ongoing supervision focusing on the innovation. Provide training for clinical supervisors who will supervise clinicians who provide the innovation.*	
2.4. Centralize technical assistance *Develop and use a centralized system to deliver technical assistance focused on implementation issues.*	
3. Adapt and tailor to context	
3.1. Tailor strategies	

Tailor the implementation strategies to address barriers and leverage facilitators that were identified through earlier data collection.	
3.2. Promote adaptability *Identify the ways a clinical innovation can be tailored to meet local needs and clarify which elements of the innovation must be maintained to preserve fidelity.*	
3.3. Use data experts *Involve, hire and/or consult experts to inform management on the use of data generated by implementation efforts.*	
3.4. Use data warehousing techniques *Integrate clinical records across facilities and organizations to facilitate implementation across systems.*	
4. Develop stakeholder interrelationships	
4.1. Identify and prepare champions *Identify and prepare individuals who dedicate themselves to supporting, marketing, and driving through an implementation, overcoming indifference or resistance that the intervention may provoke in an organization.*	
4.2. Organize clinician implementation team meetings *Develop and support teams of clinicians who are implementing the innovation and give them protected time to reflect on the implementation effort, share lessons learned, and support one another's learning.*	

4.3. Recruit, designate, and train for leadership *Recruit, designate, and train leaders for the change effort.*	
4.4. Inform local opinion leaders *Inform providers identified by colleagues as opinion leaders or "educationally influential" about the clinical innovation in the hopes that they will influence colleagues to adopt it.*	
4.5. Build a colation *Recruit and cultivate relationships with partners in the implementation effort.*	
4.6. Obtain formal commitments *Obtain written commitments from key partners that state what they will do to implement the innovation.*	
4.7. Identify early adopters *Identify early adopters at the local site to learn from their experiences with the practice innovation.*	
4.8. Conduct local consensus discussions *Include local providers and other stakeholders in discussions that address whether the chosen problem is important and whether the clinical innovation to address it is appropriate.*	
4.9. Capture and share local knowledge *Capture local knowledge from implementation sites on how implementers and clinicians made something work in their setting and then share it with other sites.*	
4.10. Use advisory boards and workgroups	

Create and engage a formal group of multiple kinds of stakeholders to provide input and advice on implementation efforts and to elicit recommendations for improvements.	
4.11. Use an implementation advisor *Seek guidance from experts in implementation*	
4.12. Model and simulate change *Model or simulate the change that will be implemented prior to implementation.*	
4.13. Visit other sites *Visit sites where a similar implementation effort has been considered successful.*	
4.14. Involve executive boards *Involve existing governing structures (e.g., boards of directors, medical staff boards of governance) in the implementation effort, including the review of data on implementation processes.*	
4.15. Develop an implementation glossary *Develop and distribute a list of terms describing the innovation, implementation, and stakeholders in the organizational change.*	
4.16. Develop academic partnerships *Partner with a university or academic unit for the purposes of shared training and bringing research skills to an implementation project.*	
4.17. Promote network weaving *Identify and build on existing high-quality working relationships and networks within and outside the organization, organizational units,*	

teams, etc. to promote information sharing, collaborative problem-solving, and a shared vision/goal related to implementing the innovation.	
5. Train and educate stakeholders	
5.1. Conduct ongoing training *Plan for and conduct training in the clinical innovation in an ongoing way.*	
5.2. Provide ongoing consultation *Provide ongoing consultation with one or more experts in the strategies used to support implementing the innovation.*	
5.3. Develop educational materials *Develop and format manuals, toolkits, and other supporting materials in ways that make it easier for stakeholers to learn about the innovation and for clinicians to learn how to deliver the clinical innovation.*	
5.4. Make training dynamic *Vary the information delivery methods to cater to different learning styles and work contexts, and shape the training in the innovation to be interactive.*	
5.5. Distribute educational materials *Distribute educational materials (including guidelines, manuals, and toolkits) in person, by mail, and/or electronically.*	
5.6. Use train-the-trainer strategies *Train designated clinicians or organizations to train others in the clinical innovation.*	
5.7. Conduct educational meetings	

Hold meetings targeted toward different stakeholder groups (e.g., providers, administrators, other organizational stakeholders, and community, patient/consumer, and family stakeholders) to teach them about the clinical innovation.	
5.8. Conduct educational outreach visits *Have a trained person meet with providers in their practice setting to educate providers about the clinical innovation with the intent of changing the provider's practice.*	
5.9. Create a learning collaborative *Facilitate the formation of groups of providers or provider organizations and foster a collaborative learning environment to improve implementation of the clinical innovation.*	
5.10. Shadow other experts *Provide ways for key individuals to directly observe experienced people engage with or use the targeted practice change/innovation.*	
5.11. Work with educational institutions *Encourage educational institutions to train clinicians in the innovation.*	
6. Support clinicians	
6.1. Facilitate relay of clinical data to providers *Provide as close to real-time data as possible about key measures of process/outcomes using integrated modes/channels of communication in a way that promotes use of the targeted innovation.*	
6.2. Remind clinicians	

Develop reminder systems designed to help clinicians to recall information and/or prompt them to use the clinical innovation.	
6.3. Develop resource sharing agreements *Develop partnerships with organizations that have resources needed to implement the innovation.*	
6.4. Revise professional roles *Shift and revise roles among professionals who provie care, and redesign job characteristics.*	
6.5. Create new clinical teams *Change who serves on the clinical team, adding different disciplines and different skills to make it more likely that the clinical innovation is delivered (or is more successfully delivered).*	
7. Engage consumers	
7.1. Involve patients/consumers and family members *Engage or include patients/consumers and families in the implementation effort*	
7.2. Intervene with patients/consumers to enhance uptake and adherence *Develop strategies with patients to encourage and problem solve around adherence.*	
7.3. Prepare patients/consumers to be active participants *Prepare patients/consumers to be active in their care, to ask questions, and specifically to inquire about care guidelines, the evidence behind clinical decisions, or about available evidence-supported treatments.*	

7.4. Increase demand *Attempt to influence the market for the clinical innovation to increase competition intensity and to increase the maturity of the market for the clinical innovation.*	
7.5. Use mass media *Use media to reach large numbers of people to spread the word about the clinical innovation.*	
8. Utilize financial strategies	
8.1. Fund and contract for the clinical innovation *Governments and other payers of services issue requests for proposals to deliver the innovation, use contracting processes to motivate providers to deliver the clinical innovation, and develop new funding formulas that make it more likely that providers will deliver the innovation.*	
8.2. Access new funding *Access new or existing money to facilitate the implementation.*	
8.3. Place innovation on fee for service lists/formularies *Work to place the clinical innovation on lists of actions for which providers can be reimbursed (e.g., a drug is placed on a formulary, a procedure is now reimbursable).*	
8.4. Alter incentive/allowance structures *Work to incentivize the adoption and implementation of the clinical innovation.*	
8.5. Make billing easier *Make it easier to bill the clinical innovation.*	

8.6. Alter patient/consumer fees *Create fee structures where patients/consumers pay less for preferred treatments (the clinical innovation) and more for less-preferred treatments.*	
8.7. Use other payment schemes *Introduce payment approaches (in a catch-all category)*	
8.8. Develop disincentives *Provide financial disincentives for failure to implement or use the clinical innovations.*	
8.9. Use capitated payments *Pay providers or care systems a set amount per patient/consumer for delivering clinical care.*	
9. Change infrastructure	
9.1. Mandate change *Have leadership declare the priority of the innovaton and their determination to have It implemented.*	
9.2. Change record systems *Change records systems to allow better assessment of implementation or clinical outcomes.*	
9.3. Change physical structure and equipment *Evaluate current configurations and adapt, as needed, the physical structure and/or equipment (e.g., changing the layout of a room, adding equipment) to best accommodate the targeted innovation.*	
9.4. Create or change credentialing and/or licensure standards	

Create an organization that certifies clinicians in the innovation or encourage an existing organization to do so. Change governmental professional certification or licensure requirements to include delivering the innovation. Work to alter continuing education requirements to shape professional practice toward the innovation.	
9.5. Change service sites *Change the location of clinical service sites to increase access.*	
9.6. Change accreditation or membership requirements *Strive to alter accreditation standards so that they require or encourage use of the clinical innovation. Work to alter membership organization requirements so that those who want to affiliate with the organization are encouraged or required to use the clinical innovation.*	
9.7. Start a dissemination organization *Identify or start a separate organization that is responsible for disseminating the clinical innovation. It could be a for-profit or non-profit organization.*	
9.8. Change liability laws *Participate in liability reform efforts that make clinicians more willing to deliver the clinical innovation.*	

6. OUTCOMES AND RESULTS	
6.1. **Patient level primary outcomes**	
Outcome name	
Outcome measure	
Time points measured	
Results	

APPENDIX 5 - List of studies assessed for full-text eligibility, along with the reasons for exclusion

Study	Exclude reason
Alrahahleh M, Subih M, Megdadi R, Altarabsheh SE, Alfawaeer Z, Saad A, Khalil T. Cardiac rehabilitation program effect on health-related quality of life among patients with coronary artery bypass grafts. *Crit Care Nurs Q.* 2024;47(1):19–28. DOI: 10.1097/CNQ.0000000000000488	Wrong concept
Alsara O, Reeves RK, Pyfferoen MD, Trenary TL, Engen DJ, Vitse ML, Kessler SM, Kushwaha SS, Clavell AL, Thomas RJ, Lopez-Jimenez F, Park SJ, Perez-Terzic CM. Inpatient rehabilitation outcomes for patients receiving left ventricular assist device. *Am J Phys Med Rehabil.* 2014;93(10):860–8. DOI: 10.1097/PHM.0000000000000101	Wrong concept
Amstad T, Taeymans J, Englberger L, Mohacsi P, Steiner D, Wilhelm MJ, Hermann M. Cardiac rehabilitation in patients with ventricular assist device. *J Cardiopulm Rehabil Prev.* 2022;42(2):97–102. DOI: 10.1097/HCR.0000000000000615	Wrong concept
Clinical Efficacy of a Medical Centre- and Home-based Cardiac Rehabilitation Program for Patients With Coronary Heart Disease after Coronary Bypass Graft Surgery	Wrong concept
Aronov D, Bubnova M, Iosseliani D, Orekhov A. Cardiac rehabilitation after coronary artery bypass grafting: clinical and angiographic results. *Arch Med Res.* 2019;50(3):122–32. DOI: 10.1016/j.arcmed.2019.07.007	Wrong concept
Asiri FY, Marchetti GF, Ellis JL, Otis L, Sparto PJ, Watzlaf V, Whitney SL. Effect of home-based rehabilitation on activities of daily living and gait in older adults with heart failure at risk for falling: a retrospective cohort study. *Physiother Theory Pract.* 2017;33(12):943–53. DOI: 10.1080/09593985.2017.1360422	Wrong concept

Austin J, Williams WR, Hutchison S. Patterns of fatigue in elderly heart failure patients measured by a quality of life scale (Minnesota Living with Heart Failure). *Eur J Cardiovasc Nurs.* 2012;11(4):439–44. DOI: 10.1016/j.ejcnurse.2011.04.002	Wrong concept
Avila A, Claes J, Goetschalckx K, Buys R, Azzawi M, Vanhees L, Cornelissen V. Home-based rehabilitation with telemonitoring guidance for patients with coronary artery disease (short-term results of the TRiCH study): randomized controlled trial. *J Med Internet Res.* 2018;20(6):e225. DOI: 10.2196/jmir.9943	Wrong concept
Baibolova M, Bolatbekov BA, Trusheva KS, Kuramysuly KS, Bolatbekova ZS, Yesenbekov B. Effects of the cardiac rehabilitation program on the quality of life in patients after open-heart surgery. *Heart Vessels Transpl.* 2024;8(2). DOI: 10.24969/hvt.2024.479	Wrong concept
Beckers PJ, Denollet J, Possemiers NM, Wuyts K, Vrints CJ, Conraads VM. Maintaining physical fitness of patients with chronic heart failure: a randomized controlled trial. *Eur J Prev Cardiol.* 2010;17(6):660–7. DOI: 10.1097/HJR.0b013e328339ccac	Wrong concept
Bhasipol A, Sanjaroensuttikul N, Pornsuriyasak P, Yamwong S, Tangcharoen T. Efficiency of the home cardiac rehabilitation program for adults with complex congenital heart disease. *Congenit Heart Dis.* 2018;13(6):952–8. DOI: 10.1111/chd.12659	Wrong concept
Bilbrey T, Martin J, Zhou W, Bai C, Vaswani N, Shah R, Chokshi S, Chen X, Bhusri S, Niemi S, Meng H, Lei Z. A dual-modality home-based cardiac rehabilitation program for adults with cardiovascular disease: single-arm remote clinical trial. *JMIR Mhealth Uhealth.* 2024;12:e59098. DOI: 10.2196/59098	Wrong concept
Bittencourt HS, Cruz CG, David BC, Rodrigues E Jr, Abade CM, Junior RA, Carvalho VO, Dos Reis FBF, Gomes Neto M.	Wrong concept

Addition of non-invasive ventilatory support to combined aerobic and resistance training improves dyspnea and quality of life in heart failure patients: a randomized controlled trial. *Clin Rehabil.* 2017;31(11):1508–15. DOI: 10.1177/0269215517704269	
Boidin M, Gayda M, Henri C, Hayami D, Trachsel LD, Besnier F, Lalongé J, Juneau M, Nigam A. Effects of interval training on risk markers for arrhythmic death: a randomized controlled trial. *Clin Rehabil.* 2019;33(8):1320–30. DOI: 10.1177/0269215519840388	Wrong concept
Borges JP, Mediano MFF, Farinatti P, Coelho MP, Nascimento PMC, De Oliveira Lopes G, Kopiler DA, Tibiriçá E. The effects of unsupervised home-based exercise upon functional capacity after 6 months of discharge from cardiac rehabilitation: a retrospective observational study. *J Phys Act Health.* 2016;13(11):1230–5. DOI: 10.1123/jpah.2016-0058	Wrong concept
Borland M, Rosenkvist A, Cider Å. A group-based exercise programme did not improve physical activity in patients with chronic heart failure and comorbidity: a randomized controlled trial. *J Rehabil Med.* 2014;46(5):461–7. DOI: 10.2340/16501977-1794	Wrong concept
Bravo-Escobar R, González-Represas A, Gómez-González AM, Heredia-Torres Á. Effectiveness of e-health cardiac rehabilitation program on quality of life associated with symptoms of anxiety and depression in moderate-risk patients. *Sci Rep.* 2021;11(1):83231. DOI: 10.1038/s41598-021-83231-y	Wrong concept
Bravo-Escobar R, González-Represas A, Gómez-González AM, Montiel-Trujillo A, Aguilar-Jimenez R, Carrasco-Ruíz R, Salinas-Sánchez P. Effectiveness and safety of a home-based cardiac rehabilitation programme of mixed surveillance in patients with ischemic heart disease at moderate cardiovascular risk: a randomised, controlled clinical trial. *BMC Cardiovasc Disord.* 2017;17(1):49. DOI: 10.1186/s12872-017-0499-0	Wrong concept

Bryndal A, Glowinski S, Grochulska A. Influence of risk factors on exercise tolerance in patients after myocardial infarction—early cardiac rehabilitation in Poland. *J Clin Med.* 2022;11(19):5597. DOI: 10.3390/jcm11195597	Wrong concept
Busch JC, Lillou D, Wittig G, Bartsch P, Willemsen D, Oldridge N, Bjarnason-Wehrens B. Resistance and balance training improves functional capacity in very old participants attending cardiac rehabilitation after coronary bypass surgery. *J Am Geriatr Soc.* 2012;60(12):2270–6. doi: DOI: 10.1111/jgs.12030	Wrong concept
Chair SY, Chan SW, Thompson DR, Leung KP, Ng SK, Choi KC. Long-term effect of motivational interviewing on clinical and psychological outcomes and health-related quality of life in cardiac rehabilitation patients with poor motivation in Hong Kong: a randomized controlled trial. *Clin Rehabil.* 2013;27(12):1107–17. DOI: 10.1177/0269215513490527	Wrong concept
Chen JT, Lin TH, Voon WC, Lai WT, Huang MH, Sheu SH, Chen CK. Beneficial effects of home-based cardiac rehabilitation on metabolic profiles in coronary heart disease patients. *Kaohsiung J Med Sci.* 2016;32(5):267–75. DOI: 10.1016/j.kjms.2016.04.014	Wrong concept
Chen YW, Wang CY, Lai YH, Liao YC, Wen YK, Chang ST, Huang JL, Wu TJ. Home-based cardiac rehabilitation improves quality of life, aerobic capacity, and readmission rates in patients with chronic heart failure. *Medicine (Baltimore).* 2018;97(4):e9629. DOI: 10.1097/MD.0000000000009629	Wrong concept
Clark AM, Catto S, Bowman G, MacIntyre PD. Design matters in secondary prevention: individualization and supervised exercise improves the effectiveness of cardiac rehabilitation. *Eur J Cardiovasc Prev Rehabil.* 2011;18(5):761–9. DOI: 10.1177/1741826710397107	Wrong concept
Cornelissen VA, Defoor JG, Stevens A, Schepers D, Hespel P, Decramer M, Mortelmans L, Dobbels F, Vanhaecke J, Fagard	Wrong concept

RH, Vanhees L. Effect of creatine supplementation as a potential adjuvant therapy to exercise training in cardiac patients: a randomized controlled trial. *Clin Rehabil.* 2010;24(11):988–99. DOI: 10.1177/0269215510367995	
Dalal HM, Taylor RS, Jolly K, Davis RC, Doherty P, Miles J, van Lingen R, Warren FC, Green C, Wingham J, Greaves C, Sadler S, Hillsdon M, Abraham C, Britten N, Frost J, Singh S, Hayward C, Eyre V, Paul K, Lang CC, Smith K. The effects and costs of home-based rehabilitation for heart failure with reduced ejection fraction: the REACH-HF multicentre randomized controlled trial. *Eur J Prev Cardiol.* 2019;26(3):262–72. DOI: 10.1177/2047487318806358	Wrong concept
de Bakker M, den Uijl I, ter Hoeve N, van Domburg RT, Geleijnse ML, van den Berg-Emons RJ, Boersma E, Sunamura M. Association between exercise capacity and health-related quality of life during and after cardiac rehabilitation in acute coronary syndrome patients: a substudy of the OPTICARE randomized controlled trial. *Arch Phys Med Rehabil.* 2020;101(4):650–7. DOI: 10.1016/j.apmr.2019.11.017	Wrong concept
Delgado BM, Lopes I, Gomes B, Novo A. Early rehabilitation in cardiology – heart failure: the ERIC-HF protocol, a novel intervention to decompensated heart failure patients rehabilitation. *Eur J Cardiovasc Nurs.* 2020;19(7):592–9. DOI: 10.1177/1474515120913806	Wrong concept
de Lima AP, Pereira DG, Nascimento IO, Martins TH, Oliveira AC, Nogueira TS, Britto RR. Cardiac telerehabilitation in a middle-income country: analysis of adherence, effectiveness and cost through a randomized clinical trial. *Eur J Phys Rehabil Med.* 2022;58(4):598–605. DOI: 10.23736/S1973-9087.22.07340-3	Wrong concept
Demir Gündoğmuş P, Topçu Özcan B, Hayıroğlu M, Gündoğmuş İ, Ölçü EB, Uzun M, Orhan AL. The effect of age on outcomes at a cardiac rehabilitation center in Turkey. *Turk*	Wrong concept

Kardiyol Dern Ars. 2020;48(3):270–7. DOI: 10.5543/tkda.2020.78568	
Dias KJ, Child J, Blackinton MT, Wilson S, Brown DR, Collins SM. Frontloading home physical therapy visits for patients with heart failure: a multi-center randomized controlled trial. *Home Healthc Now.* 2024;42(4):227–35. DOI: 10.1097/NHH.0000000000001267	Wrong concept
Dodson JA, Adhikari S, Schoenthaler A, Hochman JS, Sweeney G, George B, Marzo K, Jennings LA, Kovell LC, Vorsanger M, Pena S, Meng Y, Varghese A, Johanek C, Rojas M, McConnell R, Whiteson J, Troxel AB. Rehabilitation at home using mobile health for older adults hospitalized for ischemic heart disease: the RESILIENT randomized clinical trial. *JAMA Netw Open.* 2025;8(1):e2453499. DOI: 10.1001/jamanetworkopen.2024.53499	Wrong concept
Dua JS, Cooper AR, Fox KR, Stuart AG. Exercise training in adults with congenital heart disease: feasibility and benefits. *Int J Cardiol.* 2010;138(2):196–205. DOI: 10.1016/j.ijcard.2009.01.038	Wrong concept
Duan YP, Liang W, Guo L, Wienert J, Si GY, Lippke S. Evaluation of a web-based intervention for multiple health behavior changes in patients with coronary heart disease in home-based rehabilitation: pilot randomized controlled trial. *J Med Internet Res.* 2018;20(11):e12052. DOI: 10.2196/12052	Wrong concept
Duarte Freitas P, Haida A, Bousquet M, Richard L, Mauriège P, Guiraud T. Short-term impact of a 4-week intensive cardiac rehabilitation program on quality of life and anxiety-depression. *Ann Phys Rehabil Med.* 2011;54(3):132–43. DOI: 10.1016/j.rehab.2011.02.001	Wrong concept
Dunn SL, Dunn LM, Rieth NP, Olamijulo GB, Swieringa LL, Holden TP, Clark JA, DeVon HA, Tintle NL. Impact of home- and hospital-based exercise in cardiac rehabilitation on	Wrong concept

hopelessness in patients with coronary heart disease. *J Cardiopulm Rehabil Prev.* 2017;37(1):39–48. DOI: 10.1097/HCR.0000000000000205	
Dwiputra B, Ambari AM, Triangto K, Supriami K, Kesuma TW, Zuhdi N, Phowira J, Radi B. The home-based breathing and chest mobility exercise improves cardiorespiratory functional capacity in long COVID with cardiovascular comorbidities: a randomized study. *BMC Cardiovasc Disord.* 2024;24(1):4196. DOI: 10.1186/s12872-024-04196-0	Wrong concept
Eghøj M, Zinckernagel L, Brinks TS, Kristensen ALS, Hviid SS, Tolstrup JS, Dalal HM, Taylor RS, Zwisler ADO, Egstrup K, Glümer C, Grønbæk M, Kober L, Cour KL, Nakano A, Nielsen CV, Sibilitz KL. Adapting an evidence-based, home cardiac rehabilitation programme for people with heart failure and their caregivers to the Danish context: DK:REACH-HF study. *Eur J Cardiovasc Nurs.* 2024;23(7):728–36. DOI: 10.1093/eurjcn/zvae037	Wrong concept
Estany ER, Campos Vera N, Barrera Sarduy J, Hernández García S, Valdés Martín A, Peña Bofill V, Prendes Lago E. Functional evaluation of a physical training programme in myocardial infarction patients with severe left ventricular systolic dysfunction. *Rev Colomb Cardiol.* 2020;27(4):344–50. DOI: 10.1016/j.rccar.2019.03.005	Wrong concept
Evangelista LS, Cacciata M, Strömberg A, Dracup K. Dose–response relationship between exercise intensity, mood states, and quality of life in patients with heart failure. *J Cardiovasc Nurs.* 2017;32(6):530–7. DOI: 10.1097/JCN.0000000000000407	Wrong concept
Fanget M, Bayle M, Labeix P, Roche F, Hupin D. Effects of cardiac telerehabilitation during COVID-19 on cardiorespiratory capacities in patients with coronary artery disease. *Front Physiol.* 2022;13:837482. DOI: 10.3389/fphys.2022.837482	Wrong concept

Fayazi S, Zarea K, Abbasi A, Ahmadi F. Effect of home-based walking on performance and quality of life in patients with heart failure. *Scand J Caring Sci.* 2013;27(2):246–52. DOI: 10.1111/j.1471-6712.2012.01020.x	Wrong concept
Feuerstein A, Schoenrath F, Belyavskiy E, Knierim J, Friede T, Placzek M, Bach D, Pieske-Kraigher E, Herrmann-Lingen C, Westenfeld R, Roden M, Rybczynski M, Verheyen N, Dörr M, von Haehling S, Störk S, Halle M, Falk V, Pieske B, Edelmann F. Supervised exercise training in patients with advanced heart failure and left ventricular assist device: a multicentre randomized controlled trial (Ex-VAD trial). *Eur J Heart Fail.* 2023;25(12):2252–62. DOI: 10.1002/ejhf.3032	Wrong concept
Fiogbé E, Ferreira R, Sindorf MA, Tavares SA, de Souza KP, de Castro Cesar M, Lopes CR, Moreno MA. Water exercise in coronary artery disease patients, effects on heart rate variability, and body composition: a randomized controlled trial. *Physiother Res Int.* 2018;23(3):e1713. DOI: 10.1002/pri.1713	Wrong concept
Frederix I, Hansen D, Coninx K, Vandervoort P, Vandijck D, Hens N, Van Craenenbroeck E, Van Driessche N, Dendale P. Medium-term effectiveness of a comprehensive internet-based and patient-specific telerehabilitation program with text messaging support for cardiac patients: randomized controlled trial. *J Med Internet Res.* 2015;17(7):e185. DOI: 10.2196/jmir.4799	Wrong concept
Frederix I, Van Driessche N, Hansen D, Berger J, Bonne K, Alders T, Dendale P. Increasing the medium-term clinical benefits of hospital-based cardiac rehabilitation by physical activity telemonitoring in coronary artery disease patients. *Eur J Prev Cardiol.* 2015;22(2):150–8. DOI: 10.1177/2047487313514018	Wrong concept
Freyssin C, Verkindt C, Prieur F, Benaich P, Maunier S, Blanc P. Cardiac rehabilitation in chronic heart failure: effect of an 8-week, high-intensity interval training versus continuous training.	Wrong concept

Arch Phys Med Rehabil. 2012;93(8):1359–64. DOI: 10.1016/j.apmr.2012.03.007	
Gary RA, Cress ME, Higgins MK, Smith AL, Dunbar SB. Combined aerobic and resistance exercise program improves task performance in patients with heart failure. *Arch Phys Med Rehabil.* 2011;92(9):1371–81. DOI: 10.1016/j.apmr.2011.02.022	Wrong concept
Gary RA, Cress ME, Higgins MK, Smith AL, Dunbar SB. A combined aerobic and resistance exercise program improves physical functional performance in patients with heart failure: a pilot study. *J Cardiovasc Nurs.* 2012;27(5):418–30. DOI: 10.1097/JCN.0b013e31822ad3c3	Wrong concept
Gary RA, Dunbar SB, Higgins MK, Musselman DL, Smith AL. Combined exercise and cognitive behavioral therapy improves outcomes in patients with heart failure. *J Psychosom Res.* 2010;69(2):119–31. DOI: 10.1016/j.jpsychores.2010.01.013	Wrong concept
Giordano A, Zanelli E, Scalvini S. Home-based telemanagement in chronic heart failure: an 8-year single-site experience. *J Telemed Telecare.* 2011;17(7):382–6. DOI: 10.1258/jtt.2011.110201	Wrong concept
Grace SL, Midence L, Oh P, Brister S, Chessex C, Stewart DE, Arthur HM. Cardiac rehabilitation program adherence and functional capacity among women: a randomized controlled trial. *Mayo Clin Proc.* 2016;91(2):140–8. DOI: 10.1016/j.mayocp.2015.10.021	Wrong concept
Hakala S, Kivistö H, Paajanen T, Kankainen A, Anttila MR, Heinonen A, Sjögren T. Effectiveness of distance technology in promoting physical activity in cardiovascular disease rehabilitation: cluster randomized controlled trial, a pilot study. *JMIR Rehabil Assist Technol.* 2021;8(2):e20299. DOI: 10.2196/20299	Wrong concept

Hayn D, Sareban M, Höfer S, Wiesmüller F, Mayr K, Mürzl N, Porodko M, Puelacher C, Moser LM, Philippi M, Traninger H, Niebauer J. Effect of digital tools in outpatient cardiac rehabilitation including home training—results of the EPICURE study. *Front Digit Health.* 2023;5:1150444. DOI: 10.3389/fdgth.2023.1150444	Wrong concept
Higgins RO, Rogerson M, Murphy BM, Navaratnam H, Butler MV, Barker L, Turner A, Lefkovits J, Jackson AC. Cardiac rehabilitation online pilot: extending reach of cardiac rehabilitation. *J Cardiovasc Nurs.* 2017;32(1):7–13. DOI: 10.1097/JCN.0000000000000297	Wrong concept
Houchen-Wolloff L, Boyce S, Singh S. The minimum clinically important improvement in the incremental shuttle walk test following cardiac rehabilitation. *Eur J Prev Cardiol.* 2015;22(8):972–8. DOI: 10.1177/2047487314540840	Wrong concept
Hou X, Wu X, Chen L, Zheng X, Zheng Y, Zhang Y, Wang S, Cao T, Sun Y, Ding R, Wu J, Yu B. Effectiveness and influencing factors of home-center-based cardiac rehabilitation as a transitional strategy for acute myocardial infarction patients. *Int Heart J.* 2024;65(4):612–20. DOI: 10.1536/ihj.24-030	Wrong concept
Iliou MC, Pavy B, Martinez J, Corone S, Meurin P, Tuppin P. Exercise training is safe after coronary stenting: a prospective multicentre study. *Eur J Prev Cardiol.* 2015;22(1):27–34. DOI: 10.1177/2047487313505819	Wrong concept
Karaszewski D. Comparison of two models of hospital rehabilitation in patients after coronary artery bypass grafting. *Kardiochir Torakochir Pol.* 2014;11(1):86–9. DOI: 10.5114/kitp.2014.41940	Wrong concept
Kato J, Koike A, Kuroki K, Takayanagi Y, Takahashi M, Konno H, Sekiguchi Y, Nogami A, Aonuma K. Safety and efficacy of in-hospital cardiac rehabilitation following antiarrhythmic therapy	Wrong concept

for patients with electrical storm. *J Cardiol.* 2019;73(2):171–8. DOI: 10.3390/ijerph18126440	
Khalife-Zadeh A, Dorri S, Shafiee S. The effect of cardiac rehabilitation on quality of life in patients with acute coronary syndrome. *Iran J Nurs Midwifery Res.* 2015;20(5):588–93. DOI: 10.4103/1735-9066.164504	Wrong concept
Kikuchi A, Taniguchi T, Nakamoto K, Sera F, Ohtani T, Yamada T, Sakata Y. Feasibility of home-based cardiac rehabilitation using an integrated telerehabilitation platform in elderly patients with heart failure: a pilot study. *J Cardiol.* 2021;78(1):66–71. DOI: 10.1016/j.jjcc.2021.01.010	Wrong concept
Kim YH, So WY. Gender differences in home-based cardiac rehabilitation of post-percutaneous coronary intervention patients. *Aging Clin Exp Res.* 2019;31(2):249–55. DOI: 10.1007/s40520-018-0951-8	Wrong concept
Klempfner R, Kamerman T, Schwammenthal E, Nahshon A, Hay I, Goldenberg I, Dov F, Arad M. Efficacy of exercise training in symptomatic patients with hypertrophic cardiomyopathy: results of a structured exercise training program in a cardiac rehabilitation center. *Eur J Prev Cardiol.* 2015;22(1):13–9. DOI: 10.1177/2047487313501277	Wrong concept
Knudsen MV, Petersen AK, Angel S, Hjortdal VE, Maindal HT, Laustsen S. Tele-rehabilitation and hospital-based cardiac rehabilitation are comparable in increasing patient activation and health literacy: a pilot study. *Eur J Cardiovasc Nurs.* 2020;19(5):376–85. DOI: 10.1177/1474515119885325	Wrong concept
Kono Y, Izawa H, Aoyagi Y, Ishikawa A, Sugiura T, Mori E, Yanohara R, Ishiguro T, Yamada R, Okumura S, Fujiwara W, Hayashi M, Saitoh E. Predictive impact of early mobilization on rehospitalization for elderly Japanese heart failure patients. *Heart Vessels.* 2020;35(4):531–6. DOI: 10.1007/s00380-019-01517-8	Wrong concept

Korzeniowska I, Kubacka B, Dobraszkiewicz B, Wasilewska E, Bilińska M, Rydzewska E, Piotrowicz R. Two models of early cardiac rehabilitation in male patients after myocardial infarction with preserved left ventricular function: comparison of standard outpatient versus hybrid training programmes. *Kardiol Pol.* 2011;69:220–6.	Wrong concept
Korzeniowska-Kubacka I, Bilińska M, Dobraszkiewicz-Wasilewska B, Piotrowicz R. Hybrid model of cardiac rehabilitation in men and women after myocardial infarction. *Cardiol J.* 2015;22(2):212–8. DOI: 10.5603/CJ.a2015.0004	Wrong concept
Korzeniowska-Kubacka I, Piotrowska D, Stepnowska M, Piotrowicz R, Bilińska M. The impact of exercise-only-based rehabilitation on depression and anxiety in patients after myocardial infarction. *Eur J Cardiovasc Nurs.* 2017;16(5):390–6. DOI: 10.1177/1474515116682123	Wrong concept
Koufaki P, Mercer TH, George KP, Nolan J. Low-volume high-intensity interval training vs continuous aerobic cycling in patients with chronic heart failure: a pragmatic randomised clinical trial of feasibility and effectiveness. *J Rehabil Med.* 2014;46(4):348–56. DOI: 10.2340/16501977-1278	Wrong concept
Lahtio H, Heinonen A, Paajanen T, Sjögren T. The added value of remote technology in cardiac rehabilitation on physical function, anthropometrics, and quality of life: cluster randomized controlled trial. *J Med Internet Res.* 2023;25:e42455. DOI: 10.2196/42455	Wrong concept
Lang CC, Smith K, Wingham J, Eyre V, Greaves CJ, Warren FC, Green C, Jolly K, Davis RC, Doherty PJ, Miles J, Britten N, Abraham C, Van Lingen R, Singh SJ, Paul K, Hillsdon M, Sadler S, Hayward C, Dalal HM, Taylor RS. A randomised controlled trial of a facilitated home-based rehabilitation intervention in patients with heart failure with preserved ejection fraction and	Wrong concept

their caregivers: the REACH-HFpEF pilot study. *BMJ Open.* 2018;8(4):e019649. DOI: 10.1136/bmjopen-2017-019649	
Lee BJ, Go JY, Kim AR, Chun SM, Park M, Yang DH, Park HS, Jung TD. Quality of life and physical ability changes after hospital-based cardiac rehabilitation in patients with myocardial infarction. *Ann Rehabil Med.* 2017;41(1):121–8. DOI: 10.5535/arm.2017.41.1.121	Wrong concept
Lee JJ, Ko JY, Lee S. An observational study substantiating the statistical significance of cardiopulmonary exercise with laboratory tests during the acute and subacute phases of center- and home-based cardiac rehabilitation. *Medicine (Baltimore).* 2021;100(31):e26861. DOI: 10.1097/MD.0000000000026861	Wrong concept
Li Y, Feng X, Chen B, Liu H. Retrospective analysis of exercise capacity in patients with coronary artery disease after percutaneous coronary intervention or coronary artery bypass graft. *Int J Nurs Sci.* 2021;8(3):257–63. DOI: 10.1016/j.ijnss.2021.05.008	Wrong concept
Lyu S, Chen Z, Cui M, Wei Q, Li Y, Fang H, Liu M, Liu L, Fu J, Zhang J. Effectiveness of an online/offline mixed-mode Tai Chi cardiac rehabilitation program on microcirculation in patients with coronary artery disease: a randomized controlled study. *Clin Hemorheol Microcirc.* 2023;85(4):385–93. DOI: 10.3233/CH-231894	Wrong concept
Lyu S, Wang H, Wei Q, Cui M, Li Y, Chen Z, Zhang J, Peng F. Effects of Tai Chi cardiac rehabilitation program on anxiety and depression in patients with coronary heart disease: a randomized controlled clinical trial. *Eur J Integr Med.* 2022;53:102147. DOI: 10.1016/j.eujim.2022.102147	Wrong concept
Maddison R, Rawstorn JC, Stewart RAH, Benatar J, Whittaker R, Rolleston A, Jiang Y, Gao L, Moodie M, Warren I, Meads A, Gant N. Effects and costs of real-time cardiac telerehabilitation:	Wrong concept

randomised controlled non-inferiority trial. *Heart.* 2019;105(2):122–9. DOI: 10.1136/heartjnl-2018-313189	
Madssen E, Arbo I, Granøien I, Walderhaug L, Moholdt T. Peak oxygen uptake after cardiac rehabilitation: a randomized controlled trial of a 12-month maintenance program versus usual care. *PLoS One.* 2014;9(9):e107924. DOI: 10.1371/journal.pone.0107924	Wrong concept
Mahdavi Anari L, Ghanbari-Firoozabadi M, Ansari Z, Emami M, Vafaii Nasab M, Nemaiande M, Boostany F, Neishaboury M. Effect of cardiac rehabilitation program on heart rate recovery in coronary heart disease. *J Tehran Heart Cent.* 2015;10(4):176–81.	Wrong concept
Manafi A, Joharimoghadam A, Firouzabadi AD, Abdi H, Mousavi SH. The effects of phase 2 cardiac rehabilitation on changes in obesity anthropometric indices among military and non-military men with coronary artery disease referred to a cardiac rehabilitation center. *Int Cardiovasc Res J.* 2019;13(1):11–6.	Wrong concept
Manzoni GM, Villa V, Compare A, Castelnuovo G, Nibbio F, Titon AM, Molinari E, Gondoni LA. Short-term effects of a multi-disciplinary cardiac rehabilitation programme on psychological well-being, exercise capacity and weight in a sample of obese in-patients with coronary heart disease: a practice-level study. *Psychol Health Med.* 2011;16(2):178–89. DOI: 10.1080/13548506.2010.542167	Wrong concept
Manzoor S, Hisam A, Aziz S, Mashhadi SF, Ul Haq Z. Effectiveness of mobile health augmented cardiac rehabilitation on behavioural outcomes among post-acute coronary syndrome patients: a randomised controlled trial. *J Coll Physicians Surg Pak.* 2021;31(10):1148–53. DOI: 10.29271/jcpsp.2021.10.1148	Wrong concept
Matsuo T, Morisawa T, Ohtsubo T, Ueno K, Kozawa S. Improving respiratory muscle strength and overall function in patients with cardiovascular disease through rehabilitation	Wrong concept

hospitals. *Cardiol Res.* 2024;15(1):56–66. DOI: 10.14740/cr1616	
Matsuo T, Morisawa T, Yamamoto S, Nyuba K, Maehata M, Fujii D, Iwaki H, Ueno K, Iwata K, Saitoh M, Takahashi T. Effect of in-patient cardiac rehabilitation at rehabilitation hospital for cardiology patients: two-center trial. *Heart Vessels.* 2024;39(1):75–85. DOI: 10.1007/s00380-023-02310-4	Wrong concept
Matsuo T, Ohtsubo T, Yanase T, Ueno K, Kozawa S, Matsubara T, Morimoto Y. Influence of daily aerobic exercise duration on phase 2 cardiac rehabilitation at a rehabilitation hospital and health-related quality of life after discharge. *Cardiol Res.* 2023;14(5):351–9. DOI: 10.14740/cr1527	Wrong concept
McKenzie KM, Park LK, Lenze EJ, Montgomery K, Rashdi S, Deych E, Stranczek NA, McKenzie EJ, Rich MW, Garr Barry V, Jonagan J, Talpade N, Durbin D, Carson T, Peterson LR, Racette SB, de las Fuentes L. A prospective cohort study of the impact of outpatient intensive cardiac rehabilitation on depression and cardiac self-efficacy. *Am Heart J Plus.* 2022;13:100100. DOI: 10.1016/j.ahjo.2022.100100	Wrong concept
Mitropoulos A, Anifanti M, Koukouvou G, Ntovoli A, Alexandris K, Kouidi E. Exploring the effects of real-time online cardiac telerehabilitation using wearable devices compared to gym-based cardiac exercise in people with a recent myocardial infarction: a randomised controlled trial. *Front Cardiovasc Med.* 2024;11:1410616. DOI: 10.3389/fcvm.2024.1410616	Wrong concept
Moholdt T, Bekken Vold M, Grimsmo J, Slørdahl SA, Wisløff U. Home-based aerobic interval training improves peak oxygen uptake equal to residential cardiac rehabilitation: a randomized controlled trial. *PLoS One.* 2012;7(7):e41199. DOI: 10.1371/journal.pone.0041199	Wrong concept
Mohri M, Motohama R, Sato N. Home-based cardiac rehabilitation decreases red cell distribution width in chronic	Wrong concept

heart failure. *Acta Cardiol.* 2013;68(6):615–9. DOI: 10.1080/ac.68.6.8000009	
Molino-Lova R, Pasquini G, Vannetti F, Paperini A, Forconi T, Zipoli R, Polcaro P, Cecchi F, Macchi C. The improvement of walking speed after cardiac rehabilitation is associated with the reduction in the metabolic cost of walking in older persons. *Gait Posture.* 2012;35(3):458–61. DOI: 10.1016/j.gaitpost.2011.11.007	Wrong concept
Morisawa T, Ueno K, Fukuda Y, Kanazawa N, Kawaguchi H, Zaiki R, Fuzisaki H, Yoshioka H, Sasaki M, Iwata K, Koyama T, Kitai T, Furukawa Y, Takahashi T. Significance of sequential cardiac rehabilitation program through inter-hospital cooperation between acute care and rehabilitation hospitals in elderly patients after cardiac surgery in Japan. *Heart Vessels.* 2017;32(10):1220–6. DOI: 10.1007/s00380-017-0983-6	Wrong concept
Mutwalli HA, Fallows SJ, Arnous AA, Zamzami MS. Randomized controlled evaluation shows the effectiveness of a home-based cardiac rehabilitation program. *Saudi Med J.* 2012;33(2):152–9.	Wrong concept
Nabutovsky I, Ashri S, Nachshon A, Tesler R, Shapiro Y, Wright E, Vadasz B, Offer A, Grosman-Rimon L, Klempfner R. Feasibility, safety, and effectiveness of a mobile application in cardiac rehabilitation. *Isr Med Assoc J.* 2020;22(6):357–63.	Wrong concept
Najafi F, Nalini M. Hospital-based versus hybrid cardiac rehabilitation program in coronary bypass surgery patients in western Iran: effects on exercise capacity, risk factors, psychological factors, and quality of life. *J Cardiopulm Rehabil Prev.* 2015;35(1):29–36. DOI: 10.1097/HCR.0000000000000087	Wrong concept
Nalini M. Outpatient cardiac rehabilitation use after coronary bypass surgery in the west of Iran. *J Cardiopulm Rehabil Prev.* 2014;34(4):263–70. DOI: 10.1097/HCR.0000000000000070	Wrong concept

Oliveira MF, Santos RC, Artz SA, Mendez VMF, Lobo DML, Correia EB, Ferraz AS, Umeda IK, Sperandio PA. Safety and efficacy of aerobic exercise training associated to non-invasive ventilation in patients with acute heart failure. *Arq Bras Cardiol.* 2018;110(5):467–75. DOI: 10.5935/abc.20180039	Wrong concept
Park HK, Kim KH, Kim JH, Song MK, Choi IS, Han JY. Comparison of obesity-related index and exercise capacity between center-based and home-based cardiac rehabilitation programs. *Ann Rehabil Med.* 2019;43(3):297–304. DOI: 10.5535/arm.2019.43.3.297	Wrong concept
Parreira LB, Vitorino PVO, Jardim PCBV, Sousa ALL, Jardim TV, Sousa WM, Justo AFO, Barroso WKS. Comparison between supervised and partly supervised cardiac rehabilitation protocols in hypertensive patients: a randomized controlled trial. *Curr Hypertens Rev.* 2018;14(2):161–9. DOI: 10.2174/1573402114666180413121016	Wrong concept
Patnaik S, Nathan S, Bui A, Kar B, Gregoric I, Gilley CB. Impact of structured physical therapy protocol among heart transplant recipients while on intra-aortic balloon pump in the pretransplant period. *Artif Organs.* 2023;47(1):198–204. DOI: 10.1111/aor.14378	Wrong concept
Pinto BM, Dunsiger SI, Farrell N, Marcus BH, Todaro JF. Psychosocial outcomes of an exercise maintenance intervention after phase II cardiac rehabilitation. *J Cardiopulm Rehabil Prev.* 2013;33(2):91–8. DOI: 10.1097/HCR.0b013e3182825531	Wrong concept
Piotrowicz E, Baranowski R, Bilinska M, Stepnowska M, Piotrowska M, Wójcik A, Korewicki J, Chojnowska L, Malek LA, Klopotowski M, Piotrowski W, Piotrowicz R. A new model of home-based telemonitored cardiac rehabilitation in patients with heart failure: effectiveness, quality of life, and adherence. *Eur J Heart Fail.* 2010;12(2):164–71. DOI: 10.1093/eurjhf/hfp181	Wrong concept

Piotrowicz E, Stepnowska M, Leszczyńska-Iwanicka K, Piotrowska D, Kowalska M, Tylka J, Piotrowski W, Piotrowicz R. Quality of life in heart failure patients undergoing home-based telerehabilitation versus outpatient rehabilitation: a randomized controlled study. *Eur J Cardiovasc Nurs.* 2015;14(3):256–63. DOI: 10.1177/1474515114537023	Wrong concept
Piotrowicz E, Pencina MJ, Opolski G, Zaręba W, Banach M, Kowalik I, Orzechowski P, Szalewska D, Pluta S, Główczyńska R, Irzmański R, Oręziak A, Kalarus Z, Lewicka E, Cacko A, Mierzyńska A, Piotrowicz R. Effects of a 9-week hybrid comprehensive telerehabilitation program on long-term outcomes in patients with heart failure: the Telerehabilitation in Heart Failure Patients (TELEREH-HF) randomized clinical trial. *JAMA Cardiol.* 2020;5(3):300–8. DOI: 10.1001/jamacardio.2019.5006	Wrong concept
Piotrowicz E, Zieliński T, Bodalski R, Rywik T, Dobraszkiewicz-Wasilewska B, Sobieszczałska-Małek M, Stepnowska M, Przybylski A, Browarek A, Szumowski Ł, Piotrowski W, Piotrowicz R. Home-based telemonitored Nordic walking training is well accepted, safe, effective and has high adherence among heart failure patients, including those with cardiovascular implantable electronic devices: a randomised controlled study. *Eur J Prev Cardiol.* 2015;22(11):1368–77. DOI: 10.1177/2047487314551537	Wrong concept
Pistono M, Giordano A, Gnemmi M, Gambarin FI, Granata M, Imparato A, Temporelli PL, Mannucci L, Prolo S, Corrà U. The pivotal role of an early post-acute cardiac rehabilitation as an evidence-based management of left ventricular assist device patients. *Artif Organs.* 2025;49(5):886–93. DOI: 10.1111/aor.14940	Wrong concept
Poortaghi S, Atri SB, Safayian A, Baghernia A. General health improves with home-based cardiac rehabilitation program. *Saudi Med J.* 2011;32(4):407–11.	Wrong concept

Poortaghi S, Baghernia A, Golzari SE, Safayian A, Atri SB. The effect of home-based cardiac rehabilitation program on self-efficacy of patients referred to a cardiac rehabilitation center. *BMC Res Notes.* 2013;6:287. DOI: 10.1186/1756-0500-6-287	Wrong concept
Pourghane P, Nejad PA, Taghi Razavi Tousi SM. Effect of cardiac rehabilitation on sexual satisfaction of patients after coronary artery bypass graft surgery. *J Guilan Univ Med Sci.* 2021;30(117):2–13.DOI: 10.32598/JGUMS.30.1.1469.2	Wrong concept
Pratesi A, Baldasseroni S, Burgisser C, Orso F, Barucci R, Silverii MV, Venturini S, Ungar A, Marchionni N, Fattirolli F. Long-term functional outcomes after cardiac rehabilitation in older patients: data from the Cardiac Rehabilitation in Advanced aGE: EXercise TRaining and Active follow-up (CR-AGE EXTRA) randomised study. *Eur J Prev Cardiol.* 2019;26(14):1470–8. DOI: 10.1177/2047487319854141	Wrong concept
Pressler A, Christle JW, Lechner B, Grabs V, Haller B, Hettich I, Jochheim D, Mehilli J, Lange R, Bleiziffer S, Halle M. Exercise training improves exercise capacity and quality of life after transcatheter aortic valve implantation: a randomized pilot trial. *Am Heart J.* 2016;182:44–53. DOI: 10.1016/j.ahj.2016.08.007	Wrong concept
Racodon M, Vanhove P, Fabre C, Malanda F, Secq A. Comparison between hybrid cardiac rehabilitation and center-based cardiac rehabilitation: a noninferiority randomized controlled trial. *Int J Rehabil Res.* 2025;48(1):25–30. DOI: 10.1097/MRR.0000000000000658	Wrong concept
Ramadi A, Haennel RG, Stone JA, Arena R, Threlfall TG, Hitt E, Aggarwal SG, Haykowsky M, Martin BJ. The sustainability of exercise capacity changes in home versus center-based cardiac rehabilitation. *J Cardiopulm Rehabil Prev.* 2015;35(1):21–8. DOI: 10.1097/HCR.0000000000000084	Wrong concept
Ranković G, Djindjić N, Ranković-Nedin G, Marković S, Nejić D, Milicić B, Djindjić B. The effects of physical training on	Wrong concept

cardiovascular parameters, lipid disorders and endothelial function. *Vojnosanit Pregl.* 2012;69(11):956–60.	
Reeves GR, Whellan DJ, O'Connor CM, Duncan P, Eggebeen JD, Morgan TM, Leigh C, Hewston A, Pastva A, Patel MJ, Kitzman DW. A novel rehabilitation intervention for older patients with acute decompensated heart failure: the REHAB-HF pilot study. *JACC Heart Fail.* 2017;5(5):359–66.	Wrong concept
Reibis R, Jannowitz C, Halle M, Pittrow D, Gitt A, Völler H. Management and outcomes of patients with reduced ejection fraction after acute myocardial infarction in cardiac rehabilitation centers. *Curr Med Res Opin.* 2015;31(2):211–9. DOI: 10.1185/03007995.2014.977854	Wrong concept
Rivas-Estany E, Barrera-Sarduy JD, Sixto-Fernández S, Rodríguez-Nande LM, Kesser-García C. Cuban program for cardiac rehabilitation: results. *Rehabilitacion.* 2013;47(4):238–44. DOI: 10.1016/j.rh.2013.07.003	Wrong concept
Rognmo O, Moholdt T, Bakken H, Hole T, Mølstad P, Myhr NE, Grimsmo J, Wisløff U. Cardiovascular risk of high- versus moderate-intensity aerobic exercise in coronary heart disease patients. *Circulation.* 2012;126(12):1436–40. DOI: 10.1161/CIRCULATIONAHA.112.123117	Wrong concept
Russo N, Compostella L, Tarantini G, Setzu T, Napodano M, Bottio T, D'Onofrio A, Isabella G, Gerosa G, Iliceto S, Bellotto F. Cardiac rehabilitation after transcatheter versus surgical prosthetic valve implantation for aortic stenosis in the elderly. *Eur J Prev Cardiol.* 2014;21(11):1341–8. DOI: 10.1177/2047487313494029	Wrong concept
Sadeghi M, Izadi A, Hadavi MM, Rafati Fard M, Roohafza H. Comparison of the effect of 12- and 24-session cardiac rehabilitation on physical, psychosocial and biomedical factors in ischemic heart disease patients. *Horm Mol Biol Clin Investig.*	Wrong concept

2020;41(1):/ [pagination unavailable]. DOI: 10.1515/hmbci-2019-0023	
Saeidi M, Soroush A, Komasi S, Singh P. A hybrid cardiac rehabilitation is as effective as a hospital-based program in reducing chest pain intensity and discomfort. *Korean J Pain.* 2017;30(4):265–71. DOI: 10.3344/kjp.2017.30.4.265	Wrong concept
Safiyari-Hafizi H, Taunton J, Ignaszewski A, Warburton DER. The health benefits of a 12-week home-based interval training cardiac rehabilitation program in patients with heart failure. *Can J Cardiol.* 2016;32(4):561–7. DOI: 10.1016/j.cjca.2016.01.031	Wrong concept
Salavati M, Fallahinia G, Vardanjani AE, Rafiei H, Mousavi S, Torkamani M. Comparison between effects of home-based cardiac rehabilitation programs versus usual care on the patients' health-related quality of life after coronary artery bypass graft. *Glob J Health Sci.* 2015;8(4):196–202. DOI: 10.5539/gjhs.v8n4p196	Wrong concept
Salzwedel A, Heidler MD, Meng K, Schikora M, Wegscheider K, Reibis R, Völler H. Impact of cognitive performance on disease-related knowledge six months after multi-component rehabilitation in patients after an acute cardiac event. *Eur J Prev Cardiol.* 2019;26(1):46–55. DOI: 10.1177/2047487318791609	Wrong concept
Sandberg C, Hedström M, Wadell K, Dellborg M, Ahnfelt A, Zetterström AK, Öhrn A, Johansson B. Home-based interval training increases endurance capacity in adults with complex congenital heart disease. *Congenit Heart Dis.* 2018;13(2):254–62. DOI: 10.1111/chd.12562	Wrong concept
Sandercock GRH, Cardoso F, Almodhy M, Pepera G. Cardiorespiratory fitness changes in patients receiving comprehensive outpatient cardiac rehabilitation in the UK: a multicentre study. *Heart.* 2013;99(11):785–90. DOI: 10.1136/heartjnl-2012-303055	Wrong concept

Savage PD, Rengo JL, Menzies KE, Ades PA. Cardiac rehabilitation after heart valve surgery: comparison with coronary artery bypass graft patients. *J Cardiopulm Rehabil Prev.* 2015;35(4):231–7. DOI: 10.1097/HCR.0000000000000104	Wrong concept
Scane K, Alter D, Oh P, Brooks D. Adherence to a cardiac rehabilitation home program model of care: a comparison to a well-established traditional on-site supervised program. *Appl Physiol Nutr Metab.* 2012;37(2):206–13. DOI: 10.1139/h11-151	Wrong concept
Schmidt C, Magalhães S, Gois Basilio P, Santos C, Oliveira MI, Ferreira JP, Ribeiro F, Santos M. Center- vs home-based cardiac rehabilitation in patients with heart failure: EXIT-HF randomized controlled trial. *JACC Heart Fail.* 2025;13(5):695–706. DOI: 10.1016/j.jchf.2024.09.024	Wrong concept
Schnöll F, Laimer H, Altenberger J, Hödl R, Schwann H, Marko C, Müller R, Kullich W. Reduction of coronary risk factors immediately and 1 year after inpatient rehabilitation in a highly motivated patient cohort. *Wien Med Wochenschr.* 2015;165(3):71–8. DOI: 10.1007/s10354-014-0339-0	Wrong concept
Schopfer DW, Whooley MA, Allsup K, Pabst M, Shen H, Tarasovsky G, Duvernoy CS, Forman DE. Effects of home-based cardiac rehabilitation on time to enrollment and functional status in patients with ischemic heart disease. *J Am Heart Assoc.* 2020;9(19):e017099. DOI: 10.1161/JAHA.120.016456	Wrong concept
Scrutinio D, Guida P, Passantino A, Scalvini S, Bussotti M, Forni G, Vaninetti R, La Rovere MT. Characteristics, outcomes, and long-term survival of patients with heart failure undergoing inpatient cardiac rehabilitation. *Arch Phys Med Rehabil.* 2022;103(5):891–898.e4. DOI: 10.1016/j.apmr.2021.10.014	Wrong concept
Segev D, Hellerstein D, Carasso R, Dunsky A. The effect of a stability and coordination training programme on balance in older adults with cardiovascular disease: a randomised	Wrong concept

exploratory study. *Eur J Cardiovasc Nurs.* 2019;18(8):736–743. DOI: 10.1177/1474515119864201	
Semsar-Kazerooni K, Dima D, Valiquette J, Berube-Dufour J, Goldfarb M. Early mobilization in people with acute cardiovascular disease. *Can J Cardiol.* 2021;37(2):232–240. DOI: 10.1016/j.cjca.2020.03.038	Wrong concept
Seo Y, Yates B, Laframboise L, Pozehl B, Norman JF, Hertzog M. A home-based diaphragmatic breathing retraining in rural patients with heart failure. *West J Nurs Res.* 2016;38(3):270–291. DOI: 10.1177/0193945915584201	Wrong concept
Servantes DM, Pelcerman A, Salvetti XM, Salles AF, de Albuquerque PF, de Salles FCA, Lopes C, de Mello MT, Almeida DR, Filho JAO. Effects of home-based exercise training for patients with chronic heart failure and sleep apnoea: a randomized comparison of two different programmes. *Clin Rehabil.* 2012;26(1):45–57. DOI: 10.1177/0269215511403941	Wrong concept
Shah ND, Banta CW, Berger AL, Hattenberger A, Zimmerman A, Martin BE, Wu E, Majumdar U, Kirchner HL, Matsumura ME. Retrospective comparison of outcomes and cost of virtual versus center-based cardiac rehabilitation programs. *J Am Heart Assoc.* 2024;13(24):e036861. DOI: 10.1161/JAHA.124.036861	Wrong concept
Sharma KNS, Pailoor S, Choudhary NR, Bhat P, Shrestha S. Integrated yoga practice in cardiac rehabilitation program: a randomized control trial. *J Altern Complement Med.* 2020;26(10):918–927. DOI: 10.1089/acm.2019.0250	Wrong concept
Shen T, Wang Y, Ren C, Song Y, Gao W, Liu F, Li G, Wei Z, Wang P, Zhao W. The effects of CPET-guided cardiac rehabilitation on exercise tolerance in older persons with CHD after PCI. *Sci Rep.* 2023;13(1):19994. DOI: 10.1038/s41598-023-47494-x	Wrong concept

Sinclair J, Dillon S, Lowe NM, Melia A. Effects of a nutrition education programme in stage IV cardiac rehabilitation patients: a 3-arm randomised controlled trial. *Life.* 2024;14(1):95. DOI: 10.3390/life14010063	Wrong concept
Smith KM, McKelvie RS, Thorpe KE, Arthur HM. Six-year follow-up of a randomised controlled trial examining hospital versus home-based exercise training after coronary artery bypass graft surgery. *Heart.* 2011;97(14):1169–1174. DOI: 10.1136/hrt.2010.202036	Wrong concept
Smolis-Bąk E, Dąbrowski R, Piotrowicz E, Chwyczko T, Dobraszkiewicz-Wasilewska B, Kowalik I, Kazimierska B, Jędrzejczyk B, Smolis R, Gepner K, Maciąg A, Sterliński M, Szwed H. Hospital-based and telemonitoring guided home-based training programs: Effects on exercise tolerance and quality of life in patients with heart failure (NYHA class III) and cardiac resynchronization therapy. A randomized, prospective observation. *Int J Cardiol.* 2015;199:442–447. DOI: 10.1016/j.ijcard.2015.07.041	Wrong concept
Smolis-Bąk E, Rymuza H, Kazimierska B, Kowalik I, Chwyczko T, Borowiec A, Rongies W, Jankowska A, Szwed H, Dąbrowski R. Improvement of exercise tolerance in cardiopulmonary testing with sustained safety after regular training in outpatients with systolic heart failure (NYHA III) and an implantable cardioverter-defibrillator: Prospective 18-month randomized study. *Arch Med Sci.* 2017;13(5):1094–1101. DOI: 10.5114/aoms.2016.61938	Wrong concept
Snoek JA, Prescott EI, Van Der Velde AE, Eijsvogels TMH, Mikkelsen N, Prins LF, Bruins W, Meindersma E, González-Juanatey JR, Peña-Gil C, González-Salvado V, Moatemri F, Iliou M-C, Marcin T, Eser P, Wilhelm M, Van't Hof AWJ, De Kluiver EP. Effectiveness of home-based mobile guided cardiac rehabilitation as alternative strategy for nonparticipation in clinic-based cardiac rehabilitation among elderly patients in Europe: A	Wrong concept

randomized clinical trial. *JAMA Cardiol.* 2021;6(4):463–468. DOI: 10.1001/jamacardio.2020.5218	
Snoek JA, Meindersma EP, Prins LF, van't Hof AWJ, de Boer MJ, Hopman MT, Eijsvogels TMH, de Kluiver EP. The sustained effects of extending cardiac rehabilitation with a six-month telemonitoring and telecoaching programme on fitness, quality of life, cardiovascular risk factors and care utilisation in CAD patients: The TeleCaRe study. *J Telemed Telecare.* 2021;27(8):473–483. DOI: 10.1177/1357633X19885793	Wrong concept
Song Y, Ren C, Liu P, Tao L, Zhao W, Gao W. Effect of smartphone-based telemonitored exercise rehabilitation among patients with coronary heart disease. *J Cardiovasc Transl Res.* 2020;13(4):659–667. DOI: 10.1007/s12265-019-09938-6	Wrong concept
Steinacker JM, Liu Y, Muche R, Koenig W, Hahmann H, Imhof A, Kropf C, Brandstetter S, Schweikert B, Leidl R, Schiefer DH. Long term effects of comprehensive cardiac rehabilitation in an inpatient and outpatient setting. *Swiss Med Wkly.* 2011;141:w13141. DOI: 10.57187/smw.2011.13141	Wrong concept
Sturchio A, Di Gianni A, Campana B, Genua M, Storti M, Di Iasi G, Monaco S, Colella M, dello Buono A, D'Addese E, Capomolla S. Coronary Artery RIsk MAnagement Programme (CARIMAP) delivered by a rehabilitation day-hospital: impact on patients with coronary artery disease. *J Cardiopulm Rehabil Prev.* 2012;32(6):386–393. DOI: 10.1097/HCR.0b013e31826eeeca	Wrong concept
Swank AM, Funk DC, Manire JT, Allard AL, Denny DM. Effect of resistance training and aerobic conditioning on muscular strength and submaximal fitness for individuals with chronic heart failure: influence of age and gender. *J Strength Cond Res.* 2010;24(5):1298–1305. DOI: 10.1519/JSC.0b013e3181d82e5d	Wrong concept
Szalewska D, Tomaszewski J, Kusiak-Kaczmarek M, Niedoszytko P, Gierat-Haponiuk K, Haponiuk I, Bakuła S. Influence of a hybrid form of cardiac rehabilitation on exercise	Wrong concept

tolerance in coronary artery disease patients with and without diabetes. *Kardiol Pol.* 2015;73(9):753–760. DOI: 10.5603/KP.a2015.0088	
Szczepańska-Gieracha J, Morka J, Kowalska J, Kustrzycki W, Rymaszewska J. The role of depressive and anxiety symptoms in the evaluation of cardiac rehabilitation efficacy after coronary artery bypass grafting surgery. *Eur J Cardiothorac Surg.* 2012;42(5):e108–e114. DOI: 10.1093/ejcts/ezs463	Wrong concept
Tabet JY, Meurin P, Benzidi Y, Beauvais F, Ben Driss A, Weber H, Renaud N, Dumaine R, Grosdemouge A, Cohen Solal A. Greater prognostic value of peak VO_2 after exercise training program completion in heart failure patients. *Int J Cardiol.* 2013;168(4):4139–4144. DOI: 10.1016/j.ijcard.2013.07.076	Wrong concept
Takada S, Kondo T, Yasunaga M, Watanabe S, Kinoshita H, Fukuhara S, Yamamoto Y. Early rehabilitation in older patients hospitalized with acute decompensated heart failure: A retrospective cohort study. *Am Heart J.* 2020;230:44–53. DOI: 10.1016/j.ahj.2020.09.009	Wrong concept
Tang LH, Zwisler AD, Berg SK, Doherty P, Taylor RS, Langberg H. Is the cardiovascular response equivalent between a supervised center-based setting and a self-care home-based setting when rating of perceived exertion is used to guide aerobic exercise intensity during a cardiac rehabilitation program? *Am J Phys Med Rehabil.* 2017;96(6):381–387. DOI: 10.1097/PHM.0000000000000628	Wrong concept
Taylor-Piliae RE, Silva E, Sheremeta SP. Tai Chi as an adjunct physical activity for adults aged 45 years and older enrolled in phase III cardiac rehabilitation. *Eur J Cardiovasc Nurs.* 2012;11(1):34–43. DOI: 10.1016/j.ejcnurse.2010.11.001	Wrong concept
ter Hoeve N, Sunamura M, Stam HJ, van Domburg RT, van den Berg-Emons RJG. A secondary analysis of data from the OPTICARE randomized controlled trial investigating the effects	Wrong concept

of extended cardiac rehabilitation on functional capacity, fatigue, and participation in society. *Clin Rehabil.* 2019;33(8):1355–1366. DOI: 10.1177/0269215519842216	
Tsos A, Sushchenko L, Bielikova N, Indyka S. Influence of working out at home on the expansion of cardiovascular disease risk factors. *J Phys Educ Sport.* 2016;16(3):1008–1011.DOI: 10.7752/jpes.2016.03159	Wrong concept
Van Berendoncks AM, Garnier A, Beckers P, Hoymans VY, Possemiers N, Fortin D, Van Hoof V, Dewilde S, Vrints CJ, Ventura-Clapier R, Conraads VM. Exercise training reverses adiponectin resistance in skeletal muscle of patients with chronic heart failure. *Heart.* 2011;97(17):1403–1409. DOI: 10.1136/hrt.2011.226373	Wrong concept
van Dissel AC, Blok IM, Hooglugt J-LQ, de Haan FH, Jørstad HT, Mulder BJM, Bouma BJ, Winter MM. Safety and effectiveness of home-based, self-selected exercise training in symptomatic adults with congenital heart disease: A prospective, randomised, controlled trial. *Int J Cardiol.* 2019;278:59–64. DOI: 10.1016/j.ijcard.2018.12.042	Wrong concept
Varnfield M, Karunanithi M, Lee CK, Honeyman E, Arnold D, Ding H, Smith C, Walters DL. Smartphone-based home care model improved use of cardiac rehabilitation in postmyocardial infarction patients: results from a randomised controlled trial. *Heart.* 2014;100(22):1770–1779. DOI: 10.1136/heartjnl-2014-305783	Wrong concept
Vorwerg S, Stamm O, Menant A, Alex S, Müller-Werdan U. Observational study in cardiac rehabilitation groups phase III: a comparison of perceived and measured training intensity during a moderate-intensity workout. *Eur J Phys Rehabil Med.* 2021;57(3):414–423. DOI: 10.23736/S1973-9087.20.06379-0	Wrong concept
Wakefield B, Drwal K, Scherubel M, Klobucar T, Johnson S, Kaboli P. Feasibility and effectiveness of remote, telephone-	Wrong concept

based delivery of cardiac rehabilitation. *Telemed e-Health.* 2014;20(1):32–38. DOI: 10.1089/tmj.2013.0079	
Wang W, Chair SY, Thompson DR, Twinn SF. Effects of home-based rehabilitation on health-related quality of life and psychological status in Chinese patients recovering from acute myocardial infarction. *Heart Lung.* 2012;41(1):15–25. DOI: 10.1016/j.hrtlng.2011.05.005	Wrong concept
Wehmeier UF, Schweitzer A, Jansen A, Probst H, Grüter S, Hähnchen S, Hilberg T. Effects of high-intensity interval training in a three-week cardiovascular rehabilitation: a randomized controlled trial. *Clin Rehabil.* 2020;34(5):646–655. DOI: 10.1177/0269215520912302	Wrong concept
West RR, Jones DA, Henderson AH. Rehabilitation after myocardial infarction trial (RAMIT): multi-centre randomised controlled trial of comprehensive cardiac rehabilitation in patients following acute myocardial infarction. *Heart.* 2012;98(8):637–644. DOI: 10.1136/heartjnl-2011-300302	Wrong concept
Winter MM, Van der Bom T, De Vries LCS, Balducci A, Bouma BJ, Pieper PG, Van Dijk APJ, Van der Plas MN, Picchio FM, Mulder BJM. Exercise training improves exercise capacity in adult patients with a systemic right ventricle: a randomized clinical trial. *Eur Heart J.* 2012;33(11):1378–1385. DOI: 10.1093/eurheartj/ehr396	Wrong concept
Wolkanin-Bartnik J, Pogorzelska H, Bartnik A. Patient education and quality of home-based rehabilitation in patients older than 60 years after acute myocardial infarction. *J Cardiopulm Rehabil Prev.* 2011;31(4):249–253. DOI: 10.1097/HCR.0b013e31821c1391	Wrong concept
Wu CM, McKeon J, Abbott JD, Jiang L, Wu WC. Referral to cardiac rehabilitation and outcomes for patients with Takotsubo cardiomyopathy. *J Cardiopulm Rehabil Prev.* 2019;39(3):E8–E11. DOI: 10.1097/HCR.0000000000000433	Wrong concept

Xia K, Bai C, Ding R, Kong Y, Fan X, Liu Y, Liu B, Chen X. Feasibility of a smartphone app for prescribed exercise tutoring in patients with stable coronary heart disease. *Digit Health.* 2023;9:20552076231155504. DOI: 10.1177/20552076231197424	Wrong concept
Xueyu L, Hao Y, Shunlin X, Rongbin L, Yuan G. Effects of low-intensity exercise in older adults with chronic heart failure during the transitional period from hospital to home in China: a randomized controlled trial. *Res Gerontol Nurs.* 2017;10(3):121–128. DOI: 10.3928/19404921-20170411-02	Wrong concept
Young L, Hertzog M, Barnason S. Effects of a home-based activation intervention on self-management adherence and readmission in rural heart failure patients: the PATCH randomized controlled trial. *BMC Cardiovasc Disord.* 2016;16(1):176. DOI: 10.1186/s12872-016-0339-7	Wrong concept
Zhang QY, Hu Q, Li Y, Sun Y, He JF, Qiu MH, Zhang J, Liang YC, Han YL. Efficacy of CPET combined with systematic education of cardiac rehabilitation after PCI: a real-world evaluation in ACS patients. *Adv Ther.* 2021;38(9):4836–4846. DOI: 10.1007/s12325-021-01871-y	Wrong concept
Zhang Z, Wang L, Xi J, Sun X. Impact of exercise training at different intensity levels on cardiac function and exercise capacity in patients with chronic heart failure: a prospective cohort study. *J Rehabil Med.* 2022;54:jrm00347. DOI: 10.2340/jrm.v54.1023	Wrong concept
Zheng Y, Guo J, Tian Y, Qin S, Liu X. Effect of home-based cardiac telerehabilitation in patients after percutaneous coronary intervention: a randomized controlled trial. *CIN: Computers, Informatics, Nursing.* 2024;42(12):898–904. DOI: 10.1097/CIN.0000000000001167	Wrong concept
Zhu LY, Li MY, Li KH, Yang X, Yang YY, Zhao XX, Yan T, Li MM, Luo SQ, Zhang ML, Su JZ. Effect of exercise prescription	Wrong concept

implementation rate on cardiovascular events. *Front Cardiovasc Med.* 2021;8:753672. DOI: 10.3389/fcvm.2021.753672	