Journal of Education, Health and Sport. 2026;88:68438. eISSN 2391-8306.

https://doi.org/10.12775/JEHS.2026.88.68438

Journal of Education, Health and Sport. eISSN 2450-3118

Journal Home Page
https://apcz.umk.pl/JEHS/index

MATEJA, Patrycja, FABIŚ, Katarzyna, ZBYLUT, Mateusz, BUCZEK, Sylwia, BYJOŚ, Ewa, MSTOWSKA, Weronika, MILEWSKA, Kamila, BURY, Karolina, NALIUKA, Hanna, and MŁYNARCZYK, Katarzyna. Exercise-based Rehabilitation in Chronic Heart Failure – A Narrative Review. Journal of Education, Health and Sport. 2026;88:68438. eISSN 2391-8306.
https://doi.org/10.12775/JEHS.2026.88.68438

The journal has had 40 points in Minister of Science and Higher Education of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of 05.01.2024 No. 32318. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical culture sciences (Field of medical and health sciences); Health Sciences (Field of medical and health sciences).
Punkty Ministerialne 40 punktów. Załącznik do komunikatu Ministra Nauki i Szkolnictwa Wyższego z dnia 05.01.2024 Lp. 32318. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 19.01.2026. Revised: 09.02.2026. Accepted: 02.02.2026. Published: 17.02.2026.

Exercise-based Rehabilitation in Chronic Heart Failure - A Narrative Review

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Abstract

Chronic heart failure is a widespread clinical condition associated with reduced exercise tolerance, impaired quality of life, and increased morbidity and mortality. Exercise-based cardiac rehabilitation represents an essential component of non-pharmacological management in patients with chronic heart failure; however, optimal training strategies and delivery models remain under discussion. This narrative review summarizes current evidence regarding the safety, efficacy, and feasibility of exercise-based rehabilitation across different heart failure phenotypes. The analysis includes conventional centre-based programs, home-based rehabilitation, telerehabilitation, and novel exercise modalities. Available evidence indicates that structured exercise training improves functional capacity, exercise tolerance, and health-related quality of life, regardless of rehabilitation setting. Combined aerobic and resistance training, as well as high-intensity interval training, appear to provide greater functional benefits than moderate continuous exercise, particularly under supervised conditions. Functional assessment using cardiopulmonary exercise testing remains the reference standard, while the six-minute walk test offers a practical alternative in routine clinical practice. Individualized, patient-centred rehabilitation strategies are crucial for optimizing outcomes and supporting long-term engagement in physical activity among patients with chronic heart failure.

Keywords: chronic heart failure, physical exercise, cardiac rehabilitation, 6 minute walking test, exercise training

1. Introduction

Heart failure (HF) is a prevalent clinical syndrome that affects millions of individuals worldwide and remains a leading cause of morbidity, recurrent hospitalizations, impaired quality of life, and premature mortality [1]. Rather than representing a single disease entity, HF is defined as a clinical condition characterized by symptoms and/or signs resulting from structural and/or functional abnormalities of the heart, supported by increased natriuretic peptide concentrations and/or objective findings of pulmonary or systemic congestion. [2]

Based on left ventricular ejection fraction (LVEF), HF is commonly categorized into distinct phenotypes. Heart failure with reduced ejection fraction (HFrEF) is defined by an LVEF below 40% and reflects significant systolic dysfunction of the left ventricle. Patients with mildly reduced systolic function, characterized by an LVEF between 41% and 49%, are classified as having heart failure with mildly reduced ejection fraction (HFmrEF). Evidence from retrospective analyses of randomized controlled trials suggests that this subgroup may derive benefit from therapeutic strategies similar to those applied in HFrEF, which has led to a refinement of terminology from “mid-range” to “mildly reduced” ejection fraction. Heart failure with preserved ejection fraction (HFpEF) refers to patients with typical symptoms and signs of HF, evidence of structural and/or functional cardiac abnormalities or elevated natriuretic peptides, and an LVEF of 50% or higher [3]. Classification based on ejection fraction is important due to differences in response to treatment [4].

Regardless of the underlying heart failure phenotype, physical exercise is an non-pharmacological component of cardiac rehabilitation. Chronic heart failure is frequently accompanied by additional conditions such as frailty, depressive symptoms, and impaired functional capacity, all of which should be considered when planning comprehensive rehabilitation strategies [3]. Beyond reduced aerobic capacity, patients with chronic heart failure often exhibit impairments in balance, postural control, and gait parameters, including gait speed, stride length, and performance during single- and dual-task activities, when compared with healthy individuals. These deficits may increase the risk of falls and contribute to further functional decline, also be a point of attachment for individualised exercises [5].

In this review, we aim to summarize evidence on physical activity as a key element in the management of chronic heart failure, encompassing conventional, home-based, telerehabilitation, and innovative approaches, with particular attention to differences related to left ventricular ejection fraction, where such data are available. By evaluating safety, efficacy, and feasibility, we aim to provide guidance for optimizing patient-centered rehabilitation strategies.

2. Methods and Methodology

This narrative review was conducted using articles sourced from PubMed by keywords: “physical exercise”, “heart failure”, “cardiac rehabilitation”, “6 minute walking test”. We examined randomized clinical trials, observational studies, meta-analyses, and technological innovations related to exercise-based cardiac rehabilitation in chronic heart failure. Studies from multiple decades were reviewed to provide historical evolution and current clinical perspectives. We didn’t narrow it to a specific timeline. We rejected works without an English translation, loose or unrelated to the topic.

3.1 Cardiac rehabilitation – assessment tests

Cardiac rehabilitation relies on a broad range of assessment methods selected according to the study design and research objectives. In this review, particular attention is given to several commonly applied tests which are especially relevant for the evaluation of functional capacity in patients undergoing cardiac rehabilitation.

The cardiopulmonary exercise test (CPET) remains the reference method for comprehensive assessment of exercise capacity and cardiorespiratory performance. The test consist of performing physical activity on an ergometer while simultaneously using a gas analyser to asses peak oxygen consumption (peak VO2). [6]. However, the present review focuses primarily on studies that incorporated the six-minute walk test (6MWT). The 6MWT represents a practical alternative due to its low cost, ease of implementation, and wide availability, making it especially suitable for everyday clinical practice and for centres lacking advanced diagnostic equipment [7]. Although traditionally classified as a submaximal test, evidence suggests that patients with chronic heart failure may reach maximal or near-maximal exertion during the final phase of the 6MWT. Mapelli et al. demonstrated that, in this population, physiological responses monitored by a gas analyser during the last minute of the test were comparable to or exceeded those achieved during cycle-ergometer CPET. Therefore, despite its favourable safety profile, the 6MWT should be performed under appropriate supervision, as adverse events, although rare, may occur similarly to those reported during CPET [8].

Nevertheless, the usefulness of the 6MWT for determining exercise training intensity remains limited. Piaggi et al., in a multicenter cross-sectional study, evaluated several predictive equations designed to estimate maximal work rate measured by CPET based on 6MWT performance. None of the proposed models provided sufficient accuracy, leading the authors to emphasize the necessity of CPET for individualized exercise prescription in patients with heart failure, at least at the initial stage of rehabilitation [9].

Prognostic implications of 6MWT performance have also been reported. Wegrzynowska-Teodorczyk et al. observed that patients with HFrEF who covered distances of 468 m or less during the 6MWT exhibited significantly lower overall survival and hospitalization-free survival during a three-year follow-up period [7].

In addition to functional exercise testing, heart rate variability (HRV) analysis represents a supplementary assessment tool that provides insight into autonomic regulation of cardiac function. HRV is derived from variations in consecutive R–R intervals recorded on electrocardiography. Commonly applied indices include time-domain measures, such as the standard deviation of normal-to-normal intervals (SDNN) and the root mean square of successive differences (RMSSD), as well as frequency-domain components reflecting sympathetic and parasympathetic modulation of heart rate dynamics [10].

3.2 Cardiac rehabilitation: exercise modalities and training duration

Exercise-based intervention constitutes a fundamental element of comprehensive management in patients with chronic heart failure. Although the European Society of Cardiology (ESC) acknowledges the clinical value of physical training, detailed recommendations concerning specific exercise modalities, intensities, and durations remain limited [3]. Nevertheless, a growing body of evidence, including that described later in this review, indicates that structured rehabilitation programs incorporating physical exercise lead to measurable improvements in clinical status, functional capacity, and quality of life in this patient population.

In individuals with HFpEF, various exercise modalities—including aerobic training, resistance exercises, inspiratory muscle training, and combined protocols—have consistently been associated with increases in peak oxygen uptake compared with non-training control groups. Notably, resistance-based interventions and high-intensity interval training with active recovery phases appear to elicit greater improvements in cardiorespiratory performance than continuous moderate-intensity aerobic exercise [11]. Among frail patients with HFrEF, high-intensity interval aerobic training has demonstrated superior outcomes relative to moderate-intensity protocols, although both approaches resulted in significant gains in exercise tolerance and health-related quality of life following 24 supervised sessions [12].

Evidence also suggests that clinically meaningful benefits may be achieved even in the absence of conventional aerobic exercise. Training programs combining inspiratory muscle training with peripheral resistance exercises performed at low to moderate intensities have been shown to enhance respiratory muscle strength, peripheral muscular performance, and functional walking capacity, as assessed by the 6MWT, in symptomatic and debilitated patients with heart failure. Importantly, moderate-intensity combined inspiratory muscle training and resistance training may additionally contribute to improvement in NYHA functional class [13]. These findings are consistent with the work of Laoutaris et al., who demonstrated that inspiratory muscle training represents a safe and effective strategy for increasing exercise capacity, alleviating dyspnea, and improving quality of life in patients with HFrEF [14].

Araya-Ramírez et al. reported that the majority of patients enrolled in cardiac rehabilitation programs incorporating both aerobic and resistance components experience functional improvement. The magnitude of benefit was greatest among individuals with lower baseline exercise capacity and among those who completed a higher number of supervised training sessions [15].

Pharmacological optimization may further potentiate the effects of exercise-based rehabilitation. Li et al. demonstrated that treatment with sacubitril/valsartan is associated with improvements in cardiac structure and function (including increased LVEF and reduced LVED, LVEDD, and NT-proBNP levels), pulmonary function parameters (FEV_1, FVC, and FEV_1/FVC), arterial blood gas indices, exercise tolerance, and quality of life. When combined with a supervised inpatient rehabilitation program consisting of aerobic, resistance, and flexibility exercises, these benefits were significantly amplified, alongside reductions in rehospitalisation rates and major adverse cardiovascular events in patients with CHF [16]. Comparable outcomes were observed by Wang et al. in patients with LVEF below 45% who underwent six months of CPET-guided training in conjunction with optimal medical therapy [17]. Similarly, Mahmoodi et al. reported reductions in left ventricular end-diastolic dimensions following an eight-week rehabilitation program integrating aerobic and resistance training with daily breathing exercises [18].

In contrast, increasing habitual physical activity alone may be insufficient to induce functional improvement. Vetrovsky et al. investigated the effects of elevating daily step counts in patients with HFrEF and found that, despite higher activity levels, no significant enhancement in functional capacity was achieved. These findings underscore the importance of structured, supervised rehabilitation programs with predefined training intensity and duration to elicit clinically relevant adaptations [19].

Interindividual variability in response to exercise training may be partially explained by differences in autonomic nervous system function. Ricca-Mallada et al. identified HRV as a potential modifier of training response in patients with HFrEF. Participants with lower baseline HRV values (high-frequency power <150 ms^2/Hz and rMSSD <20 ms) exhibited significant improvements after 24 weeks of supervised aerobic training, including enhanced HRV indices, increased LVEF, longer 6MWT distance, improved NYHA functional class, and a reduction in adverse clinical events [10]. Conversely, Compostella et al. reported that reduced HRV predicted limited improvement in working capacity following a short-term exercise-based rehabilitation program [20]. Discrepancies between studies may be attributed to methodological differences, including shorter intervention duration, proximity to an episode of acute heart failure, and higher overall training intensity [10, 20].

Early initiation of physical rehabilitation during hospitalization has also been shown to be both feasible and beneficial. Delgado et al. demonstrated that an in-hospital program comprising respiratory exercises, calisthenics, cycling, walking, and stair climbing—performed at least twice daily on five or more days per week—was safe for patients with decompensated heart failure and resulted in improvements in functional capacity and independence in activities of daily living [21].

Despite the robust evidence supporting exercise-based cardiac rehabilitation, not all patients respond uniformly. Brubaker et al. observed that only approximately one quarter of elderly patients with HFrEF achieved a clinically meaningful increase in peak VO_2 ($\geq$10%) following a 16-week endurance training program. Responders additionally exhibited favorable neurohormonal modulation, including suppression of aldosterone activity and a trend toward reduced angiotensin II levels, as well as improved indices of diastolic function, suggesting potential biological determinants of training responsiveness [22].

3.3 Home-based and telerehabilitation cardiac rehabilitation

Telerehabilitation offers a home-based alternative for cardiac rehabilitation, especially for patients facing barriers such as limited access to healthcare facilities or other logistical constraints [23]. This approach allows structured exercise programs to be delivered remotely while maintaining clinical oversight.

Tousignant et al. reported that real-time physiological monitoring using wearable biomedical sensors can be implemented safely in HFrEF patients during telerehabilitation. The continuous monitoring enables clinicians to adjust exercise intensity appropriately, ensuring safety throughout the sessions [23].

Studies indicate that telerehabilitation can enhance patients' functional capacity and is generally well accepted. Additionally, several reports suggest improvements in health-related quality of life [24,25]. In a 90-day follow-up, Chen et al. observed that participants in telerehabilitation programs experienced fewer hospital readmissions [24]. Nonetheless, this model may incur higher costs compared with traditional inpatient rehabilitation [23].

3.4 Novel and alternative physical rehabilitation programs

To improve long-term adherence to exercise among patients with heart failure, increasing attention has been directed toward novel and alternative models of cardiac rehabilitation. One such modality is Nordic walking (NW), which integrates aerobic and resistance components by using poles in a dynamic, coordinated manner during walking [26]. Compared with conventional walking, NW engages a greater number of muscle groups, including the upper extremities, and contributes to improved postural stability and balance [26, 27].

Keast et al. demonstrated that, in contrast to standard inpatient rehabilitation programs, participation in NW was associated with a small but significant reduction in depressive symptoms, as measured by the Hospital Anxiety and Depression Scale. Furthermore, NW has been shown to effectively improve functional capacity in both supervised inpatient settings [26] and telemonitored home-based programs. Importantly, Piotrowicz et al. confirmed the safety of NW in patients with cardiovascular implantable electronic devices, which are frequently used in the population with chronic heart failure [27].

Beyond exercise modality, individual preferences and behavioral strategies play a critical role in promoting physical activity. It remains important to identify which patients benefit most from simple exercise advice, structured rehabilitation programs, or behavior-oriented approaches such as motivational interviewing. Evidence suggests that motivational interviewing—grounded in established behavior-change theories and delivered through a flexible, patient-centered framework—can effectively increase physical activity levels in patients with heart failure over the short term. While both structured exercise programs and motivational interviewing have demonstrated efficacy, individual responses vary, indicating that tailored interventions may enhance overall effectiveness. Expanding and testing these approaches in broader clinical settings may support public health efforts to provide diverse and adaptable options for increasing physical activity among older adults with heart failure [28].

Another important determinant of adherence is patients' ability to monitor their health status, adjust lifestyle behaviors, and perform exercises safely. Incorporating specially trained nurses into the rehabilitation team may address these needs [28,29]. Nurse-led models of care have been shown to be potentially cost-effective, as they are associated with reduced healthcare resource utilization, fewer hospital admissions, and improved long-term adherence to both lifestyle modifications and pharmacological treatment [29].

Innovative programs combining physical and psychological components have also been explored. Lu et al. introduced a mindfulness-based walking intervention in which patients focus attention on breathing, body movements, and the surrounding environment without distraction or judgment. This approach resulted in significantly greater improvements in functional capacity and higher satisfaction with cardiac rehabilitation compared with standard care [30].

Technological advances have further expanded rehabilitation possibilities through motion-assisted training using wearable robotic devices, such as the hybrid assistive limb. This technology supports gait training and motor performance, with studies reporting improvements in walking distance and long-term functional outcomes in patients with chronic heart failure compared with conventional sit-to-stand exercises. Although some outcomes were comparable between intervention and control groups, the concept is particularly promising for patients with markedly reduced walking speed (<80 m/min), highlighting its potential relevance for severely impaired populations [31].

Finally, culturally adapted forms of physical activity may offer attractive alternatives to traditional exercise-based rehabilitation. Traditional Greek dancing, for example, combines rhythmic movement with social interaction and has been associated with improvements in lower limb strength, endurance, and jumping ability among cardiac rehabilitation participants [32]. Such culturally familiar activities may enhance motivation, enjoyment, and long-term adherence to rehabilitation programs.

4. Conclusions

Physical exercise represents a fundamental component of chronic heart failure management. While all forms of physical activity provide benefits, mixed programs incorporating high-intensity interval training appear to be particularly effective. Better outcomes are generally observed in patients demonstrating higher adherence to the prescribed regimen.

To ensure safety and optimize results, it is recommended to determine each patient's maximal exercise capacity through a functional test before initiating a rehabilitation program. Due to the limited number of studies and their conflicting results, the preferred test for assessing maximal physical capacity is the CPET. When CPET is unavailable, the test 6MWT provides a reliable alternative for monitoring functional improvements during rehabilitation.

For patients with limited access to rehabilitation centres, home-based programs offer a practical solution and may support ongoing engagement in physical activity. Additionally, exploring diverse exercise modalities may further enhance patient adherence and contribute to improved clinical outcomes.

Disclosure

Supplementary Materials

Not applicable.

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Receiving funding: not applicable

All authors have read and agreed with the published version of the manuscript.

Funding

The review did not receive any funding.

Institutional Review Board Statement

Not applicable. Ethical review and approval were not required for this study as it is a systematic narrative review of previously published literature and did not involve primary data collection involving human or animal subjects.

Informed Consent Statement

Not applicable.

Data Availability Statement

Not applicable.

Conflicts of Interest

Authors declare no conflicts of interest.

Acknowledgments

Not applicable.

AI

In preparing this work, the authors used ChatGPT for the purpose of improving language, enhancing readability and verification of bibliographic styles. After using this tool, the authors have reviewed and edited the content as needed and accept full responsibility for the substantive content of the publication.

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