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Physical Activity in the Management of Heart Failure with Reduced Ejection Fraction A Review of Current Evidence and Recommendations

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Abstract:

Introduction: Heart failure with reduced ejection fraction (HFrEF) remains a chronic cardiovascular condition characterized by increased morbidity and mortality. Advancements in pharmacological therapy is abundant, but there is mounting recognition for non-pharmacological approaches such as structured physical activity for improving life quality and functional capability. Current recommendations suggest the addition of physical exercises as a complementary treatment for patients with HFrEF, and the strength of recommendations is backed by a considerable amount of evidence.

Aim of the study: This review aims to synthesize current scientific evidence regarding the role of physical activity in the management of patients with HFrEF, with a focus on its impact on clinical outcomes, including prognosis, functional capacity, and quality of life. Additionally, it seeks to provide recommendations on the types, intensity, and modalities of exercise best suited to this population.

Materials and Methods: A comprehensive search of the literature was conducted using databases such as PubMed, UpToDate, ScienceDirect, and Google Scholar. The review included studies evaluating exercise interventions in HFrEF populations, focusing on clinical outcomes, safety considerations, and recommendations from leading cardiology societies.

Results and conclusions: The analysis confirms that dynamic aerobic training, resistance training, and inspiratory muscle training for breathing and pulmonary rehabilitation constitute the most effective exercise strategies for HFrEF patients and their impact on exercise ability and functional quality of life is substantial. While meta-analyses do not consistently demonstrate a reduction in all-cause and cardiovascular mortality, cardiac rehabilitation based on physical exercise remains fundamental in the treatment of HFrEF. Individualized exercise prescriptions based on the FITT-VP model (Frequency, Intensity, Time, Type, Volume, and Progression) are encouraged to improve patient results.

Keywords: physical activity and heart failure with reduced ejection fraction, exercise and heart failure, rehabilitation and heart failure, and physical exercise and prognosis in heart failure patients.

Introduction:

Heart failure with reduced ejection fraction (HFrEF) is a chronic cardiovascular disease with an unfavourable prognosis. It is estimated that the prevalence of this condition ranges from 1% to 2% of the population in Europe and North America.(1) Heart failure with reduced ejection fraction (HFrEF) represents the most prevalent form of heart failure, characterised by a constellation of clinical symptoms associated with a diminished left ventricular ejection fraction (LVEF) of less than 40%.(2) The most common causes of HFrEF include ischaemic heart disease, poor blood pressure control, valvular heart disease and cardiomyopathies.(3) Patients with HFrEF exhibit a range of compensatory mechanisms, both hemodynamic and neurohormonal, which serve to mitigate the effects of cardiac dysfunction. However, these mechanisms have a detrimental long-term impact on prognosis due to the development of progressive cardiac remodeling, which results in a reduction in myocardial contractility and compliance. Consequently, pharmacological therapies targeting these compensatory mechanisms have been developed and represent a key component of treatment for patients with HFrEF, significantly improving their prognosis.(4) Nevertheless, lifestyle modification remains the foundation of cardiovascular disease management and is emphasized in the 2021 European Society of Cardiology (ESC) guidelines for heart failure.(5) The role of physical activity in the prevention of cardiovascular diseases is well-documented, leading to general recommendations for the population to engage in 150–300 minutes of moderate or 75–150 minutes of vigorous aerobic physical activity per week.(6) However, a key question remains regarding the impact of specific forms and intensities of physical activity on patients with existing cardiovascular disease. This study aims to review the literature concerning the effects of various forms, durations, and intensities of physical exercise on patients with chronic heart failure with reduced left ventricular ejection fraction.

Physiology:

Regular physical exercise in healthy individuals has been demonstrated to induce a range of physiological adaptations, and its health-promoting effects have been well-documented in the scientific literature. In the long term, aerobic exercise has been demonstrated to result in a number of beneficial outcomes, including:

1) It has been demonstrated that regular exercise increases cardiac output.(7) Regular exercise has been demonstrated to elevate both heart rate and stroke volume, which collectively serve

to enhance cardiac output.(8) This is of critical importance for ensuring an adequate blood supply to the working body.

2) It has been demonstrated that regular exercise has a beneficial effect on vascular function.(9) Regular exercise has been demonstrated to enhance vascular autoregulation, thereby enabling vascular responses to be adjusted in order to meet the needs of the tissues. Furthermore, it enhances vascular longevity and impedes the progression of atherosclerosis.

3) It enhances microcirculation. The exercise-induced increase in blood vessel density, particularly in the microcirculation of muscles, results in enhanced tissue perfusion.(10) This adaptation facilitates the regulation of peripheral resistance, which is a pivotal factor in the control of blood pressure.

4) It regulates the activity of nitric oxide (NO). Nitric oxide (NO) plays a pivotal role in vasodilation and lowering blood pressure.(11)

5) It influences neurohormonal systems, which regulate vascular diameter. Physical activity promotes vasodilatory mechanisms by modulating neurohormonal pathways that regulate vascular diameter.

6) Furthermore, regular exercise reduces oxidative stress, as evidenced by decreased oxidative damage in the body.(12)

7) It also adapts the myocardium, increasing cardiac mass and efficiency, which improves myocardial contractility and relaxation.(13)

8) Additionally, exercise positively affects lipid profiles and promotes fat burning, thereby improving metabolic health.(14)

It has been demonstrated that regular aerobic and dynamic physical activity has the effect of enhancing the efficiency of the cardiovascular system. The long-term impact of regular physical activity on the risk of developing cardiovascular diseases, including heart failure, remains a topic of ongoing research. Nevertheless, the extant evidence suggests that exercise is an effective method for reducing the probability of developing heart failure.(15) Even low-intensity activities, such as walking or leisurely cycling, have been demonstrated to reduce this risk over time. It has been demonstrated that individuals who engage in higher-intensity exercise and possess superior physical fitness are less likely to experience future instances of heart failure. In order to mitigate the risk of heart failure, it is recommended that individuals engage in regular, dynamic and aerobic activities, such as running, cycling or interval training. It is important to ensure that the intensity of these activities is appropriate to the individual's fitness level. The monitoring of physical activity enables the assessment of both the intensity and duration of exercise. The findings of research studies indicate that the optimal intensity range for physical activity is moderate-intensity aerobic exercise performed for a duration of between 150 and 300 minutes per week. This level of activity provides an optimal balance between the benefits of reducing heart failure risk and the time spent exercising.(15) Nevertheless, it seems that increasing the intensity and duration of exercise has the effect of amplifying the positive impact on the reduction of risk factors associated with heart failure.

The classification of physical exercise and the measurement of exercise intensity

There are a number of different forms of physical exercise and a variety of methods for assessing the intensity of these activities. In order to provide a clearer understanding of the subject matter, we will begin by introducing the most common classification system used to categorise exercise. This system categorises exercise based on the type of muscle contraction involved, and the following are the main categories:

1) Dynamic exercise - is defined as any activity that involves isotonic muscle activity, whereby muscles change their length during contraction. The primary metabolic component of this type of exercise is aerobic work, whereby energy is derived from the oxidation of fatty acids and carbohydrates. An example of dynamic exercise is running.

2) Static exercise - is characterised by isometric muscle contractions, whereby energy is primarily derived from the utilisation of muscle phosphocreatine and the breakdown of glycogen into glucose, which subsequently undergoes glycolysis.

3) Mixed exercise - is a form of training that incorporates both dynamic and static muscle contractions.

The intensity of physical exercise is typically evaluated in the context of dynamic exercises and can be classified into objective and subjective methods.(16)

Objective Methods:

1) Absolute intensity calculated in METs (Metabolic Equivalent of Task). The MET (Metabolic Equivalent of Task) represents the ratio of oxygen consumption during exercise to resting oxygen consumption, with 1 MET equating to 3.5 ml O_2 per kilogram of body weight per minute. Intensity classifications based on MET values are as follows:

    a) Low intensity: 1.5–3 MET

b) Moderate intensity: 3.0–5.9 MET

c) High intensity: 6.0 MET or above

While this scale is highly accurate, it may prove challenging to implement in everyday settings.(17)

2) Relative intensity. This method is based on the percentage of maximal oxygen uptake (VO_2max), which is an individual measure indicating the maximum volume of oxygen that a person can utilise during exercise, depending on their aerobic fitness level. The intensity of exercise based on VO_2max can be classified as follows:(18)

    a) Low intensity: <50% VO_2max

    b) Moderate intensity: 50–70% VO_2max

    c) High intensity: >70% VO_2max

Subjective Methods:

1) Subjective numerical scales, exemplified by the 20-point Borg scale. In this method, the individual subjectively rates their level of fatigue before, during, and after physical activity on a numerical scale, such as from 6 to 20. The scale is defined as follows: a rating of 6 indicates minimal perceived exertion, whereas a rating of 20 indicates the maximum level of perceived exertion. This method is uncomplicated and straightforward to implement.

2) Talk test. A straightforward assessment in which the intensity of the exercise is determined based on the individual's ability to speak during physical activity.

    a) Low to moderate intensity: the individual is able to converse in a sustained manner during the course of the exercise.

    b) High intensity – The individual is unable to maintain a conversation and is therefore limited to speaking in short phrases or single words.

An accurate assessment of exercise intensity is of paramount importance for the planning of physical activity, the determination of its safety, and the evaluation of progress over successive training sessions.(19)

The Place of Physical Exercise in the Context of Heart Failure Treatment Guidelines

The 2021 guidelines of the European Society of Cardiology (ESC) represent the most authoritative document regarding the diagnosis and management of heart failure in the European Union. These guidelines recommend physical activity for all patients with heart failure with reduced ejection fraction (HFrEF) who are physically capable of exercising. This recommendation is classified as Class IA, which represents the highest level of evidence and strength of recommendation.(5) However, the guidelines do not specify the type, duration, or intensity of exercise that is most advisable. A more comprehensive analysis of the literature reveals certain nuances related to physical exercise in this patient population.

Patients with Heart Failure with Reduced Ejection Fraction (HFrEF)

The cohort of patients with HFrEF is characterised by significant heterogeneity, attributable to the diversity of underlying mechanisms of heart failure, the extent of myocardial damage, the presence of comorbidities, and the degree of heart failure symptoms. A commonly employed instrument for expedient assessment of symptom severity in these patients is the New York Heart Association (NYHA) functional classification.(20) The heterogeneity of symptoms among patients represents a significant challenge in the extrapolation of results from certain studies to the entire population of heart failure patients.

What is the current state of knowledge regarding exertion in heart failure?

A number of large-scale studies have been conducted with the objective of evaluating the mortality rate among patients with heart failure who are undergoing interventions such as physical exercise. The results are inconclusive. However, comprehensive meta-analyses have not demonstrated a reduction in all-cause mortality in patients undergoing cardiac rehabilitation.(21) Furthermore, parameters such as cardiovascular-specific mortality and the number of hospitalisations have been evaluated. The results of these large meta-analyses are not as promising as anticipated and do not indicate a notable reduction in these variables.(21) Nevertheless, other parameters that are important for patients' daily functioning require further attention. Although the impact of exercise on mortality reduction remains a topic of debate, there is evidence that patients undergoing rehabilitation experience an improvement in their physical capacity. This improvement is evident not only in the subjective assessments made by patients themselves, but also in objective measures such as peak oxygen consumption (VO_{2max}). An enhanced physical capacity directly translates into an improvement in daily functioning, thereby enabling patients to cope more effectively with the demands of everyday life. Patients who engage in physical exercise rehabilitation report an improvement in quality of life (QoL), as evidenced by meta-analyses.(22) In light of this notable improvement in quality of life, exercise-based rehabilitation is now regarded as a cornerstone of treatment for patients with heart failure. At present, there is a focus on developing systemic solutions to ensure that patients with heart failure have access to high-quality cardiac rehabilitation. (23)

What methodology can be employed to assess a patient's fitness level in a practical manner prior to the commencement of physical exercise?

The most appropriate method for evaluating a patient's fitness level prior to commencing cardiac rehabilitation and for selecting appropriate exercises is cardiopulmonary exercise testing (CPET) with patient-limited exertion and measurement of VO2max.(24) However, this is a method that is both specialised and less accessible. In clinical practice, more straightforward tests that can be conducted in a variety of settings, such as the six-minute walk test (6MWT), are adequate.(25, 26) This test provides an overview of the patient's functional capacity and allows for the monitoring of improvements in fitness over the course of rehabilitation. To estimate muscle strength, a simple one-repetition maximum (1RM) test may be employed, whereby the patient performs a single repetition with the maximum weight they can lift.(27) This test should be performed for each muscle group in order to estimate the patient's baseline strength and track its progression over time during training. These straightforward tests are adequate for routine clinical practice. More advanced techniques for assessing fitness, such as CPET, are primarily utilised in research settings.

The Role of Physical Exercise as a Baseline Prognostic Indicator in Patients with Heart Failure

In light of the ongoing debate surrounding the role of physical exercise as a treatment for heart failure, it is important to consider the following observation. Baseline assessment of physical fitness provides a means of estimating the risk of mortality. There is a strong correlation between low fitness indicators (e.g., low VO_{2max}, short exercise duration) and a high risk of death within a defined timeframe.(28, 29) This shifts the perspective on the role of physical exercise, framing it as a prognostic tool in the long-term monitoring of patients.

Selection of Exercises

It is well established that physical exercise has a beneficial effect on patients with heart failure. The question now arises as to what an optimal exercise programme, tailored to these patients, should entail.

1) Early mobilization of the patient. Prior to initiating more advanced exercise interventions, it is essential to ensure that the patient has achieved stability with regard to heart failure symptoms. Furthermore, the gradual introduction of movement should be undertaken in a manner that is feasible for the patient. In the initial stages, patients should be encouraged to engage in simple activities that require coordination, such as sitting up or walking (with or without assistance). The objective is to maintain their motor function and prevent muscle

mass loss. All activities should be conducted under careful monitoring of symptoms (e.g., chest pain, dyspnoea, fatigue) and basic clinical parameters, such as blood pressure and heart rate measurements.(30)

2) Aerobic dynamic exercises. Moderate-intensity aerobic training, when performed over an extended duration (45 to 60 minutes), has been demonstrated to have the most well-established role in improving patients' quality of life and ensuring safety.(31) This type of training should prioritise exercises that engage large muscle groups in a dynamic and coordinated manner. Examples of such exercises, which are both straightforward for patients to learn and well-tolerated, include walking, cycling, arm ergometry (e.g. rowing machines), and swimming. Each session should commence with a five-minute warm-up comprising both static and dynamic exercises. Similarly, each session should conclude with a minimum of five minutes dedicated to a post-exercise cool-down. At the commencement of the rehabilitation programme, the recommended frequency for this type of activity is two to three days per week, with a gradual increase to a target frequency of three to five days per week. It is essential to facilitate progressive training to enable patients to adapt to the exercise and translate these adaptations into enhanced daily functioning.(32) This progression can be guided by the FITT-VP algorithm (F – Frequency, I – Intensity, T – Time, T – Type, V – Volume, P – Progression). Typically, only one component of the algorithm is adjusted at a time, most commonly by increasing either the duration or intensity of the exercise session.(33)

3) Resistance training. This type of training is of vital importance in the prevention of muscle mass loss in patients with heart failure. The optimal timing for integration is typically around 3 to 4 weeks after the commencement of aerobic exercise, when patients have begun to adapt to the physical exertion.(34) It is imperative to refrain from the Valsalva manoeuvre, as it may have a detrimental impact on the function of a heart that is already compromised. It is recommended that, initially, exercises which engage large muscle groups be undertaken, such as squats and bench presses. It is recommended that the use of lighter weights with a higher number of repetitions be employed. It is of significant importance to ensure that the number of repetitions is increased or that the weights are augmented from one training session to the next. This facilitates the development of muscle mass, indicates adequate patient adaptation, and enhances the likelihood of improving their quality of life.(35)

4) Inhalation muscle training. This frequently overlooked aspect of training for patients with heart failure has recently received increased attention due to evidence indicating that the weakness of inspiratory muscles, which is commonly observed in patients with heart failure and reduced ejection fraction, is associated with an elevated risk of cardiovascular mortality.(36) Inhalation muscle training can be conducted using a threshold resistance device, which makes inhalation more difficult for the patient, thereby compelling them to generate greater force through their inspiratory muscles. It is recommended that this type of training be performed twice daily, 6 to 7 days a week, for several weeks.(37)

For training programmes for patients to be effective in enhancing the quality of life, reducing discomfort, and improving daily functioning, it is crucial that the training intensity progresses in a controlled manner, ideally utilising the FITT-VP algorithm.(38) Patients with heart failure represent a challenging group to mobilise for physical activity due to the debilitating symptoms and frequently occurring depressive symptoms that they experience. However, similar to healthy individuals, maintaining regularity and progression in training sessions is essential to maximise the likelihood of therapeutic success.(39)

Conclusions

It is well-established that regular physical activity is associated with a reduced risk of cardiovascular disease. A series of adaptive mechanisms associated with regular exercise has been demonstrated to result in a reduction in the risk of significant heart disease, including heart failure. Moreover, patients who engage in regular physical activity have been observed to exhibit superior prognoses and disease progression compared to those who do not participate in such activity in the event of heart failure onset. Heart failure with reduced ejection fraction (HFrEF) is a serious diagnosis that has a significant impact on patient prognosis, often resulting in outcomes that are less favourable than those associated with oncological diagnoses. The benefits of physical exercise are widely acknowledged by global cardiology societies, who recommend that every patient without contraindications should engage in some form of physical activity. Despite the expectation that physical exercise would result in a reduction in overall mortality from all causes in this patient group, large meta-analyses have not observed such an effect. Nevertheless, structured, regular, and supervised rehabilitation through exercise plays a pivotal role in the treatment of patients with heart failure. This role is frequently referred to as a cornerstone in the management of patients with this diagnosis. Furthermore, the capacity for exercise in patients with HFrEF is a prognostic indicator that correlates well with the risk of death. The most logical and evidence-based approach for initiating treatment in patients with heart failure appears to be early mobilisation, followed by supervised dynamic aerobic training, provided there are no contraindications, and the incorporation of resistance exercises. Furthermore, it is recommended that regular inhalation muscle training be included in such a plan. The most critical aspects of exercise in heart failure are the regularity and progression of the exercise programme, which should be tailored according to the FITT-VP framework. It is recommended that rehabilitation through physical activity should be supervised by qualified personnel in either a stationary, hybrid, or remote modality. This approach enhances safety, improves compliance, allows for the observation of outcomes, and ultimately contributes to the improvement of the quality of life for patients with heart failure and reduced left ventricular ejection fraction.

Disclosure

Author's contribution

Conceptualization: Mateusz Teofilak, Natalia Smyl; methodology: Aleksandra Słowikowska, Marcelina Sztyler - Krąkowska, Natalia Smyl, Dariusz Fabian; formal analysis: Julia Szatkowska, Franciszek Kędziora, Agnieszka Wąsowicz, Jan Siwiec; check: Natalia Smyl, Olga Śpiołek, Marcelina Sztyler - Krąkowska; formal analysis: Julia Szatkowska; investigation: Franciszek Kędziora; resources: Olga Śpiołek, Mateusz Teofilak; writing - rough preparation: Olga Śpiołek, Jan Siwiec, Aleksandra Słowikowska, Julia Szatkowska, Natalia Smyl; writing - review and editing: Franciszek Kędziora, Dariusz Fabian, Agnieszka Wąsowicz, Marcelina Sztyler - Krąkowska; visualization: Agnieszka Wąsowicz; supervision: Mateusz Teofilak, Natalia Smyl; project administration: Mateusz Teofilak.

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