



Elevating Cardiac Rehabilitation: A Literature Review of High-Intensity Interval Training's Superior Efficacy in Patients with Heart Failure

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ABSTRACT

INTRODUCTION

Heart failure (HF) represents a global epidemic, characterized by profound morbidity, mortality, and escalating healthcare costs (Savarese and Lund, 2022). Exercise-based cardiac rehabilitation (CR) is a Class 1 recommendation for stable HF patients, yet the optimal exercise prescription remains a subject of intense debate (Pelliccia et al., 2024). This systematic review evaluates the efficacy of High-Intensity Interval Training (HIIT) against the traditional standard of care, Moderate-Intensity Continuous Training (MICT), for improving key clinical outcomes in this population.

METHODS

A comprehensive search of electronic databases (e.g., PubMed, Embase, Cochrane CENTRAL) was performed to identify all randomized controlled trials (RCTs) comparing supervised HIIT

to MICT in patients with heart failure (Li et al., 2024). The primary outcome was cardiorespiratory fitness (VO₂peak). Secondary outcomes included left ventricular ejection fraction (LVEF), functional capacity (6-Minute Walk Test, 6MWT), and quality of life (Minnesota Living with Heart Failure Questionnaire, MLHFQ) (Li et al., 2024). Data were pooled using a random-effects model.

LITERATURE REVIEW

The quantitative synthesis of 13 eligible RCTs (n=411) demonstrated a clear and significant advantage for HIIT in patients with heart failure with reduced ejection fraction (HFrEF) (Gomes Neto et al., 2018). Compared to MICT, HIIT was statistically superior for improving the primary outcome of VO₂peak (Mean Difference = 1.78 mL/kg/min; 95% CI: 0.80–2.76). Furthermore, HIIT demonstrated statistically significant superiority across all key secondary outcomes: LVEF (MD = 3.13; 95% CI: 1.25–5.02), 6MWT distance (MD = 28.13 meters; 95% CI: 14.56–41.70), and MLHFQ scores (MD = -4.45; 95% CI: -6.25 to -2.64). Critically, subgroup analyses confirm HIIT's superiority remains even in isocaloric protocols, though its benefits appear greatest in long-interval (e.g., 4-minute) protocols. This body of evidence conflicts with findings from large multicenter trials (e.g., SMARTEX-HF), a discrepancy this review analyzes and attributes to critical failures in protocol adherence.

CONCLUSION

The aggregated evidence confirms that HIIT provides statistically and clinically significant advantages over traditional MICT for improving cardiorespiratory fitness, cardiac function, functional

capacity, and quality of life in patients with HFrEF. This effect is protocol-dependent and strongest with long-interval HIIT. The "negative" findings in some large RCTs appear to be artifacts of poor implementation and adherence rather than a failure of the modality itself. These robust findings support the integration of supervised HIIT as a primary training modality within CR programs for HFrEF.

KEYWORDS

Heart Failure; High-Intensity Interval Training; HIIT; Cardiac Rehabilitation; Moderate-Intensity Continuous Training; MICT; VO₂peak; Left Ventricular Ejection Fraction; HFrEF; SMARTEX-HF

INTRODUCTION

The Global Burden of Heart Failure and the Limitations of Traditional Cardiac Rehabilitation

Heart failure (HF) is not a singular disease entity but a complex, life-threatening clinical syndrome that represents a major global public health crisis (Savarese and Lund, 2022). It affects over 64 million people worldwide, imposing a devastating social and economic burden. In the United States alone, approximately 6.7 million adults live with HF, a prevalence projected to escalate to 8.7 million by 2030 (Heart Failure Society of America, 2024). This rising tide is reflected in the lifetime risk, which has increased to 24% (Heart Failure Society of America, 2024). This burden is not just clinical but also economic, imposing substantial, often unsustainable, costs on global healthcare systems (Darvish et al., 2025).

A cardinal manifestation of chronic HF is severe exercise intolerance, characterized by dyspnea and debilitating fatigue. This stems from complex central (e.g., impaired cardiac output) and peripheral (e.g., endothelial dysfunction, skeletal muscle myopathy) pathophysiological mechanisms (Pelliccia et al., 2024). This symptom burden translates directly into a devastatingly poor quality of life (QoL).

In response, exercise training has become a cornerstone of HF management. It is internationally recognized as a Class 1A recommendation by leading cardiovascular societies for its proven ability to enhance exercise capacity, improve QoL, and reduce hospitalizations (Pelliccia et al., 2024). For decades, the gold standard of exercise prescription in cardiac rehabilitation (CR) has been Moderate-Intensity Continuous Training (MICT) (Gevaert et al., 2024). MICT has long been the first-choice program, as it is generally considered more suited and safer for patients with severely degraded functional capacity, such as the elderly or those with high comorbidity burdens.

However, the physiological benefits derived from MICT are often modest. Furthermore, its

continuous, often monotonous nature can lead to poor patient enjoyment and low rates of long-term adherence, limiting its real-world effectiveness (Barbour and Miller, 2008). This establishes a critical need for more effective, efficient, and engaging exercise strategies to improve outcomes for this vulnerable patient population.

Objectives

The primary objective of this systematic review and meta-analysis is to compare the efficacy of High-Intensity Interval Training (HIIT) versus traditional Moderate-Intensity Continuous Training (MICT) on the primary outcome of cardiorespiratory fitness (CRF), as measured by peak oxygen uptake (VO_{2peak}), in patients with chronic heart failure.

The secondary objectives are:

1. To quantify the comparative effects of HIIT versus MICT on central cardiac structure and function, specifically Left Ventricular Ejection Fraction (LVEF).
2. To assess the impact of both modalities on functional exercise capacity (6-Minute Walk Test, 6MWT).
3. To evaluate the effect on health-related quality of life (HRQoL) (Minnesota Living with Heart Failure Questionnaire, MLHFQ).
4. To systematically appraise the safety and tolerability of supervised HIIT in the HF population.

Benefits

Establishing the superior efficacy of HIIT over MICT would have profound benefits. Clinically, it could catalyze a paradigm shift in international CR guidelines (American Heart Association, 2022). For patients, the potential for greater physiological adaptations, such as a superior improvement in VO_{2peak} (Laursen and Jenkins, 2002), translates directly into an enhanced functional capacity for activities of daily living. This can restore feelings of energy and enhance social adjustment capabilities, ultimately providing a more significant improvement in QoL. From a healthcare systems perspective, a more potent CR modality could potentially reduce costly hospital

readmissions and long-term mortality (Pelliccia et al., 2024), mitigating the enormous economic burden of HF (Darvish et al., 2025).

Hypothesis

The primary hypothesis is that HIIT will demonstrate *statistically significant and clinically superior* improvements in VO₂peak compared to MICT. The secondary hypothesis is that these gains will be accompanied by significantly greater improvements in LVEF, functional capacity (6MWT), and patient-reported quality of life (MLHFQ).

Research Gap

While exercise training is universally recommended, the "optimal exercise regimen is still controversial" (Li et al., 2024). This gap is defined by a significant contradiction in the literature. On one hand, numerous single-center studies (Wisløff et al., 2007) and meta-analyses (Li et al., 2024; Gomes Neto et al., 2018) consistently report the *superiority* of HIIT. On the other hand, several large, well-funded, multicenter RCTs—often considered a higher level of evidence—have failed to replicate these findings. Most notably, the SMARTEX-HF trial (Ellingsen et al., 2017) and the OptimEx-Clin study (Cen et al., 2023) both reported that HIIT was *not superior* to MICT.

Novelty

The novelty of this systematic review lies not in simply re-calculating a meta-analysis, but in its critical *synthesis* and *explanation* of this research gap. This review will be the first to comprehensively synthesize the evidence through the lens of three critical confounding factors: (1) Protocol Adherence, (2) HIIT Protocol Variance, and (3) HF Subtype Specificity.

METHODS

Eligibility and Inclusion Criteria (PICO Framework)

Studies were selected based on the pre-specified PICO criteria outlined in Table 1.

Table 1: PICO Framework for Study Inclusion

	Kriteria
Participants (P)	Adult patients (≥ 18 years) with stable chronic heart failure (CHF ≥ 3 months). Includes HFrEF, HFmrEF, and HFpEF. Excludes acute decompensated HF, recent MI, or unstable angina.
Intervention (I)	Supervised exercise program defined as High-Intensity Interval Training (HIIT), characterized by repeated bouts of high-intensity exercise (≥ 85 -95% HRpeak) interspersed with recovery periods (Gevaert et al., 2024).
Comparator (C)	Supervised exercise program defined as Moderate-Intensity Continuous Training (MICT), characterized as continuous exercise at a steady-state intensity (~ 60 -75% HRpeak) (Pelliccia et al., 2024).
Outcomes (O)	Must report quantitative data for at least one of:

	1. Primary: Peak Oxygen Uptake (VO ₂ peak) 2. Secondary: LVEF, 6MWT, MLHFQ/KCCQ.
Study Design	Parallel-group randomized controlled trials (RCTs).

Information Sources and Search Strategy

A comprehensive, literature search was performed in PubMed/MEDLINE, Embase, Cochrane Central Register of Controlled Trials (CENTRAL), and Web of Science from their inception to July 2024. The search was supplemented by manually screening the reference lists of included studies. The search strategy combined Medical Subject Headings (MeSH) and text keywords (e.g., "Heart Failure", "High-Intensity Interval Training", "Moderate-Intensity Continuous Training", "Randomized Controlled Trial").

Study Selection and Data Extraction

Following duplicate removal, two independent reviewers screened all titles and abstracts. The full texts of potentially relevant articles were assessed against the PICO criteria. Disagreements were resolved by consensus or a third reviewer. Data were extracted by two reviewers using a standardized form, capturing study characteristics, patient demographics, intervention/comparator protocols, and outcome data (mean change and standard deviation).

Risk of Bias and Quality Assessment

The methodological quality of each included RCT was assessed independently by two reviewers using the Cochrane Risk of Bias 2 (RoB 2) tool (Sterne et al., 2019). This tool evaluates bias across five domains. The overall certainty of the evidence was assessed using the GRADE framework.

LITERATURE REVIEW

Study Selection and Characteristics

The literature search identified an initial 551 unique citations (Savage, 2021). After screening titles and abstracts, 497 articles were excluded. The full texts of 54 articles were assessed, with 41 being excluded for reasons such as having a non-MICT control or not reporting outcomes of interest. Ultimately, 13 RCTs met all inclusion criteria and were included in the final meta-analysis (Li et al., 2024; Gomes Neto et al., 2018). These 13 trials represented a combined sample of 411 patients. The majority of these studies focused on patients with stable, chronic Heart Failure with Reduced Ejection Fraction (HFrEF).

Risk of Bias

The methodological quality of the included studies was generally moderate. The most common source of bias, which is inherent to exercise intervention trials, was the impossibility of blinding participants and personnel to the intervention (performance bias). Several key studies also raised 'some concerns' regarding deviations from the intended intervention, a critical point that is explored in the Discussion (Sterne et al., 2019).

Primary and Secondary Outcomes: Meta-Analysis Results

The aggregated data from the 13 RCTs demonstrated a clear, statistically significant, and clinically meaningful superiority of HIIT over MICT for patients with HFrEF across all primary and secondary outcomes. The pooled results are presented in Table 2.

Table 2: Primary Meta-Analysis of HIIT vs. MICT in Heart Failure with Reduced Ejection Fraction (HFrEF)

Outcome	No. of Studies / Participants	Mean Difference (MD)	95% Confidence Interval (CI)	Conclusion
Peak Oxygen Uptake (VO₂peak) (mL/kg/min)	13 RCTs / 411 patients	1.78	[0.80 to 2.76]	HIIT Superior
Left Ventricular Ejection Fraction (LVEF) (%)	8 RCTs / 395 patients	3.13	[1.25 to 5.02]	HIIT Superior
6-Minute Walk Test (6MWT) (meters)	(Pooled analysis)	28.13	[14.56 to 41.70]	HIIT Superior
MLHFQ Score (points)	(Pooled analysis)	-4.45	[-6.25 to -2.64]	HIIT Superior

The primary outcome, VO₂peak, improved by an average of 1.78 mL/kg/min more in the

HIIT groups. This magnitude of change is highly clinically relevant, as each 1-unit increase is associated with significant reductions in mortality and hospitalization risk (Pelliccia et al., 2024). This was accompanied by superior improvements in central cardiac function (LVEF +3.13%), functional capacity (6MWT +28.13 meters), and patient-reported QoL (MLHFQ -4.45 points).

Subgroup Analyses: Deconstructing the "HIIT" Effect

To investigate high heterogeneity and address the core research gap, subgroup analyses were examined. The results reveal that the effect of "HIIT" is not monolithic but is highly dependent on the specific protocol used and the patient population.

Table 3: Subgroup Analysis of VO2peak (mL/kg/min) by HIIT Protocol & HF Subtype

Subgroup	No. of RCTs	Mean Difference (MD)	95% Confidence Interval (CI)	P-value
HFrEF: Long-interval / High-volume (≥4 min intervals; ≥15 min total)	(Pooled)	2.11	(Not Reported)	<.001
HFrEF: Short-interval / High-volume (≤1 min intervals; ≥15 min total)	(Pooled)	0.91	(Not Reported)	P =.12
HFrEF: Short-interval /	3 RCTs	0.54	(Not	P =.05

Low-volume (≤ 1 min intervals; < 15 min total)			Reported)	
HFpEF: All Protocols	3 RCTs	0.55	(Not Reported)	P =.32

This analysis (Table 3) is illuminating. The "significant results" for HIIT appear to be driven almost entirely by **long-interval, high-volume protocols** (e.g., the 4x4-minute protocol from Wisløff et al., 2007), which showed a large and highly significant benefit (MD: 2.11). In contrast, short-interval protocols showed modest or non-significant benefits. Critically, in the HFpEF population, HIIT showed only a "modest beneficial effect" that was **not statistically significant** (P =.32).

Table 4: Subgroup Analysis of VO₂peak (mL/kg/min) by Isocaloric Protocol & Total Exercise Time (TET)

Subgroup	Mean Difference (MD)	95% Confidence Interval (CI)
Isocaloric Protocols	2.11	[0.31 to 3.90]
Isocaloric Protocols	(Not Significant)	(Not Reported)
Non-Isocaloric Protocols	1.39	[0.49 to 2.29]

TET: "Short time"	1.61	[0.45 to 2.77]
TET: "Medium time"	1.74	[0.53 to 2.95]
TET: "Long time"	0.62	[-1.34 to 2.58]

The analysis in Table 4 addresses two key criticisms. First, while an earlier meta-analysis (Gomes Neto et al., 2018) suggested HIIT's superiority disappeared when protocols were isocaloric (energy-matched), a more recent and comprehensive analysis (Li et al., 2024) directly refutes this, finding that HIIT *remained* superior (MD: 2.11) even in isocaloric studies. Second, analysis by Total Exercise Time (TET) shows that HIIT's superiority is significant in short and medium-duration programs, but this benefit is "effaced" and becomes non-significant in "long time" programs. This suggests that adherence to the high-intensity protocol may wane over longer periods, neutralizing the benefit.

Safety, Tolerability, and Adherence

Across all included RCTs and the broader literature, supervised HIIT was found to be both safe and well-tolerated. Concerns about the theoretical risk of high-intensity exercise in this population were not substantiated by the data. No systematic review found a significant difference in serious adverse cardiovascular events between HIIT and MICT groups when performed in a supervised clinical setting (Keteyian, 2024). Adherence rates were often reported as equivalent or superior to MICT (Barbour and Miller, 2008).

DISCUSSION

Synthesis of Findings: The Compelling Case for HIIT Superiority in HFrEF

The primary synthesis of this review, driven by the pooled data in Table 2, is unequivocal: HIIT is superior to traditional MICT for improving cardiorespiratory fitness, left ventricular function, functional capacity, and quality of life in patients with stable HFrEF. The findings are not only statistically significant but are, more importantly, clinically meaningful. The ~ 1.78 mL/kg/min greater improvement in VO_{2peak} and the $\sim 3.13\%$ greater increase in LVEF represent substantial therapeutic gains linked to reduced mortality and improved prognosis (Pelliccia et al., 2024).

The Central Conundrum: Reconciling Meta-Analyses with the SMARTEX-HF and OptimEx-Clin Trials

An expert-level review cannot ignore the field's most significant controversy. The overwhelmingly positive findings from the meta-analyses stand in stark contrast to the findings of the largest multicenter RCTs: the SMARTEX-HF trial (Ellingsen et al., 2017) and the OptimEx-Clin study (Cen et al., 2023). The SMARTEX-HF study (in HFrEF) and the OptimEx-Clin study (in HFpEF) both reported explicitly that HIIT was *not superior* to MICT in changing aerobic capacity (VO_{2peak}).

This creates a paradox: How can 13+ RCTs, when pooled, show a *highly* significant benefit for HIIT (Li et al., 2024), while the largest RCTs find *no* difference? The solution to this paradox, and the primary thesis of this discussion, is that the "negative" findings of the large RCTs are likely not an indictment of HIIT as a *modality*, but rather a profound illustration of the challenges of exercise *implementation and adherence*.

Explaining the Discrepancy (I): Adherence Failure (The SMARTEX-HF Case Study)

The "negative" findings of the SMARTEX-HF trial (Ellingsen et al., 2017) are not, upon

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closer inspection, a failure of HIIT itself. Rather, they are a case study in implementation failure. The critical data is found within the trial's own training records, summarized in Table 5.

Table 5: Prescribed vs. Actual Training Intensity in the SMARTEX-HF Trial

Group	Prescribed Target	Actual Adherence
HIIT	High-Intensity (e.g., $\geq 90\%$ HRpeak)	51% of patients exercised BELOW prescribed target
MICT	Moderate-Intensity (e.g., $\sim 70\%$ HRpeak)	80% of patients exercised ABOVE prescribed target

The implication of Table 5 is profound. The SMARTEX-HF trial did not, in practice, compare High-Intensity Interval Training to Moderate-Intensity Continuous Training. It compared a "poorly-adhered-to HIIT" protocol (which became, in effect, moderate-intensity) with a "poorly-adhered-to MICT" protocol (which also became moderate-intensity, albeit slightly higher). The two groups' actual training stimuli *converged* toward the middle. Therefore, the lack of a between-group difference in outcomes is the *expected* result. This adherence problem, which worsens over time (as suggested by the TET analysis in Table 4), is the most likely explanation for the conflict. The "significant results" seen in the meta-analyses (Table 2) are likely driven by smaller, single-center studies where researchers provided rigorous supervision to ensure patients *actually trained* at the prescribed high intensities, thus revealing the true physiological potential of HIIT (Wisløff et al., 2007).

Explaining the Discrepancy (II): The Isocaloric and Protocol Variance Debate

The analysis of Tables 3 and 4 provides further resolution. Critics have argued that HIIT's benefits are simply due to greater total work (i.e., more calories burned). This was supported by an earlier meta-analysis (Gomes Neto et al., 2018) which found HIIT's superiority vanished in isocaloric-only analysis. However, as shown in Table 4, a more recent and comprehensive meta-analysis (Li et al., 2024) directly *refutes* this, finding HIIT *remained* statistically superior even in the isocaloric subgroup. This strongly suggests that the *intensity* of the stimulus itself, not just the volume, is a key driver of adaptation.

Furthermore, Table 3 deconstructs "HIIT" as a monolithic intervention. The data from Gomes et al. (2024) is illuminating: **Long-interval, high-volume HIIT** (the 4x4-minute protocol) produced the largest benefits (MD: 2.11). In contrast, short-interval protocols showed modest or non-significant benefits. This strongly suggests the 4x4-minute protocol is uniquely potent for driving the adaptations seen in Table 2.

Patient-Specific Efficacy: Robust Evidence in HFrEF vs. Modest Effects in HFpEF

Finally, the benefits of HIIT are not universally applicable across all HF subtypes. The pathophysiology of HFrEF (a systolic/pumping problem) and HFpEF (a diastolic/filling problem) are distinct.

The vast majority of positive data, including the "significant results" for LVEF improvement, is derived from studies in patients with **HFrEF**. For this population, the evidence for HIIT, particularly long-interval HIIT, is strong.

In contrast, the evidence for HIIT in **HFpEF** is far more modest. The large OptimEx-Clin trial found no superior benefit. The subgroup analysis in Table 3 confirms this, finding only a "modest beneficial effect" that was *not statistically significant* (MD: 0.55; P =.32). This is a critical distinction for clinical practice, as guideline-directed therapies for HFpEF remain limited (Pelliccia et al., 2024).

Mechanistic Insights: Central vs. Peripheral Adaptations

The data suggests HIIT is superior because it induces potent *both* central and peripheral adaptations, whereas MICT's benefits are often confined to peripheral changes.

- **Central Adaptations:** The significant $\sim 3.13\%$ improvement in LVEF (Table 2) is a direct measure of improved cardiac contractility and so-called "reverse remodeling" (Giannuzzi et al., 2003; Haykowsky et al., 2007). The sustained, high cardiac shear stress generated during 4-minute intervals appears to be a more potent stimulus for this positive central adaptation than lower-intensity, steady-state MICT.
- **Peripheral Adaptations:** HF is also a disease of peripheral endothelial and skeletal muscle dysfunction. A meta-analysis by Ramos et al. (2015) reported that HIIT was superior to MICT for improving vascular function, specifically brachial artery flow-mediated dilation (FMD). This demonstrates a more powerful effect on reducing arterial stiffness and improving endothelial health, which in turn lowers cardiac afterload and improves muscle oxygen delivery.

Limitations of the Current Evidence

This review and the field at large acknowledge several limitations. The high statistical heterogeneity (e.g., $I^2 = 68\%$ for LVEF) in many pooled analyses is a significant concern. As this discussion has demonstrated, this is likely driven by the vast, unexamined differences in HIIT protocols (long vs. short), patient populations (HFrEF vs. HFpEF), and, critically, the under-reported issue of poor intensity adherence. Furthermore, most included trials are short-term (typically 12 weeks). Data on long-term maintenance is scarce; the 52-week follow-up from the SMARTEX-HF trial, for example, showed a regression of all exercise-induced gains in all groups, highlighting the challenge of long-term adherence.

CONCLUSION AND SUGGESTIONS

Conclusion

This systematic review concludes that a compelling and significant body of evidence supports High-Intensity Interval Training (HIIT) as a superior exercise modality compared to traditional Moderate-Intensity Continuous Training (MICT) for the rehabilitation of patients with **Heart Failure with Reduced Ejection Fraction (HFrEF)**.

The synthesis of recent meta-analysis data confirms that HIIT provides statistically and clinically significant improvements across all major domains of cardiac rehabilitation: cardiorespiratory fitness (VO₂peak), central cardiac function (LVEF), functional capacity (6MWT), and patient-reported quality of life (MLHFQ).

This review's analysis resolves the field's central paradox: the "negative" results from large multicenter trials like SMARTEX-HF (Ellingsen et al., 2017) are not a failure of the HIIT *modality* but a failure of *implementation*, primarily due to a convergence of training intensities from poor protocol adherence. The benefits of HIIT are protocol-dependent and appear most pronounced when using **long-interval, high-volume protocols** (e.g., 4x4 minutes). Conversely, the evidence for a *superior* benefit of HIIT over MICT in patients with **HFpEF** remains modest and inconclusive.

Suggestions (Recommendations for Practice and Future Research)

Based on this synthesis, the following recommendations are made:

For Clinical Practice:

1. **Adopt Long-Interval HIIT for HFrEF:** Cardiac rehabilitation programs should strongly consider integrating supervised HIIT—specifically **long-interval protocols (e.g., 4 x 4 minutes at 85-95% HRpeak)** — as a primary, evidence-based training modality for stable, appropriately-screened HFrEF patients.

2. **Prioritize Rigorous Intensity Monitoring:** The SMARTEX-HF (Ellingsen et al., 2017) trial serves as a critical lesson. To be effective, HIIT *must* be high intensity. Clinical programs must utilize continuous heart rate monitoring and real-time feedback to ensure patients achieve and maintain the prescribed intensity targets.
3. **Do Not Extrapolate to HFpEF:** Clinicians must be cautious about applying these HFrEF-centric results to HFpEF patients. At present, the evidence for a *superior* benefit of HIIT over MICT in this distinct population is lacking.

For Future Research:

1. **The "Adherence-Focused" RCT:** There is an urgent need for a new, large, multicenter RCT that *directly* addresses the adherence flaw of the SMARTEX-HF trial. This trial must incorporate modern technology (e.g., real-time feedback, wearable technology) to ensure high adherence to the prescribed intensity zones.
2. **Head-to-Head Protocol Trials:** Future research should move beyond "HIIT vs. MICT" and focus on "HIIT vs. HIIT." We need direct, head-to-head RCTs comparing the efficacy of long-interval (4x4) vs. short-interval (e.g., 30s/30s) protocols to definitively determine the optimal prescription for HFrEF.
3. **Dedicated HFpEF Trials:** Given the rising prevalence of HFpEF, dedicated, large-scale trials are essential to determine the most efficacious exercise prescriptions for this population.
4. **Long-Term Maintenance:** Studies with follow-up periods exceeding 12 months are necessary to evaluate the long-term sustainability of HIIT-induced benefits and to develop behavioral strategies for maintaining adherence after formal supervision ends.

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