

Role of High-Intensity Interval Training and Moderate-Intensity Continuous Training as Exercise-Based Rehabilitation Strategies for Patients with Coronary Artery Disease

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Abstract: Coronary artery disease is one of the major cardiovascular disorders associated with impaired physical capacity, reduced quality of life, recurrent cardiovascular events, and increased mortality. Exercise-based cardiac rehabilitation is an important component of secondary prevention because structured physical activity can improve functional capacity, cardiovascular risk factors, health-related quality of life, and long-term clinical outcomes. Moderate-intensity continuous training has traditionally been the principal aerobic exercise strategy used in cardiac rehabilitation, whereas high-intensity interval training has gained increasing attention because of its potential to provide a strong cardiorespiratory stimulus within relatively shorter exercise periods. The present research paper examines the role of HIIT and MICT as exercise-based rehabilitation strategies for patients with CAD, focusing on their effects on cardiorespiratory fitness, exercise capacity, cardiovascular risk factors, quality of life, safety, adherence, and clinical applicability.

Keywords: Coronary Artery Disease, Cardiac Rehabilitation, High-Intensity Interval Training, Moderate-Intensity Continuous Training.

I. INTRODUCTION

Coronary artery disease is a chronic cardiovascular condition in which atherosclerotic changes in the coronary arteries can restrict myocardial blood flow and impair cardiovascular function. Patients with CAD may experience angina, reduced exercise tolerance, physical inactivity, psychological difficulties, and limitations in daily activities. Consequently, management of CAD extends beyond pharmacological treatment and revascularization and includes lifestyle modification, physical activity, risk-factor management, and cardiac rehabilitation. Contemporary guidelines recommend cardiac rehabilitation for eligible patients because participation is associated with improvements in cardiovascular outcomes, functional capacity, and quality of life.

Exercise training is a central component of cardiac rehabilitation. Traditionally, moderate-intensity continuous training has been widely used because it is relatively simple to prescribe and can be adapted to a broad range of patients. MICT generally involves maintaining a continuous moderate exercise workload for a predetermined duration. Walking, treadmill exercise, stationary cycling, and similar aerobic activities are commonly used.

High-intensity interval training has subsequently emerged as an alternative exercise strategy. HIIT involves repeated periods of relatively vigorous exercise separated by periods of recovery or lower-intensity exercise. The underlying rationale is that repeated exposure to higher exercise intensities can produce a strong cardiovascular stimulus and potentially improve cardiorespiratory fitness more efficiently. Research comparing HIIT with MICT has produced encouraging findings, although results are not completely consistent across studies.

A systematic review and meta-analysis involving 17 studies and 953 cardiac rehabilitation participants reported greater improvements in cardiorespiratory fitness with HIIT than MICT and found no deaths or cardiac hospitalizations during the training interventions included in the analysis.

More recent evidence continues to investigate whether HIIT should be routinely preferred over MICT. A 2025 systematic review and meta-analysis involving 17 studies and 1,182 participants reported a statistically significant improvement in peak VO_2 with HIIT compared with MICT when the total number of exercise sessions was identical. Nevertheless, current clinical guidance emphasizes individualization rather than universal replacement of MICT with HIIT.

II. EXERCISE-BASED CARDIAC REHABILITATION IN CORONARY ARTERY DISEASE

Cardiac rehabilitation is a comprehensive, multidisciplinary intervention involving exercise training, patient assessment, nutritional counselling, weight management, blood-pressure and lipid management, diabetes management, tobacco cessation, psychosocial management, physical-activity counselling, and exercise training. The 2023 AHA/ACC guideline recommends referral to cardiac rehabilitation for appropriate patients with chronic coronary disease, including eligible patients after myocardial infarction, percutaneous coronary intervention, and coronary artery bypass grafting.

Exercise-based rehabilitation can improve functional capacity and quality of life and is associated with improved cardiovascular outcomes. The rehabilitation process should not be considered simply as an exercise prescription; rather, it represents a structured strategy for helping patients progressively return to physically active lifestyles while controlling cardiovascular risk factors.

III. MODERATE-INTENSITY CONTINUOUS TRAINING

MICT involves continuous aerobic exercise performed at moderate intensity for a predetermined duration. It has traditionally formed the foundation of aerobic exercise programmes for patients with cardiovascular disease. Typical activities include walking, treadmill exercise, cycling, swimming, and other rhythmic aerobic activities.

The major strength of MICT is its practicality. Because the exercise intensity remains relatively stable, patients can learn to regulate their effort and rehabilitation professionals can monitor exercise responses. MICT can also be progressively adjusted according to changes in exercise tolerance.

The 2024 ESC guideline recommends aerobic exercise at least three days per week, preferably more frequently, at moderate or moderate-to-high intensity for patients with chronic coronary syndromes. It specifically identifies MICT as the most feasible and cost-effective aerobic training modality for this population.

MICT may contribute to improvements in aerobic capacity, cardiovascular risk-factor control, functional performance, and quality of life. Its effectiveness, however, depends considerably on adherence, exercise volume, programme duration, and appropriate progression.

IV. HIGH-INTENSITY INTERVAL TRAINING

HIIT consists of repeated intervals of relatively vigorous exercise separated by recovery intervals. The duration and intensity of the work and recovery periods can vary according to the patient's fitness level and rehabilitation objectives. HIIT has attracted considerable attention because high-intensity exercise can impose a substantial cardiovascular stimulus. The recovery intervals allow patients to repeatedly perform higher-intensity work without maintaining the vigorous intensity continuously.

Evidence indicates that HIIT can improve cardiorespiratory fitness in cardiac rehabilitation populations. The earlier meta-analysis by Gomes-Neto and colleagues found HIIT to be superior to MICT for improving cardiorespiratory fitness, while also reporting no deaths or cardiac hospitalizations during training in the included studies. More recent evidence has also reported greater peak- VO_2 improvements with HIIT under some study conditions.

However, HIIT should not automatically be considered appropriate for every patient. Clinical assessment, exercise tolerance, symptoms, cardiovascular stability, and individual rehabilitation goals must be considered before higher-intensity intervals are introduced.

V. COMPARISON BETWEEN HIIT AND MICT

Variable	HIIT	MICT
Exercise pattern	Repeated vigorous intervals with recovery periods	Continuous exercise
Intensity	Relatively high during work intervals	Moderate and relatively stable
Recovery	Planned recovery intervals	Usually no interval recovery
Main objective	Strong cardiovascular stimulus and improvement in fitness	Progressive aerobic conditioning
Exercise prescription	Requires careful individualization	Relatively simple
Monitoring	Generally greater	Comparatively straightforward
Exercise capacity	Can produce substantial improvement	Consistently improves aerobic capacity
Practicality	More demanding for some patients	Broadly practical
Cost-effectiveness	Depends on setting and protocol	Generally highly feasible
Patient suitability	Selected clinically stable patients	Broad range of rehabilitation patients
Evidence	Potentially greater peak-VO ₂ improvement in some studies	Strong established evidence
Current guideline position	Selectively prescribed	Foundational aerobic modality

The important point is that current guidelines do not establish HIIT as universally superior. The 2024 ESC guideline states that there is insufficient evidence to promote HIIT over MICT, although HIIT can be prescribed for selected patients and specific objectives such as improving peak VO₂.

VI. EFFECTS ON CARDIORESPIRATORY FITNESS

Cardiorespiratory fitness is an important outcome in CAD rehabilitation. Peak oxygen uptake (peak VO₂) is commonly used to evaluate aerobic capacity and exercise tolerance.

HIIT has demonstrated significant potential for increasing peak VO₂. The meta-analysis of cardiac rehabilitation studies found HIIT to produce greater improvements in cardiorespiratory fitness than MICT. A subsequent meta-analysis involving 1,182 participants similarly reported an improvement in peak VO₂ favouring HIIT when the total number of exercise sessions was the same.

However, differences in training volume, interval structure, intervention duration, and patient characteristics can influence the findings. Therefore, peak VO₂ improvements should be interpreted within the context of the complete exercise prescription rather than attributed solely to exercise intensity.

VII. EFFECTS ON FUNCTIONAL CAPACITY

Functional capacity refers to the ability to perform physical activities required for everyday life. Reduced functional capacity is common in patients with CAD and can negatively affect independence and quality of life.

Both HIIT and MICT can improve functional capacity through progressive cardiovascular conditioning. MICT can provide a gradual and sustainable increase in exercise tolerance, whereas HIIT may provide an additional stimulus for patients who have developed an adequate exercise base.

The 2023 AHA/ACC guideline states that moderate-to-higher intensity exercise training within cardiac rehabilitation improves functional capacity, health-related quality of life, cardiovascular risk-factor control, and mortality outcomes.

VIII. EFFECTS ON CARDIOVASCULAR RISK FACTORS

Exercise is an important component of cardiovascular risk-factor management. Regular physical activity can support improvements in physical fitness, blood-pressure control, metabolic health, body composition, and overall cardiovascular health.

The 2023 AHA/ACC guideline recommends aerobic exercise for patients with chronic coronary disease who do not have contraindications. It recommends at least 150 minutes per week of moderate-intensity aerobic activity or at least 75 minutes per week of higher-intensity aerobic activity, or an equivalent combination.

Table 2. Potential Rehabilitation Effects

Outcome	HIIT	MICT
Cardiorespiratory fitness	Strong potential improvement	Consistent improvement
Peak VO ₂	Often substantial improvement	Substantial improvement
Functional capacity	Improved	Improved
Cardiovascular risk-factor control	Potential benefit	Established benefit
Quality of life	Potential improvement	Established improvement
Exercise tolerance	Improved	Improved
Long-term adherence	Depends on patient preference and tolerance	Generally practical
Clinical application	Individualized	Broadly applicable

IX. EFFECTS ON QUALITY OF LIFE

Quality of life is an important outcome because CAD can affect physical activity, work, social participation, emotional well-being, and independence. Cardiac rehabilitation can help patients regain confidence in physical activity and improve their ability to perform everyday activities.

The 2023 AHA/ACC guideline identifies improved quality of life as one of the benefits associated with exercise training and cardiac rehabilitation.

Although both HIIT and MICT may contribute to improvements in quality of life, the response can vary between individuals. Patient preference and perceived enjoyment may influence long-term adherence. Consequently, exercise selection should consider not only physiological effects but also whether the patient can realistically maintain the programme.

X. SAFETY OF HIIT AND MICT

Safety is a central consideration when exercise is prescribed to patients with CAD. Exercise programmes should be individualized according to clinical status, functional capacity, symptoms, medications, and cardiovascular risk.

The 2024 ESC guideline states that exercise is contraindicated in patients with refractory or unstable angina and certain high-risk cardiovascular conditions, including high-grade arrhythmias and decompensated heart failure.

Similarly, the 2023 AHA/ACC guideline identifies unstable angina and other severe or unstable cardiovascular conditions as situations in which exercise may be contraindicated.

Therefore, HIIT should generally be considered only after appropriate clinical assessment and should be introduced progressively in suitable patients. MICT may be easier to implement during the early stages of rehabilitation because its intensity can be maintained at a moderate level.

XI. ROLE OF INDIVIDUALIZATION

An important principle emerging from contemporary guidelines is that exercise prescription should be individualized. The 2024 ESC guideline recommends using the FITT framework frequency, intensity, time, and type to develop exercise programmes according to individual characteristics.

Table 3. Individual Factors Relevant to Exercise Prescription

Factor	Importance in Rehabilitation
Age	Influences exercise tolerance and programme progression
Baseline fitness	Determines starting exercise intensity
Cardiovascular stability	Important for safety
Previous MI/revascularization	Helps determine rehabilitation needs
Symptoms	Guides exercise modification
Comorbidities	May affect exercise selection
Medication	Can influence heart-rate response
Patient preference	Influences adherence
Exercise experience	Helps determine appropriate progression
Rehabilitation goals	Determines training emphasis

Thus, the decision between HIIT and MICT should be based on a combination of clinical assessment, exercise capacity, patient preference, available rehabilitation resources, and programme objectives. Although research comparing HIIT and MICT has expanded considerably, several research gaps remain. First, HIIT protocols differ substantially across studies with respect to interval duration, intensity, recovery periods, frequency, and total training volume. This heterogeneity makes direct comparison difficult. Second, many studies involve relatively selected cardiac rehabilitation populations, which may limit the generalizability of findings to patients with multiple comorbidities or different clinical characteristics.

Third, much of the literature emphasizes physiological outcomes such as peak VO_2 rather than long-term outcomes such as sustained adherence, hospitalization, recurrent cardiovascular events, and mortality. Fourth, recent meta-analytic evidence has shown that differences between HIIT and MICT can depend on how the programmes are matched for example, by number of sessions or exercise volume.

Future research should therefore investigate standardized HIIT protocols, long-term safety, adherence, patient preferences, cost-effectiveness, and clinically meaningful outcomes in diverse CAD populations.

XII. DISCUSSION

The evidence demonstrates that both HIIT and MICT have important roles in exercise-based rehabilitation for patients with CAD. MICT remains an established and highly feasible aerobic training strategy. Its relatively simple structure makes it appropriate for many patients and allows progressive improvement in aerobic fitness. The 2024 ESC guideline specifically identifies MICT as the most feasible and cost-effective aerobic training modality for patients with chronic coronary syndromes.

HIIT provides another option for appropriately selected patients. Evidence from systematic reviews indicates that HIIT can produce substantial improvements in cardiorespiratory fitness and may provide greater improvements in peak VO_2 under some study conditions.

However, the available evidence should not be interpreted as establishing HIIT as universally superior. The ESC guideline explicitly states that there is currently insufficient evidence to promote HIIT over MICT for all patients with chronic coronary syndromes. Instead, HIIT may be prescribed selectively when improving peak VO_2 or another specific rehabilitation objective is desired.

Therefore, HIIT and MICT can be understood as complementary components of a flexible rehabilitation model. MICT may provide the foundation for aerobic conditioning, while HIIT may subsequently be introduced in clinically stable patients who can tolerate higher-intensity exercise. This approach allows rehabilitation to progress according to the patient's functional capacity rather than treating exercise intensity as a fixed prescription.

XIII. SUGGESTED REHABILITATION MODEL

Table 4. Progressive Exercise-Based Rehabilitation Model

Stage	Main Strategy	Purpose
Stage 1	Assessment and low/moderate activity	Establish baseline and safety
Stage 2	MICT	Develop aerobic tolerance
Stage 3	Progressive MICT	Improve functional capacity
Stage 4	Selected HIIT introduction	Provide additional cardiorespiratory stimulus
Stage 5	HIIT + MICT according to individual needs	Maintain/improve fitness
Stage 6	Long-term exercise programme	Sustain cardiovascular health

This model emphasizes that rehabilitation should be progressive rather than based on a single exercise method. Patient monitoring and clinical judgment should guide progression.

XIV. CONCLUSION

High-intensity interval training and moderate-intensity continuous training are both relevant exercise-based rehabilitation strategies for patients with coronary artery disease. MICT has a well-established role because it is practical, feasible, relatively simple to prescribe, and applicable to a broad range of patients. HIIT has emerged as an effective alternative that can produce substantial improvements in cardiorespiratory fitness and may provide additional improvements in peak VO_2 in appropriately selected patients.

However, current evidence does not establish HIIT as universally superior to MICT. The 2024 ESC guideline recommends individualized exercise prescription and states that evidence remains insufficient to promote HIIT over MICT generally. The 2023 AHA/ACC guideline likewise recognizes both moderate-to-higher intensity exercise and HIIT as potentially beneficial approaches within appropriate cardiac rehabilitation programmes.

The most appropriate rehabilitation strategy is therefore one that considers the patient's clinical stability, baseline fitness, symptoms, functional capacity, preferences, adherence potential, and rehabilitation objectives. MICT can serve as a foundation for progressive aerobic conditioning, whereas HIIT can be incorporated selectively when clinically appropriate. Ultimately, the effectiveness of exercise-based rehabilitation depends not simply on achieving a particular exercise intensity but on developing a safe, progressive, individualized, and sustainable physical-activity programme.

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