

Review of High-Intensity Interval Training Versus Moderate-Intensity Continuous Training on Functional Performance and Exercise Tolerance in Coronary Artery Disease

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Abstract: *Coronary artery disease is one of the major cardiovascular conditions associated with reduced aerobic capacity, impaired functional performance, exercise intolerance, and diminished quality of life. Exercise-based cardiac rehabilitation is an important component of secondary prevention and is designed to improve cardiovascular fitness, functional capacity, and the ability to perform daily physical activities. High-intensity interval training and moderate-intensity continuous training are two commonly investigated exercise approaches for individuals with CAD. HIIT involves repeated periods of relatively high-intensity exercise interspersed with active recovery, whereas MICT involves continuous exercise performed at a moderate and relatively stable intensity.*

Keywords: Coronary Artery Disease, Exercise Tolerance, Functional Performance, VO₂Peak, Cardiac Rehabilitation.

I. INTRODUCTION

Coronary artery disease is characterized by pathological changes in the coronary arteries that can restrict myocardial blood flow and negatively affect physical functioning and exercise capacity. Patients with CAD commonly experience reduced aerobic fitness, fatigue, impaired exercise tolerance, and limitations in performing occupational, recreational, and daily physical activities. Exercise-based cardiac rehabilitation is therefore an important part of the management of stable CAD because regular physical training can improve cardiorespiratory fitness and functional capacity. Among different exercise approaches, HIIT has received considerable research attention because it provides repeated periods of higher-intensity exercise separated by recovery intervals, whereas MICT generally maintains a continuous moderate exercise intensity. The comparison between these two approaches has become important because exercise intensity may influence the magnitude and efficiency of improvements in aerobic capacity.

Earlier systematic reviews demonstrated that interval-based training could produce greater increases in peak oxygen consumption than continuous training in CAD populations. Pattyn (2014), for example, found that aerobic interval training produced an approximately 1.60 mL/kg/min greater improvement in peak VO₂ than moderate continuous training. Similarly, Liou (2016) reported an approximately 1.78 mL/kg/min greater increase in VO₂peak with HIIT compared with moderate continuous training. These findings have encouraged researchers to investigate whether higher-intensity intervals provide additional functional benefits beyond conventional continuous exercise.

II. CONCEPT OF HIIT AND MICT

HIIT is generally characterized by repeated bouts of exercise performed at a relatively high intensity, followed by lower-intensity recovery periods. The precise intensity and duration vary substantially among cardiac rehabilitation studies. MICT, in contrast, involves maintaining exercise at a moderate intensity for a relatively continuous period.

Both methods can be performed using treadmill walking or running, cycling, rowing, or other aerobic exercise modalities.

The physiological rationale for HIIT is that short periods of higher-intensity exercise may stimulate substantial cardiovascular and metabolic adaptations while allowing the participant to accumulate a relatively high training stimulus through intermittent recovery. MICT may provide a more stable and predictable physiological workload and is commonly used in conventional cardiac rehabilitation. Importantly, the distinction between HIIT and MICT should not be interpreted as a simple comparison of "hard" versus "easy" exercise because total exercise duration, energy expenditure, recovery periods, baseline fitness, supervision, and progression can all influence training outcomes.

III. FUNCTIONAL PERFORMANCE IN CORONARY ARTERY DISEASE

Functional performance refers to an individual's ability to perform physical activities requiring cardiovascular and muscular capacity. In CAD research, functional performance may be assessed through measures such as peak VO_2 , six-minute walk distance (6MWD), exercise-test duration, workload, anaerobic threshold, and other measures of submaximal exercise capacity. Peak VO_2 is particularly important because it provides an objective measure of maximal aerobic capacity and is strongly related to exercise tolerance.

Earlier evidence has consistently demonstrated improvements in peak VO_2 following both interval and continuous aerobic training. Pattyn (2014) included nine study groups involving 206 CAD patients and found that interval training produced a significantly greater improvement in peak VO_2 than moderate continuous training. The authors also reported improvements in submaximal exercise capacity, although the evidence base for secondary outcomes was smaller.

More recent evidence has expanded the number of participants and outcomes examined. Gomes-Neto (2025) reviewed 27 studies involving 1,454 patients and reported that HIIT produced a greater improvement in $\text{VO}_{2\text{peak}}$ than MICT, with a mean difference of 2.11 mL/kg/min. A separate 2025 systematic review and meta-analysis involving 22 studies and 1,364 participants reported greater improvements in peak VO_2 and six-minute walk distance with HIIT compared with MICT. These findings indicate that HIIT may provide an additional stimulus for improving functional performance, although differences in training protocols and patient populations need to be considered.

IV. EXERCISE TOLERANCE

Exercise tolerance represents the capacity to sustain physical activity for a specified period or workload without excessive symptoms or physiological limitation. Reduced exercise tolerance is common among people with CAD and may restrict independence and participation in daily activities. Exercise rehabilitation aims to progressively increase the amount of physical work that an individual can perform. Both HIIT and MICT can improve exercise tolerance by promoting cardiovascular and peripheral adaptations.

Evidence from previous meta-analyses indicates that interval training can improve aerobic capacity more substantially than continuous exercise in some CAD populations. The meta-analysis by Liou (2016), which included 10 studies and 472 patients, found a greater improvement in $\text{VO}_{2\text{peak}}$ with HIIT compared with MICT. However, MICT demonstrated somewhat greater reductions in resting heart rate and body weight in that analysis. Such findings demonstrate that the effects of different exercise modes may vary according to the outcome being considered. Therefore, exercise tolerance should not be evaluated using a single physiological measure.

V. CARDIORESPIRATORY FITNESS

Cardiorespiratory fitness is one of the principal outcomes of cardiac rehabilitation. It reflects the ability of the cardiovascular and respiratory systems to supply oxygen during physical activity. HIIT has been proposed as an efficient method for increasing cardiorespiratory fitness because participants repeatedly exercise at intensities close to their higher aerobic capacity. Hannan (2018) examined 17 studies involving 953 cardiac rehabilitation participants and found that HIIT produced greater improvements in cardiorespiratory fitness than MICT. Their analysis also reported no

deaths or cardiac events requiring hospitalization during training among the included studies, although safety should always be considered in relation to appropriate clinical screening and supervision.

The findings of these studies suggest that HIIT can be incorporated into cardiac rehabilitation for appropriately selected patients. Nevertheless, the presence of statistically greater improvements in cardiorespiratory fitness does not mean that MICT is ineffective. MICT also produces meaningful improvements and may be suitable for patients who are beginning rehabilitation, have lower baseline fitness, or require a more gradual progression of exercise intensity.

VI. IMPORTANCE OF TRAINING DOSE

One of the most important issues in comparing HIIT and MICT is whether the total exercise dose is equivalent. Training duration, frequency, intensity, recovery intervals, and total energy expenditure can influence outcomes. The apparent superiority of HIIT may partly reflect the greater physiological stimulus generated by higher-intensity intervals rather than the interval structure itself. This issue is supported by meta-analytic evidence. The 2017 systematic review by Gomes-Neto found that HIIT improved peak VO_2 more than MICT overall; however, when the analysis was restricted to isocaloric exercise protocols, the difference was no longer statistically significant. The updated 2025 meta-analysis reached a similar conclusion: HIIT showed a greater overall improvement in $\text{VO}_{2\text{peak}}$, whereas the difference between HIIT and MICT was not significant in the subgroup of isocaloric programs. This suggests that total training dose may be an important explanation for differences between the two approaches.

VII. QUALITY OF LIFE AND FUNCTIONAL HEALTH

Cardiac rehabilitation is not limited to improving physiological exercise capacity. Quality of life, confidence in physical activity, independence, and the ability to participate in daily activities are also important outcomes. Evidence comparing HIIT and MICT has not consistently demonstrated a major difference in quality-of-life outcomes. Gomes-Neto (2025) found no significant differences between HIIT and MICT in physical, emotional, and social domains of health-related quality of life. This suggests that although HIIT may provide greater gains in some physiological outcomes, both exercise strategies can contribute to broader rehabilitation goals.

VII. SAFETY AND CLINICAL CONSIDERATIONS

Safety is a central consideration when high-intensity exercise is prescribed to people with CAD. HIIT involves periods of greater cardiovascular stress and should therefore be appropriately individualized. Patient assessment, clinical stability, exercise testing when indicated, monitoring of symptoms and physiological responses, and gradual progression are important considerations. Evidence from cardiac rehabilitation studies suggests that HIIT can be performed safely in appropriately selected and supervised participants. Hannan (2018) reported no deaths or cardiac events requiring hospitalization during training across the included studies, although adverse events were reported in both groups. Safety findings from controlled research should not be generalized to every patient with CAD, particularly individuals with unstable symptoms or contraindications to high-intensity exercise.

VIII. COMPARATIVE REVIEW OF HIIT AND MICT

Parameter	High-Intensity Interval Training (HIIT)	Moderate-Intensity Continuous Training (MICT)
Exercise pattern	Repeated high-intensity intervals with recovery	Continuous moderate-intensity exercise
Primary physiological stimulus	Higher intermittent cardiovascular stimulus	Sustained moderate cardiovascular stimulus
Peak VO_2	Frequently shows greater improvement	Consistently improves
Exercise tolerance	Can produce substantial improvement	Produces meaningful improvement
Six-minute walk	Evidence suggests potential additional	Improves functional walking capacity

performance	improvement	
Cardiorespiratory fitness	Often greater improvement in comparative studies	Significant improvement
Quality of life	Improves, but superiority is not consistently demonstrated	Improves, with similar overall effects in several studies
Resting heart rate	May improve	Some studies report greater reductions
Body weight	Variable effects	Some analyses indicate slightly greater reduction
Training complexity	Requires interval prescription and monitoring	Relatively simple to prescribe
Clinical supervision	Particularly important during higher-intensity intervals	Also important in cardiac rehabilitation
Suitability	Appropriately selected and clinically stable patients	Broadly applicable and often useful during progressive rehabilitation

The table summarizes findings reported across systematic reviews and meta-analyses rather than representing the result of one individual clinical trial.

IX. SUMMARY OF MAJOR EVIDENCE

Study	Design/Participants	Main Finding
Pattyn (2014)	Meta-analysis; 206 CAD patients	Interval training produced greater improvement in peak VO_2 than moderate continuous training
Liou (2016)	Meta-analysis; 472 CAD patients	HIIT produced greater improvement in $\text{VO}_{2\text{peak}}$; MICT showed greater reductions in resting heart rate and body weight
Gomes-Neto (2017)	Systematic review/meta-analysis; 609 patients	HIIT improved peak VO_2 more than MICT overall, but superiority disappeared in isocaloric comparisons
Hannan (2018)	Systematic review/meta-analysis; 953 cardiac rehabilitation participants	HIIT produced greater improvement in cardiorespiratory fitness
Gomes-Neto (2025)	Updated systematic review/meta-analysis; 1,454 patients	HIIT produced greater $\text{VO}_{2\text{peak}}$ improvement overall; no significant difference in isocaloric subgroup
2025 CAD meta-analysis	Systematic review/meta-analysis; 1,364 patients	HIIT improved peak VO_2 and 6-minute walk distance compared with MICT

The evidence therefore demonstrates a recurring pattern: HIIT often produces statistically greater improvements in aerobic capacity and some measures of functional performance, but the magnitude of the difference is influenced by the exercise dose and protocol.

X. DISCUSSION

The reviewed literature indicates that both HIIT and MICT are effective exercise strategies for improving physical capacity among individuals with CAD. HIIT has attracted attention because several systematic reviews have identified greater improvements in $\text{VO}_{2\text{peak}}$ compared with MICT. The physiological explanation may involve repeated exposure to higher cardiovascular workloads, which can promote central and peripheral adaptations associated with oxygen transport and utilization. However, the evidence should not be interpreted as demonstrating universal superiority of HIIT for every patient or every outcome.

A particularly important finding is the effect of isocaloric comparisons. When HIIT and MICT are matched for energy expenditure, differences in $\text{VO}_{2\text{peak}}$ become smaller and may no longer be statistically significant. This finding suggests that the total training stimulus, rather than intensity pattern alone, may explain part of the observed advantage

of HIIT. Consequently, exercise prescription should consider intensity together with duration, frequency, energy expenditure, progression, adherence, and individual patient characteristics.

MICT remains an important component of cardiac rehabilitation because it provides a predictable and easily monitored exercise stimulus. It can be particularly useful during initial rehabilitation or for patients who require gradual progression. HIIT may subsequently be incorporated when patients are clinically stable and capable of tolerating higher exercise intensities under appropriate supervision. Thus, the two methods may be viewed as complementary approaches rather than mutually exclusive alternatives.

Although considerable evidence is available comparing HIIT and MICT, several research gaps remain. First, HIIT protocols differ substantially in interval duration, work intensity, recovery intensity, total exercise time, and training frequency, making direct comparisons difficult. Second, studies differ in participant characteristics, including age, sex, baseline fitness, left ventricular function, previous myocardial infarction, and revascularization status. Third, many studies emphasize VO_{2peak} while comparatively fewer investigate longer-term functional independence, real-world physical activity, adherence, and sustained exercise tolerance. Fourth, the evidence concerning safety is largely derived from supervised rehabilitation settings, and additional research is required to determine how HIIT can be implemented safely in less supervised environments. Future research should also use standardized training doses and outcome measures to improve comparability.

XI. CONCLUSION

The reviewed evidence indicates that both high-intensity interval training and moderate-intensity continuous training can improve functional performance, cardiorespiratory fitness, and exercise tolerance in individuals with coronary artery disease. Across several systematic reviews and meta-analyses, HIIT has generally demonstrated greater improvements in peak VO_2 than MICT when the programs are compared without strict matching of total exercise dose. However, the apparent difference becomes smaller or disappears when HIIT and MICT are designed to be isocaloric, indicating that overall training volume and energy expenditure are important contributors to adaptation.

HIIT may therefore provide an efficient training stimulus for appropriately selected and clinically stable CAD patients, particularly when delivered within a structured cardiac rehabilitation program. MICT remains an effective and practical approach and may be particularly useful for patients beginning rehabilitation or progressing gradually toward higher exercise intensities. The available evidence does not support treating one method as universally appropriate for all CAD patients; instead, exercise prescription should be individualized according to clinical status, baseline functional capacity, exercise tolerance, goals, supervision, and rehabilitation stage. Future well-designed randomized trials should investigate standardized HIIT and MICT protocols, long-term adherence, functional independence, safety, quality of life, and clinically meaningful outcomes in diverse CAD populations.

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