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High-Intensity Interval Training *(HIIT)* vs. Moderate-Intensity Continuous Training *(MICT)* in Optimizing Cardiorespiratory Capacity (VO2max)

High-Intensity Interval Training (HIIT) vs. Moderate-Intensity Continuous Training (MICT) in the Optimization of Cardiorespiratory Fitness (VO2max)

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Summary

Introduction: Physical inactivity is a primary risk factor for mortality and chronic diseases, with cardiorespiratory capacity (VO2max) being a robust predictor of health. Given the low adherence to traditional guidelines, High-Intensity Interval Training (HIIT) emerges as a time-efficient method. **Objective:** The aim of this review is to compare the effectiveness of HIIT versus Moderate-Intensity Continuous Training (MICT) in optimizing VO2max across different age groups and levels of evidence. **Results:** Physiological evidence indicates that HIIT generates a more potent metabolic signal, resulting in superior mitochondrial biogenesis when volume is matched. Systematic reviews and *umbrella reviews* in adults demonstrate that HIIT is consistently superior to MICT in increasing VO2max, particularly in older adults. However, randomized controlled trials (RCTs) in young, healthy adults have sometimes found equivalence in VO2max gains, although MICT may be superior for secondary outcomes such as reduced systolic blood pressure. **Conclusion:** HIIT is a robust stimulus and generally superior to MICT for improving VO2max, supporting its inclusion in exercise guidelines. However, it is crucial to note that primary RCTs have methodological limitations related to small sample sizes and analyses in very specific groups.

Furthermore, the literature is marked by significant heterogeneity regarding ideal HIIT protocols, the precise definition of which is beyond the scope of this review.
Keywords: “High-intensity interval training”; “HIIT”; “Moderate-intensity continuous training”; “MICT”; “Cardiorespiratory capacity”; “VO2 max”.

Abstract

Introduction: Physical inactivity is a primary risk factor for mortality and chronic diseases, with cardiorespiratory fitness (VO2max) being a robust health predictor. Given the low adherence to traditional guidelines, High-Intensity Interval Training (HIIT) emerges as a time-efficient method. **Objective:** The objective of this review is to compare the efficacy of HIIT versus Moderate-Intensity Continuous Training (MICT) in optimizing VO_2max across different age groups and levels of evidence. **Results:** Physiological evidence indicates that HIIT generates a more potent metabolic signal, resulting in superior mitochondrial biogenesis when volume is matched. Systematic reviews and umbrella reviews in adults consistently demonstrate that HIIT is superior to MICT in increasing VO2max, particularly in older adults. However, randomized controlled trials (RCTs) in young, healthy adults have sometimes found an equivalence in VO2max, although MICT may be superior for secondary outcomes, such as systolic blood pressure reduction. **Conclusion:** HIIT is a robust and, generally, superior stimulus to MICT for enhancing VO2max, supporting its inclusion in exercise guidelines. However, it is crucial to note that primary RCTs often exhibit methodological limitations related to small sample sizes and analyzes of highly specific groups. Furthermore, the literature is marked by significant heterogeneity regarding the ideal HIIT protocols, the precise definition of which falls outside the scope of this review.
Keywords: “High-intensity interval training”; “HIIT”; “Moderate-intensity continuous training”; “MICT”; “VO2max”.

1. Introduction

Physical inactivity is a known independent global risk factor for mortality.

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and the development of chronic non-communicable diseases (NCDs), such as diseases Cardiovascular. Cardiorespiratory capacity, measured by maximum oxygen consumption. (VO2max) is a more robust predictive marker of mortality than even risk factors. traditional conditions such as hypertension, diabetes, and obesity. VO2max represents the maximum oxygen uptake. which can be captured and used (consumed) by the body during physical activity, and is capable of to infer the cardiorespiratory capacity of individuals in a robust way. Sedentary individuals have an annual decline of approximately 1% in VO2max after the third decade of life, which It reinforces the importance of evidence-based exercise programs for public health and... Healthy aging.

Classic physical activity guidelines recommend a minimum of 150 minutes per week. of moderate-intensity aerobic activity (50-70% of maximum heart rate). In However, despite the continuous moderate-intensity training *(moderate-intensity continuous* training). *training (MICT)* is classically used as a way to improve capacity. Regarding cardiorespiratory issues, overall adherence to these recommendations is notoriously low, with a lack of Time is one of the main obstacles. In response to this barrier, interval training *(high-High-intensity interval training (HIIT)* has emerged as a potentially efficient alternative. This modality involves repeated periods of high-intensity exercise interspersed with periods recovery. *HIIT,* which requires "near-maximum" efforts (>80% of heart rate). Maximum (maximum), is a type of interval training that offers a reduction in volume and time. total exercise compared to *MICT,* making it a promising protocol for mitigating the harmful effects of inactivity and aging.

Several recent studies highlight HIIT as a promising strategy not only for improvement in cardiorespiratory capacity (the target of this study), but also for weight loss and Cardiac rehabilitation. However, MICT, a traditionally performed physical activity, still seems... It is essential, considering that it is easier to implement, evolve, and access. Therefore, We know that both methods can bring important benefits. However, it's important to note that... The point of question is whether HIIT could bring even better results for increasing VO2 max was achieved in a shorter training time than MICT. Comparative studies have been conducted. in recent years with that goal.

In order to standardize the terms used in this study, we will use the Weston's nomenclature defines HIIT as "near-maximum" efforts capable of generating an increase in heart rate (HR) to >80% of maximum HR, often reaching 85-95%. MICT, on the other hand, is defined, comparatively, as effort carried out continuously in lower intensities[1].

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2. Objective

The primary objective of this study is to compare the effectiveness of High-Intensity Interval Training. Intensity (HIIT) in relation to Moderate Intensity Continuous Training (MICT) in improvement in cardiorespiratory capacity, as measured by maximum consumption of oxygen (VO2 max). The aim is to determine if HIIT, with its lower volume and exercise time, It offers a superior or equivalent stimulus to MICT to optimize VO2 max, providing evidence to support the recommendation of a more efficient exercise protocol in combating the risks health problems associated with physical inactivity.

3. Materials and Methods

For the purposes of this study, a narrative literature review was conducted. based on high-level evidence. The search was conducted in the PubMed database. Search terms included combinations of the descriptors *"high-intensity interval training", "moderate-intensity continuous training", "cardiovascular fitness"* and *"maximum VO2".* They were The following were prioritized for inclusion: randomized clinical trials, systematic reviews, and meta-analyses. published in recent years that addressed the two modalities in a comparative way. It was used a study published in 2017[1], focused on the physiological adaptations of the sports modalities Aerobic exercise, as an initial theoretical basis to foster discussion and results.

4. Results and Discussion

Aerobic training, whether continuous or interval, induces physiological adaptations. classic methods, such as increasing maximum aerobic capacity as measured by VO2 and content. mitochondrial in skeletal muscle. However, the intensity of exercise acts as a powerful mediator of these gains. Understanding the physiological and biochemical differences in the different The different types of aerobic exercise are the starting point for understanding the potential differences. High-intensity interval training generates a more acute metabolic signal. intense, with greater activation of kinases such as AMPK and CaMKII, resulting in an expression more pronounced regulatory factors of mitochondrial biogenesis compared to Training Moderate Intensity Continuous (MICT)[1]. This greater power of the metabolic signal translates into different efficiencies in terms of time and volume. In studies where the total workload is Compared to MICT, HIIT has been shown to be superior in increasing mitochondrial content. Physiological findings support the proposal for more time-efficient exercise protocols[1].

A 2021 meta-analysis comparing HIIT with MICT in middle-aged and older adults. It was revealed that both exercise protocols are highly effective in improving VO2 max. However, the primary result demonstrated that HIIT produced a significant increase.

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higher in VO2max compared to MICT when the intervention protocols were
When compared, this superiority of HIIT was maintained in all sub-analyses performed, suggesting that, especially in the older adult population, higher intensity exercise is a a more potent stimulus for cardiovascular and peripheral adaptations that culminate in an increase of VO2max[2]. These findings reinforce the validity of intensity as a key factor in optimizing training programs, even in populations less tolerant of large volumes of exercise.

On the other hand, a randomized clinical trial conducted in healthy young men (aged 18) (at 44 years old), which compared a low-volume HIIT protocol with MICT over eight weeks later, the study revealed no statistically significant difference in VO2 gain after adjustment. by covariates in the analysis comparing the groups. Although it is not the scope of this study, As additional information, in this study MICT was superior to HIIT in improving blood pressure. systolic blood pressure (SBP), producing a significantly greater reduction. These findings suggest that, for young and healthy individuals, VO2max can be similarly improved by Both protocols are valid, but MICT may be more effective for optimizing PAS.

With the aim of investigating the effectiveness of exercise in an adolescent population, filling an age gap not fully covered by other studies focused on adults young and old, the randomized clinical trial by Yang et al. (2025) ÿ compared the combination of HIIT + MICT *versus* MICT alone in male adolescents over 12 weeks. The results indicated that the combination of HIIT and MICT was superior in multiple outcomes of Physical *performance* compared to MICT alone. The experimental group (HIIT + MICT) demonstrated a significantly greater increase in lung capacity and achieved times significantly faster in speed and aerobic endurance tests, in addition to improvements Superior in the long jump. In contrast to studies in adults, where MICT showed superior performance. Effective for outcomes such as systolic blood pressure, the combined high-intensity approach... In adolescents, it optimized both cardiorespiratory capacity and *performance .* neuromuscular.

Seeking to aggregate previous meta-analysis results to provide a more accurate estimate. Comprehensive, a recent *umbrella reviewÿ ,* published in 2024, synthesized 24 systematic reviews and meta-analyses involving more than 12,000 adult participants (18 to 84 years old) and provided the The most up-to-date consensus of evidence on the effectiveness of HIIT. The central conclusion is that HIIT It is consistently superior to Moderate Intensity Continuous Training (MICT) in Increase in VO2 max. The data confirmed that HIIT produced statistically significant increases. significant VO2max differences compared to MICT (with a weighted average difference) ranging from 0.52 to 3.76 mL/kg/min).

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The robustness of these findings is remarkable, as the superiority of HIIT was maintained in several subpopulations and exercise modalities. The positive effect was consistently observed in apparently healthy adults, overweight/obese individuals, the elderly, and even athletes. high-level. Although this review has focused strictly on the adult population, it provides high-level evidence that exercise intensity is a critical factor in optimizing The gains in cardiopulmonary capacity in adult individuals, supporting the incorporation of HIIT. in the physical activity guidelines for the general population.

5. Final Considerations

In conclusion, the current evidence, especially from high-level meta-analyses, It establishes that exercise intensity is a crucial mediator of physiological adaptations, being High-intensity interval training (HIIT) consistently outperforms training. Continuous moderate intensity training (MICT) to optimize gains in maximum energy consumption. Oxygen in various adult populations. This superiority, driven by a signal The most potent molecular molecule that promotes mitochondrial biogenesis was observed in a remarkable way in Middle-aged and older adults, and this translated into better physical *performance* in adolescents. However, it is crucial to recognize that the primary Randomized Clinical Trials (RCTs) in this context... The field often presents methodological limitations related to analyses of very large groups. specific limitations and the use of small samples require caution in generalizations. Additionally, Significant heterogeneity was observed among the studies regarding mode, duration, and The work-rest relationship of the HIIT protocols employed, however, the determination of the regime The ideal interval for different populations is beyond the scope of this review.

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