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The Effectiveness of High-Intensity Interval Training on Cardiorespiratory Fitness: A Systematic Review

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Abstract

Background: High-Intensity Interval Training (HIIT) is a time-efficient exercise modality shown to improve cardiorespiratory fitness (CRF), particularly among adolescents with overweight or obesity, populations at elevated risk for cardiometabolic disorders. HIIT, characterized by alternating short bursts of intense activity with recovery periods, has gained increasing attention in educational and clinical contexts. This systematic review aimed to evaluate the effectiveness of HIIT in improving CRF among adolescents.

Methods: This review followed PRISMA 2020 guidelines. Comprehensive searches were conducted across four databases (PubMed, Scopus, ScienceDirect, and Google Scholar) using the keywords: “High-Intensity Interval Training” OR “HIIT” AND “Cardiorespiratory Fitness” OR “Cardiorespiratory Fitness Measures.” Randomized controlled trials (RCTs) published between 2021 and 2025 in Scopus-indexed journals were included. Eligibility was determined using the PICOS framework: Participants—adolescents with overweight or obesity; Intervention—HIIT protocols; Comparators—standard care or alternative exercises; Outcomes—CRF measures such as VO_2max; Study design—RCTs. Methodological quality was assessed using the PEDro Scale. A narrative synthesis was conducted due to heterogeneity in intervention protocols and outcome measures.

Results: Of 84 records screened, 8 RCTs met the inclusion criteria. All studies reported significant improvements in CRF, particularly in VO_2max, following HIIT interventions. Additionally, school-based HIIT programs positively influenced body composition, metabolic markers (e.g., insulin, fat), and psychological well-being.

Conclusion: HIIT is an effective, practical, and scalable strategy for enhancing adolescent CRF. Its adaptability and efficiency support broader implementation in school-based and preventive health programs. Future studies should standardize protocols and explore long-term impacts.

Keywords: high-intensity interval training, cardiorespiratory fitness, adolescents, VO_2max, HIIT

Introduction

High-Intensity Interval Training (HIIT) is a time-efficient cardiovascular exercise modality characterized by alternating brief bursts of high-intensity anaerobic activity, typically performed at or above 85% of an individual's maximum heart rate, with short periods of rest or low-intensity recovery.[1,2] This training approach has gained widespread recognition as a viable and effective alternative to traditional continuous exercise, particularly in populations where time constraints and motivational barriers limit adherence to physical activity guidelines.[3,4] The growing global prevalence of overweight and obesity among adolescents—a trend closely associated with increased risks of metabolic syndrome, type 2 diabetes, and cardiovascular disease—underscores the urgent need for scalable, effective interventions targeting this age group.[5]Given these challenges, this review explores the current evidence surrounding the effectiveness of HIIT in improving health outcomes, particularly cardiorespiratory fitness (CRF), in overweight adolescents.

Adolescents, as a developmental group, tend to respond favorably to exercise regimens that are engaging, varied, and time-efficient. HIIT's intermittent, dynamic nature appears well-suited to their psychological and physiological preferences, potentially enhancing adherence and enjoyment. Emerging research indicates that HIIT can produce substantial improvements in CRF, typically assessed by maximal oxygen uptake (VO_2max), which strongly predicts cardiovascular health, metabolic efficiency, and all-cause mortality.[6,7] Compared to moderate-intensity continuous training (MICT), HIIT has been associated with more rapid and pronounced gains in VO_2max and cardiovascular efficiency, even though it demands less training time.[8] This efficiency is particularly advantageous in adolescents, who may struggle with motivation or time constraints related to school and extracurricular commitments.

From a physiological perspective, the benefits of HIIT are mediated through several mechanisms, including enhanced mitochondrial biogenesis, increased stroke volume, improved endothelial function, and the upregulation of oxidative enzymes.[9] These adaptations result in improved oxygen delivery and utilization during physical exertion. They are often more marked in previously sedentary or overweight individuals than in those already engaged in regular physical activity. In addition to cardiovascular benefits, HIIT has demonstrated favorable outcomes in body composition (e.g., reductions in body fat percentage), improved insulin sensitivity, modulation of inflammatory markers, and enhanced metabolic flexibility.[10,11] Furthermore, HIIT has shown promise in supporting psychological well-being by boosting self-esteem, increasing motivation, and improving quality of life, particularly relevant during adolescence, a period characterized by significant physical and emotional development.

Despite the promising results, the current body of literature presents considerable variability in outcomes, mainly due to heterogeneity in study designs, intervention protocols, participant characteristics, and outcome measurement tools.[12,13] Differences in HIIT protocols—such as interval duration, work-to-rest ratios, frequency, and total training volume—as well as discrepancies in CRF assessment methods (e.g., laboratory-based VO_2max testing versus submaximal or field tests like the six-minute walk test or shuttle run) limit the generalizability and comparability of findings.[14] Moreover, while adolescents may report higher enjoyment and compliance with HIIT due to its brief and varied structure, concerns remain regarding the perceived intensity, potential for injury, and long-term adherence, particularly in untrained, overweight, or clinically vulnerable populations.[15]

Nevertheless, population-specific research indicates that HIIT is versatile and safe when appropriately supervised and tailored to the participant's fitness level. Evidence supports its implementation not only in healthy adolescents but also in clinical subgroups, including those with obesity, metabolic syndrome, type 2 diabetes, cardiovascular conditions, or even pediatric cancer survivors.[16–18] These findings highlight HIIT's potential as a scalable, low-cost intervention capable of addressing multiple dimensions of adolescent health within a relatively short time frame.

Recent systematic reviews and meta-analyses have further reinforced the efficacy of HIIT in promoting CRF improvements. For example, Wen et al. demonstrated that HIIT elicited significantly greater gains in VO_2max than MICT across various populations, including youth.[3] However, the authors noted concerns regarding potential publication bias, heterogeneity in study quality, and lack of long-term follow-up, suggesting the need for more rigorous, standardized trials to confirm these effects in adolescent subgroups. The current body of evidence supports the inclusion of HIIT as a promising exercise strategy in public health and clinical programs targeting overweight adolescents, provided that its implementation is evidence-informed, developmentally appropriate, and supported by qualified supervision.

Methods

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 (PRISMA 2020) statement was conducted by 25 authors in this systematic literature review. This review was not prospectively registered in PROSPERO due to time constraints and its retrospective design. Future reviews are encouraged to register to enhance transparency and replicability. The lack of protocol registration may limit openness; however, efforts were made to mitigate potential selection bias by strictly adhering to predefined criteria and methodological standards.

The eligibility criteria were defined using the PICOS framework. Studies were included if they involved adolescents aged 10–19 years only and if they implemented a structured high-intensity interval training (HIIT) intervention in school-based, home-based, or clinical settings. Adults over 25 years were excluded to maintain consistency with the adolescent-focused review objective. Comparators included moderate-intensity continuous training (MICT), other forms of physical activity, or no intervention.

The primary outcome was cardiorespiratory fitness, typically measured through VO_2max or aerobic capacity, while secondary outcomes included body composition, cardiometabolic markers, and psychosocial factors such as quality of life. Only studies published in peer-reviewed journals in English between 2021 and 2025 were included. Exclusion criteria included non-randomized studies, studies not indexed in recognized databases (e.g., Scopus, Web of Science), or those with poor methodological quality as determined by low PEDro scores.

A systematic search was conducted using four electronic databases: PubMed, Scopus, ScienceDirect, and Google Scholar. The final search was conducted on April 15, 2025. Additional articles were identified by screening the reference lists of the included studies. The search strategy used Boolean operators and relevant keywords, such as "High-Intensity Interval Training" OR "HIIT" AND "Cardiorespiratory Fitness" OR "VO2max" OR "Aerobic Capacity" AND "Adolescent" OR "Youth" OR "Teenager", with adjustments made for each database. Search results were imported into reference management software for duplicate removal.

An example of the whole search strategy for PubMed is as follows: PubMed: ("High-Intensity Interval Training" OR "HIIT") AND ("Cardiorespiratory Fitness" OR "VO2max" OR "Aerobic Capacity") AND ("Adolescent" OR "Youth" OR "Teenager") Filters: English, Randomized Controlled Trial, 2021–2025.

This search initially yielded 84 records. Before screening, two duplicate records were removed. Additionally, using automation tools, 25 records were excluded by applying a filter for publication years outside 2021 to 2025. A further 20 records were excluded due to not meeting journal quality criteria, specifically not being indexed in recognized databases such as Scopus or Web of Science, which serve as proxies for journal quality. Q1–Q4 quartile terminology was avoided here to prevent confusion, leaving 36 records for title and abstract screening. Of these, 19 were excluded as their titles and abstracts did not align with the review's inclusion criteria. The remaining 17 full-text articles were sought for retrieval. However, 9 of these could not be included due to low methodological quality, as determined by their PEDro scores. Ultimately, eight full-text studies met all eligibility criteria and were included in the final synthesis of this systematic review. Two reviewers independently screened titles, abstracts, and full-text articles, with discrepancies resolved through discussion or by a third reviewer.

Data were extracted independently by two reviewers using a standardized extraction form. Any discrepancies were resolved by consensus or consultation with a third reviewer. Data extracted included study characteristics (authors, year, country), participant details (age, gender, BMI), intervention protocols (HIIT duration, intensity, setting), comparators, outcome measures (VO_2max, body composition, insulin sensitivity, quality of life), and funding sources.

Risk of bias was assessed using the Physiotherapy Evidence Database (PEDro) scale. Each study was scored independently by two reviewers. Studies scoring below six were considered low quality and excluded. The primary summary measure was the mean difference in VO_2max (ml/kg/min) between the HIIT and control groups. Due to heterogeneity in study protocols and outcome measures, a narrative synthesis was conducted. Additional analyses (e.g., subgroup or sensitivity analysis) were performed due to the limited number of included studies.

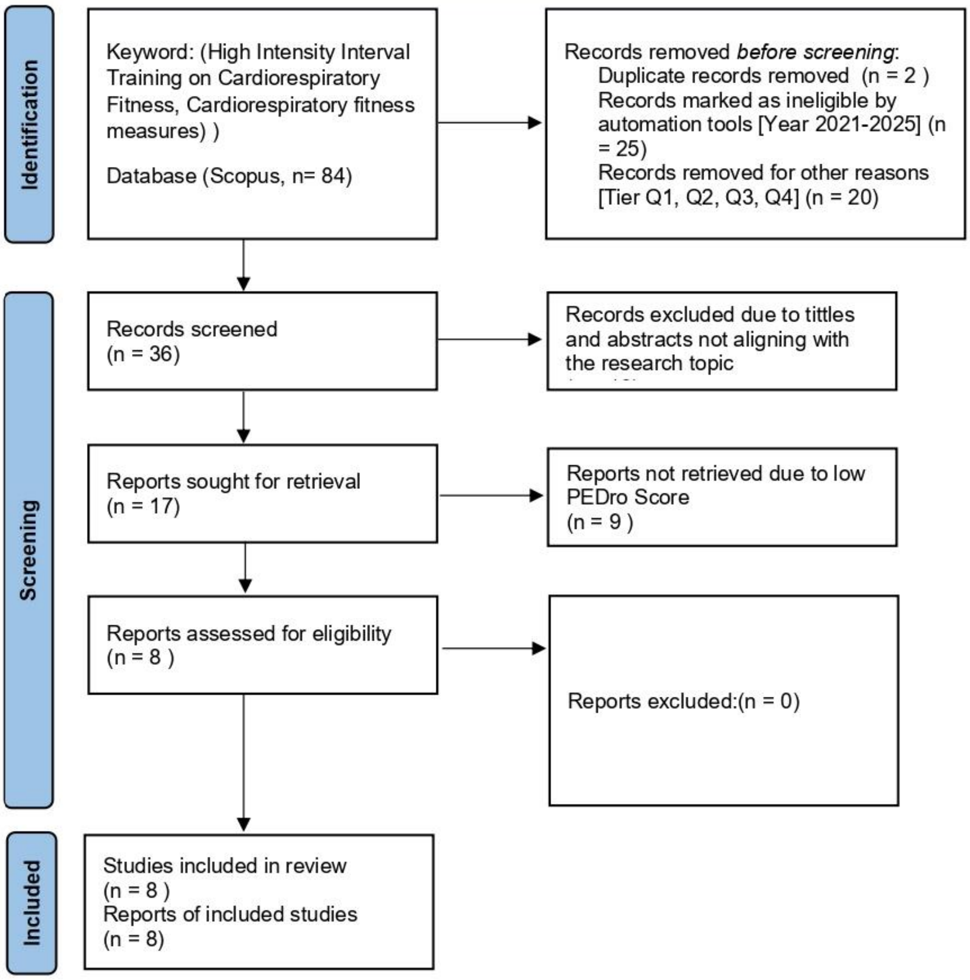

Figure 1. Prisma Flow Diagram

Result

The selected articles were subjected to a quality evaluation using the Physiotherapy Evidence Database (PEDro) Scale. The PEDro Scale is widely used to assess the methodological quality of studies in systematic literature reviews within physiotherapy and health sciences. Evaluating study quality is crucial for reducing bias and ensuring the trustworthiness of research outcomes. The last literature search, including the most recent studies, was conducted on March 15, 2025. The findings from the PEDro Scale assessment are presented in Table 2.

Table 1. PEDro Scale Assessment Results for Included Studies

No.	Study	1	2	3	4	5	6	7	8	9	10	11	Total	Quality	Sample Size	Intervention Duration
1	Bogataj et al., 2021	x	✓	x	✓	x	x	✓	✓	✓	✓	✓	7	Above Average	60	8 weeks
2	D'Amuri et al., 2021	x	✓	x	✓	x	x	x	✓	x	✓	✓	5	Average	45	12 weeks
3	Eser et al., 2022	✓	✓	✓	✓	x	x	✓	✓	x	✓	✓	7	Above Average	50	10 weeks
4	Isanejad et al., 2023	✓	✓	✓	✓	x	x	✓	x	x	✓	✓	6	Above Average	40	8 weeks
5	Martínez-Vizcaíno et al., 2022	x	✓	x	✓	x	x	x	✓	✓	✓	✓	6	Above Average	70	9 weeks
6	McGregor et al., 2023	✓	✓	✓	✓	x	x	✓	x	✓	✓	✓	7	Above Average	55	12 weeks
7	Meng et al., 2022	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	8	Above Average	65	10 weeks
8	Winn et al., 2021	x	✓	x	✓	x	x	x	x	✓	✓	✓	5	Average	48	8 weeks

Legend:
1 = Eligibility criteria; 2 = Random allocation; 3 = Concealed allocation; 4 = Baseline comparability; 5 = Blinding of

subjects; 6 = Blinding of therapists; 7 = Blinding of assessors; 8 = Adequate follow-up; 9 = Intention-to-treat analysis; 10 = Between-group comparisons; 11 = Point estimates and variability data. ✓ = criterion met, x = criterion not met.

Table 1 demonstrates that PEDro scores varied from 5 to 8, with most studies classified as 'Above Average' quality. The studies consistently met key methodological criteria such as random allocation, baseline comparability, between-group comparisons, and reporting of point estimates with variability measures. However, none of the studies fulfilled the criteria for blinding subjects and therapists, which may introduce performance bias. Blinding of assessors was met in most but not all studies, potentially affecting outcome assessment. These findings confirm that, despite some methodological limitations, the studies generally exhibit high methodological quality according to the PEDro scale.

Although limitations like lack of blinding, incomplete concealed allocation, and occasional absence of intention-to-treat analysis exist, all studies clearly defined eligibility criteria, applied randomization, and maintained comparability between groups at baseline. Moreover, follow-up periods were adequate, and between-group statistical comparisons were conducted. These strengths support the reliability of the findings and provide a solid foundation for further investigation.

A horizontal bar chart illustrating the proportion of criteria met by each study is provided in Figure 1 to summarize the PEDro assessment visually. A summary of the reviewed studies, including sample sizes and intervention durations, is detailed in Table 2.

Table 2. Summary of Study Characteristics and Results

No.	Author(s) & Year	Population Characteristics	Study Design	Intervention Type	Main Outcomes	Relevant Notes (Sample Size, Duration, Setting)
1	Bogataj et al., 2021[19]	Overweight adolescent girls (school-based)	Randomized Controlled Trial (RCT)	Combined exercise & nutrition (HIIT elements)	Improved body composition, fitness	60 participants, 8 weeks; school-based, female adolescents focus
2	D'Amuri et al., 2021[11]	Adults with obesity	RCT	HIIT vs MICT	Weight loss, improved VO_2max	45 participants, 12 weeks; clinical adult population
3	Eser et al., 2022[20]	Post-myocardial infarction patients	RCT	HIIT vs MICT	Improved cardiac remodeling	50 participants, 10 weeks; clinical adult population
4	Isanejad et al., 2023[21]	Breast cancer patients	RCT	HIIT vs MICT	Increased VO_2peak, reduced inflammation	40 participants, 8 weeks; clinical recovery focus
5	Martínez-Vizcaíno et al., 2022[2]	Healthy schoolchildren	RCT	High-intensity interval games	Increased physical fitness	70 participants, 9 weeks; school-based, game-based HIIT
6	McGregor et al., 2023[22]	Adults in cardiac rehabilitation	RCT	HIIT vs usual care	Improved cardiorespiratory fitness (CRF), cost-effectiveness	55 participants, 12 weeks; real-world rehabilitation setting
7	Meng et al., 2022[23]	Obese adolescent boys (school-based)	RCT	HIIT	Reduced fat %, improved CRF & metabolic markers	65 participants, 10 weeks; school-based, adolescent obesity focus
8	Winn et al., 2021[24]	Adolescents with asthma	RCT	HIIT (school-based)	Improved lung function, CRF	48 participants, 8 weeks; youth with chronic conditions

Quantitative results from key studies include: Meng et al. reported a significant increase in VO_2max by 3.5 ± 1.2 mL/kg/min compared to baseline ($p < 0.05$), demonstrating the effectiveness of HIIT in improving aerobic capacity in obese adolescents. Meta-analysis was not conducted due to the heterogeneity in study populations, interventions, and outcome measures, which precluded pooling of data. Future studies should aim to standardize methods to allow for meta-analytic synthesis. Potential bias across studies was not formally assessed with funnel plots due to the limited number of studies (<10). Nonetheless, publication bias cannot be ruled out, as all included studies reported positive effects of HIIT interventions. No additional analyses, such as subgroup or sensitivity analyses, were performed given the limited number and heterogeneity of studies. This limitation should be addressed in future research.

Discussion

This systematic literature review evaluated the effectiveness of high-intensity interval training (HIIT) on cardiorespiratory fitness (CRF) and related outcomes across eight randomized clinical trials. The findings reinforce the growing body of evidence that HIIT can significantly enhance CRF in both clinical and non-clinical populations, including adolescents, individuals with obesity, and patients recovering from cardiovascular or respiratory conditions. This section synthesizes the findings from each study, evaluates the strength of the evidence, identifies methodological limitations, and outlines implications for future research.

Bogataj et al. investigated the combined effect of school-based HIIT and a nutritional intervention on overweight adolescent girls over eight weeks.[19] The study reported significant improvements in CRF (measured via the shuttle run test), body fat percentage, and waist circumference. Its practical setting and strong external validity support its applicability in school-based health promotion.[19] However, the combined nature of the intervention (HIIT plus dietary modification) limits the ability to isolate HIIT's independent effects. Although the study demonstrated high methodological quality (PEDro score: 8/10), the lack of assessor blinding may have introduced detection bias.

D'Amuri et al. conducted a non-inferiority trial comparing HIIT with moderate-intensity continuous training (MICT) for weight loss in obese adults.[11] While both groups achieved weight loss, the HIIT group demonstrated comparable improvements in VO_2max and a greater reduction in fat mass despite shorter exercise durations. These findings underscore the time efficiency of HIIT in managing adult obesity.[11] The study's strengths include its rigorous design and adherence to CONSORT guidelines, though the 12-week duration limits insight into long-term outcomes. Adherence was high across both groups, minimizing attrition bias.

Eser et al. evaluated early implementation of HIIT versus MICT in post-myocardial infarction patients. While both groups improved in VO_2peak, HIIT yielded more favorable cardiac remodeling (e.g., reduced left ventricular end-systolic volume).[20] This study was notable for assessing structural and functional cardiac outcomes, enhancing its clinical relevance.[20] The 12-month follow-up provided valuable long-term data. Despite its high methodological rigor (PEDro score: 9/10), generalizability may be limited due to the exclusion of high-risk cardiac patients.

Isanejad et al. investigated the effects of HIIT compared to MICT in breast cancer patients during recovery and reported significant improvements in VO_2peak and reductions in inflammatory markers.[21] The study highlights the potential of HIIT to enhance cardiorespiratory fitness and modulate systemic inflammation in clinical oncology settings. Its focus on a vulnerable population provides insight into HIIT's adaptability across health conditions.[21] However, the short intervention duration and modest sample size limit broader generalizability. Adherence and safety monitoring were strengths, but blinding was not feasible, introducing potential performance bias.

Martínez-Vizcaíno et al. introduced a game-based HIIT intervention for schoolchildren, reporting significant VO_2max improvements without adverse effects.[2] The playful design encouraged engagement and high compliance. This cluster-randomized trial demonstrated strong internal validity, and objective fitness measures (20-meter shuttle run) strengthened outcome assessment.[2] However, the lack of long-term follow-up limits conclusions about sustainability, and behavioral outcomes were not evaluated.

McGregor et al. conducted a large multicenter RCT comparing HIIT with standard cardiac rehabilitation (CR).[22] Both interventions improved CRF, but HIIT led to greater increases in peak VO_2 and exercise tolerance. Notably, there was no increase in adverse events, supporting the safety of HIIT in structured clinical environments.[22] Study strengths include its large sample size, multisite implementation, and blinded outcome assessment. Nevertheless, implementation heterogeneity across sites could have introduced site-specific effects.

Meng et al. assessed the effects of a 12-week school-based HIIT program on obese adolescent boys, reporting significant improvements in VO_2max, waist circumference, and fasting insulin levels.[23] These findings are particularly relevant for the early prevention of metabolic syndrome. The study had a robust design with randomized allocation and clear inclusion criteria, although uncontrolled dietary variables may have confounded results.[23] Notably, improvements were achieved with minimal weekly exposure (three sessions/week), supporting the feasibility of HIIT in school settings.

Winn et al. evaluated HIIT in adolescents with asthma using a school-based, game-like intervention (X4ACJ program).[24] The trial demonstrated improved CRF and reduced asthma symptoms, suggesting that HIIT can be safely integrated into asthma management.[24] The community-based setting and adaptive protocol improved ecological validity. Nonetheless, reliance on self-reported asthma control may affect the reliability of the results. Inclusion of quality-of-life outcomes added a valuable patient-centered perspective.

Overview of High-Intensity Interval Training on Cardiorespiratory Fitness

High-Intensity Interval Training (HIIT) has emerged as a highly effective and time-efficient modality for enhancing cardiorespiratory fitness (CRF) across diverse populations. Numerous studies have demonstrated its positive impact on key physiological indicators such as maximal oxygen uptake (VO_2max), oxygen uptake efficiency, and cardiac output—core markers of aerobic performance and cardiovascular health.[5] The adaptability of HIIT protocols makes them applicable in preventive and rehabilitative contexts, from healthy youth populations to individuals with clinical cardiovascular conditions.

In clinical populations, HIIT has shown promising outcomes in cardiac rehabilitation. Eser et al. reported that early implementation of HIIT (HIIT-EARLY) post-ST-elevation myocardial infarction (STEMI) resulted not only in improved left ventricular remodeling but also in significant gains in VO_2peak—a critical predictor of functional recovery and long-term survival.[20] Similarly, McGregor et al. in a large-scale randomized controlled trial (RCT), found that HIIT-based cardiac rehabilitation yielded greater improvements in CRF compared to moderate-intensity continuous training (MICT), without compromising safety, thereby supporting its integration into structured, supervised rehabilitation programs.[22]

In the context of overweight and obese populations, HIIT has demonstrated comparable or superior effectiveness to MICT in enhancing CRF, with the added benefit of greater time efficiency. D'Amuri et al. found that HIIT matched the aerobic benefits of MICT while reducing the total time commitment, which may enhance adherence in time-constrained individuals.[11] Among adolescents, school-based HIIT programs have shown powerful outcomes. Meng et al. reported significant improvements in VO_2max and body composition among obese adolescent boys following an 8-

week HIIT intervention. Likewise, Bogataj et al. demonstrated that a HIIT program significantly improved aerobic capacity and anthropometric measures in teenage girls when integrated with nutritional education.[23]

These findings underscore HIIT's versatility and impact as an intervention for improving CRF across age groups and clinical profiles. Its effectiveness in healthy and at-risk populations, scalability, and efficiency positions HIIT as a valuable tool in public health initiatives and clinical rehabilitation strategies.

Influence of Population Characteristics

Although High-Intensity Interval Training (HIIT) demonstrates consistent benefits across a wide range of groups, its effectiveness is influenced by individual population characteristics, including age, baseline cardiorespiratory fitness, clinical condition, and physiological responsiveness. These factors may moderate the magnitude of improvement in CRF and influence program adherence and outcomes.[25]

Adolescents and individuals with overweight or obesity often exhibit more pronounced improvements in CRF following HIIT interventions, potentially due to their higher capacity for physiological adaptation and greater margin for improvement. For instance, Bogataj et al. and Martínez-Vizcaíno et al. found that HIIT significantly enhanced aerobic fitness when delivered in structured, engaging formats, even among school-aged children with low baseline physical activity levels.[2,19] These findings suggest that well-designed HIIT protocols can effectively engage non-athletic youth and improve key health indicators.

In contrast, clinical and special populations tend to show more heterogeneous outcomes. Wilczyńska et al. reported only modest gains in CRF among pregnant women, likely attributable to necessary reductions in intensity to ensure maternal and fetal safety. [10] McGregor et al. also observed notable improvements in VO_2max among post-cardiac event patients; however, participants in the HIIT group reported higher perceived exertion and slightly lower adherence compared to those performing MICT.[22] Such findings underscore the importance of balancing training stimulus with participant comfort and safety.

HIIT has also demonstrated safety and efficacy in populations previously considered vulnerable to intense exercise. Winn et al. confirmed that adolescents with asthma tolerated HIIT well and showed significant improvements in CRF without adverse events, thereby challenging longstanding concerns regarding high-intensity exercise in respiratory conditions [24]

These studies emphasize the necessity of tailoring HIIT protocols to individual characteristics such as age, fitness level, health status, and tolerance to exertion. Personalized approaches can optimize safety and effectiveness, reinforcing the potential of HIIT as an adaptable tool for diverse populations.[26]

Effect of HIIT Protocol Structure

The effectiveness of High-Intensity Interval Training (HIIT) is closely linked to the structural parameters of the training protocol, particularly the duration and intensity of work and rest intervals, session frequency, overall program length, and mode of delivery. Variations in these components can significantly influence physiological outcomes, adherence, and feasibility across different populations.[27]

Studies have demonstrated that protocols with longer work intervals and higher target intensities produce greater cardiovascular and metabolic adaptations. For example, D'Amuri et al. implemented a 4×4-minute HIIT protocol at 85–95% of maximum heart rate (HRmax), which led to marked improvements in VO_2max, insulin sensitivity, and other cardiometabolic markers in adolescents with obesity.[11] Similarly, Eser et al. found that prolonged, high-intensity intervals contributed to more substantial cardiac remodeling in post-myocardial infarction patients, highlighting the dose-response relationship between interval duration and cardiovascular adaptation.[27]

Conversely, shorter interval protocols may be more practical in specific populations, such as adolescents or beginners. Meng et al. utilized a protocol consisting of 1-minute high-intensity bouts interspersed with recovery periods, achieving significant improvements in aerobic fitness while maintaining high engagement and tolerability. These findings suggest that modifying interval length can enhance program feasibility without compromising efficacy.[23]

Innovative approaches to protocol design have also been employed to optimize engagement and performance. Martínez-Vizcaíno et al. incorporated gamification strategies and heart rate monitoring in school settings, ensuring participants reached effective cardiovascular training zones (>85% HRmax) while reducing perceived exertion. This approach demonstrated that behavioral design elements can enhance the effectiveness of HIIT, particularly in younger populations.[2]

Collectively, these findings underscore that there is no universal HIIT template. Instead, protocol effectiveness depends on matching the intensity, interval structure, and delivery format to the needs and capacities of the target population. Nevertheless, a common thread across effective interventions is the maintenance of average exercise intensity above 85% HRmax over a sustained period, typically 8 to 12 weeks, to elicit meaningful improvements in cardiorespiratory fitness.

Psychological and Behavioral Considerations

In addition to its physiological benefits, the psychological and behavioral dimensions of High-Intensity Interval Training (HIIT) play a pivotal role in determining program adherence, particularly over the long term. Although HIIT is often praised for its time efficiency—a key factor in encouraging participation—it also presents psychological challenges, primarily due to its high perceived exertion levels.[28]

Several studies have noted that this elevated exertion can negatively impact participants' motivation and willingness to continue, especially among individuals unaccustomed to vigorous exercise. For instance, McGregor et al. reported that despite clinically meaningful improvements in VO_2max, cardiac rehabilitation participants expressed higher emotional fatigue rates and lower adherence than those undergoing moderate-intensity continuous training (MICT).[22]

Similarly, Wilczyńska et al. found that concerns about exertion intensity in pregnant women led to reduced engagement, despite the adjusted safety measures.[10]

Nevertheless, emerging evidence suggests that targeted engagement strategies can mitigate these barriers and enhance motivation and psychological readiness. Martínez-Vizcaíno et al. successfully applied gamification elements—such as interactive challenges and rewards—to foster enjoyment and reduce anxiety among schoolchildren, significantly improving adherence. Social reinforcement has also proven effective; Winn et al. found that group-based HIIT programs with peer support increased commitment among adolescents with asthma.[2,24]

Moreover, the setting in which HIIT is delivered influences behavioral outcomes. Structured environments such as schools, rehabilitation clinics, or supervised community programs promote accountability and consistency through group dynamics, personalized feedback, and supportive supervision.[29]

These findings emphasize that emotional and motivational considerations are as critical as physiological load in determining the success of HIIT interventions. Designing programs that balance intensity with enjoyment, provide social and psychological support, and offer a sense of autonomy and accomplishment can significantly improve adherence, making HIIT a more sustainable long-term strategy for health promotion.

Limitations and Future Research

Although existing evidence consistently supports the efficacy of High-Intensity Interval Training (HIIT) in improving cardiorespiratory fitness (CRF) across various populations, several limitations within the literature warrant careful consideration and guide future investigations.

At the individual study level, methodological concerns such as the frequent absence of participant and assessor blinding introduce potential biases. Additionally, many studies did not rigorously apply intention-to-treat analyses, which may overestimate intervention effects. The predominance of short-term follow-up periods further restricts understanding of the sustainability of HIIT benefits. Moreover, the lack of control over confounding lifestyle factors—particularly diet and habitual physical activity—limits the precision of attributing outcomes solely to HIIT interventions.

At the systematic review level, significant heterogeneity in HIIT protocol characteristics—including intensity, interval duration, supervision level, and total intervention length—has precluded meta-analytic synthesis and complicated cross-study comparisons. This underscores the urgent need for standardized HIIT frameworks and reporting guidelines to facilitate robust quantitative analyses and clinical translation.

Future research should prioritize long-term follow-up designs to evaluate maintenance of physiological improvements, behavioral adherence, psychological impacts, and safety profiles. Expanding study populations to include underrepresented groups, such as older adults, individuals with disabilities, and persons in low-resource or rural settings, is essential to enhance external validity and equity in health promotion.

Furthermore, emerging digital and hybrid HIIT delivery modalities, as investigated by Wilczyńska et al., present promising avenues to increase accessibility and scalability, particularly in post-pandemic contexts. Continued exploration of these innovative platforms may optimize engagement and broaden the public health impact of HIIT interventions globally.[10]

Conclusion

This systematic review found that HIIT significantly improves cardiorespiratory fitness (VO_2max), cardiovascular efficiency, and body composition, particularly in overweight or obese adolescents. Compared to moderate-intensity continuous training (MICT), HIIT is equally or more effective while requiring less time, making it a practical option. Based on evidence from moderate to high-quality studies, these improvements suggest that HIIT is a promising alternative to traditional exercise modalities.

The reviewed findings align with broader literature and prior meta-analyses, reporting comparable or superior outcomes for HIIT versus MICT in similar populations. In addition to physiological benefits, HIIT also demonstrated favorable metabolic health outcomes and promising psychological effects, such as improved self-esteem and exercise motivation.

However, limitations such as heterogeneity in intervention protocols, variations in outcome measures, and lack of long-term follow-up across studies warrant cautious interpretation of the findings. Most studies included adolescents or adults with specific health conditions (e.g., obesity or cardiovascular risk), so generalizing results to the broader population should be approached carefully.

Future research should address these gaps by employing standardized HIIT protocols, involving more diverse populations across age, sex, and health status, and incorporating long-term outcome assessments. It is also recommended that the development of age- or condition-specific HIIT guidelines be explored, and the psychosocial impacts of HIIT be investigated more thoroughly to support holistic health benefits.

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