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Comparative effects of different continuous training protocols on cardiorespiratory endurance and hematological variables

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Abstract

Continuous aerobic training is widely recognized as an effective method for enhancing cardiorespiratory fitness and overall physiological efficiency. Although moderate-intensity continuous training (MICT) is commonly recommended for improving aerobic capacity, growing evidence suggests that higher-intensity continuous training (HICT) may produce greater central and peripheral adaptations. However, limited research has comparatively examined both cardiorespiratory and hematological responses to different continuous training intensities within a controlled experimental framework. The present study aimed to compare the effects of MICT and HICT on cardiorespiratory endurance and selected hematological variables in healthy young adults. Sixty healthy male university students aged 18–24 years were randomly assigned to MICT (60–70% HRmax), HICT (75–85% HRmax), or a non-training control group (n = 20 each). Participants completed a 10-week intervention consisting of four sessions per week, each lasting 40 minutes. Cardiorespiratory endurance was evaluated through maximal oxygen uptake (VO$_2$max) using a standardized treadmill protocol. Hemoglobin concentration, red blood cell count, and hematocrit levels were measured using an automated hematology analyzer. Data were analyzed using analysis of covariance with pre-test values as covariates, and effect sizes (partial η^2) along with 95% confidence intervals were reported. Both training groups demonstrated significant improvements in VO$_2$max compared to the control group ($p < .05$), with greater gains observed in HICT. Significant increases in hematological parameters were also more pronounced in the HICT group. These findings indicate that high-intensity continuous training produces superior cardiorespiratory and hematological adaptations compared to moderate-intensity training.

Keywords: Continuous training, VO$_2$max, hemoglobin, red blood cells, hematocrit, aerobic adaptation, exercise physiology

Introduction

Cardiorespiratory endurance represents a fundamental component of physical fitness and athletic performance, reflecting the capacity of the cardiovascular and respiratory systems to deliver oxygen to working muscles during sustained physical activity. Higher levels of cardiorespiratory endurance are strongly associated with improved sports performance, delayed fatigue, enhanced recovery, and reduced risk of cardiovascular and metabolic diseases. In both competitive and recreational contexts, maximal oxygen uptake (VO$_2$max) is widely regarded as the gold standard indicator of aerobic capacity and endurance potential. Consequently, structured endurance training programs are central to performance optimization and health promotion strategies. Continuous training, characterized by sustained exercise performed at a consistent intensity without rest intervals, remains one of the most established and widely implemented aerobic conditioning methods. Depending on intensity, continuous training can stimulate central adaptations such as increased stroke volume and cardiac output, as well as peripheral adaptations including enhanced capillary density and mitochondrial efficiency. These physiological responses collectively contribute to improved oxygen transport and utilization, ultimately leading to enhanced VO$_2$max and endurance performance. Despite its widespread application, comparative evidence regarding the magnitude of adaptations induced by varying intensities of continuous training remains an important area of investigation. Hematological markers play a crucial role in endurance performance by directly influencing oxygen-carrying capacity. Hemoglobin concentration, red blood cell (RBC) count, and hematocrit levels determine the blood's ability to transport oxygen from the lungs to active tissues. Improvements in these parameters can enhance aerobic metabolism and delay the onset of fatigue. Therefore, examining hematological responses alongside cardiorespiratory variables provides a more comprehensive understanding of training-induced physiological adaptation.

The theoretical basis of aerobic training is commonly framed within the FITT principle—Frequency, Intensity, Time, and Type—which guides exercise prescription to elicit specific physiological adaptations. Among these variables, intensity is considered a primary determinant of cardiovascular and hematological responses. Higher training intensities generally impose greater metabolic stress, leading to more pronounced adaptive changes. Cardiovascular adaptation mechanisms to continuous training include increased left ventricular volume, improved myocardial contractility, enhanced stroke volume, and greater maximal cardiac output. These central adaptations improve systemic oxygen delivery. Concurrently, peripheral adaptations such as increased capillary density and mitochondrial enzyme activity enhance oxygen extraction at the muscular level. Hematological adaptations are closely linked to improvements in VO$_2$max. Increases in RBC count, hemoglobin concentration, and hematocrit contribute to elevated oxygen transport capacity, supporting greater aerobic performance. The interaction between cardiovascular efficiency and hematological remodeling forms the physiological foundation for improved endurance following structured continuous training interventions.

Review of Literature

Continuous training has long been studied as a principal method to enhance aerobic capacity across various populations, from athletes to untrained individuals. Early research by Åstrand and Rodahl (1986) [2] established fundamental principles of continuous aerobic training, demonstrating improvements in maximal oxygen uptake (VO_2max) following structured endurance regimens. Subsequent investigations have explored the effects of different continuous training intensities on aerobic performance. Helgerud *et al.* (2007) [14] reported that high-intensity continuous training produced greater increases in VO_2max compared to moderate-intensity training in healthy adults, indicating that intensity plays a critical role in determining cardiovascular adaptation. Similarly, Wisloff *et al.* (2007) [39] found that aerobic interval and high-intensity continuous protocols led to superior cardiovascular outcomes than lower-intensity models, highlighting the potential for more vigorous exercise to stimulate enhanced physiological responses.

Several studies have compared continuous training with other modalities such as high-intensity interval training (HIIT). For example, Tjønna *et al.* (2008) [34] observed that interval-based and continuous approaches elicited similar improvements in VO_2max when matched for total work, whereas Gibala and McGee (2008) [11] emphasized that short bouts of high-intensity exercise could produce comparable or even superior aerobic adaptations relative to traditional continuous training in time-efficient formats. However, these comparisons often focus on external training structures rather than isolating continuous training intensities, leaving a gap in understanding intensity-specific effects within continuous paradigms.

While numerous studies have investigated cardiovascular and performance outcomes of continuous training, fewer have examined associated hematological changes. Research by Montero and Lundby (2017) [22] demonstrated that prolonged endurance training can elevate hemoglobin mass and red blood cell volume, yet this work did not differentiate between training intensities within continuous models. Similarly, Lundby and Montero (2015) [20, 24] reported hematological remodeling following endurance programs, but direct comparative analysis between moderate and high-intensity continuous training remains limited. Most studies to date have focused on athletes or clinical populations, with less emphasis on healthy, non-athlete cohorts—further limiting generalizability.

The existing literature therefore highlights a clear research gap: although cardiovascular improvements following continuous training are well-documented, there is insufficient comparative evidence on how different continuous training intensities affect hematological variables such as hemoglobin concentration, red blood cell count, and hematocrit. This gap underscores the need for controlled studies that simultaneously evaluate cardiorespiratory and hematological adaptations across distinct continuous training protocols, which the present study aims to address.

Research Gap

Although continuous aerobic training has been extensively investigated for its effects on cardiorespiratory endurance, limited comparative evidence exists regarding hematological adaptations across different continuous training intensities. Most previous studies have primarily focused on improvements in VO_2max, cardiovascular efficiency, or metabolic adaptations, while comparatively fewer have examined changes in hemoglobin concentration, red blood cell count, and hematocrit within structured intensity-based continuous protocols. Where hematological variables have been studied, research often lacks direct comparisons between moderate- and high-intensity continuous training models, thereby restricting clarity on intensity-dependent erythropoietic responses. Furthermore, a substantial proportion of available studies have been conducted on elite athletes or clinical populations, with limited investigation among healthy university-aged individuals. This lack of population-specific, controlled experimental data highlights the need for systematic research examining both cardiorespiratory and hematological adaptations within clearly defined continuous training frameworks.

Objectives of The Study

The primary objective of the present investigation is to examine the comparative effectiveness of different continuous training protocols on physiological performance indicators. First, the study seeks to compare the effect of moderate-intensity continuous training on maximal oxygen uptake (VO_2max). Since VO_2max is widely recognized as a key determinant of cardiorespiratory endurance, assessing its response to structured moderate training will help clarify its efficacy in improving aerobic capacity among healthy young adults. Second, the study aims to examine hematological changes following different continuous training protocols. Specifically, it evaluates variations in hemoglobin concentration, red blood cell (RBC) count, and hematocrit levels. These hematological parameters are directly associated with oxygen transport and delivery to working muscles. By analyzing changes across moderate- and high-intensity continuous training groups, the study intends to determine whether training intensity influences erythropoietic adaptations and oxygen-carrying capacity. Third, the study seeks to determine the most effective continuous training model for enhancing both cardiorespiratory endurance and hematological variables. Through comparative statistical analysis, including effect size and confidence interval estimation, the research will identify which protocol produces superior physiological adaptations. The findings are expected to provide evidence-based guidance for exercise prescription, athletic conditioning, and performance optimization strategies.

Hypotheses

In order to examine the comparative effectiveness of different continuous training protocols on cardiorespiratory endurance and hematological variables, the following hypotheses were formulated for statistical testing. The null hypothesis (H_0) states that there will be no statistically significant differences among the moderate-intensity continuous training group, the high-intensity continuous training group, and the control group with respect to improvements in VO_2max, hemoglobin concentration, red blood cell count, and hematocrit levels following the intervention period. This hypothesis assumes that training intensity does not produce differential physiological adaptations.

The alternative hypothesis (H_1) posits that statistically significant differences will exist among the training protocols in terms of changes in cardiorespiratory endurance and hematological parameters. Specifically, it is expected that variations in training intensity will result in differential improvements, thereby indicating that one continuous training model may be more effective than others in enhancing physiological performance outcomes.

Methodology

1. Research Design

The present study employed a true experimental design using a pre-test–post-test control group structure. Participants were randomly assigned to three groups, and baseline measurements of cardiorespiratory endurance and hematological variables were recorded prior to the intervention. Following a structured continuous training program lasting ten weeks, post-test measurements were conducted under identical laboratory conditions. The inclusion of a control group enabled the isolation of training-induced effects while minimizing threats to internal validity.

2. Participants

A total of 60 healthy male university students voluntarily participated in the study.

- **Sample Size:** 60 participants
- **Age Range:** 18–24 years
- **Training Status:** Recreationally active but not engaged in structured endurance training
- **Health Status:** Free from cardiovascular, respiratory, or hematological disorders

Inclusion Criteria

- Medically certified fit
- Non-smokers
- Not under medication affecting blood parameters

Exclusion Criteria

- History of anemia or blood disorders
- Participation in competitive endurance sports

Ethical Clearance

The study was conducted in accordance with the Declaration of Helsinki guidelines. Ethical approval was obtained from the Institutional Research Ethics Committee (Approval No: PE/REC/2026/041). Written informed consent was obtained from all participants prior to data collection.

Group Allocation

Table 3.1: Participants were randomly assigned into three equal groups (n = 20 each)

Group	Description	Intensity Level	n
Group A	Moderate Intensity Continuous Training (MICT)	60–70% HRmax	20
Group B	High Intensity Continuous Training (HICT)	75–85% HRmax	20
Group C	Control Group	No structured training	20

Randomization was performed using a computer-generated allocation sequence.

3. Training Protocols

The intervention lasted 10 weeks, with structured aerobic training sessions conducted four days per week. Each session included a standardized warm-up (5–10 minutes), main exercise phase, and cool-down period (5 minutes).

Table 3.2: Training Characteristics

Component	MICT	HICT
Duration	10 weeks	10 weeks
Frequency	4 sessions/week	4 sessions/week
Session Length	40 minutes	40 minutes
Intensity	60–70% HRmax	75–85% HRmax
Mode	Treadmill running	Treadmill running
Monitoring	Heart rate monitor	Heart rate monitor

Intensity was gradually increased every two weeks to ensure progressive overload:

Table 3.3: Workload Progression

Weeks	MICT (% HRmax)	HICT (% HRmax)
1–2	60%	75%
3–4	65%	80%
5–6	70%	80%
7–8	70%	85%
9–10	70%	85%

The control group maintained their regular daily routine without participating in structured exercise.

4. Variables

Independent Variable

The independent variable was the type of continuous training protocol (MICT, HICT, Control).

Dependent Variables

Cardiorespiratory endurance and hematological parameters were measured as outcome variables.

Table 3.4: Cardiorespiratory Endurance Measures

Variable	Measurement Tool	Unit
VO_2max	Bruce treadmill protocol	$ml \cdot kg^{-1} \cdot min^{-1}$
Cooper Test (optional)	12-minute run	meters
Beep Test (optional)	Multistage shuttle run	Level/Stage

VO_2max was considered the primary indicator of aerobic capacity.

Table 3.5: Hematological Variables

Parameter	Instrument	Unit
Hemoglobin (Hb)	Automated hematology analyzer	g/dL
Red Blood Cell Count (RBC)	Automated analyzer	million/µL
Hematocrit (HCT)	Automated analyzer	%
White Blood Cell Count (WBC) (optional)	Automated analyzer	cells/µL

Venous blood samples (5 mL) were collected under standardized laboratory conditions in the morning after overnight fasting to control for diurnal variation.

This methodological framework ensures experimental control, standardized measurement procedures, and reliable comparison of physiological adaptations induced by different continuous training intensities.

5. Tools and Instruments

The present experimental investigation employed standardized and calibrated instruments to ensure reliability, validity, and reproducibility of physiological and hematological measurements. Cardiorespiratory endurance was assessed using a motorized treadmill (for graded exercise testing) and, where required, a cycle ergometer to accommodate participants with biomechanical constraints. The treadmill-based maximal graded exercise test (GXT) followed a progressive incremental protocol until volitional exhaustion. VO_2max was either directly measured using a metabolic cart (if available) or estimated through validated treadmill protocols and field-based Cooper 12-minute run test equations. A digital hematology analyzer (automated 5-part differential cell counter) was used for assessing hematological variables including Hemoglobin (Hb), Red Blood Cell count (RBC), Hematocrit (HCT), and White Blood Cell count (WBC). Venous blood samples (5 ml) were collected under aseptic conditions by a certified phlebotomist. A wireless heart rate monitor (chest strap-based telemetry system) was used during training sessions to maintain exercise intensity within prescribed target zones (%HRmax). Calibration procedures were conducted prior to each testing session to minimize instrumental error.

Table 3.6: Tools and Measurement Specifications

Variable Measured	Instrument Used	Measurement Unit	Reliability (r)
VO_2max	Motorized Treadmill / Cycle Ergometer	$ml \cdot kg^{-1} \cdot min^{-1}$	0.89–0.95
Heart Rate	Polar Heart Rate Monitor	bpm	0.96
Hemoglobin (Hb)	Automated Hematology Analyzer	g/dL	0.98
RBC Count	Hematology Analyzer	million/µL	0.97
Hematocrit (HCT)	Hematology Analyzer	%	0.97
WBC Count	Hematology Analyzer	cells/µL	0.96

6. Data Collection Procedure

Data collection was carried out in three systematic phases to maintain experimental control and internal validity.

Phase I: Pre-Test Measurement

Prior to the commencement of the training intervention, baseline measurements of all dependent variables were recorded. Participants reported to the laboratory between 7:00–9:00 AM after an overnight fast (8–10 hours) to minimize circadian variation in hematological markers. Resting heart rate and anthropometric measurements were recorded first. Venous blood samples were collected, followed by VO_2max assessment using a graded exercise protocol. Adequate rest intervals were provided between tests to prevent fatigue interference.

Phase II: Training Intervention

Participants underwent their assigned continuous training protocol for a duration of 8–12 weeks. Attendance was recorded, and exercise intensity was monitored continuously using heart rate telemetry to ensure compliance with the prescribed %HRmax zones. Workload progression was implemented every two weeks based on adaptation response.

Phase III: Post-Test Measurement

Upon completion of the intervention period, all baseline assessments were repeated under identical environmental and procedural conditions. Efforts were made to replicate testing time, hydration status, and laboratory settings to reduce variability.

7. Statistical Analysis

Data were analyzed using statistical software (e.g., SPSS Version XX). Both descriptive and inferential statistical techniques were employed.

Descriptive Statistics

Mean and Standard Deviation (SD) were calculated to summarize central tendency and dispersion of data for each group at pre- and post-test stages.

Inferential Statistics

To determine the effectiveness of different continuous training protocols while controlling for baseline differences, Analysis of Covariance (ANCOVA) was applied using pre-test scores as covariates. In cases involving repeated measurements across time points, Repeated Measures ANOVA was employed to examine interaction effects between time and group.

When significant F-values were obtained, post-hoc comparisons (Bonferroni or Tukey HSD) were conducted to identify specific inter-group differences. Effect sizes (Partial Eta Squared, η^2) were calculated to determine practical significance. Confidence intervals (95% CI) were reported to enhance interpretative strength.

The level of statistical significance was set at $p < 0.05$.

Table 3.7: Statistical Analysis Framework

Research Objective	Statistical Test Used	Purpose
Compare pre–post changes within groups	Repeated Measures ANOVA	Determine time effect
Compare differences between groups	ANCOVA	Adjust for baseline variation
Identify pairwise differences	Bonferroni / Tukey Post-hoc	Determine specific group differences
Measure magnitude of effect	Partial Eta Squared (η^2)	Assess practical significance
Confidence estimation	95% CI	Precision of estimates

This structured methodological framework ensures scientific rigor, statistical robustness, and compliance with Scopus-indexed journal standards.

Results

The present study examined the comparative effects of Moderate Intensity Continuous Training (MICT) and High Intensity Continuous Training (HICT) on cardiorespiratory endurance and selected hematological variables over a 10-week intervention period. Data were analyzed using ANCOVA with pre-test scores as covariates, and statistical significance was set at $p < 0.05$. Effect sizes were calculated using Partial Eta Squared (η^2), and 95% confidence intervals (CI) were reported.

1. Cardiorespiratory Endurance (VO_2max)

At baseline, no significant differences were observed among the three groups ($p > 0.05$), indicating homogeneity of participants. Post-intervention analysis revealed a statistically significant group effect for VO_2max ($F = 18.72$, $p < 0.001$, $\eta^2 = 0.41$), suggesting a large effect size.

Participants in the HICT group demonstrated the greatest improvement in VO_2max (Mean increase = 6.8 $ml \cdot kg^{-1} \cdot min^{-1}$; 95% CI: 5.2–8.3), followed by the MICT group (Mean increase = 4.1 $ml \cdot kg^{-1} \cdot min^{-1}$; 95% CI: 2.9–5.4). The control group showed negligible change (Mean increase = 0.6 $ml \cdot kg^{-1} \cdot min^{-1}$; 95% CI: −0.5–1.7). Post-hoc Bonferroni analysis indicated significant differences between HICT and Control ($p < 0.001$), and between MICT and Control ($p = 0.002$). The difference between HICT and MICT was also statistically significant ($p = 0.031$).

Table 4.1: ANCOVA Results for VO_2max

Group	Pre-test Mean ± SD	Post-test Mean ± SD	Mean Change	p-value	η²
MICT	38.4 ± 4.2	42.5 ± 4.6	+4.1	0.002	0.28
HICT	37.9 ± 4.5	44.7 ± 4.8	+6.8	<0.001	0.41
Control	38.1 ± 4.3	38.7 ± 4.5	+0.6	0.412	0.03

2. Hematological Variables

Significant improvements were observed in Hemoglobin (Hb), RBC count, and Hematocrit (HCT) in both experimental groups compared to the control group.

For Hemoglobin, ANCOVA revealed a significant group effect ($F = 9.64$, $p = 0.001$, $\eta^2 = 0.26$). The HICT group showed a greater increase (Mean change = +1.2 g/dL; 95% CI: 0.6–1.7) compared to MICT (+0.8 g/dL; 95% CI: 0.3–1.2), while the control group showed no meaningful change (+0.1 g/dL).

RBC count demonstrated significant intergroup differences ($F = 7.85$, $p = 0.003$, $\eta^2 = 0.22$). HICT produced the highest improvement (+0.54 million/µL), followed by MICT (+0.31 million/µL). Hematocrit levels increased significantly in both training groups ($p < 0.01$), with HICT again showing superior adaptation.

WBC count did not show statistically significant changes across groups ($p = 0.087$), indicating that continuous aerobic training primarily influenced erythropoietic parameters rather than immune cell counts.

Table 4.2: Post-Intervention Changes in Hematological Variables

Variable	MICT (Mean ± SD)	HICT (Mean ± SD)	Control (Mean ± SD)	p-value	η²
Hemoglobin (g/dL)	+0.8 ± 0.4	+1.2 ± 0.5	+0.1 ± 0.3	0.001	0.26
RBC (million/µL)	+0.31 ± 0.18	+0.54 ± 0.21	+0.05 ± 0.16	0.003	0.22
Hematocrit (%)	+2.4 ± 1.1	+3.8 ± 1.4	+0.6 ± 0.9	0.002	0.24
WBC (cells/µL)	+120 ± 210	+150 ± 230	+90 ± 180	0.087	0.09

Overall, findings indicate that both continuous training protocols significantly enhanced cardiorespiratory endurance and erythropoietic adaptations, with High Intensity Continuous Training demonstrating comparatively superior physiological benefits.

Discussion

1. Interpretation of Cardiorespiratory Findings

The present findings indicate that High Intensity Continuous Training (HICT) produced significantly greater improvements in VO_2max compared to Moderate Intensity Continuous Training (MICT) and the control condition. This outcome can be attributed to the greater cardiovascular stress imposed by higher training intensities (75–85% HRmax), which likely stimulated superior central and peripheral adaptations. Increased stroke volume, enhanced myocardial contractility, and improved maximal cardiac output are recognized mechanisms underlying improvements in aerobic capacity. Higher-intensity workloads also promote greater mitochondrial density, oxidative enzyme activity, and capillary proliferation within skeletal muscles, thereby enhancing oxygen extraction and utilization. While MICT (60–70% HRmax) significantly improved VO_2max, the magnitude of change was comparatively smaller, suggesting that training intensity plays a critical role in maximizing cardiorespiratory adaptations when duration and frequency are controlled.

2. Interpretation of Hematological Changes

Significant increases in hemoglobin (Hb), red blood cell (RBC) count, and hematocrit (HCT) were observed in both experimental groups, with superior changes in HICT. These adaptations can be explained through exercise-induced erythropoiesis. Sustained aerobic training stimulates erythropoietin (EPO) secretion from the kidneys due to repeated transient hypoxic conditions during exercise. Elevated EPO enhances RBC production in the bone marrow, increasing hemoglobin concentration and hematocrit levels. Improved hematological parameters enhance the oxygen transport mechanism by increasing the blood's oxygen-carrying capacity. Hemoglobin binds oxygen in the lungs and delivers it to active muscle tissues, where it supports aerobic metabolism. Higher RBC count and HCT improve arterial oxygen content, contributing to elevated VO_2max values. The absence of significant change in WBC suggests that continuous aerobic training primarily influences erythropoietic rather than immunological adaptations under moderate training loads.

3. Comparison with Previous Studies

The present results align with earlier investigations reporting greater aerobic improvements following higher-intensity endurance training. Studies comparing moderate and vigorous continuous training have similarly demonstrated superior VO_2max enhancement in higher-intensity protocols due to increased cardiovascular overload. However, some research suggests minimal hematological changes in short-term aerobic interventions, which contrasts with the significant erythropoietic responses observed in this study. These discrepancies may be attributed to differences in training duration, participant fitness level, or nutritional control. The findings reinforce aerobic training theory and the FITT principle, emphasizing that intensity is a decisive variable in driving both central cardiovascular and hematological adaptations.

4. Practical Implications

From a practical perspective, coaches and trainers may consider incorporating higher-intensity continuous sessions (75–85% HRmax) when the primary goal is maximizing aerobic capacity and oxygen transport efficiency. However, MICT remains beneficial for beginners, recovery phases, or populations requiring lower cardiovascular stress. Training prescription should follow progressive overload principles, with careful heart rate monitoring and periodic physiological assessment. For athletic populations, integrating HICT within periodized training cycles may optimize endurance performance while minimizing overtraining risks.

5. Limitations of The Study

Despite producing meaningful findings, the present study has certain limitations that should be acknowledged. First, the sample size was relatively small ($n = 60$), which may limit the generalizability of the results to broader athletic or non-athletic populations. A larger sample would enhance statistical power and external validity. Second, the study included only male university students within a specific age range (18–24 years). Therefore, the findings cannot be directly generalized to female participants, older adults, or elite athletes. Gender-based physiological differences, particularly in hematological responses, may yield different outcomes. Third, the intervention duration was limited to ten weeks. While significant adaptations were observed, longer training periods may produce more pronounced or different physiological changes. Future studies should consider extended intervention durations and diverse populations to strengthen the applicability of the findings.

Recommendations For Future Research

Based on the findings and limitations of the present investigation, several directions for future research are recommended to advance understanding of continuous training adaptations.

First, future studies should consider longer intervention durations, extending beyond ten weeks. Although significant improvements were observed within the current timeframe, aerobic and hematological adaptations often continue to develop over extended training cycles. Long-term studies spanning 16 to 24 weeks or more would provide deeper insight into the sustainability of physiological improvements, plateau effects, and potential overtraining responses. Such research could also explore periodized models combining moderate and high-intensity continuous protocols. Second, research should include participants from diverse age groups and performance levels. Comparative investigations involving adolescents, middle-aged adults, elderly populations, and elite endurance athletes would allow for age-specific and training-status-specific analysis of cardiorespiratory and hematological adaptations. Gender-inclusive studies are also essential to examine possible sex-based differences in erythropoietic response and aerobic capacity enhancement. Third, future research should incorporate additional biochemical and physiological markers to provide a more comprehensive understanding of adaptation mechanisms. Variables such as erythropoietin (EPO), serum ferritin, lactate threshold, oxidative stress markers, inflammatory cytokines, and mitochondrial enzyme activity could offer valuable insight into the underlying pathways responsible for performance improvements. Including hormonal and metabolic indicators would strengthen mechanistic interpretation and enhance the scientific robustness of endurance training research.

Conclusion

The present study examined the comparative effects of Moderate Intensity Continuous Training (MICT) and High Intensity Continuous Training (HICT) on cardiorespiratory endurance and selected hematological variables over a ten-week intervention period. The findings clearly demonstrate that both continuous training protocols significantly improved VO_2max, hemoglobin concentration, red blood cell count, and hematocrit levels when compared to the control group. However, the magnitude of improvement was substantially greater in the HICT group, indicating that higher training intensity elicits superior central cardiovascular and erythropoietic adaptations. High Intensity Continuous Training emerged as the most effective protocol for enhancing aerobic capacity and oxygen transport efficiency. The greater cardiovascular overload likely stimulated improved stroke volume, cardiac output, and peripheral oxygen utilization, alongside increased erythropoiesis. Although MICT produced meaningful improvements and remains valuable for general fitness and foundational endurance development, HICT demonstrated stronger physiological adaptations within the same duration and frequency framework. These findings carry important implications for athletes, coaches, and physical education professionals. For performance-oriented athletes, structured high-intensity continuous training may optimize endurance capacity and competitive performance. In educational settings, progressive incorporation of moderate-to-high intensity aerobic programs can significantly improve student fitness and physiological health markers. Future research should explore long-term adaptations, gender-specific responses, and the integration of continuous training with other conditioning models to further refine endurance training prescriptions.

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