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High Intensity Circuit Training Increases Both Aerobic Capacity in Healthy Males

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Abstract

This study aims to demonstrate the effect of high-intensity circuit training on increasing aerobic capacity in healthy men. The research employed a true-experimental design, utilizing a quantitative approach with a pretest-posttest control group structure. The participants were 20 male students aged 20-22, each with a body mass index (BMI) ranging from 19 to 23 kg/m^2 and typical vital signs. The subjects were randomly assigned to G_1 (control group; n=10) and G_2 (high-intensity circuit training group; n=10). The high-intensity circuit training for G_2 was conducted at an intensity of 85-90% of maximum heart rate (HRmax) thrice weekly for eight weeks. Aerobic capacity was assessed using the Multi-stage Fitness Test (the beep test). Data analysis was performed using paired sample t-tests and independent sample t-tests, with a significance level set at 5%. The results indicated that the average aerobic capacity in the pretest and posttest in G_1 changed from 25.02±1.21 to 25.67±1.36 mL/kg/min (p=0.254), while in G_2, it improved from 26.13±1.35 to 32.31±2.16 mL/kg/min (p=0.001). The findings led to the conclusion that the eight-week high-intensity circuit training intervention was effective in enhancing the aerobic capacity of healthy males.

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INTRODUCTION

In the contemporary landscape of health and fitness, the encroachment of sedentary lifestyles has become a pervasive concern, with profound implications for public health (Fang et al., 2021). The insidious rise of inactivity, fueled by technological advancements and changing work environments, has precipitated a myriad of health challenges, necessitating a reevaluation of exercise paradigms (Woessner, et al., 2021). Regular physical exercise emerges as a pivotal countermeasure, not merely as a cornerstone of health but as a transformative force that enhances the functionality of various physical components, thereby fortifying the body's resilience against the deleterious effects of modern living (Malm et al., 2019). The quest to augment aerobic capacity is particularly salient, given its role as a bulwark against the risk of premature fatigue and a spectrum of health complications (Bull et al., 2020). It is within this context that the improvement of aerobic capacity through structured exercise assumes critical importance, serving as a preventive strategy and a therapeutic intervention (Joyner & Lundby, 2018; Shadmehri et al., 2021).

Amidst the plethora of training methodologies, circuit training has ascended to prominence, lauded for its efficacy in enhancing aerobic capacity across diverse populations, from the general public to elite athletes (Salih et al., 2020; Kumari et al., 2023). This training modality, characterized by high-intensity exercises interspersed with active rest periods, typically spans 30-50 minutes per session. It represents a harmonious fusion of aerobic and resistance training, meticulously designed to optimize the exercise impact and catalyze physiological adaptations (Myers et al., 2015).

The orchestration of an exercise program that concurrently elevates aerobic and anaerobic capacities is a testament to the sophistication of modern exercise science (Patel et al., 2017). High-intensity circuit training, in particular, has captured the attention of the fitness community for its robust support of high-demand physical activities (Schmidt et al., 2016). This method has been increasingly adopted in recent years, owing to its potent efficacy and time-efficient nature (Pawlak et al., 2015; Clayton et al., 2019). Scholarly reviews and empirical investigations have consistently underscored the effectiveness of high-intensity circuit training in enhancing both aerobic and anaerobic capacities, leading to significant improvements in physical fitness and muscle endurance (Foster et al., 2015; Miyamoto-Mikami et al., 2018; Gutiérrez-Arroyo et al., 2023; Schmidt et al., 2016).

This study is poised to contribute to the burgeoning discourse on high-intensity circuit training, with a particular focus on its impact on the aerobic capacity of healthy males. By bridging the research gap with empirical evidence, this investigation seeks to substantiate the benefits of high-intensity circuit training and its role in the broader context of physical fitness and health optimization. In doing so, it aspires to inform future interventions and guide individuals in their pursuit of optimal health in an increasingly sedentary world.

METHODS

The research methodology was true-experimental, utilizing a quantitative approach with a pretest-posttest control group format. The study involved 20 students from the Department of Sports Science at the State University of Malang, aged 20-22, with a body mass index

(BMI) of 19-23 kg/m^2 and standard vital signs. Subject selection was conducted using consecutive sampling, while group allocation was determined by random sampling. Participants were divided into G_1 (control group) and G_2 (high-intensity circuit training group), with ten individuals in each. The high-intensity circuit training was administered at 85-90% HRmax thrice weekly for eight weeks. Aerobic capacity was assessed pre and post-intervention using the Multi-stage Fitness Test (bleep test). Data analysis was performed using paired sample t-tests and independent sample t-tests at a 5% significance level, utilizing SPSS version 21.0 for statistical analysis. effect size evaluation using Cohen's d (Wiriawan et al., 2024).

RESULT

The descriptive analysis results showed no differences in the characteristics of the research subjects in the two study groups, between the control group (G_1) and the high-intensity circuit training group (G_2), as seen in Table 1. Figure 1 and Table 2 present the results of the aerobic capacity analysis of both groups.

Table 1. Description on the subjects' characteristics of study

Variable	G_1 (n=10)	G_2 (n=10)	p-value
Age (yrs)	20.80±0.79	20.90±0.74	0.773
Weight (kg)	57.90±4.56	60.60±3.84	0.169
Height (m)	1.65±0.04	1.67±0.03	0.297
BMI (kg/m^2)	21.22±1.02	21.82±1.03	0.203
BT (°C)	36.05±0.28	35.55±0.78	0.083
SBP (mmHg)	115.00±8.49	113.00±8.23	0.600
DBP(mmHg)	81.00±7.38	80.00±6.67	0.754
HR (bpm)	71.20±5.98	69.20±5.43	0.444

Description: BMI: Body mass index; BT: Body temperature; DBP: Diastolic blood pressure; HR: Heart rat; SBP: Systolic blood pressure.

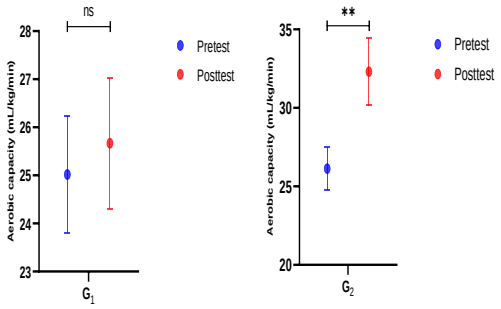

Figure 1. Aerobic capacity (mL/kg/min) pretest and posttest in each group

Description: (ns) Not significant from pretest in control group (G_1) $p \geq 0.05$. (**) Significant from pretest in high-intensity circuit training group (G_1) $p \leq 0.001$.

Table 2. Difference between aerobic capacity (mL/kg/min) in both groups

Variable	G_1 (n=10)	G_2 (n=10)	p-value	Mean (95% CI)	Effect size
Pretest	25.02±1.21	26.13±1.35	0.069	-1.11 (-2.32 to 0.09)	-
Posttest	25.67±1.36	32.31±2.16*	0.001	-6.64 (-8.36 to -4.92)	3.681
Difference	0.65±1.69	6.18±1.79*	0.001	-5.53 (-7.16 to -3.89)	3.182
Change	2.78±6.85	23.73±7.12*	0.001	-20.96 (-27.52 to -14.39)	3.001

(*)Significant from control group (G_1) $p \leq 0.001$.

DISCUSSION

The main findings of this study showed that a high-intensity circuit training intervention program carried out for eight weeks applied to healthy men significantly increased aerobic capacity. The results obtained in this study are in line with the results of previously reported studies, which reported that high-intensity circuit training was proven to be effective in increasing aerobic capacity (Heinrich et al., 2012; Atakan et al., 2021; Gutiérrez-Arroyo et al. 2023). Posnakidis et al. (2022), researching the effects of high-intensity functional training, reported improved muscle endurance and cardiorespiratory throughout the body after eight weeks of intervention. Likewise, Gutiérrez-Arroyo et al. (2023) reported improvements in physical fitness after high-intensity circuit training intervention for eight weeks. Ram et al. (2020) reported improvements in aerobic fitness after six weeks of high-intensity interval training intervention. A 12-week high-intensity interval training intervention has also been proven effective in improving adolescent boys' physical health (Meng et al., 2022). The increase in aerobic capacity was likely caused by the high-intensity circuit training intervention carried out for eight weeks. During the intervention, the body may have adapted to the training load, resulting in good adaptation to the cardiovascular system by increasing aerobic capacity.

Aerobic capacity measures the body's ability to optimally perform oxidative metabolism (Pangilinan & Hornyak, 2013). Regular exercise can increase aerobic capacity (Gutiérrez-Arroyo et al., 2023). The higher a person's aerobic capacity, the greater the oxygen utilization in the muscles (Gater, 2009). The higher a person's activity, the higher the oxygen demand, so increasing oxygen capacity is needed to support the high demand for oxygen so that the body does not easily experience fatigue when carrying out high-intensity activities due to the buildup of lactic acid in the blood. However, on the other hand, the lower the aerobic capacity, the faster the muscle's ability to do work, causing premature fatigue because the body cannot supply oxygen quickly, which has implications for the buildup of lactic acid in the blood. VO_2max measures the functional limits of the cardio-respiratory system and is the most valid single index for maximal exercise capacity. It is considered a benchmark for measuring cardiovascular function capacity and aerobic capacity (Lokhande et al., 2015). High-intensity circuit training is an exercise model proven effective in increasing aerobic capacity. Aerobic capacity can increase by around 40% -60% if training is carried out using correct training principles and systematically. Good aerobic capacity will influence the functional abilities of the body. This exercise aims to increase ATP-PC in muscle work. Its function is that during training, less lactic acid is formed, and a higher level of resistance to acidity is caused by lactic acid (Takahata, 2018). Proven research by Mallesh et al. (2017) reported that high-intensity circuit training increases the anaerobic threshold, increases lactic acid clearance, and delays the onset of fatigue, reducing the risk of premature fatigue. High-intensity circuit training has also been reported to improve blood pressure, lipoproteins, and triglycerides in obese adult men (Paoli et al., 2013). Therefore, high-intensity circuit training can be a choice for increasing aerobic capacity in healthy males.

CONCLUSION

It is evident from the study that high-intensity circuit training (HICT),

conducted at an intensity of 85-90% HRmax with a frequency of three sessions per week for eight weeks, is efficacious in improving the aerobic capacity of healthy men. Consequently, HICT can be recommended as an innovative and effective training approach to enhance aerobic performance in athletes.

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