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EFFECT OF CIRCUIT TRAINING ON MAXIMUM OXYGEN UPTAKE (VO2 MAX) OF ADOLESCENTS

Zia Ullah
Instructor, Physical Education, Government Higher Secondary School, Khar No. 1, Bajaur, Pakistan. Email: zia131.ullah@gmail.com

Sarmad Ijaz
MPhil Scholar, Department of Sports Science and Physical Education, The University of Haripur, Haripur, Pakistan. Email: sijaz60841@gmail.com

Anila Iqbal
PhD Scholar, Department of Sports Science and Physical Education, The University of Haripur, Haripur, Pakistan. Email: anila.phyedu.sportssci@leads.edu.pk

Abstract

Circuit training is an incredibly effective method for improving overall fitness through a series of fast-paced exercises. However, the impact of circuit training on VO2 max, a crucial indicator of cardiovascular fitness, has yet to be thoroughly explored in adolescents. This study aims to fill this gap in knowledge by investigating the effects of circuit training on the VO2 max levels of adolescents in a confident and assertive manner. This study utilized an experimental pre/post-intervention design and was conducted at the Government College of Management Sciences in Pakistan. The 24 participants were randomly assigned to two groups: circuit training (n=12) and control (n=12). A pre-test was conducted before the 12-week circuit training intervention for the experimental group. The study findings revealed a noteworthy disparity in VO2 max levels between the experimental and control groups. The experimental group exhibited a substantial improvement of (2.83±0.07), whereas the control group showed a negligible improvement of (0.45±1.07). The results were indicative of the superiority of the experimental group over the control group. A twelve-week 12-circuit training intervention is an effective protocol for increasing the VO2 max of adolescents aged 16-19.

Keywords: VO2; Circuit Training; Adolescents.

Introduction

Circuit training is a popular training method that involves a series of exercise stations arranged in a circuit, targeting different muscle groups, often interspersed with brief periods of rest or active recovery. (Marcos-Pardo et al., 2019). It offers versatility, variety, and the ability to customize workouts to meet specific fitness goals. This approach has gained popularity among individuals of various fitness levels,

including athletes, fitness enthusiasts, and those seeking to improve overall health and fitness. By combining strength and cardiovascular exercises in a continuous sequence, it allows individuals to work multiple muscle groups and elevate their heart rate within a shorter time frame, making it known for its time-efficient nature (Izquierdo et al., 2021).

Circuit training is an excellent choice for individuals with busy schedules who want to maximize their workout in a limited time period. It typically incorporates a variety of exercises targeting different muscle groups throughout the body, allowing for a comprehensive, full-body workout. This approach enables individuals to develop strength, endurance, and muscular balance across various muscle groups, while also working on both upper and lower body muscles, core stability, and functional movements (Paskalis et al., 2022). One of the key benefits of circuit training is the ability to customize workouts to meet specific fitness goals, as it offers a variety of exercises and the ability to change the exercise sequence. This variety helps prevent boredom, maintains motivation, and allows individuals to continually progress and improve their fitness levels.

Regular physical activity is crucial for healthy growth and development in adolescence, as it is a critical period of physical and psychological changes (Calcaterra et al., 2022). Engaging in regular physical activity can have numerous benefits for adolescents, such as maintaining a healthy weight, strengthening bones and muscles, improving cardiovascular health, and enhancing overall physical fitness (Orben et al., 2020). Moreover, it can also reduce the risk of developing chronic diseases like obesity, heart disease, type 2 diabetes, and certain types of cancer.

VO2 max is an important indicator of cardiovascular fitness and endurance capacity. It is a measure that represents an individual's maximum capacity to consume and utilize oxygen during intense exercise (Calcaterra et al., 2022). Additionally, VO2 max is a representation of the maximum amount of oxygen an individual can utilize during intense exercise, reflecting aerobic capacity. This understanding is crucial for researchers, athletes, and fitness professionals in optimizing training programs, evaluating aerobic performance, and assessing overall health (Lake et al., 2022). VO2 max is considered the gold standard measure of cardiorespiratory fitness. When it comes to measuring cardiovascular

fitness, VO2 max values play a crucial role. VO2 max reflects the efficiency of the cardiovascular system, including the heart, lungs, and blood vessels, in delivering oxygen to working muscles during exercise (Naureen et al., 2022). The higher the VO2 max values, the better the cardiovascular fitness and the ability to perform sustained aerobic activities (Hackett, 2020). This measurement is closely linked to endurance performance in activities such as running, cycling, swimming, and other aerobic exercises. Athletes with higher VO2 max values can sustain intense exercise for longer durations without experiencing fatigue (Kramer et al., 2020). VO2 max is particularly relevant in sports that require prolonged efforts, such as long-distance running or cycling. It is also utilized in cardiac and pulmonary rehabilitation programs to assess an individual's functional capacity and track improvements over time (Santisteban et al., 2022). VO2 max measurements provide valuable information for setting exercise intensity levels, designing personalized exercise regimens, and monitoring progress during the recovery process (Jensen et al., 2023). Additionally, VO2 max measurements aid in evaluating the effectiveness of rehabilitation interventions.

During adolescence, significant physiological changes occur, making it an ideal time to study the potential benefits of circuit training on VO2 max (Gao & Yu, 2023). It is crucial to understand the impact of circuit training on VO2 max in adolescents for various reasons. First, improving aerobic capacity during adolescence can promote long-term cardiovascular health, reducing the risk of chronic diseases later in life (Lopez-Jaramillo et al., 2022). Secondly, studying the effects of circuit training on VO2 max can help inform physical education programs and exercise prescriptions for adolescents, leading to optimized fitness outcomes. Lastly, a comprehensive understanding of the relationship between circuit training and VO2 max in adolescents can contribute to the development of evidence-based exercise interventions.

This research study investigated the effect of circuit training on the VO2 max levels of adolescents. The study will involve a group of adolescents who will undergo a structured circuit training program for a specific duration. Pre- and post-intervention assessments of VO2 max levels will be conducted to analyze the effectiveness of circuit training in enhancing the aerobic capacity of adolescents. The findings of this study will provide valuable insights into the

benefits of circuit training for adolescents. This research article aims to examine the impact of circuit training on the maximum oxygen uptake (VO2 max) of adolescents. The ultimate goal is to provide evidence-based recommendations for physical education and exercise programming based on the potential benefits of circuit training on VO2 max. The study's outcomes may help improve the understanding of effective training methods for enhancing cardiovascular fitness among adolescents, contributing to the existing literature on adolescent fitness.

Materials and Methods

The aim of this study was to investigate the effect of circuit training on the maximum oxygen uptake of male adolescents aged 16-19 years. A total of 24 male students from the Government College of Management Sciences in Haripur, Khyber Pakhtunkhwa, Pakistan, were randomly selected and divided into an experimental group (n=12) and a control group (n=12) based on established inclusion and exclusion criteria (see Table 01). The experimental group participated in a circuit training protocol five days a week for 12 weeks, while the control group continued with their regular activities without involvement in a circuit training program. Prior to the intervention, both groups underwent a pre-test to measure maximal oxygen consumption, referred to as VO2 max, using the Beep test, and the values were recorded in units of liters or milliliters of oxygen per minute. Post-test data was collected after the 12-week circuit training intervention to determine any changes in VO2 max. The VO2 max of both groups was measured in the same environment for both the pre-test and post-test. The data was tabulated for subsequent analysis.

Table 1. Inclusion and Exclusion criteria for the selection of participants

Inclusion Criteria	Exclusion Criteria
Inactive students (for the last 4 months)	Active players
Have no chronic disease	Chronic disease
Non-Smokers	Smokers
Age between 16-19 years	Age below 16 and above 19

Statistical Analysis

An inferential statistical tool (Paired Sample T-test) was used to assess the effect of Circuit Training on maximum oxygen uptake among adolescents between two groups (experimental and control). The level of significance was fixed at a 0.05 level of confidence for all cases. The statistical analysis was done using SPSS version 26.

Results and Discussion

Table 2. Circuit Training schedule for 12 weeks

Stage	Circuit Drills	Duration	Rest intervals	Sets
1	Calf raises	30 Seconds	30 seconds	2 sets (Week 1-6)
	Single-leg standing calf raises	30 Seconds		3 sets (Week 7-12)
2	Static lunges	30 Seconds	30 seconds	2 sets (Week 1-6)
	Reverse lunge with knee drive	30 Seconds		3 sets (Week 7-12)
3	Push-ups with steps out	30 Seconds	30 seconds	2 sets (Week 1-6)
	Bent knee push-up	30 Seconds		3 sets (Week 7-12)
4	Double pulse squats	30 Seconds	30 seconds	2 sets (Week 1-6)
	Squat jumps	30 Seconds		3 sets (Week 7-12)
5	Bench dips	30 Seconds	30 seconds	2 sets (Week 1-6)
	Triceps push-ups on knees	30 Seconds		3 sets (Week 7-12)
6	Abdominal crunches	30 Seconds	30 seconds	3 sets (Week 1-6)
	Front planks reach out	30 Seconds		3 sets (Week 7-12)

(Four-minute warm-up leading to the Training Protocol and a 4-minute cool down after the protocol were among the important considerations of the intervention)

Table 3. Paired sample t-test showing the difference between pre and post-test VO2 max

Name of Variable	Group	Pre-test score (Mean ± SD)	Post-test score (Mean ± SD)	t	df	Sig.
VO2 max	Experimental	31.98±1.99	34.81±1.92	12.60	11	.000
	Control	32.05±1.68	32.51±2.04	1.48	11	.166

Testing Variable	Research Grading	N	$\bar{X}$	std	df	F	Sig.
The overall attitude of health and physical education students toward research	60 %	48	4.4150	.32719	(3, 184)	0.343	.497
	70 %	101	4.3853	.28844			
	80 %	30	4.4368	.31110			
	90 %	9	4.4888	.3879			

a = .05, M = Mean and SD = Standard deviation

Table 3 indicates a significant effect on the VO_2 max of participants of EG which points towards a constructive effect of CT on the VO2 max of participants. This increase occurred because of a self-designed CT protocol applied to participants. In the pre-test, the VO2 max (mean±SD) was 31.98±1.99 and at the end of the 12-week CT intervention VO2 max (mean±SD) was 34.81±1.92 t-

value 12.60 and p-value .000 which is less than the alpha value of 0.05. The reason behind the significant increase in VO2 max was the regular CT. The results clearly showed that regular CT can reduce VO2 max among adolescents.

Table 3 indicates an insignificant effect on VO2 max of participants of CG which points towards a negative effect of not participating in any training program. In the pre-test, the VO2 max (mean±SD) was 32.05±1.68 and at the end of 12 weeks, VO2 max (mean±SD) was 32.51±2.04 t-value 1.48, and p-value .166 which is greater than alpha value 0.05. The results clearly showed that nonparticipation in any circuit training exercise may harm the VO2 max.

The study found that performing CT for 12 weeks, 5 days a week, can significantly improve VO2 max. This is consistent with previous studies, such as Themistocleous et al. (2021) which showed the benefits of intermittent circuit exercise on VO2 max among obese and overweight individuals aged 18-55. Ikenna et al. (2020) also found that CT can improve VO2 max in apparently healthy adult females. Ravi and DD (2024) showed that a CT program can improve muscle strength, agility, anaerobic performance, and cardiovascular endurance. Similarly, Sperlich et al. (2017) found that functional high-intensity CT can improve body composition, peak oxygen uptake, strength, and certain dimensions of life in overweight women. Overall, the results of this study suggest that CT can be an effective way to improve VO2 max.

Conclusion

The study aimed to determine the effects of circuit training on maximum oxygen uptake among adolescents. The results indicate that engaging in CT five days a week has a positive impact on maximum oxygen consumption. Regular participation in CT routines can significantly improve maximal oxygen intake. During exercise, the heart pumps more blood with each beat, and the lungs take in more oxygen to meet the increased energy requirements. Regular engagement in CT routines leads to enhanced delivery of oxygen to the working muscles and oxygen utilization by the muscles, increasing VO2 max. Adolescents aged 16 to 19 can benefit from a well-designed CT regimen, which can improve the functionality of the respiratory and cardiovascular systems, leading to better oxygen intake and utilization. The researchers concluded that circuit training had a positive impact on the VO2 max of male adolescents aged between 16-19 years.

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Conflict of Interest

The authors declared no conflict of interest for this particular study.

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