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EFFECT OF CYCLING SPECIFIC CIRCUIT TRAINING (CSCT) ON PHYSIOLOGICAL VARIABLES IN AMATEUR CYCLISTS – A RANDOMIZED CONTROLLED TRIAL

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Abstract

Background: Circuit training (CT) is a popular methodology in fitness and wellness programs, as well as in sports, because its modulation induces physiological benefits**.** It is an efficient and challenging form of conditioning that develops strength and endurance, both aerobic and anaerobic capacities and coordination in one exercise session which has been shown to effectively develop strength and cardiovascular fitness which are most essential components required for a cyclist to give them an upper edge over other. Hence this study aimed to find the effect of Cycling Specific Circuit Training (CSCT) on selected Physiological Variables in amateur cyclists.

Objective: To find out the effect of Cycling Specific Circuit Training on Power and VO2 max in Amateur Cyclists.

Methodology: After designing the study Institutional Ethical Approval was taken. Consent was obtained from all the participants. 52 samples were screened and 40 were selected based on eligibility criteria , further divided into Group A (experimental group) and Group B (control group). Pre-assessment was done at Week 0. The experimental group received the CSCT program for 3 sessions per week for 6 weeks, receiving total 18 sessions. The control group received regular exercise program for same time duration. 7 were dropped out and Post-assessment was done at week 6.

Result: Statistical analysis was done using paired and unpaired t test. There was an extremely significant difference between the groups analysis at week 6 for power ($p<0.0001$) and VO2 max ($p<0.0001$).

Conclusion: Cycling Specific Circuit Training Program that incorporates the exercises specific to the physical demands of cyclist incorporated for 6 weeks have shown significant improvement in power and vo2 max of amateur cyclist

Keywords: circuit training, amateur cyclists, power, vo2 max, physiological variables, aerobic and anaerobic, RAST, Queens step test.

1. INTRODUCTION

There are diverse requirements and anatomical intricacies involved in cycling. It underscores that cyclist, often considered among the fittest athletes, must possess not only high aerobic fitness and muscular endurance but also agility and strength. The requirement for agility stems from navigating through city streets, while the demand for strength is essential for handling the weight of the bikes, which can be as heavy as 70 pounds [1, 2, 27]

The anatomy of cycling is focusing on the dual purposes of muscle usage: power production and balance. The pedal stroke involves complex muscle activation patterns, with the quads and glutes serving as the primary power producers. Core and upper body muscles come into play to provide stability and balance over the bike's three contact points. The significance of various muscle groups, including leg muscles (quads, hamstrings, glutes, and calves), core muscles (abdominals and erector spinae), and upper body muscles (triceps, latissimus dorsi, and pectorals), is outlined. [25]

The pedal cycle is divided into two main phases: the power phase and the recovery phase. The power phase, occurring from 12 o'clock to 6 o'clock, involves the activation of hip and knee extensors, with the gastrocnemius contributing to plantar flexion. The recovery phase, from 6 o'clock back to 12 o'clock, is characterized by the engagement of tibialis anterior, hamstrings, and hip flexors. [26, 21, 22]

The trunk, back, and arms plays a crucial role in stabilizing the spine and maintaining posture during cycling. The importance of muscles like multifidi, quadratus lumborum, erector spinae, abdominal muscles, latissimus dorsi, and trapezius is highlighted. It also notes potential issues such as cyclist's palsy due to sustained pressure on hands. [22, 23]

The lower limb joints, including the pelvis, hip, knee, and ankle, are discussed in relation to their functions during cycling. The essay emphasizes the impact of irregular force or compression on the foot, potentially leading to neural pain and tissue damage. [22, 24]

Circuit training, characterized by a series of exercises with minimal rest, is highlighted for its ability to simultaneously develop strength and cardiovascular fitness.[13,14] Previous studies with similar characteristics were focused on short term effects of 2-4 weeks, therefore it is still to be established whether chronic improvements can be accomplished over longer period of time. Hence, we hypothesize that Cycling Specific Circuit Training may have improvement on physiological parameters in amateur cyclists over a period of 6 weeks.

2. MATERIALS AND METHODS

2.1 Study Design:

Single blind parallel group randomized controlled trial was conducted at Pravara Institute of Medical Sciences. The IEC no is **Dr.APJAKCOPT/BPT/UG/2023/77**.

2.2 Trial Registration:

Clinical Trials Registry-India (CTRI) registration is done. The CTRI registration no is **CTRI/2023/09/058057**

2.3 Study Setting : Study was conducted at Department of Sports, PIMS(DU), Loni, Ahmednagar, Maharashtra, India

2.4 Study Duration: September 2022 to December 2023.

2.5 Sample size calculation:

Sample size was calculated using open Epi software, with 95% confidence interval and power of 80%. Grounded on the above-mentioned assumptions, the sample size needed for this study was 40 participants.

2.6 Participant recruitment:

Participants who are cyclists with age ranging from 18 to 40 years-old, both male and female amateur cyclists who qualified PARQ questionnaire, ready to sign the consent were included in the study. The players suffering from any recent injuries, any type of systemic illness, players who are irregular and are involved in any other type of personal training methods, or taking any medications that may affect alertness or balance were excluded.

2.7 Randomization Allocation:

Randomization was done by Computer Generated Sequence into group A (Experimental group) and group B (Control group) and allocation was done with Sequentially Numbered Opaque Sealed Envelope (SNOSE) method. It was single blind trial, participants involved in groups were blinded.

2.8 Procedure:

The potential participants were assessed according to the eligibility criteria. The participants willing to participate were provided with written and verbal information sheet and were required to give written consent form for undergoing study. Prior to the tests, the participants executed a standardized warm-up protocol. The intervention group performed CSCT, while the control group performed the regular conventional program. The sessions were held on Mondays, Wednesdays, and Fridays. Both the groups were assessed at week 0 and week 6. Before the intervention protocols, demographic data were collected. Power was assessed using RAST and VO_2 Max were assessed using Queens Step test.

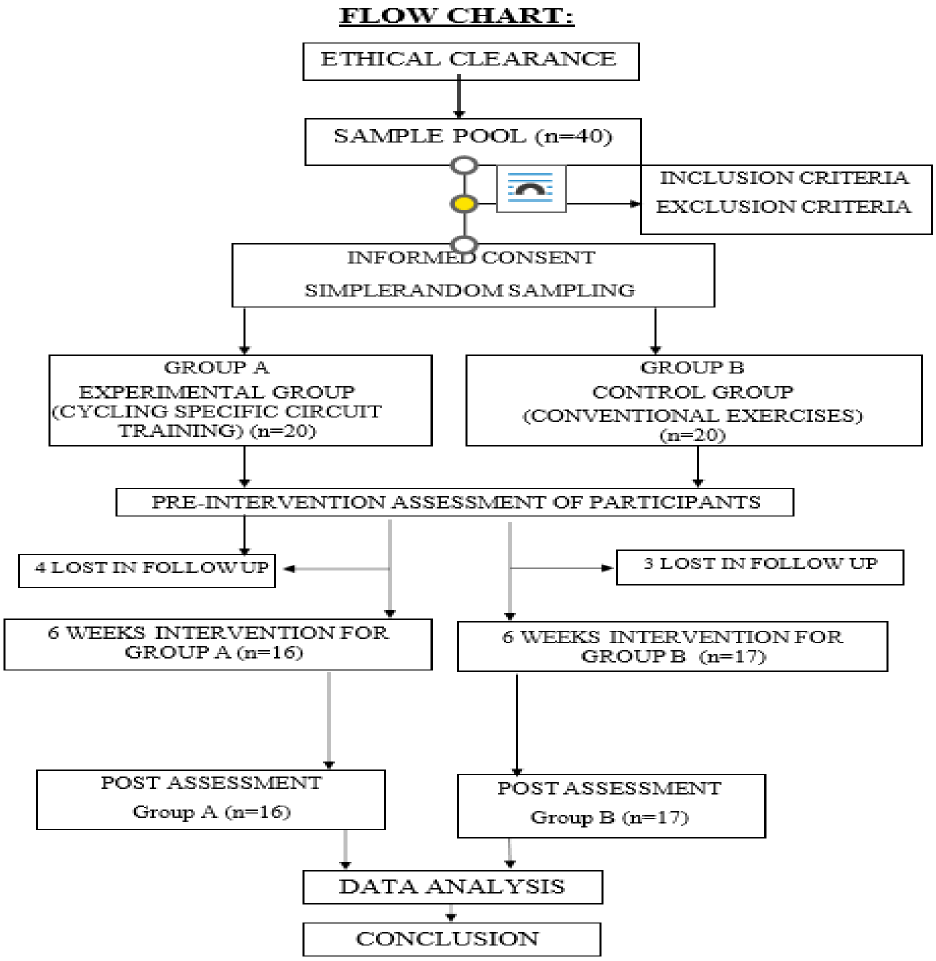

Figure 1: Design and flow of participants through the trial

2.9 Outcome measures:

- **Queen's Step test** was used to assess the VO_2 max.
- **Running based Anaerobic Sprint Test (RAST**) was used to assess the anaerobic power.

2.10 Statistical analysis:

Analyses were conducted using Instat software. Paired t test was used to identify between group differences. Quantitative variables were reported as mean and standard deviation. The mean between-group difference between the experimental and control groups were calculated with unpaired data and reported with a 95% confidence interval.

Table 1: Common warm up exercises for both groups

Sr. No	Exercise	Volume	Freq
1	Brisk walk	7 mins	3 sessions per week
2	Step up and down	7 mins	
3	ROM exercises	20 reps * 3 sets	
4	High Knees	25 reps * 2 sets	
5	Lateral Stretch	20sec	

TABLE 2: Content and progression of the experimental group intervention.

	Week 1 and Week 2		
Sr. No	**Exercise**	**Volume**	**Freq**
1	Dumbbell curl	8 reps * 2 Sets	3 sessions /week
2	Planks	3 reps * 2 Sets	
3	Squats jump	10 reps * 2 Sets	
4	Crunches	10 reps * 2 Sets	
5	Skipping	50 reps * 2 Sets	
6	Step ups	20 reps * 3 Sets	
7	Seated row	10 reps * 2 Sets	
Week 3 and Week 4			
1	Shoulder press	8 reps * 2 Sets	3 sessions /week
2	Plank with Fitball	3 reps * 2 Sets	
3	Compass jumps	10 reps * 2 Sets	
4	Bicycle crunch	10 reps * 2 Sets	
5	Mountain climbers	3 Mins	
6	Bulgarian split squats	15 reps * 2 Sets	
7	Stiff leg dead lift	10 reps * 2 Sets	
Week 5 and Week 6			
1	Bench dips	8 reps * 2 Sets	3 sessions /week
2	V sit abs exercise	8 reps * 2 Sets	
3	Leg press	10 reps * 2 Sets	
4	Side planks	10 reps * 2 Sets	
5	Burpees	50 reps * 2 Sets	
6	Front squat	20 reps * 2 Sets	
7	Pull ups	10 reps * 2 Sets	

Duration 30-45 minutes, frequency of 3 days per week

TABLE 3: Content of the Control group exercises

Sr. No	**Exercise**	**Volume**	**Freq**
1	Treadmill	7 mins	3 sessions per week
2	Stationary Cycling	7 mins	
3	Knee to chest	20 reps * 3 sets	
4	Squats	25 reps * 2 sets	
5	Bicep curls	15 reps * 3 sets	

Duration 30 - 45 minutes, frequency of 3 days per week

Table 4 Common cool down exercises for both the groups

Sr. No	Exercise	Volume
1	Stretching of major group of muscles	20 sec
2	Deep breathing exercise	10 reps * 2 sets

3. RESULTS

At the baseline, there were non-significant differences between the groups in age and weight as $p>0.05$.

The demographic and physical characteristics of participants at the baseline are shown in Table 5.

TABLE 5: Baseline demographic and physical characteristics

Characteristics	Experimental (n=16)	Control (n=17)
Age, mean	22.0625(1.237)	22.11765(1.269)
Weight, mean	65.0625(9.198)	71.11765(16.556)

TABLE 6: Mean (SD) of groups, mean (SD) within-group difference and mean (95% CI) between-group difference

Outcome	Groups				Within Groups Difference		Between group difference
	Week 0		Week 6		Week 6 - week 0		week6 - week 0
	Exp	Control	Exp	Control	Exp	Control	Exp - control
Maximum Power	762.77 (140.65)	973.91 (92.657)	1295.7 (179.95)	1030.6 (98.964)	532.93 (39.3)	56.69 (6.307)	476.24
Minimum Power	502.16 (49.541)	457.25 (59.342)	603.3 (40.154)	494.49 (63.504)	101.14 (9.387)	37.24 (4.162)	63.9
VO2 Max	36.117 (5.294)	33.516 (4.133)	62.036 (4.912)	52.651 (5.442)	25.919 (0.382)	19.135 (1.309)	6.784

4. DISCUSSION

The study aimed to estimate the effects of Cycling Specific Circuit Training on VO2 Max and Anaerobic power compared with controlled regimen of conventional exercises. Study generated very precise estimates for each of these outcomes, which both showed clearly greater benefits from the CSCT. The Cycling Specific Circuit Training program was safe and there was no attrition among those using it over 6 week period.

Physiological Adaptations in Cycling

Previous research has delved into the metabolic aspects of cycling, highlighting the interplay between aerobic and anaerobic systems. Cycling-specific circuit training is proposed as a novel approach to address these demands comprehensively, aiming to improve aerobic capacity, muscular strength, and endurance simultaneously. By combining resistance training and aerobic conditioning in a circuit format, cyclists may enhance their performance beyond traditional training methods.

Maximum Power and Muscular Endurance

The paragraph discusses the observed improvements in maximum power and muscular endurance following a specific intervention, which align with principles of resistance training and aerobic conditioning. Maximum power output is crucial for cycling performance, especially during sprints and high-intensity intervals.[10,11] Cycling-specific circuit training, which includes exercises like weighted squats and plyometric jumps, promotes neuromuscular adaptations that enhance power production. Additionally, improvements in muscular endurance, indicated by increases in minimum power, suggest delayed fatigue onset and better ability to sustain efforts over longer durations.[12,13]

VO2 Max and Aerobic Capacity

The paragraph discusses the notable increases in VO2 max following an intervention, indicating enhancements in aerobic capacity, which is vital for endurance performance in cycling. Aerobic capacity represents the maximum rate of oxygen uptake and utilization during exercise, crucial for sustaining prolonged efforts at submaximal intensities.[13,14] Cycling-specific circuit training, focusing on high-intensity intervals and cardiovascular conditioning, induces beneficial adaptations in cardiac output, stroke volume, and mitochondrial density. These adaptations improve oxygen delivery and utilization by muscles, contributing to enhanced endurance performance [14,15]

Comparative Analysis and Superior Outcomes

The paragraph compares the outcomes of an experimental group undergoing cycling-specific circuit training with those of a control group. Both groups showed improvements in physiological variables, but the experimental group demonstrated notably greater enhancements. This discrepancy implies that cycling-specific circuit training offers unique benefits beyond traditional training methods. By combining resistance and aerobic training, cyclists can maximize their performance potential and gain a competitive advantage on race day.

5. CONCLUSION

From the results of present study both the group showed improvement in power and VO_2 max. When compared between the groups the experimental group was estimated to be more effective than control group and effect appeared to be more significant at week 6.

CLINICAL IMPLICATION

We recommend that CSCT program can be used as one of training methods in regular exercise sessions by coaches and physical teachers to enhance power and VO_2 max in cyclists.

LIMITATION

Study is limited to one center. The gender co-relation for the outcome variables is not done.

FUTURE SCOPE

Same study can be conducted at various levels like semiprofessionals, professional cyclists by varying the intensities.

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CONFLICT OF INTEREST: Author has no conflict of interest

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