International Journal of Physical Education, Sports and Health 2022; 9(2): 25-30

P-ISSN: 2394-1685
E-ISSN: 2394-1693
Impact Factor (ISRA): 5.38
IJPESH 2022; 9(2): 25-30

www.kheljournal.com
Received: 17-01-2022
Accepted: 21-02-2022

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To study the effect of sports specific training program on selective physical and physiological variables in basketball players

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Abstract
Background: Basketball sports demands high level of cardiovascular, musculoskeletal and metabolic capacities and this demands of the game place players at risk of sustaining injuries. However, the rate of injuries in game situations were 2 times higher than in practices and this is due to the fact that movements during the game are unpredictable. Therefore, a player should have a high level of fitness in order to perform the workload and basketball specific rapid movements. The proper sports specific conditioning program is need of an hour to optimize the greater potentials of players. Purpose of the study was to evaluate the effect of sports specific circuit training on selective fitness variables.
Method: Ethical clearance was taken from the institutional committee and Subjects were selected according to the eligibility criteria, informed consent was taken prior to the study and subjects were selected by simple random sampling method. n= 36 participants were recruited according to the selection criteria and were randomly allocated to experimental group (n=18) and control group (n=18). The experimental group underwent training for 45min, 3 times per week for 4 weeks; the control group performed conventional exercises for 4 weeks. Data was collected statistical analysis was done and result and conclusion were withdrawn.
Results: After 4 weeks training, the experimental group has demonstrated significant improvement in Anaerobic power and anaerobic capacity improved by 335.68 (95% CI 137.43 to 533.92) with an p value of < 0.05 compared with control group. While agility and vertical jump height has also shown improvement with an p value >0.05.
Conclusion: Sports specific training program composed of multiple skill training components has shown significant effect in improving anaerobic power and capacity and has shown beneficial effect on agility and vertical jump height. However, these sports specific circuit training can be useful for the coaches with players in developing the physical and physiological levels and to improve athletes' performance.

Keywords: Sports specific training program, basketball, vertical jump height, RAST, agility

Introduction

Basketball is one of the most popular team sports in the world. Basketball is a highly intermittent game that involves repeating transitions between attack and defence and frequent movement changes (McInnes *et al*., 1995). During a basketball game, periods of high-intensity activity are interrupted by periods of low to moderate intensity activity. These activities differ in terms of movement structure (e.g., running, jumping, sideways movement), intensity, distance, frequency, and duration. Despite the numerous health benefits, participation in a physically demanding sport such as basketball can result in increased risk of injury. Injuries can counter the effects of sports participation if an athlete is unable to continue to participate because of residual effects of injury [1, 2]. Basketball is a sport which is characterized complicated movements such as: running, changes of direction, lateral movements, jumps, and uncontrolled landings. However, the rate of injuries in game situations were 2 times higher than in practices and this is due to the fact that movements during the game are unpredictable. Therefore, a player should have a high level of cardiovascular and musculoskeletal fitness in order to perform the workload and basketball specific rapid movements. In order to minimize the injuries, improving aerobic and anaerobic capacity as well as neuromuscular performance such as power, balance and agility is needed [3].

Current research has shown increase in prevalence of injuries in basketball players with high percentage of injuries in ankle/foot (39.7%), knee (14.7%), head/face/neck (13.6%), arm/hand (9.6%), and hip/thigh/upper leg (8.4%) are most commonly injured sites in basketball. The most frequent injury diagnoses are ligament sprains (44.0%), muscle/tendon strains (17.7%), contusions (8.6%), fractures (8.5%), and concussions (7.0%) [1].

Morgan and Adamson at the University of Leeds first developed circuit training in the 1950s. It is a versatile training method as it can be adapted for many different situations, sections of the population and fitness requirements, and can be used at any time of the year. While the exercises are normally laid out in a circular pattern, the pattern can be varied for motivational purposes to that of a star, square, semi-circle, V-shape, line or zigzag [4].

The term 'sport specific training' implies that exercises should mimic as much as possible the actions of the body during participation in a given sport. Specificity should not, however, be over emphasized when selecting resistance exercises because it could lead to imbalances. Consequently, finding a balance between general and specific exercises would be appropriate in a circuit [4].

Circuit training is a method of fitness training that is designed to develop general, all-round physical and cardiovascular fitness [3]. Benefits of circuit training include: 1. Improvements in muscular strength 2. Improvements in cardiovascular fitness 3. Improvements in muscular endurance 4. Increased social interaction during a workout 5. Increased adherence to exercise [5].

There is a need for programs to prevent injuries in athletes. However, we investigated the effect of sports specific circuit training programs on altering proposed lower extremity injury.

Material and Methods

Design

A randomized control trial was conducted in Orthopaedic physiotherapy department, Pravara Institute of Medical Sciences, with intension to treat analysis. Ethical approval was taken from the institute with ref no. PIMS/Dr.APJAKCOPT/IEC/2021/163. Participants were assessed according to the eligibility criteria. Participants who were willing to participate in the study were provided with verbal and written information sheet, and were required to give the informed consent before being allocated to a group and undergoing baseline assessment. Randomization was done using the simple random sampling into 2 groups Experimental group and Control group. Outcome assessor was blinded in the study. Participants in the experimental group received a 4-week sports specific circuit training and those in control group received basic exercises for4-weeks. At day-0 demographic data and baseline assessment was done and post assessment was done at 4 week.

Participants, therapist

Participants were eligible for the study if they were aged between-18-24 years players, Male and female players, Players qualifying PAR-Q, players willing to participate, players ready to give consent form, Players practicing on daily basis, Players participating in intercollege and above level. Exclusion criteria was History of any recent injury and any recent acute systemic illness.

Interventions

Experimental group

The intervention was performed for 4 weeks 3 times a week. Sports specific circuit training was administered which included warm-up, running exercise, strength, plyometrics and balance and cooldown. Each exercise was progressed after 2 weeks. (Table 1)

Control group

Participants will be permitted to continue with their regular exercise program and practice which involves warm-up, stretching, joint range of motion, running, squatting and dribbling exercises followed by cool down.

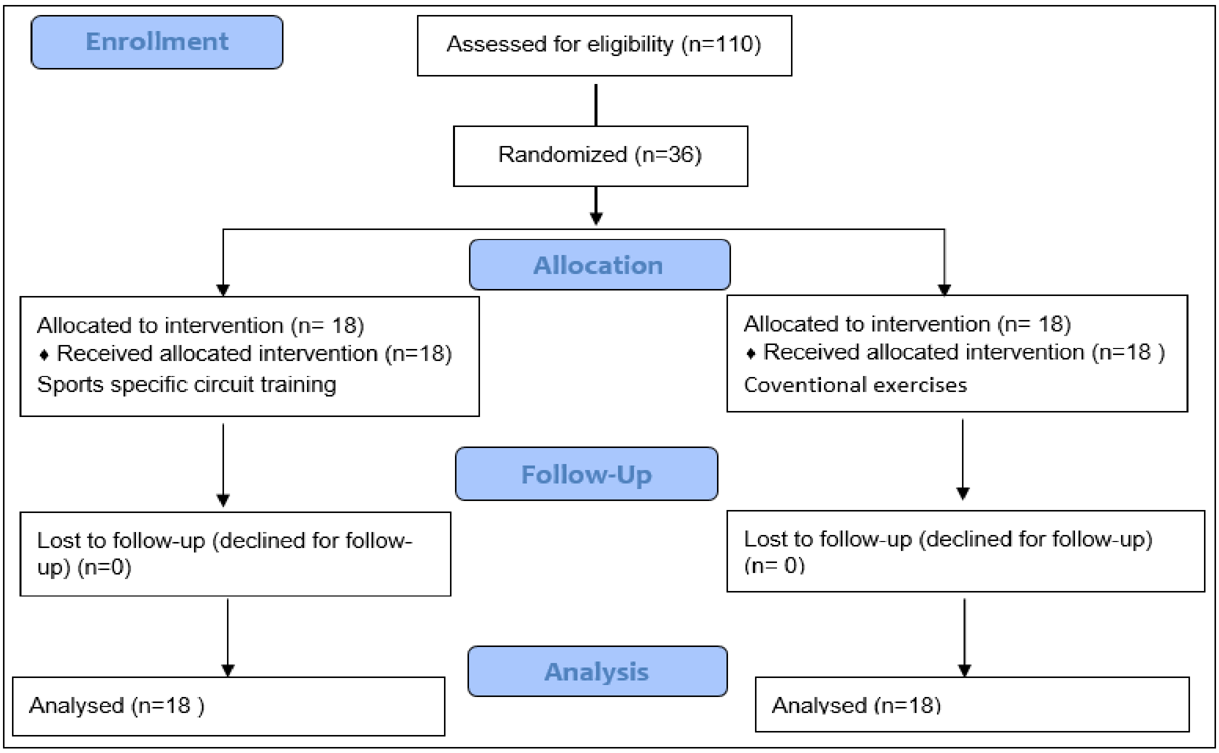


Fig 1: Consort chart

Sport specific circuit training program outline

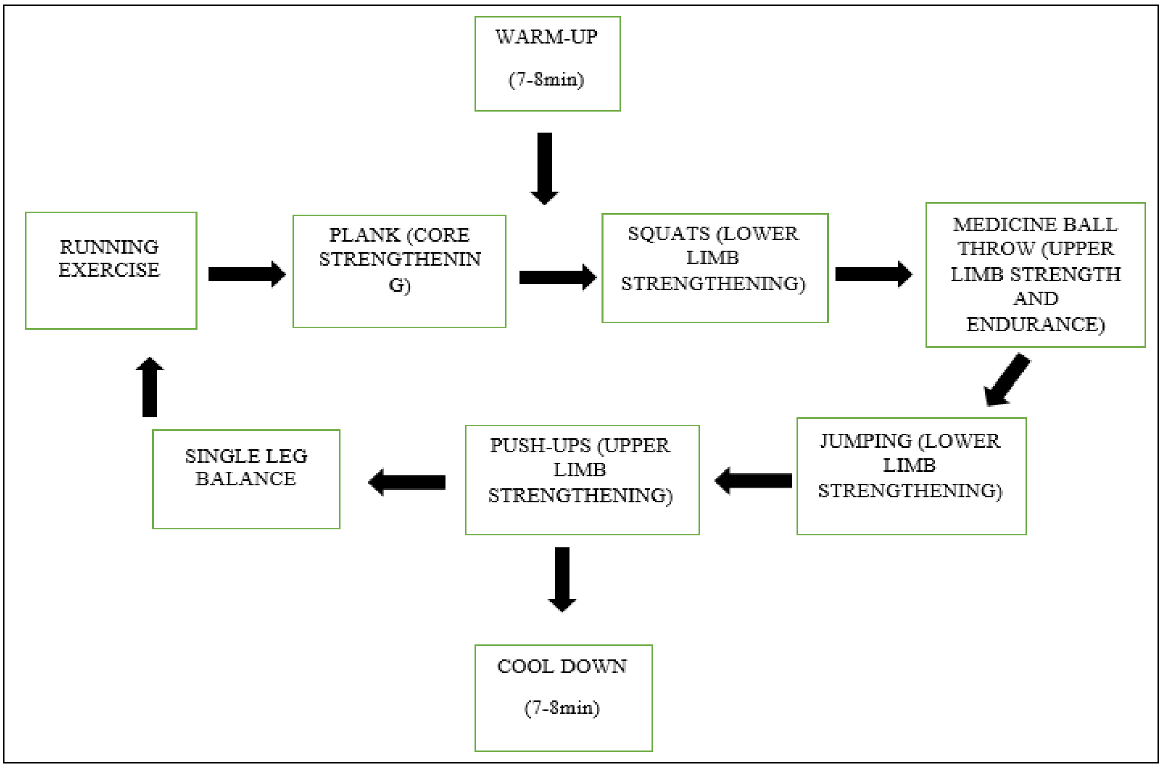


Fig 2: Sports specific circuit training program outline

- 1 session is 1 complete circuit
- Total sessions -3 per week
- Duration of training program -4 weeks

Table 1: Circuit training program

Exercise	**Progression 1 and 2**	
	Week 1&2	**Week 3&4**
Warm-up	7-8 min	7-8min
1. Running exercises, 8 minutes (along the major diameter of the basketball court, about 28 meters)	10	10
-Running, straight ahead	2	3
-Running, Hip out	2	3
-Running, Hip in	2	3
-Running, circling	2	3
-Running and jumping	2	3
-Running, quick run		
2. Strength, plyometrics, balance, (30 minutes)		
-Planks	Level 1: plank with 30 sec hold 3 sets	Level 2: plank with hand lifts 3 sets
- Squats	Level 1: with heels raised 2x30seconds	Level 2: 1-leg squat 2x10(each leg)
-Medicine ball throw	Level 1: medicine ball chest pass	Level 2: medicine ball overhead pass
- Jumping	Level 1: lateral jumps 3x15seconds 3 times along the major diameter of the basketball court	Level 2: box jumps 3x15seconds 3 times along the major diameter of the basketball court
-Push-ups	Level 1: full pushup 3x10	Level 2: plyometric pushup 3x10
-Single-leg balance	Level 1: single leg balance holding the ball for 30 sec on each leg for 2 sets	Level 2: single leg balance throwing and catching ball with partner for 30sec for 2 sets
Cool-down- ROM and stretching	7-8min	7-8min

Outcome measures

T-drill test

The players started the test with one foot on the starting line. They had to sprint forward to a cone placed at 10 metres, shuffle to the left to a cone placed 5 metres away, shuffle to the right 10 metres to a third cone, shuffle to the left to the central cone, and then sprint backwards until the starting/finishing line. Time was measured and the best sprint time out of three trials was used for the statistical analysis.

RAST

The RAST consisted of 6 maximal efforts of 35m, separated by a passive recovery period of 10s. The time of each effort of 35m was recorded using a system of photocells located at the beginning and at the end of the 35m.

Using the time of each effort, it was possible to determine the power (P) in each effort (P=total body mass × distance2)/time3). As variables of RAST, the peak power (PP), defined as the greater power achieved among the 6 efforts, the mean power (MP), defined as mean power among the 6 efforts, and minimum power (Pmin), defined as minimum power achieved among the 6 efforts, were determined and shown in units relative to body mass (PPREL, MPREL, PminREL) and absolute values (PPABS, MPABS, PminABS), as well as the fatigue index (FI) [FI (%)=((PP – Pmin)/ PP)×100]. All efforts were performed on a field

Vertical Jump Height

The vertical jump test was performed using a Vertec. With feet hip-width apart and hands at the waist, participants were instructed to perform a countermovement jump by bending their knees and then jumping as high as possible while reaching up with their preferred hand. Participants performed one practice jump and two test jumps. The absolute jump height reached by the hand (cm) and the jump height difference between standing height and jumping height (cm) were recorded. The highest value (cm) was used for data analysis.

Results and Discussion

Flow of participants through the study

36 participants met the eligibility criteria and were randomized into 2 groups experimental (n=18) and control group (n=18). Follow-up of no patient was lost (Figure 1). At 4-week post assessment, 18 participants in experimental group and 18 in control group were in the study. The groups were comparable at baseline as presented in (Table 2).

Effect of intervention

All group data is presented in (Table 3 and 4)

Vertical jump height

Within group analysis

Participants in experimental group, demonstrated no significant statistic difference p>0.01 in vertical jump height with mean±SD (pre-38.28±9.566 to post-38.44±9.69). While in control group p>0.01 with mean±SD (pre-40.44V7.93 to post-40.56±7.93)

Between group analysis

The mean between group difference in vertical jump height was 2.11(95%CI 8.107 to 3.88) with a p value of 0.475. That is, vertical jump height had no significant difference in both groups.

Agility

Within group analysis

Participants in experimental group, demonstrated significant statistic difference p<0.001 in agility with mean±SD (pre-14.62±1.39 to post-13.86±1.82). While in control group p>0.05 with mean±SD (pre-14.99±1.79 to post-14.98±1.79)

Between group analysis

The mean between group difference in agility was 1.13 (95%CI 2.35 to 0.09) with a p value of 0.068. That is, agility had no significant difference in both groups.

RAST

Within group analysis

Participants in experimental group, demonstrated no significant statistic difference *p*>0.05 in anaerobic power and anaerobic capacity with mean±SD (average power-pre-319.51±148.94 to post-343.12±232.26 and anaerobic capacity-pre-9.40±12.28 to post-5.06±4.38). While in control group *p*>0.05 with mean±SD (anaerobic power-pre-359.01±184.01 to post-379.08±181.42 and anaerobic capacity pre- 9.44±13.20 to post-11.41±13.19)

Between group analysis

The mean between group difference in RAST (average power) was 335.68 (95%CI 137.43 to 533.92) That is, although average power improved in both groups, the mean between group difference favored the experimental group by indicating 335.68 increase in average power than in control group with a p value of 0.005

The mean between group difference in RAST (fatigue index) was 5.806 (95%CI 12.46 to 0.85) That is, although fatigue index improved in both groups, the mean between group difference favored the experimental group by indicating 5.806 increase in average power than in control group with a p value of 0.001.

Table 2: Demographic data

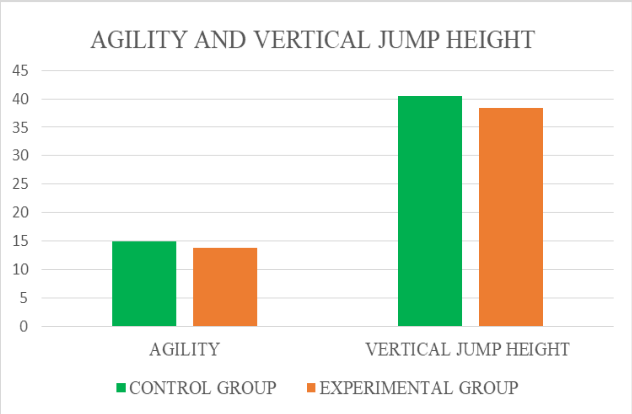
	Experimental	Control
Age	19.83±1.24	20.33±0.90
Height	168.52±6.40	169.72±7.67
Weight	63.66±14.13	65.33±9.06
BMI	22.20±4.02	22.66±2.67
Pulse	92.83±10.26	92.66±8.91
BP-diastolic	115.22±7.48	115.27±8.52
systolic	80.88±7.91	75.88±8.77

Table 3: Mean (SD) of within group differences

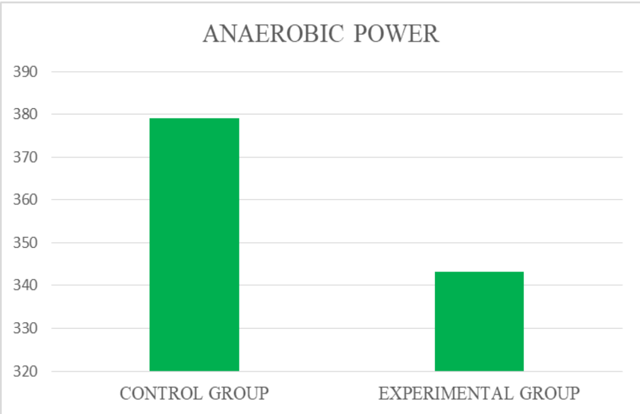
	Experimental					Control				
	Pre-test mean	std	Post-test mean	std	P value	Pre-test mean	std	Post-test mean	std	P value
Agility	14.62	1.398	13.82	1.799	0.001	14.99	1.798	14.98	1.797	0.562
Vertical Jump Height	38.28	9.566	38.44	9.697	0.083	40.44	7.935	40.56	7.935	0.163
Rast – Anaerobic Power	319.51	148.94	343.12	232.26	0.586	359.01	184.01	379.08	181.42	0.795
Fatigue Index	9.40	12.28	5.06	4.38	0.246	9.44	13.20	11.41	13.19	0.684

Table 4: Mean difference and p-value of between-group differences

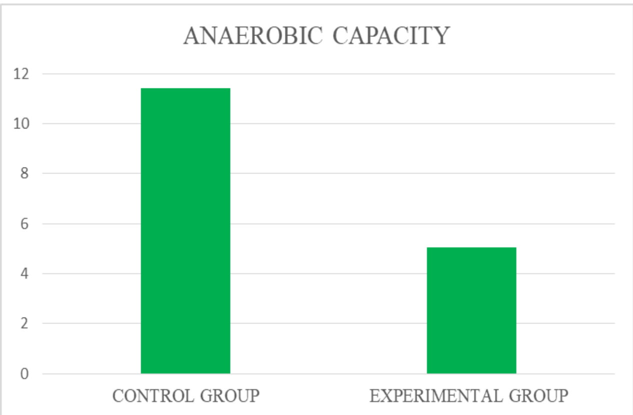
	Mean difference	P- value	Confidence interval
Agility	1.16	0.06	2.35 to 0.09
Vertical Jump Height	2.11	0.475	8.107 to 3.88
RAST -Anaerobic Power	335.68	0.005	137.43 to 533.92
Fatigue Index	5.806	0.001	12.46 to 0.85



Graph 1: Comparison of mean of pre- and post agility and vertical jump height between experimental and control group



Graph 2: Comparison of mean of pre- and post anaerobic power between experimental and control group



Graph 3: Comparison of mean of pre- and post anaerobic capacity between experimental and control group

Adverse effect

All patients in each group who were followed up at the end of the study reported no adverse events during the intervention period.

Discussion

Sport specific circuit training is different kind of training program that is effective in preparing athletes for competition according to the need of the sports. This type of program consists of a number of ''stations'' where a given exercise is performed, usually within a specified time. Once the exercise is completed at 1 station, the subject moves rapidly to the next station, performing another exercise also within a prescribed time period. The circuit is completed once the exercises at all stations are performed [6, 7].

The objective of the study was to find out the effect of sports specific circuit training on physical and physiological variables of basketball players. The training duration was 4 weeks with a frequency of 3 days a week and analysis were done.

Explosive power, an ability to generate maximum muscle strength in the shortest possible time (Santos & Janeira, 2008) is an extremely important motor ability to play basketball (Lehnert *et al*., 2013; Aksović *et al*., 2020a; Aksović *et al*., 2021). Vertical jumps are often used to estimate the explosive power of the lower extremities. The improvements achieved were the result of enhanced neuromuscular function. The occurrence of post activation potentiation is believed to increase the rate of force development, thereby increasing speed and power production as described by Sale D *et al*. [8, 9, 10].

The post results for the vertical jump height improved for the experimental group but were not statistically significant (p>0.05). In addition, recovery interval duration was extremely short and thus may not have allowed the maintenance of strength and power production during subsequent sets (Ratamess *et al*., 2009), since substantial fatigue has the potential to affect the motor recruitment pattern (Hautier *et al*., 2000; Mendez-Villanueva *et al*., 2007, 2008; Racinais *et al*., 2007). Some cross-sectional studies have observed a reduction in the vastus lateralis and rectus femoris maximal EMG amplitude and voluntary activation (Brocherie *et al*., 2015; Mendez-Villanueva *et al*., 2008; Racinais *et al*., 2007) during and after running and repeated sprints protocols, but not all (Bishop, 2012). Taken together, these results might suggest that a progressive inhibition of motor units or decrease in motor unit firing rate or neural drive to the muscle due to eventual fatigue could result in an ineffective stimulus to improve the maximal EMG amplitude. (Bishop, 2012) [11, 12].

The post-test results for the agility performance parameters improved for both the groups but were not statistically significant (p>0.05). while in experimental group it improved from (14.82±13.62) which was statistically significant (p<0.01).

Training produces increased levels of anaerobic substrates that is ATP, PCR, free creatine and glycogen accompanied by an improvement in muscular strength. Increased quantity and activity to key enzymes that control the anaerobic phase of glucose catabolism with an increase in fiber size (fast twitch muscle fibers). It also enhances the metabolic capacity of the specifically trained muscle fibers, but it also facilitates recruitment and modulation of firing sequence of the appropriate motor units achieved in the movement [13].

In sports specific circuit training repetition of exercise causes lactate stacking which results in a higher blood lactate level than with just one bout of exhaustive effort. As with all training regimens, one must exercise the specific muscle group that require enhanced lactate-producing capacity. So, a basketball player must perform movements and direction changes similar to those required by sport [13].

There is evidence to support the concept that a six-week, multicomponent training program which included resistance, plyometric and speed training significantly enhanced strength, jumping ability and speed in female adolescent athletes as compared to a no exercising control group [14].

Along the same line, Taskin studied the effects of an eight-station circuit training session conducted three times per week for 10 weeks on speed, agility, and aerobic capacity. The results showed significant improvement for all the parameters studied. Furthermore, study of Kumar reported a significant increase in the leg muscle strength and agility of subjects participating in six station circuit training (exercise for 25 - 35 sec with 20 - 30 sec rest at each station, 2 - 4 sets with a 2 - 3 min rest period between each set for a duration of eight weeks) as shown improvement in agility [15, 16].

Anaerobic power is the peak power achieved during the test while anaerobic capacity is total work accomplished.[13] The circuit training program in this study appeared to have effect on the anaerobic power of the subjects in the experiment the group (379.08±181.42 to 343.12±232.26) ($p<0.05$). However, the anaerobic power of the experimental group was significantly higher than the value for the control group. Anaerobic capacity of the experiment group increased significantly from (11.41±13.19 to 5.06±4.38) ($p<0.001$). The experimental group showed a significantly higher anaerobic capacity than the control group.

Short term training produces higher levels of blood and muscle lactate and greater muscle glycogen depletion compared with untrained counterparts; better performances are usually associated with higher blood lactate levels supporting the belief that training for brief, all-out exercise enhances the glycolytic systems capacity to generate energy. It also enhances short-term transfer by increasing the body's buffering capacity [13].

These results imply that the sports specific circuit training program designed which is short term training procedures in this study was responsible for an increase in an anaerobic capacity found in participants and that an increase in muscle strength be responsible for the increase in anaerobic capacity.

Conclusion

Sports specific circuit training program composed of multiple skill training components has shown significant effect in improving anaerobic power and capacity and has shown beneficial effect on agility and vertical jump height. However, these sports specific circuit training can be useful for the coaches with players in developing the physical and physiological levels and to improve athletes' performance.

Limitations

Smaller sample size
Shorter duration of study

Clinical Implication

Sports specific circuit training can be useful for the coaches with players in developing the physical and physiological levels and to improve athletes' performance.

Acknowledgements: I wish to express my deep gratitude to my guide Dr. Pradeep Borkar and all the participants who participated in my study.

Ethical Reg No: PIMS/Dr.APJAKCOPT/IEC/2021/163

CTRI Reg No: CTRI/2021/11/037946

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