Research

Effectiveness of Sports Specific Circuit Training and High Intensity Interval Training on Aerobic Capacity in Male Basketball Players

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ABSTRACT

Objective: To find out the effectiveness of Sports Specific Circuit Training and High Intensity Interval Training on aerobic capacity in male basketball players.

Study design: Quasi experimental study design.

Subject: 40 subjects of basketball players with age group 18- 25 years of male gender, having agility score of <11.5 and V – sit and reach scores plus or above half inch from the point of zero.

Intervention: 20 subjects in the group A received Sports Specific Circuit Training and 20 subjects in group B received High Intensity Interval Training.

Outcome measures: Aerobic Capacity (VO2 Max).

Results: Statistical analysis was done by using Paired 't' and independent 't' test showed significant improvement in improving aerobic capacity (VO2Max).

Conclusion: It is concluded that there is statistically significant improvement in aerobic capacity High Intensity Interval Training when compared to Sports Specific Circuit Training in male basketball players.

Keywords

Sports specific circuit training; High intensity interval training aerobic capacity VO2 Max; Agility; V – Sit and reach; Basketball players

Introduction

Basketball has gained worldwide popularity and fascinated players and spectators with its dynamic characteristics as a team sport. In this sport, players cover about 4500–5000 m during a 40-min game with a variety of multidirectional movements such as running, dribbling, and shuffling at variable velocities and jumping [1]. Basketball is an intermittent sport where a large number of different activities and situations are developed [2]. Besides, basketball is characterized by speed and repeated changes in the direction of activities and movement, especially since May 2000 when the rules were modified [3]. Basketball requires a combination of energy from both the aerobic and anaerobic energy systems. The ability to deliver oxygen to the tissues during prolonged bouts of exercise requires a well-developed aerobic system to efficiently perform at peak levels for extended training sessions. The ability to perform faster and more explosively with less fatigue is based on anaerobic power [4]. Aerobic power is the ability to deliver oxygen to the tissues during prolonged bouts of

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exercise (VO2 max). The ability to condition an athlete in aerobic training drills allows for play at higher-intensity levels and for prolonged periods of time. High-level aerobic training increases the anaerobic threshold, enhances lactic acid clearance, and delays the onset of fatigue. Muscle strength and power provide explosive energy both to the upper and lower extremities. These components are essential to maximize performance in rebounding, positioning, jumping, sprinting, and driving to the basket. Muscular endurance is vital to allow for repeated power throughout the course of a play or longer. Aerobic endurance training in conjunction with muscle strengthening provides peak performance for short and long energy demands [5]. Physical capacity of athletes is an important element of success in sports achievements. It involves a huge number of different capacities, with aerobic capacity being its major component. Aerobic capacity denotes a general extent of metabolic processes occurring in the human organism, and stands for a larger portion of the total energetic capacity. Maximal oxygen uptake (VO2 max) refers to the intensity of aerobic processes, and actually represents the capacity of the organism to utilize at a certain moment the maximum amount of oxygen VO2max is considered to be the most important component of endurance performance [6].

Physiological basis of physical capacity of an organism incorporates the functional capacity of the organism to increase the level of metabolic processes in keeping with the requirement of physical effort being exposed to the metabolic processes in this sense mean the transformation of chemical energy into mechanical one [7].

Morgan and Adamson at the University of Leeds first developed circuit training in the 1950's. 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 [8].

Circuit training is a method of fitness training that is designed to develop general, all-round physical and cardiovascular fitness [9]. 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 [10,11].

High-intensity interval training (HIT) is characterized by repeated sessions of relatively brief, intermittent exercise, often performed with an "all out" effort or at an intensity close to that which elicits peak oxygen uptake (i.e., 90% of VO2 peak). High-intensity interval training (HIT) for several weeks improves markers of aerobic energy metabolism, such as maximal aerobic capacity and the maximal activities of mitochondrial enzymes.

Regular endurance training improves performance during tasks that rely mainly on aerobic energy metabolism, in large part by increasing the body's ability to transport and utilize oxygen and by altering substrate metabolism in working skeletal muscle [12].

Sports performance is the result of the interplay of various mental and physical factors. One of the main factors to improve and maximize athletic performance is the development of physical abilities. The capabilities of fitness are strength, speed, endurance and flexibility [13].

Agility has been traditionally referred to as the ability to change body direction, or position, in space. Recent research, however, has transformed the definition to include changes in direction in response to stimuli. Sports, such as basketball require intermittent stops, starts, changes of direction, pivots and cuts. These motor tasks are movements that make agility an imperative skill for basketball athletes [14].

Flexibility has been defined in many ways. It is used the term joint mobility indicates the degree of bending the normal range or scope of a joint or series of joints. Several sit-and-reach tests (SRs) are commonly used in health-related and physical fitness test batteries to evaluate the hamstring and lower back flexibility.

Flexibility and agility are also key factors that permit the quick stops, starts, and turns these athletes must perform [15] as well as sport-specific skills that are essential to successfully compete at a national and international level [16].

A simpler method than monitoring heart rate is the Rating of Perceived Exertion (RPE). RPE is a subjective measure and asks the exerciser to think about how hard they feel their body is

working against a standardized scale [17]. Many researchers concluded that sports specific circuit training is beneficial for improving aerobic capacity in basketball players and high intensity interval training improves aerobic capacity in soccer players. The effect of sports specific circuit training and high intensity interval training on aerobic capacity in male basketball players is currently unclear. Hence the need of this study is to evaluate the benefits of sports specific circuit training and high intensity interval training on aerobic capacity in male basketball players.

Materials and Methods

■ Study design and sample

This is a Quasi experimental, comparative type study done in Sports Authority of Andhra Pradesh, Lal Bahadur Stadium, Gymkhana Grounds, Hyderabad, Andhra Pradesh India. 40 off season basketball players were conveniently selected and explained clearly about the procedure and written informed consent was taken and explained them the whole information obtained from them will be kept confidential.

Male subjects with age 18 - 25 years, with sit and reach test above ½ inch and T –Agility test score10.5sec and below and who are able to fulfill the pre-screening test were included in this study.

Subjects who had a history of fractures and trauma for past one year, who had a history of sprains and strains for past three months, history of Cardio - respiratory problems, participating in competitive sports, undergoing any other exercise training were excluded from the study.

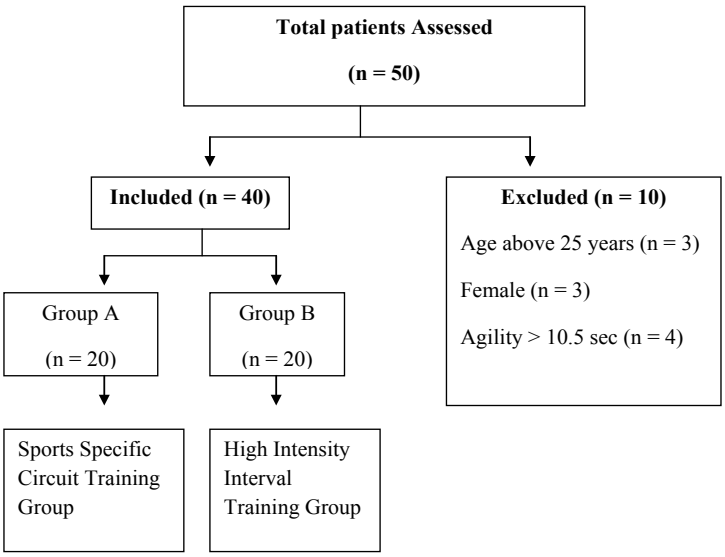
The subjects were assessed prior to the study for the details of parity, age, type of birth. Before providing the Questionnaire, they were explained in detail about the study and the questionnaire. Pre-test for the subjects was done with VAS and female sexual index questionnaire which was given to the subjects and explained and were asked to fill.

Then the study population was divided in to two groups conveniently, Group A subjects were allotted with the treatment of ultrasound therapy, Group B subjects were allotted with the treatment of scar mobilization.

Procedure

Total of 40 Subjects were divided in to 2 groups by convenient sampling 20 in each group. Subjects were taken up for the study after they fulfilled the inclusion criteria. All subjects were evaluated prospectively in the ground and explained about sports specific circuit training to group A and High intensity interval training to group B. Written informed consent was obtained from them. All 2 groups were participated in the training program for 3 days a week 2 sessions per day for six weeks.

Prior to the training the subjects VO2 max was measured by using 1Mile Run test Formula to predict VO2max = 108.844 - 0.1636W - 1.438T - 0.1928H. (Where W = Weight in kg, T = Time for the one mile run and H = Heart Rate at the end of the run) and Treadmill VO2 Max test VO2max = 42 + (Time × 2) "Time" is the total time of the test expressed in minutes and fractions of a minute. Outcome measures were reassessed after 6th week of first assessment:



Group A

■ Sports specific circuit training

The group A underwent sports specific circuit training was carried out on outdoor courts for four times with four minute intervals for every subject. Training protocol average running time of one circuit was 36 second and the total distance covered during on lap was approximately 108m. The proportion of the circuit considered 'offence' activity where a basketball was dribbled was 42%, while 58% was considered 'defensive' activity without the ball. 72% of the movement forward sprinting, 20% side shuffling, 8% back pedaling. One field goal attempt, one rebound, three vertical jump, one pivot, and 14 changes of direction were completed during one repeat of the circuit.

■ Sports specific circuit training includes

1-2. Forward sprint.

2. Pivot left.

2-3. Shuffle left.

3-4. Shuffle right.

4-5. Shuffle left.

5-6. Shuffle right.

6-7. Run into vertical jump collect ball upon landing.

7-10. Speed dribble ball around the cones.

10-11. Speed dribbles.

11-12. Speed dribbles.

12-13. Layup attempt.

13. Layup rebound.

13-14. Speed dribbles.

14-15. Forward sprint.

15-1. back peddles circuit completes.

■ Group b

■ High intensity interval training protocol

The group B undergoes 6 weeks duration of High intensity interval training 3 days per week and 2 sessions per day on treadmill. The duration of training 64 minutes in this 32 minutes training in the morning and 32 min training in the evening, the intensity and speed based on rate of perceived exertion.

■ HIIT training session includes

■ Time intensity/speed perceived exertion

5 min. Warm up at an easy-moderate pace /4-5

4 min. gradually increase your speed, incline and/or resistance until you're working at an intense pace. You should be out of your comfort zone and breathing hard, but able to sustain this level for the full 4 minutes/ 8-9

2 min. Reduce speed to a very light pace to fully recover /3-4

4 min. Increase your speed, incline and/or resistance until you're working at an intense pace/ 8-9.

2 min. Reduce speed to a very light pace to fully recover /3-4.

4 min. Increase your speed, incline and/or resistance until you're working at an intense pace/ 8-9.

2 min. Reduce speed to a very light pace to fully recover/ 3-4.

4 min. Increase your speed, incline and/or resistance until you're working at an intense pace/ 8-9

5 min. Cool down at a very easy/3-4.

Results

From the 40 subjects analysed there is no dropout and all 40 subjects were taken with post test assessment. The pre-test and post-test of 1 Mile run test and Treadmill VO2 Max among Group A subjects were tabulated in **Table 1.** There was a statistical difference between pre and post-test 1 Mile run test in group A subjects trained with sports specific circuit training, $p<0.05$, mean of 1 Mile run test score before the sports specific circuit training was 57.8155 which was increased significantly to mean of 63.847 and there was a statistical difference between pre-test and post Treadmill VO2 max test in group A subjects trained with sports specific circuit training with $p<0.05$, mean of Treadmill VO2 max before the training was 59.003 which was increased significantly to mean of 62.962 after sports specific circuit training.

Pre-test and post-test of 1 Mile run test and Treadmill VO2 Max among Group B subjects were tabulated in **Table 2.** There was a statistical difference between pre-test and post 1 Mile run test in group B subjects treated with high intensity interval training $p<0.05$, mean of 1 Mile run test score before the high intensity interval training was 60.49 which was increased significantly to mean of 64.888 and there was a statistical difference between pre-test and post Treadmill VO2 max test in group A subjects trained with high intensity interval training with $p<0.05$, mean of Treadmill VO2 max before the training was 60.822 which was increased significantly to mean of 65.017 after high intensity interval training.

Post test values of 1 Mile run test and Treadmill VO2 Max were compared between both the groups in **Table 3,** which shows the post-test mean value of 1 Mile run test in group A (63.8370) and in group B is (64.8885) which shows that there was no significant difference between both the groups($p>0.05$). This graph also shows the post test mean value of Treadmill

Table 1: Comparison of pre test and post test values of 1 Mile run test and Treadmill VO2 Max in Sport Specific Circuit Training Group A.

GROUP A		PRE-TEST		POST-TEST		t-values	Significance
		MEAN	SD	MEAN	SD		
PAIR 1	1Mile run test	57.8155	2.77811	63.847	2.940822	-8.987	.000
PAIR 2	Treadmill vo2 max test	59.003	1.55798	62.962	2.312	-14.374	.000

Table 2: Comparison of pre test and post test values of 1 Mile run test and Treadmill VO2 Max in high intensity interval training Group B.

GROUP B		PRE-TEST		POST-TEST		t-values	Significance
		MEAN	SD	MEAN	SD		
PAIR 3	1Mile run test	60.49	2.03883	64..888	2.03903	-12.107	0.000
PAIR 4	Treadmill vo2 max test	60.822	1.75662	65.017	2.09657	-19.407	0.000

Table 3: Comparison of post test values of 1 Mile run test and Treadmill VO2 Max Measure in between sport specific circuit training group A and high intensity interval training group B.

	GROUP A		GROUP B		t-test	Significance
	MEAN	SD	MEAN	SD		
1 Mile run test	63.8370	2.94082	64.8885	2.03903	-1.302	0.201
Treadmill vo2 max	62.9625	2.31200	65.0170	2.09657	-2.944	0.006

VO2 max in group A (62.9625) and in group B is (65.0170) which infers that there is a significant difference between both the groups($p<0.05$).

Discussion

The game of basketball is recreational and a competitive game. It helps promotion of health, body control, alertness, co-ordination and team spirit [42]. The major finding of this study is that specifically designed sport specific circuit training in basketball court and high intensity interval training on treadmill fulfils the criteria for aerobic capacity.

Results of this study showed that sports specific circuit training and High intensity interval training programs was more beneficial in terms of Aerobic capacity for the basketball players ($p < 0.05$) **(Tables 1 and 2).** Several underlying mechanisms for the effect of sports specific circuit training and High intensity interval training programs on Aerobic capacity for the basketball players have been proposed.

The normal aerobic capacity (VO2 Max) for a male basketball players ranges from 45-65 (ml/kg/min).High intensity interval training improves the aerobic capacity due to the High-intensity intermittent training program increases oxidative enzyme activity in muscle [43].

Due to High Intensity Interval Training recruits fast-twitch muscle fibers. These fibers are designed for short-lived, powerful bursts of energy. Steady-state cardio recruits slow-twitch muscle fibers, which are structured for endurance. Fast-twitch fibers need more fuel than do slow-twitch fibers to function and to recover from a workout [44]. Short-term high-intensity interval training, performed 4–5 times per week, leads to an increase in peak oxygen uptake [45].

High intensity interval training was done on the treadmill thrice a week and two sessions per day which VO2 max is a good indicator of fitness level and may change with training. However, if training is already optimal then genetic factors may limit the VO2 max obtained. This test must thus be interpreted in relation to your training and performance potential [46].

Sports specific circuit training design was based on a previous design [47] and adapted to mimic as closely as possible the movement patterns of basketball match play. The training is very easy to practice in the Basketball court which improves the aerobic capacity. The basketball specific endurance circuit induced greater improvements in aerobic fitness, suggesting it was somewhat effective in improving aerobic fitness during the competitive season [48].

Endurance training increases the capacity of the muscles to store glycogen. In High-intensity exercise of short duration (1-2 minutes), almost all energy is supplied from glycogen stored in skeletal muscle. Carbohydrate is the only nutrient that provides energy when the muscles have insufficient oxygen for their needs [49].

High intensity interval training (HIT) is defined as recurring sessions of exercise bouts at an "all out" effort level (greater than 90% of HR max or VO2 max) separated by periods of recovery. Its primary use for many years has been with elite athletes. Exercise duration and frequency may lead to variability in training adaptations. The length of the bout, number of times repeated in one session, time of day the bout is executed, recovery time between bouts, and recovery time between the sessions could also contribute to changes in metabolic, cardiovascular, and pulmonary adaptations.

Immediate energy is required in order to perform high intensity intervals, which requires large amounts of ATP an increased stimulus for ATP production from the increases observed in ATP production markers such as creatine phosphate, creatine kinase, glycogen, lactate dehydrogenase, and lactate.

The role in the production of ATP through anaerobic energy systems. Researchers have found an increase in the production of each marker with HIT, although a reduction in creatine phosphate was observed during HIT sessions in other studies.

Anaerobic glycolysis is a system in which glycogen is converted to ATP for immediate use, typically less than 2-3 minutes. Changes in glycogen, such as increased resting glycogen content and a reduced rate of glycogen utilization during matched-work exercise, were found with HIT. An increased resting glycogen content should result in a delay in the onset of fatigue. Subjects trained every day for two weeks in one study which led to a significantly lowered rate of glycogenolysis, increased creatine kinase, pyruvate kinase, and lactate dehydrogenase activity.

The higher the lactate threshold, the less lactate produced at a given work rate or intensity. High production of lactate following repeated bouts of exercise could possibly induce an aerobic adaptation by improving metabolism of pyruvate.

High intensity exercise bouts less than 10 seconds are considered mainly anaerobic but if a bout lasts longer than 10 seconds a greater demand for energy will occur and cause an increased involvement from the aerobic energy systems. If a 30 second bout were to be repeated three more times, by the fourth bout, the energy would primarily be derived from oxidative metabolism. This could possibly be attributed to an increased rate of oxygen transport and utilization.

Sprint-training bouts of 10 seconds with 50-second rest periods found an increase in the peak rate of the sarcoplasmic reticulum Ca_2+ release following training. High intensity interval training has also shown improved mechanisms contributing to oxygen delivery. Sprint interval training, greater vasodilation of the blood vessels occurs during exercise which could be a mechanism for a reduction in resistance and a possible increased blood flow.

The increased dilation caused a decrease in vascular resistance which was greatest in the white region, the fast twitch skeletal muscle, of the trained rats consequently leading to a proposed overall increase in blood flow capacity. An increase in blood flow through a decreased vessel resistance allows for a greater oxygen delivery to the working muscles which increases the oxygen available for extraction which in turn may increase VO2 max [50].

The improvement in the aerobic capacity after the sport specific circuit training because the duration of the study was six weeks three days per week two sessions per day which is more than the previous study. In mother study the training was done on the competitive session but this study was done on the off season basketball players.

Although there is improvement in Aerobic capacity (VO2 Max) within the groups A and B **(Tables 1 and 2)** but in between the groups A & B Aerobic capacity (VO2Max) improvements are significant in treadmill VO2 max when compare to the 1mile run test after the spot specific circuit training and high intensity interval training **(Table 3)**. Reasons for no improvements in Aerobic capacity (VO2 Max) in 1 Mile Run test after trainings was the Players training programs were undergone on different surfaces and environment could be the initial, and the duration of the trainings were not similar at the baseline. Hence there is no significant difference between sports specific circuit training and high intensity interval training in 1 mile run test values Aerobic capacity but in Tread mill VO2Max values shows improvement in aerobic capacity in Male Basketball Players **(Table 3)**. Hence there is a significant difference in improving aerobic capacity after High intensity interval training when compared to Sports specific circuit training.

Conclusion

This study concludes that there is a significant difference in improving aerobic capacity after High intensity interval training when compared with Sports specific circuit training.

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