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Aerobic endurance (VO_2 max) in elite Indian basketball players: A cross sectional study

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Abstract
The physiological demands imposed on basketball players is provided by the aerobic and anaerobic energy systems. It was conventionally assumed that anaerobic training improved the strength and conditioning of basketball players. However, recent studies show the importance of aerobic training in athletes. The Yo-Yo intermittent recovery test is used to assess an athlete's aerobic capacity. This study aimed to determine the maximal oxygen uptake (VO_2 max) of basketball players using Yo-Yo intermittent recovery test. The study included 24 participants. The athletes were asked to follow the command given by an audio clip, to run back and forth between placed cones. Distance covered (marked at 5 and 20 meters) and speed levels were recorded (distance/time), and VO_2 max was calculated using Yo-Yo intermittent recovery test. Results of the study reported that the VO_2 max of the players was 48.06±60 ml/kg/min. Distance covered by the participants was 1456.67±313.39 meters, with minimum of 800 and maximum of 1880 meters. The maximum speed level was achieved by the player positioned in post/power forward (17.37±0.58 km/hr). The distance covered and the speed level had a strong correlation with VO_2 max ($P< 0.001$). The study concluded that the VO_2 max or the aerobic endurance is a key point in every sport, and yet there are no research papers on the aerobic endurance (VO_2 max) of elite Indian basketball players. The aerobic endurance of basketball players in this study was found to be 48.06±60 ml/kg/min, suggesting further aerobic conditioning in basketball players in India is essential.

Keywords: Aerobic endurance, athletes, basketball, exercise tolerance, VO2 max, Yo-Yo intermittent recovery test

1. Introduction
Basketball has gained universal popularity with more than 2.2 million followers and is the third most popular sport in the world, after football and cricket. In an active game of basketball, 34.1% of play time is spent on running and jumping, 56.8% on walking and 9% on standing [1]. Players are known to cover almost five kilometres in an active game [2].
The physiological demands imposed on the basketball players is met by two main energy systems, namely the aerobic and anaerobic. The anaerobic system supplies energy for short durations and helps in high-intensity muscular contraction. It is also required for success in long jumps, sprints, acceleration and deceleration during the game. The aerobic metabolism helps maintain lower intensity and longer duration of movements which represent 65% of the active basketball game [3]. However, conventionally it was thought that anaerobic metabolism is the primary pathway for energy supply in the sport and hence, strength and conditioning of basketball players often overlooked the contribution of the aerobic system for the success in the game [4]. Various studies have shown the importance of aerobic training in athletes [5,6]. The physiology of basketball has been determined by both aerobic and anaerobic systems, according to some studies [7, 8].
VO_2 max (maximal oxygen uptake) is the point at which oxygen consumption plateaus and is the best predictor of cardiorespiratory endurance or aerobic fitness. There are several field tests (12-minute running test, Leger shuttle run test) available to determine VO_2 max in athletes which are inexpensive and easy to administer. Recently, the Yo-Yo intermittent recovery test was developed which was found to be more accurate, inspired by Leger multistage fitness test to inspect a person's ability to repeatedly perform intermittent exertion with a high aerobic component towards the end of the test [6].

Hence, the goal of this study was to determine the maximal aerobic capacity of basketball players with respect to VO_2 max using the Yo-Yo intermittent recovery test. This may provide useful information regarding aerobic training prescription of the players.

2. Materials and Methods

This cross-sectional study was conducted in Bengaluru, wherein 24 males from Vijaya bank basketball team, residential sports schools and various other academies, aged 18-30 years were included by random sampling method. The participants were eligible state and national level basketball players, selected by the coaches of basketball academies. For recruitment of participants, permission from authorities of the stadium was obtained. Players who were inactive in sports for more than six months, injured or recreational players were excluded from the study. Ethical clearance was obtained from institutional ethics committee (MEU-PT/EC/17/2018) and written informed consent was obtained from all the participants. Potential subjects who fulfilled the inclusion criteria were explained in detail about the study, and videos of the test were shown to the participants for easy understanding of the test process. The preferred running area was a basketball court, 28 meters in length and 15 meters in width.

Participants were asked to rest before beginning the test, and during this period, demographic data of subjects such as age, height, weight, playing position and their contact details were obtained and recorded. The test was conducted in the morning before practice, in basketball attire. A light meal, if necessary, was suggested before the test.

Distance of 25 meters was marked using measuring tape for running test and audio tape was used to give description to the players on how to follow the test. The three marking cones A, B and C were placed in the basketball court (flat ground). The distances between A to B was 5 meters and B to C was 20 meters (figure no-1) [9]. The test was performed using pre-recorded audio. The participating athlete was positioned at B and was asked to follow the command given by the audio to run back and forth as fast as possible in each level. The level of this test kept on increasing with the increase in speed. The participant was asked to stop running when he was exhausted, the distance covered at that point was considered as the test result. VO_2 max was calculated using Yo-Yo intermittent recovery test Level 1 (YYIRTL1): VO_2 max (mL/kg/min) = distance (m) × 0.0084 + 36.4. VO_2 max of the study participants was compared with the other study results [8,10]. Pearson correlation test was used to find out the relation of VO_2 max with different variables (age, height, weight, speed level and distance).

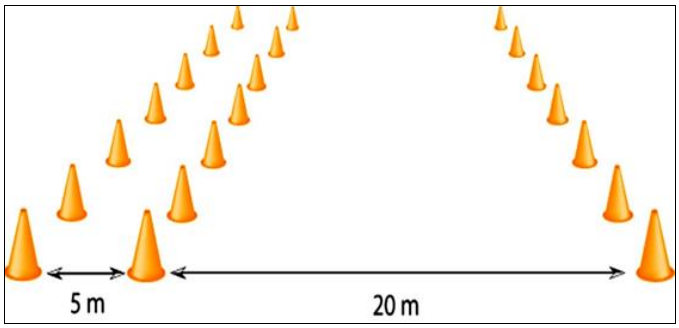

Fig 1: Schematic representation of the Yo-Yo intermittent recovery test (credit: Topend Sports)

3. Results

The mean age, height, weight, speed level, distance covered and VO_2 max of the participants included in the study was 20.79±2.00 years, 185.17±11.23 cms, 77.75±13.44 kgs, 17.09±0.972 km/h, 1456.67±313.39 m and 48.60±2.60 ml/kg/min respectively.

Participants playing as small forwards were found to be the tallest, with a mean height of 188.6±8.04 cm and had the highest speed level of 17.38±0.73 km/h. Players in the post/power forward position covered the maximum distance of 1675±183.22 m and had a higher VO_2 max of 50.38±1.44 ml/kg/min (table no-1).

Table 1: Characteristics of the players with respect to position

Variables	Position of players					
	Defender	Centre	Small forward	Shooting guard	Point guard	Post/power forward
Age (years)	21±0	22±2.94	20.67±1.86	19±0	20.5±1	20.63±2.26
Height (cm)	170±0	187±22.01	188.6±8.04	187±0	175.25±7.63	188.25±4.80
Weight (kg)	78±0	91.5±12.28	79.17±6.67	74±0	62.25±8.65	78±14.69
Speed Level (km/h)	16.5±0	16.07±1.09	17.38±0.73	16.2±0	16.75±1.07	17.37±0.58
Distance (m)	1280±0	1130±364.23	1540±235.62	1160±0	1340±329.03	1675±183.22
VO_2 max (ml/kg/min)	47.15±0	45.87±3.06	49.33±1.98	46.14±0	47.65±2.76	50.38±1.44

Data represented as Mean±SD; VO_2 max = Maximal oxygen uptake

VO_2 max was correlated with different variables, a significant correlation was found between VO_2 max and speed level (P< 0.001), VO_2 max and distance (P< 0.001). No significant correlation was seen with other variables (age, height and weight) (table no-2).

Table 2: Correlation of VO_2 max with different variables

	Variables	P value	Correlation coefficient
VO_2 max	Age	0.613	0.102
	Height	0.159	0.296
	Weight	0.393	-0.182
	Speed Level	<0.001*	0.996
	Distance	<0.001*	0.998

*Significance; VO_2 max = Maximal oxygen uptake.

Of the 24 players, 8 (33.3%) players were in the post/power forward position and 1 (4.16%) player in the defender position (figure no-2).

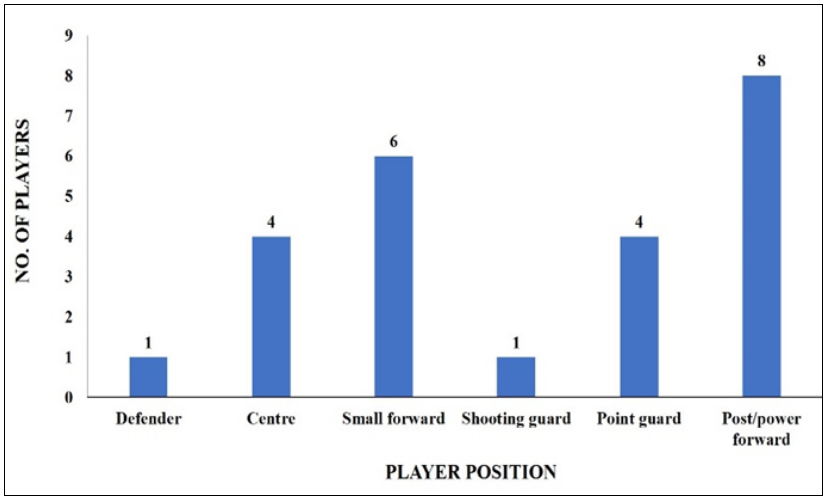

Fig 2: Details of Players position

4. Discussion

Physical fitness is crucial for any sport along with the combination of individual skills, strategy, and tactics. A fast rate of phosphocreatine (PCr) restoration is essential to sustain the high-intensity intermittent movement in athletes. Restoration of PCr is highly dependent on aerobic metabolism [5]. In the study done by Narazaki *et al.* [1], the time motion analysis of basketball players revealed that 58.8% and 32.6% of total time was spent on walking and running, respectively, which mostly requires aerobic energy. Only 9% and 1.5% of the total time on the court was spent in standing and jumping, which implied that the anaerobic demand was quite less [1].

This study showed that in 24 subjects with a mean age of 20.79±2 years, the average distance covered was 1456.67±313.39 meters and mean VO_2 max was 48.60+2.60 ml/kg/min. Even after an extensive search, we could not retrieve any published article to compare these findings on the aerobic endurance of elite Indian basketball players. However, there are a few studies conducted to establish aerobic endurance in recreational and college level players. In an experimental study done in central India to assess the aerobic fitness and physiological parameters in young training basketball players, VO_2 max was recorded as 50.33±2.36 ml/kg/min [8]. Similarly, in an appraisal by Kamble *et al.* [10], VO_2 max was 45.17±9.2 ml/kg/min. Comparing these studies with the findings of the present study indicate that there is no significant difference in the aerobic capacity between elite versus recreational or beginner basketball players among the Indian population. Hence, it may be inferred that state and national level players in India are not adequately trained for aerobic fitness. Aerobic endurance in our participants was significantly lower when compared to athletes of different nations and this corroborates with the review done at Gatorade Sports Science Institute, USA, where the scientific data on VO_2 max demand of elite USA basketball players was reported to be up to 60 ml/kg/min for males and up to 54 ml/kg/min for females [7]. Similarly, an average VO_2 max of 57.2+8.2 ml/kg/min was observed in a study done in United States by Narazaki *et al.* [1] in order to view the physiological demands of competitive basketball. The study also demonstrated that the aerobic demand during an actual match was much higher, where the players had a VO_2 max of 64.7±7 ml/kg/min, emphasizing the necessity of aerobic training [1].

In the present study, the aerobic capacity with respect to the position played showed that the player in power forward (PF) position had a greater aerobic capacity (1675+183.22 meters and 50.38+1.44 ml/kg/min) whereas the center positioned players had the least comparative aerobic endurance (1130+364.23 meters and 45.87+3.06 ml/kg/min). These findings are in contradiction to results by Castagna *et al.* [11] who report no significant positional effects on Yo-Yo intermittent recovery performance. This may be because the athletes of the present study were trained specifically, keeping the player position in consideration. For example, the role of the center (C) is to shoot the ball to the basket, they are usually tall and heavy in build, which may make them less capable of running longer distances [5]. Physiological requirements of basketball players are great, considering both cardiovascular and metabolic needs. Therefore, the scope of endurance training in athletes is high and the need for aerobic training in players should be emphasized.

4.1 Limitations

Due to lack of resources and additional expenses, field test was performed as opposed to laboratory tests which are more valid and reliable. The sample was limited to elite basketball players from Karnataka. If this study had been extended to a larger sample across the country, the results would be more representative of the population. The study only included male elite basketball players because the number of elite female basketball players in the center were limited. The results could be varied if the study was extended to both the genders.

5. Conclusion

To the best of our knowledge, this is the first study in India to quantify aerobic endurance of professional state and national level basketball players.

The purpose of the current study was to gain some insight into the aerobic endurance of Indian elite basketball players. The results of this study indicate the necessity of aerobic training among players. Basketball training model should be based on physiological determinants. The Yo-Yo intermittent recovery test results of this present study may be represented as a valid reference for future large-scale research on competitive basketball players.

6. Acknowledgements: Nil

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