

Comparative Study of Aerobic and Anaerobic Capacity in Football Players and Judo players

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Abstract

Background: Aerobic capacity of an athlete is an important element of success in sport achievements. It is functional capacity of an organism to raise the level of metabolic process in keeping with the requirement of physical effort being exposed to. Anaerobic capacity is the ability to mobilize energy during activities of intensive nature i.e. executing intensive work with explosive action in short duration of time, such as , kicking the football faster and for explosive take off in jumps etc. Both aerobic and anaerobic capacities play an important role in influencing the performance in various games and sports. .

Aim: To estimate the values of Aerobic capacity, anaerobic capacity in Football players, Judo players and control group.

Material and Methods: 30 Football players and 30 Judo players of age between 18-22 years and age and sex matched sedentary medical students were included in the study as a control group. VO₂ max was calculated by Queen's College Step test and anaerobic power by vertical jump reach test. Values were reported as mean ± SD. Football players, Judo players and control group comparison was analyzed by applying unpaired t test.

Results: The mean value of Aerobic capacity in Football players was 58.35 ± 4.4 , in Judo players was 54.7 ± 4.07 and in control group was 49.01 ± 3.96 . The mean value of anaerobic capacity in Football players was 815.42 ± 81.73 , in judo players was 823.88 ± 69.5 and in control group was 741.2 ± 153.91 . There was a highly significant ($p < 0.001$) difference between mean values of Aerobic capacity and anaerobic capacity in the three groups.

Conclusion: Football players have significantly ($p < 0.001$) higher aerobic capacity than both judo players and control group. Judo players have significantly ($p < 0.05$) higher value of anaerobic capacity than control group where as anaerobic capacity of Football players and Judo players were similar.

Key words: Aerobic capacity, Anaerobic capacity, Football, Judo

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I. Introduction

Aerobic capacity of an athlete is an important element of success in sport achievements. Physiologically, it is functional capacity of an organism to raise the level of metabolic process in keeping with the requirement of physical effort being exposed to. Metabolic process means transformation of chemical energy into mechanical one. ⁽¹⁾

VO₂max (maximum oxygen uptake) refers to the intensity of aerobic process means the maximum capacity to transport and utilize oxygen during exercise done at increasing intensity. "It is highest rate of oxygen consumption attainable during maximal exercise."⁽¹⁾ It represents physical fitness of an individual having athletic capacity.

As the intensity of exercise increases oxygen consumption also increases. However a point is reached, where exercise intensity continue to increase without rise in oxygen consumption. The point at which oxygen consumption plateau define VO₂max or maximal aerobic capacity is generally considered the best indicator of cardio respiratory endurance and aerobic fitness. ⁽²⁾

Anaerobic capacity is the ability to mobilize energy during activities of intensive nature i.e. executing intensive work with explosive action in short duration of time, such as , kicking the football faster and for explosive take off in jumps etc. These intensive burst of activities depend upon anaerobic capacity i.e. efficiency in energy production in the absence of oxygen supply, though the oxygen would be taken up later during the recovery period after cessation of activity. ⁽³⁾

The term anaerobic capacity, anaerobic power and anaerobic threshold have all been used interchangeably to denote the same physiological concept by some scientist. It is the ability of the body musculature to generate significant amount of work is consider being a strong predictor of athletic success.⁽⁶⁾ Currently anaerobic power test are implemented in both clinical and field setting and access an athlete's capability to produce both power and speed in a short period of time over a relatively short distance.⁽¹⁰⁾

Anaerobic exercise is an exercise intense enough to trigger lactate formation. It is used by athletes in non endurance sports to achieve strength, speed and power. Muscle energy system trained using anaerobic exercise develop differently compare to aerobic exercise , leading to greater performance in short duration, high intensity activities which last from mere second up to 2 minutes. Any activity, which have longer than about two minutes duration uses aerobic metabolic components.⁽²⁾

Both aerobic and anaerobic capacities play an important role in influencing the performance in various games and sports. In activities which involve working with maximal intensity for short period of time, such as weight lifting, kicking of football fast, explosive jumping etc. where anaerobic capacity play an important role in games where a sportsman has to resist fatigue relatively for longer period without effecting skill proficiency, for example, long distance running, swimming, cycling, rowing and even some team sports such as football, hockey, aerobic capacity of an individual play an important role.⁽³⁾

Football is team sport that is played in an outdoor field , and training is mainly based on movement implementing the endurance qualities consisting of moderate activity alternating with periods of intermittent high intensity⁽²⁾, and is characterize by short duration high speed run, jumps, heading and ball disputes beside other activities such as trots, low speed running and walks.⁽⁵⁾

Judo is dynamic, high –intensity intermittent sport that requires complex skill and tactical excellence for success.⁽⁶⁾

In judo movements are powerful, delivered in a short period of time, usually against the force of the opponent. It is a type of sport activity that requires the alternative metabolic involvement of aerobic and anaerobic pathways. A judo combat is characterized by the presence of brief intense muscular actions (15- to 30-seconds) in which anaerobic system is primarily involved. But the entire duration of judo combat (more than 5 minutes) implies the involvement of aerobic system, mainly towards the end of combat.⁽⁷⁾

II. Study Objective

1. To estimate the values of Aerobic capacity, anaerobic capacity in Football players, Judo players and control group.
2. To compare Aerobic Capacity, Anaerobic capacity within Football players, Judo players and control group.

III. Material and Methods

The present study was a cross sectional comparative study, conducted in the department of physiology in December 2015. The approval for the study was obtained from institutional ethical committee. Total 90 healthy subjects were included in present study.

Selection criteria: Professional football players and judo players from the Aurangabad city in the age group of 18 to 22 years, who have been playing regularly for more than three years, and have played tournament at club level, were selected as subjects. Thirty individual were included in each group
Individual in the age group of 18 to 22 years, who are having a sedentary life style with no involvement in any athletic activity or yoga, were selected as a controls. Thirty individual were included in this group.

Exclusion Criteria: Following exclusion criteria were applied.

1. Smoked any time in life
2. Subjects playing the games for less than 3 years.
3. Subject playing all the games
4. History of any major illness or chronic diseases.
5. Cardiovascular diseases.
6. Respiratory diseases.
7. Patient of diabetes mellitus.

Procedure: All the subjects and control were well explained about the nature of the study and the detailed procedure of the study. Written consent was taken from all of them. Subjects were asked to come 3 hours after their meal. They were asked not to indulge in any kind of vigorous exercise within 48 hours prior to the test. They were asked to wear comfortable clothing. Following measurements were done in a well-lit room of the Department of Physiology in the medical college.

Body weight: measured by standard weighing machine.

Standard Height: taken by measuring tape

Body mass Index: It was calculated as

Body Mass Index (BMI) = Weight in Kilograms (kg) / (Height in meter)²

Determination of VO₂max(Aerobic capacity): Queens College Step Test was used to predict maximal aerobic capacity. It is a standard method to measure one's maximal oxygen uptake using sub maximal exercise in the form of bench stepping, suitable for adults. Prior to the test, subjects were asked to warm up for 5-7 minutes consisting of brisk walking and stretching of lower limb muscles. A wooden stepping bench of 16 ¼ inch was used along with metronome and stop watch. Metronome was used to monitor the stepping cadence, which was set at 96 beats per minute (24 complete steps per minute). The step test began after a brief demonstration and practice period. The subjects were asked to perform each stepping cycle to a four step cadence, up-up-down-down continuously for 3 minutes. After completion of test, subjects remained standing while pulse rate (carotid or radial artery) was measured for 15 seconds, from 5th to 20th second of the recovery period. Fifteen second Recovery heart rate was converted to be expressed as beats per minute (15 second Heart Rate x 4)⁽⁸⁾

Following equation is used for calculating VO₂max:

VO₂max (ml/kg/min) = 111.33 – (0.42 x step test pulse rate in beats per minutes)

Determination of Anaerobic capacity: Anaerobic capacity was measured by vertical jump reach test. This test measures the difference between a person's standing reach and the height to which he could jump and touch. The power was calculated by using Lewis formula.⁽⁹⁾

Procedure is the subject was asked to warm up for 10 minutes then he holds the tip of chalk with the tip of fingers. He stands close to the wall with feet 6" apart from each other and reaches as high as possible with one hand and mark the wall with chalk (M1). The subject is asked to jump as high as possible from static position and mark the wall with the chalk in his fingers (M2). The distance between M1 & M2 was measured and recorded. Three trials were given. The maximum value among the 3 readings was used to calculate the anaerobic power by the Lewis formula. Lewis formula estimates average power-

Average power (Watts) = $\sqrt{4.9 \text{ mass (Kg)} \times \sqrt{\text{VJ (cm)}} \times 9.81}$ ⁽¹⁰⁾

Where mass is weight in Kg & VJ is distance between M1 & M2 in cm.

IV. Results

The results show no significant difference in age and the weight in the three groups. There was a significant difference (P < 0.05) between the three groups in height, body mass index (BMI) and pulse rate. The body mass index (BMI), pulse rate of control group were significantly (P < 0.05) higher than Football players and Judo players. (Refer table no 1)

Table I - Mean value of Physical characteristics in Football players, Judo players and control group

Group	Football Players	Judo Player	Controls	P value
	(Mean ± SD)	(Mean ± SD)	(Mean ± SD)	
Age(year)	19.16 ± 1.05	19.76 ± 1.07	19.03 ± 1.07	0.098
Height(cm)	170.53 ± 7.8	170.03 ± 5.4	165.03 ± 5.9	0.002**
Weight(kg)	59.26 ± 5.2	60.5 ± 4.1	63.3 ± 9.7	0.754
Body Mass Index(kg/m ²)	20.40 ± 1.57	20.95 ± 1.51	22.11 ± 3.22	0.01*
Pulse rate(beats/min)	61.9 ± 4.1	62.9 ± 4.3	70.4 ± 4.34	<0.001**

*p < 0.05 statistically significant **p < 0.001 statistically highly significant

The mean value of Aerobic capacity in Football players was **58.35 ± 4.4**, in Judo players was **54.7 ± 4.07** and in control group was **49.01 ± 3.96**. There was a highly significant (p < 0.001) difference between mean values of Aerobic capacity in the three groups. Football players have significantly (p < 0.001) higher Aerobic capacity than both Judo players and control group. Judo players have significantly (p < 0.001) higher Aerobic capacity than control group but lower than Football players.

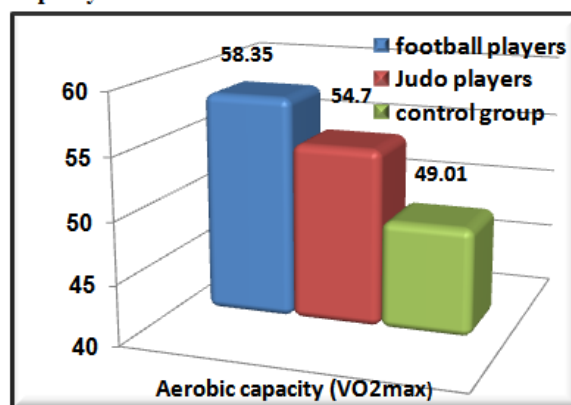
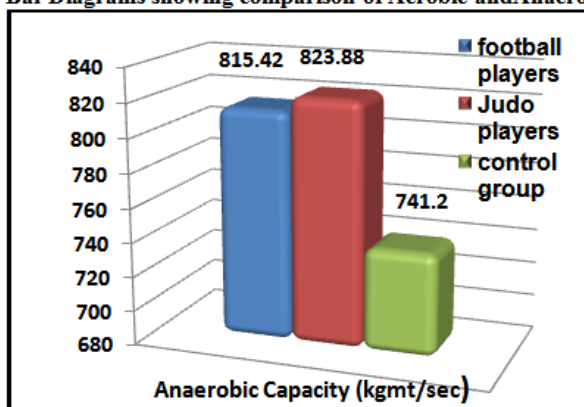
The mean value of anaerobic capacity in Football players was **815.42 ± 81.73**, in judo players was **823.88 ± 69.5** and in control group was **741.2 ± 153.91**. There was a significant (p < 0.05) difference between mean values of Anaerobic Capacity in three groups. Judo players have significantly (p < 0.05) higher value of anaerobic capacity than control group where as anaerobic capacity of Football players and Judo players were similar.(Refer table 2)

Table II –Comparison of Aerobic Capacity within Football players, Judo players and control group

Capacities	Groups			P value
	Football players (Mean ± SD)	Judo players (Mean ± SD)	Control group (Mean ± SD)	
Aerobic capacity(VO ₂ Max) (ml/kg/min)	58.35 ± 4.4	54.7 ± 4.07	49.01 ± 3.96	0.000**
Anaerobic Capacity (kg-mt/sec)/ watt	815.42 ± 81.73	823.88 ± 69.5	741.2 ± 153.91	0.007*

*p < 0.05 statistically significant

Bar Diagrams showing comparison of Aerobic and Anaerobic Capacity



IV. Discussion

The result shows significantly lower basal pulse rate in football players and judo players as compare to control group. This is due to regular exercise in football players and judo players causing bradycardia in athletes. The athlete’s heart is longer and considerably stronger than that of normal person, which allow the athlete heart to pump large stroke volume output per beat even each beat initiates feedback circulatory reflexes or other affect to cause bradycardia. ⁽¹¹⁾

Both Aerobic and Anaerobic capacities play an important role in influencing the performance in various games and sports. In activities which involve working with maximal intensity for shorter period of time, such as, Sprinting, Weight lifting, kicking of Football fast, explosive jumping etc. Where anaerobic capacity play an important role in games and sports where a sportsman has to resist fatigue relatively for longer period without effecting skill proficiency, for example, long distance running, swimming, cycling, rowing and even some team sports such as football and hockey, Aerobic capacity of individual plays an important role. ⁽⁵⁾

Football and judo are two very different sports. However, they are similar in that they include aerobic and anaerobic components. The amount of aerobic and anaerobic activity varies among these sports. Indeed, judo is an individual sport which is played indoors on a tatami and its training increases equilibrium, coordination, speed, strength, suppleness, skill, endurance and resistance. On the other hand, football is a team sport that is played in an outdoor field and training is mainly based on movement implementing the endurance qualities consisting of moderate activity alternating with periods of intermittent high intensity, leading to a significant production of metabolic heat and is characterized by short-duration high-speed runs, jumps, headings and ball disputes, besides other activities, such as trots, low-speed running and walks. ⁽¹²⁾

There was a difference between mean values of Aerobic capacity in three groups which was statistically highly significant (p < 0.001). Football players have significantly higher aerobic capacity than both Judo players and control group. Judo players have significantly higher Aerobic capacity than control group but lower than football players.

Aerobic capacity is the ability to mobilize energy for continuous performance of specific movement for prolonged time i.e. capacity for prolonged physiological functioning under continuous supply of required oxygen under conditions of required oxygen completely available. The glucose molecule is completely broken down to CO₂ and H₂O, and energy is made available as needed. ⁽⁵⁾

The probable reasons for increase in aerobic capacity in regular football players are

Football, as a representative of sports games, requires an intermittent performance with intertwining the aerobic and anaerobic exercises. The player is thus required to have an efficient energetic system which would support all 90 min maintaining full strength. The average distance made during the match by football players is 8-12 km, with aerobic/anaerobic ratio 90%:10%. ⁽¹³⁾

- 1) Regular training increases VO_2 max by increasing the cardiac output, secondary to high stroke volume and an increase in arterio-venous oxygen difference. It appears that physical training increases the VO_2 max by about 50% and rest 50% due to increased extraction of oxygen by working muscle which is reflected in an increased arterio-venous oxygen difference.⁽¹⁴⁾
- 2) The density of capillaries of the skeletal muscle is increased by training; therefore, increased capacity to irrigate the muscle with blood due to an increased vascularisation must be one of the factors responsible for increased aerobic capacity.⁽¹⁵⁾
- 3) There is a selective hypertrophy of slow twitch and fast twitch muscle fibres depending upon the type of training and activity.⁽¹⁶⁾
- 4) Following acute exercise and exercise training, there is over expression of PGC1 α in skeletal muscle and mayo tubes which results in large increase in mitochondria.⁽¹⁷⁾

Judo players have shown lower aerobic capacity than football player this was probably due to -

Judo is primarily an anaerobic base activity where VO_2 max is not an essential quality more over the duration of activity is also very shot.⁽¹⁸⁾

The practice of judo, which contains less aerobic activity than football, can increase the LM but without a real decrease of FM.⁽¹²⁾

The highest value of aerobic capacity in football players and judo players as compare to control group was due to-

The training increases VO_2 max by increasing the cardiac output, secondary to high stroke volume and an increase in arterio-venous oxygen difference. It appears that physical training increases the VO_2 max by about 50% and rest due to increase extraction of oxygen by working muscle which is reflected in an increased arterio-venous oxygen difference.⁽¹⁴⁾

The intense aerobic endurance training can induce considerable enlargement of all the cardiac chambers with a change in the cardiac configuration.⁽²¹⁾

Anaerobic capacity

There was a significant ($p < 0.05$) difference between mean values of Anaerobic Capacity in three groups. Judo players have significantly ($p < 0.05$) higher value of anaerobic capacity than control group where as anaerobic capacity of Football players and Judo players were similar.

Anaerobic capacity is the ability to mobilize energy during activities of intensive nature i.e. executing intensive work with explosive action in short duration of time, such as, kicking the football faster and for explosive take off in jumps, maximum rate for about two to three minutes under water swimming.⁽³⁾

The anaerobic capacity of judo players was higher due to the fact that –

Judo is a dynamic, physically demanding sport, requiring a high degree of physical conditioning and strength in order to be successful and offset fatigue. Many authorities characterize sport judo as an explosive power sport, requiring tremendous reserves of anaerobic power and capacity, yet operating within a well-developed aerobic system.

A judo combat is characterized by the Presence of brief intense muscular actions (15 to 30-second) in which the anaerobic system is primarily involved. On the other hand, the entire duration of judo combat (more than 5 Minutes) implies the involvement of the aerobic system, especially toward the end of the Combat.

Research has shown that the energy for muscle activity in judo is predominantly derived from anaerobic sources and suggests that of adenosine triphosphate (ATP) replenishment comes from creatine phosphate (CP) in 90 %, and lactate glycolytic pathway up to 10 %.⁽⁷⁾

There was no significant difference in anaerobic capacity of football players and judo players may be due to-

Genetic structure is a determinant factor for anaerobic power levels as well as recreational sportive activities.⁽²⁰⁾

According to the various tests of exploration, it appears that the practice of football and judo stimulates the improvement of anaerobic performance.

Footballer demands high anaerobic power as quick acceleration and deceleration are important in this sport. Although most time of the game is spent in low level activities such as walking and light jogging, repeated back-to-back sprints make speed and tolerance to lactic acid an important characteristic in players. High anaerobic power is essential for such activities. Thus a high anaerobic power helps to develop sprint quality of the players.⁽²¹⁾

High anaerobic performance of football players was attributed to the aerobic and repeated practice polymeric exercises during training in football. ⁽²⁵⁾

Both football players and judo players have significantly higher anaerobic power than control group because-

High anaerobic performance of football players and Judo players seems to be explained by a greater LM compared to control subjects and also mainly by low FM compared to the control group. ⁽²⁵⁾

Similar findings were shown by following studies.

In 1995 De Cree et al reported a significant increase of VO₂max after six weeks of judo training in woman around 17–29 years. ⁽²²⁾

In 2002 Mandigous S et al studied the Effect of two aerobic training regimens on the cardiorespiratory response of prepubertal boys. The result shows VO₂max can be increased after a training program with aerobic dominance. ⁽²³⁾

Different findings were shown by the following studies-

Nikhil Kumar Rastogi et al (2013) al conducted study on Comparison of Aerobic and Anaerobic Capacity of Male and Female Players of Individual Sports. Results showed that, aerobic capacity of different individual sports is not significantly different. More or less similar kind of aerobic capacity is required in all types of sports. Reason behind this was Aerobic capacity play vital role in all types of sports. Each sportsman has to develop it according to its need and requirement in their respective games and sports. ⁽²⁴⁾

V. Conclusion

Our study was mainly aimed to show the effect of training on Aerobic Capacity (VO₂max) and Anaerobic Capacity. It revealed that the sport activity has definite effect on Aerobic Capacity (VO₂max), which can be taken as index for cardio respiratory fitness. Thus proves benefit of regular exercise in community. We welcome the clinical trials for proving this benefit and large surveys for knowing awareness in the field of regular exercise in the form of sports like football, judo which improves both aerobic and anaerobic performance.

The result of this study strongly recommends regular physical exercise in terms of sports for the sedentary people. Secondary life style affects their work output. Regular physical exercise in terms of sport activity will definitely improve their cardio respiratory fitness by increasing vo₂max and decreasing body fat percentage and will help them to lead a better quality of life.

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