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Comparative Study of Aerobic and Anaerobic Power In Football Players and Control Group

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Abstract
Background*: Sport performance in football players is determined by Aerobic and Anaerobic power in them. Aerobic power is best indicated by VO_2max. VO_2max is maximum capacity of individual's body to transport and utilize the oxygen during exercise, which reflects the physical fitness of individual. Anaerobic power is power produced in absence of oxygen. Anaerobic capacity is useful in sprints in football players.*
Aim*: To determine values of VO_2max and anaerobic power in football player and control group.*
Material &Methods*: 30 Football players of age between 20-30 years and age and sex matched sedentary medical students were included in the study as control group. VO_2max was calculated by Harward step test and anaerobic power by Vertical Jump reach test. Values were reported as mean ± SD. Football player and control group comparison was analyzed by applying unpaired t test.*
Results*: VO_2max and anaerobic power in football player was 57.8± 4.2 mL/kg/min and 1028.5± 152.51 watts. In control group VO_2max and anaerobic power was 34.88 ± 5.28 mL/kg/min and 867.67 ± 136.90 watts. There was significant increase in VO_2max and anaerobic power in football players as compared to control group.*
Conclusions*: The significant differences probably results from the character of exercise and conducted training in the considered disciplines in football players.*
Key words*: VO_2 max, Vertical jump reach test, Anaerobic power, Harward step test.*

I. Introduction

Aerobic capacity of athletes is an important element of success in sports achievements. Physiologically, it is functional capacity of an organism to increase the level of metabolic process in keeping with the requirement of physical effort being exposed to. Metabolic process in this sense means the transformation of chemical energy into mechanical one.[1,2]

VO_2max (maximum oxygen uptake) refers to the intensity of aerobic process and actually denotes the maximum capacity to transport and utilize oxygen during exercise done at increasing intensity. "It is highest rate of oxygen consumption attainable during maximal/ exhaustive exercise."[3]It reflects physical fitness of an individual having athletic capacity.

When the muscular activity is rapid and violent then the source of energy is through anaerobic mechanism, whereas, in the case of a prolonged muscular activity the source of energy initially is through anaerobic processes followed by aerobic process.[4] Short-term muscle power depends on the degradation of ATP and its replenishment from phosphocreatine (PCr) .The rate of both processes is comparatively high, but as PCr stores are limited (sufficient for approx. 100 contractions), and need to be replenished by the slower, oxidative metabolism, the high phosphate-based power can be sustained only for a limited time. Therefore, sprinting performance basically relies upon 'anaerobic' mechanisms, whereas endurance performance is usually thought to be limited by 'aerobic' power.[5]

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 sprints of intermittent high intensity[6], and is characterized by short duration high speed runs, jumps, heading and ball disputes, besides other activities such as trots, low speed running and walks.[7]

Football is a sport that uses combination of both aerobic and anaerobic capacity. So this research is an attempt to estimate value of VO_2max and anaerobic capacity in Football Players and to compare it with control to see benefits of football as a sport to alter the capacities.

II. Material And Methods

The study was a cross sectional comparative study. The approval for the study was obtained from Institutional Ethics Committee. The study was conducted in the Department of Physiology in December 2014.

Selection criteria: Normal healthy subjects playing football in the age group 20 to 30 years who have been playing regularly 40 minutes per day for at least 5 days in a week for more than five years, and have played tournaments at club level, were selected as subjects. Individuals in the age group of 20 to 30 years, who are having a sedentary lifestyle with no involvement in any athletic activity or yoga, were selected as controls. Thirty individuals were included in both groups.

Exclusion criteria: following exclusion criteria were applied:

1. Smoked any time in life
2. Cardiovascular or Respiratory disease
3. Patient of diabetes mellitus
4. Subject playing the game for less than 5 years
5. Subject playing other game
6. History of any major illness or chronic disease

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[4] -

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

Determination of VO_2max(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 VO_2max : VO_2max (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.

The 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[9] by the Lewis formula.

Lewis formula estimates average power-

Average power (Watts) = $\sqrt{}$4.9 mass(Kg) x $\sqrt{}$VJ(cm) x 9.81 where mass is weight in Kg & VJ is distance between M1 & M2 in cm.[10]

III. Results

The results showed no significant difference in demographic data of the control group and football players. Age, height, weight and BMI of individuals showed no statistically significant difference. The basal pulse rate of both the groups differs significantly.(refer to table1)

Table 1- Demographic Data Table

	Control n=30		Football Player n=30		p value
	Mean	SD	Mean	SD	
Age(years)	26.23	2.69	26.03	3.07	0.67
Height(cm)	172.50	3.67	172.17	4.09	0.24
Weight(kg)	70.97	6.45	65.20	4.20	0.36
Body Mass Index (kg/m^2)	24.18	2.27	22.80	1.47	0.28
Pulse rate (beats/min)	74.33	4.10	65.87	4.31	<0.001*

*= Statistically significant

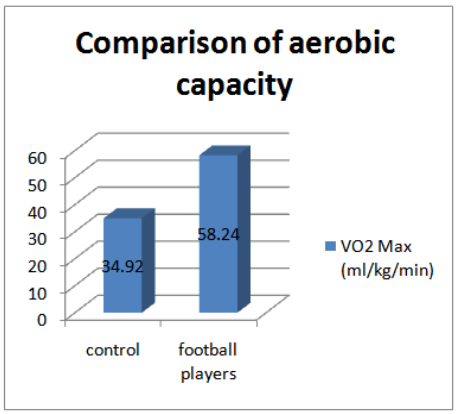
Aerobic capacity in football players was 58.24 ml/kg/min ± 4.33. In control group it was 34.92ml/kg/min ± 5.16. The results were statistically significant.(refer to table 2)

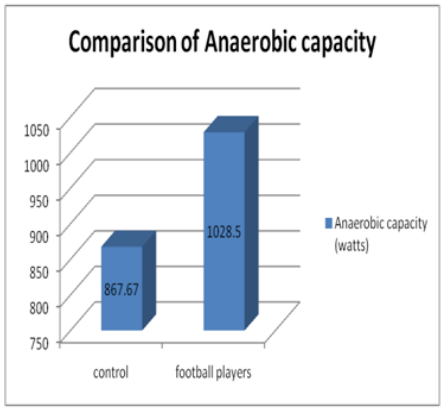
Anaerobic capacity was 1028.5 watts ± 158.5 in Football Players. Control group has anaerobic capacity of 867.67watts ± 136.91. The increase in the anaerobic capacity was statistically significant. (Refer to table 2)

Table 2: Comparison of Aerobic and Anaerobic capacities in Football Players and Control group

Capacities	Football players (mean±SD) n=30	Control (mean±SD) n=30	'P' value	Significance
VO_2 max (ml/kg/min)	58.24 ± 4.33	34.92 ± 5.16	<0.0001	***
Anaerobic capacity(watts)	1028.5 ± 158.5	867.67 ± 136.91	<0.0001	***

Bar Diagrams showing comparison of Aerobic and Anaerobic capacity





IV. Discussion

The results show significantly lower basal pulse rate in football players. This is due to regular exercise in football players causing bradycardia in Athletes. The athlete's heart is larger and considerably stronger than that of a normal person, which allows the athlete's heart to pump a large stroke volume output per beat even during periods of rest. When the athlete is at rest, excessive quantities of blood pumped into the arterial tree with each beat initiate feedback circulatory reflexes or other effects to cause bradycardia.[11]

The results show increase in both aerobic and anaerobic capacity in football players as compared to control.

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 (VO_2 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. 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 data presented by Živanić, related to physiological profile of football players, show that the average distance made during the match by football players is 8-12 km, with aerobic/anaerobic ratio of 90% :10%.[12]

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

- Regular training increases VO_2max 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_2max 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.[13]
- 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.[14]

- There is a selective hypertrophy of slow twitch and fast twitch muscle fibres depending upon the type of training and activity. [15]
- Following acute exercise and exercise training, there is over expression of PGC-1α in skeletal muscle and mayo tubes which results in large increase in mitochondria. [16]
  Similar results were found by Goran Ranković1et.al[2]., Laskowski R et al[17] when they compared aerobic capacity in sports.

Anaerobic capacity was also significantly increased in football players. This may be due to repeated sprints in game of football. Phosphagen system and creatinine phosphate are required in sprints to produce instant energy. Recovery of deleted stores of creatinine phosphate depends upon interval between the sprints. As the duration between sprints decreases the resynthesis of creatine phosphate stores occurs causing increase fatigue time.[18]

Holmyard et al., (1988) found individuals producing the highest peak power output during repeated 6s sprinting efforts on a non-motorized treadmill had the greatest decreases in mean power output. Consequently, subjects who could produce higher peak power outputs and better sprint times are most likely able to do so due to their ability to utilize a greater proportion of their creatine phosphate stores. With short recovery periods, these subjects would have lower creatine phosphate stores prior to the next sprint and are therefore likely to fatigue more over a series of repeated sprints.[19]

Hossein Soltani et.al. compared both aerobic and anaerobic capacity in Iranian players during different playing positions observed that middle and attacker players showed a significant increase in aerobic fitness or VO2max ($p<0.05$). Furthermore, defender and attackers showed a significant increase in anaerobic power during competitions season ($p<0.05$). Based on the results of conducted research, anaerobic power and aerobic fitness profiles in soccer players changed during competitions season.[20]

Thus football as a game increases both aerobic and anaerobic capacity. The game is an excellent example to increase capacities when used for regular training.

V. Conclusion

The study shows significant increase in both aerobic and anaerobic capacity in football group as compared to non exercising control group 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 which improves both aerobic and anaerobic performance.

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