A Study of Haemodynamic and Aerobic Fitness Profile of Football Players

Kumar[1], Ashok & Singh[2], Mandeep.
[1]Assistant Professor, Department of Sports Science, Punjabi University Patiala-147001, (Punjab), India.
Email: akashokin@gmail.com.
[2]PG Student, Department of Sports Science, Punjabi University Patiala-147001, (Punjab), India.

Abstract

The purpose of this study was to observe haemodynamic and aerobic fitness profile of football players. Thirty (N=30) male college football players between the age of 17 and 28 years volunteered for this study. The mean age, height and weight of football players was 21±3years, 172.63±8.64cm and 71.56±10.75Kg respectively.The mean resting pulse rate, systolic blood pressure, diastolic blood pressure, pulse pressure, mean arterial pressure, rate pressure product, stroke volume, cardiac output and VO_2 max was 69±4beats/minute, 120±3mmHg, 78±3mmHg, 42.07±4.71mmHg, 91.67±2.94 mmHg, 83.06±5.05beats.min^{-1}.mmHg, 57.38±5.65ml/beat, 3.97±0.28 L/minute and 42.60±2.26 ml.kg^{-1}.min^{-1} respectively. It was concluded from the results of this study that college level football players have less values of haemodynamic and aerobic fitness variables than elite level football players and athletes of other countries. Thus, they may need to focus on improving haemodynamic and aerobic fitness variables and this could be a focus of their training programme.

Key Words: Mean Arterial Pressure, Stroke Volume, Cardiac Output, VO_2max

Introduction

The performance of the football players depend on different kinds of physiological characteristics. Exceptional endurance performance capacity has long been known as important prerequisite for on-field performance of football players *(Ekblom, 1986; Reilly, 1997; Bangsbo et al., 2006).* For instance, a player's aerobic endurance capacity facilitates performance continuity, which is limited by endurance, throughout a 90-120 minute game. In addition, it influences the recuperation capabilities following high-intensity games and training units and the recovery following concise high-intensity exercise spurts throughout the games or training units *(Ekblom, 1986; Reilly, 1997; Reilly et al., 2008).* There is significant agreement that the maximum value for uptake, transport, and use of oxygen is a good sign of the working of the respiratory, cardiovascular and musculoskeletal systems. This is one of the reasons why research has shown great interest in the determination of haemodynamic and aerobic fitness variables, in a direct or indirect way, facilitating the understanding of physiological aspects related to performance of football players during matches and training programme. Therefore, the purpose of this study was to observe selected haemodynamic and aerobic fitness variables of college football players so that players and coaches could know the status of the physiological adaptations of football training programme.

Materials & Methods

Date of Communication: Sep.12, 2014
Date of Acceptance: Sep. 17, 2014

Thirty male college football players of state and inter-university level of participation from Mastuana College of Physical Education, Sangrur (Punjab) India volunteered to participate in this study and their age ranged between 17 to 28 years. Selected anthropometric measurements on the subjects were recorded by using standardized procedure as described by *Weiner & Lourie (1969).* The aerobic fitness (i.e.VO_2max) was predicted by using resting pulse rate for 20 seconds and enter the number of beats that counted, along with subject's age, into the following equation *(Uth et al., 2004 and Tanaka et al., 2001).*

VO_2max (ml/kg/min) = 15.3 x (MHR/RHR)
where, MHR = Maximum heart rate (beats/minute) = 208 - (0.7 x Age)
RHR = Resting heart rate (beats/minute) = 20 second heart rate x 3

The haemodynamic variables like Pulse Pressure (PP = SBP- DBP), Mean Arterial Pressure (MAP = Diastolic pressure + 1/3 (Systolic - Diastolic pressure)) *(Andy et al., 1985),* Rate pressure product (RPP = HR x SBP /100) *(Nagpal et al., 2007 & Balogun et al., 1990)* was estimated by using various equations.

Statistical Analysis

Statistical analysis was performed with SPSS version 16.0 (free trial, SPSS Inc, Chicago). Results are shown as Mean and Standard Deviation. The alpha level for the data analysis was determined at $p<0.05$.

Results & Discussion

Table 1 shows the number and percent distribution of football players according to their playing positions in the present study. As per their playing positions of the football players 43.3% (N=13) were back, 33.3% (N=10) forward, 16.7% (N=5) center and 6.7% (N=2) goalkeeper.

Table 1: Number of Football Players according to their playing positions

Playing position↓	Number	Percent
1-forward	10	33.3
2-center	5	16.7
3-back	13	43.3
4-goalkeeper	2	6.7
Total	30	100.0

Table 2: Mean ±SD of Haemodynamic & Aerobic Fitness variables of football players

Variables	Mean± Std. Deviation
Age, *year*	21±3
Height, *cms*	172.63±8.64
Weight, *Kg*	71.56±10.75
VO_2 max, *ml.kg^{-1}.min^{-1}*	42.60±2.26
Pulse Rate, *beats/minute*	69±4
Systolic Blood Pressure, *mmHg*	120±3
Diastolic Blood Pressure, *mmHg*	78±3
Pulse Pressure, *mmHg*	42.07±4.71
Mean Arterial Pressure, *mmHg*	91.67±2.94
Rate Pressure Product, *beats.min^{-1}.mmHg*	83.06±5.05
Stroke Volume, *ml/beat*	57.38±5.65
Cardiac Output, *L/minute*	3.97±0.28

The mean age, height and weight of male football players were 21±3 years, 172.63±8.64 cms and 71.56±10.75Kg respectively. The mean Systolic Blood Pressure, Diastolic Blood Pressure, Pulse Pressure, Mean Arterial Pressure, Rate Pressure Product, Stroke Volume and Cardiac Output of football players at rest was 120±3 mmHg, 78±3 mmHg, 42.07±4.71 mmHg, 91.67±2.94 mmHg, 83.06±5.05 beats.min^{-1}.mmHg, 57.38±5.65 ml/beat and 3.97±0.28 L/minute respectively. The mean VO_2 max and Pulse Rate of football players at rest was 42.60±2.26 ml.kg^{-1}.min^{-1} and 69±4 beats/minute respectively (Table 2).

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Testing of the haemodynamic and aerobic fitness variables can provide an insight to the football player's current physical capability. Also, assessment of the football player's current level of aerobic fitness reveals strengths and relative weaknesses that can become the basis for the development of an optimal training program *(Mirzaei et al., 2009).* The results of the measurements in this study were relatively comparable to the values reported in the literature for example *McMillian (2005)* reported that the mean VO_2max of elite soccer players was between 55 and 68 ml/kg/min but in the present it was 42.60±2.26 ml/kg/min . This value was similar to that reported for in other team sport but was much lower than that of elite endurance athletes (90ml/kg/min). However, players from different positions might have different level of cardiorespiratory level. *Reilly et al. (2000)* reported that among the elite Danish players, full-backs and midfield players possessed the highest values for VO_2max, whereas goalkeepers and central defenders had the lowest but in the present study no such trend related to playing position was observed and this may be due to less number of players, their training or level of participation. It is important to note that the results of aerobic fitness components vary depending upon the relationship of the athletes training schedule and competitive schedule *(Roemmich et al. 1997).* Maximum oxygen uptake is considered to be a valid indicator of the function of respiratory, cardiovascular and muscular systems working together *(Impellizzeri & Marcora, 2007).* Studies performed on untrained (UT) males have shown that a good VO_2max is above 40 ml/kg/min; a measure reported above 50 ml/kg/min is considered excellent. In relationship to sport, endurance specific athletes such as cyclists have been shown to have a VO_2max values of the order of 75 ml/kg/min *(Saltin & Astrand, 1967).* Martial art athletes generally exhibit greater cardiorespiratory endurance than untrained individuals, but not as great as athletes who focus on cardiorespiratory endurance as their primary fitness component for success in their sport, such as cyclists. In regard to martial art disciplines, a study of highly trained competitive black belt karate practitioners were found to have a VO_2max of 57.5 ml/kg/min while the lesser skilled competitive white belt karate practitioners were found to have a VO_2max *o*f 57.2 ml/kg/min *(Imamura et al., 1998).* By contrast, VO_2max values of 63.8 ml/kg/min were found in 60 England International boxers *(Smith, 2006).* Wrestlers have been reported to have values for VO_2max of 60.2 ml/kg/min *(Yoon, 2002). Crisafulli et al. (2009)* reported that maximum oxygen uptake for martial art athletes may be as low as 48.5 ml/kg/min and as high as 63.2 ml/kg/min depending upon the specific type of training discipline. Heart rate increases sharply during the first 1–2 minute of exercise, with the magnitude of the increase depending on the intensity of exercise. The increase in heart rate is brought about by parasympathetic withdrawal and activation of the sympathetic nervous system. After approximately 30 min of heavy exercise heart rate begins to drift upward. The increase in heart rate is proportional to the

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Date of Acceptance: Sep. 17, 2014

decrease in stroke volume, so cardiac output is maintained during exercise. Stroke volume exhibits a pattern of initial increase, plateaus, and then displays a negative (downward) drift. Stroke volume increases rapidly during the first minutes of exercise and plateaus at a maximal level after a workload of approximately 40–50% of VO_2max has been achieved *(Åstrand, et al., 1964).* As for light to moderate exercise, the increase in stroke volume results from an increased venous return, leading to the Frank-Starling mechanism, and increased contractility owing to sympathetic nerve stimulation. Thus, changes in stroke volume occur because left ventricular end–diastolic volume increases and left ventricular end–systolic volume decreases *(Poliner, et al., 1980).* Left ventricular end–diastolic volume increases because of the return of blood to the heart by the active muscle pump, increased venoconstriction (which decreases venous pooling, thereby increasing venous return), and increased cardiac output. Left ventricular end–systolic volume decreases owing to augmented contractility of the heart, which effectively ejects more blood from the ventricle, leaving a smaller residual volume. The downward shift in stroke volume after exercise is most likely due to thermoregulatory stress; plasma loss and a redirection of blood to the cutaneous vessels in an attempt to dissipate heat *(Rowell, 1986).* This effectively reduces venous return and thus causes the reduction in stroke volume. Diastolic blood pressure remains relatively constant because of peripheral vasodilatation, which facilitates blood flow to the working muscles. The rise in systolic blood pressure and the lack of a significant change in diastolic blood pressure cause the mean arterial pressure (MAP) to rise only slightly, following the pattern of systolic blood pressure. The increase in mean arterial pressure is determined by the relative changes in cardiac output and total peripheral resistance. Since cardiac output increases more than resistance decreases, mean arterial pressure increases slightly during dynamic exercise. However, the increase in mean arterial pressure would be much greater if resistance did not decrease.

Conclusion: It was concluded from the results of this study that college level football players of this study have lower values of haemodynamic and aerobic fitness variables than elite level football players and athletes of other countries. Thus, they may need to focus on improving haemodynamic and aerobic fitness variables and this could be a focus of their training programme.

Acknowledgment: The authors thank all the subjects who voluntarily participated in this study.

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Conflict of Interest: None declared.

Date of Communication: Sep.12, 2014
Date of Acceptance: Sep. 17, 2014

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Date of Communication: Sep.12, 2014
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