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AEROBIC CAPACITY AND NEED FOR ITS ASSESSMENT AMONGST ATHLETES: THE CASE OF KENYATTA UNIVERSITY SOCCER PLAYERS

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ABSTRACT

This paper is based on a study conducted with the aim of assessing the aerobic capacity levels of the soccer players in Kenyatta University using the Multistage Shuttle Run Test. The sample comprised eighteen soccer male players who were aged between 20– 25 years. The subjects were grouped into defenders (9), midfielders (5), strikers (2) and goalkeepers (2) and then put on the graded exercises using the shuttle run. The predicted aerobic capacity value was read against the number of shuttles a subject completed at a particular level which signified his endurance capacity. Data collected were statistically analysed by use of the dependent 't'-test and results presented with use of tables.

The results indicated increased aerobic capacity values of all players between the pre-test and post-test. The results were also a good indicator of how aerobic capacity varies with players' positional roles in the game of soccer justifying the need to departmentalise the training in order for the players to get role specific aerobic capacity in line with their positional roles and functions on the field of play.

Key Words: *Aerobic Capacity, Adenosine Triphosphate (ATP) molecules, Maximum Oxygen Consumption, Multistage Shuttle- Run Test*

Introduction

Aerobic capacity, which is also referred to as Physical Work Capacity (PWC) or maximum oxygen consumption (VO2 max) is the highest attainable oxygen consumption level in an individual during maximal or exhaustive exercise (Wilmore & Costill, 1993). As the magnitude of any endurance exercise increases, oxygen consumption also rises in direct proportion until a point is reached when it fails to rise despite a further rise in workload. This point is said to be an indicator of a person's aerobic capacity or PWC. After this point has been attained, work can only be increased anaerobically and sustained only very briefly and at a reduced tempo (Wilmore & Costill, 1993).

Conditioning for aerobic capacity is therefore a critical aspect of an athletes' training program. This owes to the fact that low aerobic capacity leads to fatigue even in more sedentary sports or activities. Such a condition lowers the performance potential of the athlete. Besides, fatigue reduces strength, speed, reaction and movement time, and has a negative influence on agility and neuromuscular coordination (Guyton, 1984). Conversely, higher levels of aerobic capacity facilitate the athletes' performance and reduce chances of serious injuries (Guyton, 1984).

According to Burke (1980), improvement in aerobic capacity varies from one person to the other depending on gender, age, genetic qualities, life style and ergometer used. Well-conditioned males record high levels of aerobic capacity than their female counterparts. However aerobic training yields similar percentage increases in both sexes resulting in improvements in both the peripheral and central fitness variables which are the major determinants of aerobic capacity (Yanker, 1999; Burke, 1980).

Soccer is one of the most popular sports worldwide in terms of participation by the athletes as well as the fans (Versi, 1986). Due to the fact that the sport lasts for one and a half hours, sometimes even longer than the official timing, it requires a good aerobic capacity of the players (Clarys, et *al.,* 1993). This is because success in a soccer game is attributable to players' aerobic capacity. Soccer players need relatively high maximum oxygen up-take as the average oxygen uptake during a soccer match can be as high as 70% of maximal oxygen uptake.

Review of Related Literature

The specific body parts involved in undergoing adaptational changes and that lead to the heightened aerobic capacity are grouped into two broad categories distinguished as (a) central fitness variables and (b) peripheral fitness variables.

a. *Central fitness variables*

The following changes lead to rise in the soccer players' aerobic capacities.

Heart rate

Heart rate at rest will decrease markedly as a result of endurance conditioning. Highly conditioned athletes have a resting heart rate of up to 40 beats per minute. During exercise, the heart rate for the same rate of work will be less as one becomes more highly conditioned. At maximal levels of exercise, the maximal heart rate will remain approximately the same following endurance training (Wilmore & Costill, 1993). According to Wilmore & Costill (1993), the major function of the heart rate during exercise is to combine with stroke volume to provide the appropriate cardiac output for the rate of work being performed. If the heart rate is too high, the diastolic filling period is reduced to a point where the stroke volume is compromised. But if the heart rate is low, the diastolic filling period is increased resulting in an increased stroke volume and hence the increased cardiac output (Leon, 1997). Additionally, aerobic training enables the heart rate to recover at a faster rate from exercise. That is, there's a faster return of the heart rate to the pre-exercise level.

Stroke volume

Changes in the stroke volume are closely related to changes in the heart rate that result from aerobic training. At rest, the stroke volume is substantially higher following an aerobic training program. Similarly, stroke volume is higher at sub-maximal, standardized rates of work, as well as at maximal levels of exercise. This increase is a result of more complete filling of the heart during diastole, resulting in a greater systolic blood volume. This avails adequate blood for delivery of oxygen and nutrients for utilization by the working tissues. The walls of the left ventricle tend to hypertrophy with training. This increased ventricular muscle mass allows an increased power of contraction which pushes a greater volume of ousted blood to the aortic arch to the working tissues of the body via the aortic arch (Leon, 1997; Wilmore & Costill, 1993).

Cardiac output

At maximal levels of work, the cardiac output is increased. This is the result of the increase in maximal stroke volume.

Pulmonary blood flow

Aerobic training increases maximal pulmonary ventilation from values of 120 litres per minute in the untrained, up to 180 litres per minute following training, and even higher in the highly trained athletes. Lung diffusion also improves with exercise, which is as a result of enhanced ventilation of the lungs, which provides a large and more efficient surface area for gas exchange during exercise and during recovery from exercise (Watson, 1995).

b. Peripheral fitness variables

Just as the case with central fitness variables, the rise in the mean aerobic capacity of the soccer players would be attributed to positive changes in the peripheral fitness variables.

Changes at the Muscles

Aerobic training leads to proliferation of capillaries and an elevation of the mitochondrial enzymes both in their concentration and activity. The mitochondrial volume and capacity of the shuttle systems for hydrogen transfer system increase. This alters muscle metabolism which enhances oxidation of lipids and sparing of glycogen as well as lowering production of lactic acid (Burke, 1980).

Aerobic training also increases the myoglobin content, which is a compound similar to haemoglobin. Its main function is to store oxygen for the increased mitochondrial activities. Myoglobin as an oxygen storage pigment supports aerobic metabolism by releasing oxygen to the mitochondria when oxygen becomes limited during exercise (Roberts, 1993; Burke, 1980). These changes in the muscles are accompanied by an increase in the number and sizes of mitochondria as well as an increase in the size of individual muscle fibres which bring about muscular hypertrophy.

It has also been established that, a rise in aerobic capacity is accompanied by improved diffusion of oxygen, carbon dioxide, and nutrients between tissue capillaries and individual cells. Cells of such a tissue also develop a higher capacity to store glycogen due to an increased presence of glycogen synthetase enzyme (Burke, 1980).

All of the above changes in central and peripheral variables have been found to occur through training/conditioning and are geared towards improving aerobic tissue respiration. In other words, they are meant to facilitate efficient inhalation of oxygen from the atmosphere, its absorption into the blood, transportation to the active muscles and its utilization in ATP production. For this purpose, since energy production also involves the use of glucose, a well conditioned muscle therefore has an increased deposit of glycogen which is converted to glucose

Shuttle Run Test adopted from Brewer, Ramsbottom and Williams (1988).

The sample comprised of eighteen male soccer players of Kenyatta University aged between twenty and twenty-five years. These players were available during the pre-test and the same retained during the post-test. Eighteen players were representative of the regular 25 players of the Kenyatta University soccer team that take part in a regional super league. The players were subdivided into nine defenders, five midfielders, two strikers and two goalkeepers. They were then put on graded exercises using the Multistage Shuttle Run Test. Before administration of the test the researchers sought the consent of all the subjects. The researchers then registered the details of the subjects on protocol sheets. Information sought included the position and names. A brief explanation on what was expected of each subject during the test was given.

The research design adopted was a pre-test and post-test study with the players being tested at the beginning of the semester and re-tested after nine weeks. Individual and collective feedback was presented to the players and discussed with the coach.

The materials used in the administration of the test included a 20m measuring tape, a pre-recorded tape, a cassette player, field markers and protocol sheets. The subjects ran between two lines marked 20m a part on the ground and were to stop when one could no longer maintain the set pace. Aerobic capacity levels were predicted using the number of shuttles the subjects completed and the level at which they were before withdrawing from the run. The data collected was statistically analysed using the dependent 't'-test.

Table 1: Individual pre- and post test individual scores and 't' value for goal keepers

Goalkeepers	Pre-test	Post-test	D	D2	Calculated 't'	Critical 't' at 0.05
1.	54.8	62.2	7.4	54.76	t=14.700	t=12.706
2.	51.4	61.7	10.3	106.09		
	Ex=106.2	EX=123.9	ED=17.7	ED=160.85		

Note: Magnitude of increase was 1.77/10.62 x 100= 16.67%

The goalkeepers improved their aerobic capacity by 16.67%. This implies that the training programme had an impact on their aerobic capacity. Given that goalkeepers cover the least distance in match situations, it is significant that the training they underwent enabled them to improve their aerobic capacity. Coaches can not ignore the fact that goal keepers are now much more involved in the game since the abolition of the back pass rule hence the need to upgrade their aerobic capacity.

Table two shows the individual pre and post test results for each defensive player and the t-value.

Table 2: Individual pre- and post test individual scores and 't' value for defenders

Defenders	Pre-test	Post-test	D	D2	Calculated 't'	Critical 't' at 0.05
1.	59.8	66.7	6.9	47.61		
2.	54.8	67.5	12.7	161.29	t=7.824	T=2.306
3.	51.9	60.6	8.7	75.69		
4.	57.6	65.6	8.0	64.00		
5.	51.4	59.8	8.4	70.56		
6.	52.5	65.6	13.0	169.00		
7.	51.9	57.6	5.7	32.49		
8.	57.1	60.6	3.5	12.25		
9.	51.4	57.6	6.2	38.44		
	Ex=488.4		ED=73.1	ED2=671.33		

Note: Magnitude of increase = 7.31/48.84 x 100= 14.97%

The results in table two show that defensive players, on average, improved their aerobic capacity by 14.97%. Defensive players play a pivotal role in the game of stopping opposing players from scoring. Various authors (Nepfer, 1992; Njororai, 1996; Reilly, 1994) have attributed the high scoring between the 76th minute and 90th minute of matches to physiological and mental fatigue of defensive players. It is therefore vital that defensive players upgrade their aerobic capacity to avoid physiological and mental deterioration that can lead to loss of a match in the last minutes of a game. Table three shows the individual pre and post test results for each of the mid field players and the 't'-value.

Table 3: Individual pre- and post test individual scores and 't' value for mid field players

Mid Fielders	Pre-test	Post-test	D	D2	Calculated 't'	Critical 't' at 0.05
1.	55.4	62.7	7.3	53.29		
2.	57.6	67.5	9.9	98.01	t=9.084	t=2.776
3.	59.8	69.5	9.7	94.09		
4.	54.8	62.2	7.4	54.76		
5.	52.5	65.5	13	169		
	Ex=280.1	Ex=327.4	ED=47.3	ED2=469.15		

Note: Magnitude of increase =4.72/28.01 x 100=16.85%

Table three shows that the mid field players, on average, improved their aerobic capacity by 16.85%. This is the highest improvement compared to defenders (14.97%), goalkeepers (16.67%), and attackers (14.42%). Mid field players cover the longest distance in a match (Muckle, 1981), hence it is appropriate that they be facilitated to have a reasonable level of aerobic capacity if they are to play their roles effectively.

Table 4: Individual pre- and post test individual scores and 't' value for attacking players

Attackers	Pre-test	Post-test	D	D2	Calculated t	Critical t 0.05
1.	57.1	65.6	8.5	72.25		
2.	52.5	59.8	7.3	53.29	13.166	12.706
	E x=109.6		E x= 15.8	E xD2=125.54		

Note: Magnitude of increase = 1.52/10.96 x 100 =14.42%

Table four shows that the attacking players, on average, improved their aerobic capacity by 14.42%. This compares favourably with the defensive players who improved by 14.97%. Attacking players require to be versatile, mobile and generally active throughout a match. It is therefore, vital that their aerobic capacity be upgraded to fully play their role on the field of play.

The pretest and the post test results of the mean aerobic capacity of Kenyatta University male soccer players are shown in table five.

Table 5: Pre –test and Post-test means of the aerobic capacity of soccer players

Positional role	Pre-test (ml/min.)	Post-test (ml/min.
Midfielders	56.02	65.50
Defenders	55.26	62.38
Strikers	54.80	62.70
Goalkeepers	53.1	61.95
Mean aerobic capacity	54.72	63.14

The results indicated that aerobic capacity levels improve with training. The high aerobic capacity levels during the post-test than the aerobic capacity levels during the pre-test could be attributed to the training of the soccer players during the semester.

The results also indicated that, aerobic capacity varies with the positional role of the players. For instance the aerobic capacity of the midfielders as compared to that of the goalkeepers could be due to the different levels of involvement amongst the players during the game of soccer. In other words, the midfielders are more vigorously involved during the game. They cover longer distances while moving at high speed as compared to the goal-keepers. Consequently, their body systems acquire an adaptative response which leads them to have a higher aerobic capacity (Berger, 1982).

Conclusion and Recommendations

Each subdivision had a mean V02max value that was different from the other. This could be attributed to the workload that each subdivision has during the game in terms of the distance they cover. For instance goalkeepers cover lesser distance as opposed to the midfielders who link between the defence and attack who have to make frequent runs which are intense throughout the 90 minutes or more of the soccer match.

Therefore, during training coaches should individualize the training programs. Players should maintain steady training programs in order to sustain the required aerobic capacity. They should also constantly monitor changes in aerobic capacity using appropriate tests such as the Multistage Shuttle-run Test.

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