A Study of Anaerobic Power and Capacity of Football Players

Kumar[1], Ashok and Singh[2], Gurwinder
[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 and report anaerobic power and capacity of football players. The design of this study required participants to perform six sprints each of 35 meter. Thirty six (N=36) male football players between the ages of 17 and 28 years volunteered for this study. The mean age, height and weight of football players was 21±2year, 172±6.81cm and 67.50±9.94Kg respectively. The mean sprint time of 1st,2nd,3rd,4th,5th and 6th sprint of football players was 5.50±0.39 seconds, 5.50±0.55 seconds, 5.57±0.56 seconds, 5.78±0.55 seconds, 5.83±0.59 seconds and 5.88±0.62 seconds respectively. The mean power generated during the 1st, 2nd, 3rd, 4th, 5th and 6th sprints by football players was 506.94±119.65 watts, 522.58±165.63 watts, 490.64±134.88 watts, 443.72±137.38 watts, 438.17±132.76 watts and 422.22±130.16 watts respectively. The maximum power, minimum power, average power and fatigue index of football players was 579.94±147.78watts, 376.00±111.66watts, 470.78±114.76watts and 6.00±3.45 respectively. It was concluded from the results of this study that sprint time increased, power declined with a high fatigue index, the football players may need to focus on improving lactate tolerance and this could be a focus of their training programme.

Key Words: Sprint time, Power, Anaerobic, Fatigue index

Introduction

However, often we think of football as a chiefly aerobic sport but in reality, it is the contrary *(Derek Arsenault, 2007).* When the sport of football activity is critically analysed, it can be understood that the game is played by the players performing at varying speeds and intensities; jogging, walking and sprinting. The greater part of play is in intervals and the motion does not last for long periods of time (e.g. chasing a lose ball, making a run into space etc.). This is the most significant factor to consider when doing football conditioning. There certainly is a need for aerobic conditioning as well, due to the fact that the intervals mentioned are repeated at various intensities and durations over the course of a ninety minute match. On the other hand, because of the nature of the sport, anaerobic conditioning should take up the majority of the cardiovascular conditioning *(Derek Arsenault, 2007).* The high level of the anaerobic capacities in football players enable them to carry out high-speed runs, which in the end may have a very important impact on match results *(Luhtanen, 1994).* Elite football players are capable of performing more high-intensity running than moderate professional football players. The players spend 1–11% of the game sprinting *(Bangsbo et al., 1991; Bangsbo 1992)*, which represents 0.5–3.0% of effective

Date of Communication: Aug. 13, 2014
Date of Acceptance: Aug. 22, 2014
SJIF IMPACT FACTOR 2013=4.65

time with ball in play *(Bangsbo, 1992; O'Donoghue, 2001)*. For this reason, it is very important to incorporate anaerobic training into overall conditioning training protocols. Because the repeated sprint ability field tests show high reliability and validity *(Metaxas et al., 2005; Psotta et al., 2005),* high reproducibility, and sensitivity *(Krustrup et al., 2003),* they may represent a valid measure of anaerobic football performance. Sprint running times have been shown to be well correlated to peak and mean power output *(Patton & Duggan, 1987; Tharp et al., 1985).* The purpose of this study was to report the anaerobic power and capacity (i.e. speed, power and fatigue index) of Punjabi football players.

Materials and Methods:

Thirty six (N=36) male Punjabi football players between the age of 17 and 28 years volunteered for this study and each participant was required to perform six sprints each of 35 meter. A rest of 10 second was given to the participants between each sprint. *Draper and Whyte (1997)* developed the Running-based Anaerobic Sprint Test (RAST) to test a runner's anaerobic performance. RAST provides researchers/coaches with measurements on peak power, average power and minimum power along with a fatigue index. Participants were refrained from participating in any heavy physical activity (except activity of daily living) within 24 hours of the testing day. Little effort has been made in the literature to evaluate the effects of the training of sprint style in male football players. Hence, due to the lack of referring literature, this study utilized only male football players as participants. Table 1 shows the number and percent distribution of football players according to their playing positions in the present study. As per the playing positions of the football players, 44.4% (N=16) were back, 27.8% (N=10) forward, 25% (N=9) center and 2.8% (N=1) goalkeeper.

Table 1: Sample composition with respect to the playing position of footballers

Playing Position	N	Percentage
Forward	10	27.8
Centre	9	25.0
Back	16	44.4
Goalkeeper	1	2.8
Total	36	100.0

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

Thirty six healthy male football players (mean age 21± 2year) from Mata Gujri College, Sri Fatehgarh Sahib (Punjab) participated in the study. The mean height and weight of thirty six football players was 172.00±6.81 cm and 67.50±9.94Kg respectively (Table 2). The mean values of the time of -1st, 2nd, 3rd, 4th, 5th & 6th sprints of football players was 5.50±0.39 seconds, 5.50±0.55 seconds, 5.57±0.56 seconds, 5.78±0.55 seconds, 5.83±0.59 seconds and 5.88 ±0.62 seconds respectively (Table 2). From the six sprint times of 35 m sprint each, the power for each sprint run was calculated and then maximum power (highest value), minimum power (lowest value) and average power (sum of all six values ÷ 6) were determined The power was calculated using the equation: Power = Weight × Distance^2 ÷ Time^3 *(Draper and Whyte, 1997).* The mean values of power of the -1st, 2nd, 3rd, 4th, 5th & 6th

Date of Communication: Aug. 13, 2014
Date of Acceptance: Aug. 22, 2014

sprints in case of football players was 506.94±119.65W, 522.58±165.63W, 490.64±134.88W, 443.72±137.38W, 438.17±132.76W and 422.22±130.16 W respectively. In addition, the maximum power, minimum power and average power of football players was 579.94±147.78watts, 376.00±111.66 watts, and 470.78±114.76 watts respectively (Table 2). The Fatigue Index was calculated using the equation: (Maximum power - Minimum power) ÷ Total time for the 6 sprints *(Draper and Whyte, 1997).* The mean fatigue index of football players was 6.00 ± 3.45 (Table 2).

Table 2. Descriptive Statistics of male football players

Variables (N=36)	Mean	Std. Deviation
Age, year	**21**	**02**
Height, cm	**172.00**	**6.81**
Weight, kg	**67.50**	**9.94**
Sprint time-1,seconds	**5.50**	**0.39**
Sprint time-2,seconds	**5.50**	**0.55**
Sprint time-3,seconds	**5.57**	**0.56**
Sprint time-4,seconds	**5.78**	**0.55**
Sprint time-5,seconds	**5.83**	**0.59**
Sprint time-6,seconds	**5.88**	**0.62**
Power-1,watts	**506.94**	**119.65**
Power-2,watts	**522.58**	**165.63**
Power-3,watts	**490.64**	**134.88**
Power-4,watts	**443.72**	**137.38**
Power-5,watts	**438.17**	**132.76**
Power-6,watts	**422.22**	**130.16**
Maximum power, watts	**579.94**	**147.78**
Minimum power, watts	**376.00**	**111.66**
Average power, watts	**470.78**	**114.76**
Fatigue index	**6.00**	**3.45**

Table 3 shows the absolute and percent increase in time among six different sprint times. It was found that the maximum absolute and percent increase value of sprint time was 0.38 seconds & 6.90% (sprint time-1 vs. sprint time-6 and sprint time-2 vs. sprint time-6) followed by 0.33 seconds & 6.00% (sprint time-1 vs. sprint time-5 and sprint time-2 vs. sprint time-5), 0.31 seconds & 5.56% (sprint time-3 vs. sprint time-6), 0.28 seconds & 5.09 % (sprint time-1 vs. sprint time-4 and sprint time-2 vs. sprint time-4), 0.26 seconds & 4.66 % (sprint time-3 vs. sprint time-5), 0.21 seconds 3.77 % (sprint time-3 vs. sprint time-4), 0.10 seconds & 1.73 % (sprint time-4 vs. sprint time-6), 0.07 seconds 1.27 % (sprint time-1 vs. sprint time-3 and sprint time-2 vs. sprint time-3) and 0.05 seconds 0.86% (sprint time-4 vs. sprint time-5 and sprint time-5 vs. sprint time-6). Thus, it was observed that the time taken by the subjects for the completion of sprint-1 and 2 was minimum (5.50±0.39 seconds and 5.50±0.55 seconds) then there was an increase in the value of time for the subsequent sprint-3 (5.57±0.56 seconds), sprint-4 (5.78±0.55 seconds), sprint-5 (5.83±0.59 seconds) and sprint-6 (5.88±0.62 seconds). This may be due to more blood lactate production in the subsequent sprints in the football players that might have lead to fatigue in them.

Table 3.Mean ±SD of absolute & percent change in time for different sprints

Variables	Mean±SD	Absolute	%percent
Sprint time-1 vs. time-2	**5.50±0.39 vs. 5.50±0.55**	**0.00**	**0.00**
Sprint time-1 vs. time-3	**5.57±0.56**	**0.07**	**1.27**
Sprint time-1 vs. time-4	**5.78±0.55**	**0.28**	**5.09**
Sprint time-1 vs. time-5	**5.83±0.59**	**0.33**	**6.00**
Sprint time-1 vs. time-6	**5.88±0.62**	**0.38**	**6.90**
Sprint time-2 vs. time-3	**5.50±0.55 vs. 5.57±0.56**	**0.07**	**1.27**

Date of Communication: Aug. 13, 2014
Date of Acceptance: Aug. 22, 2014

Sprint time-2 vs. time-4	**5.78±0.55**	**0.28**	**5.09**
Sprint time-2 vs. time-5	**5.83±0.59**	**0.33**	**6.00**
Sprint time-2 vs. time-6	**5.88±0.62**	**0.38**	**6.90**
Sprint time-3 vs. time-4	**5.57±0.56 5.78±0.55**	**0.21**	**3.77**
Sprint time-3 vs. time-5	**5.83±0.59**	**0.26**	**4.66**
Sprint time-3 vs. time-6	**5.88±0.62**	**0.31**	**5.56**
Sprint time-4 vs. time-5	**5.78±0.55 5.83±0.59**	**0.05**	**0.86**
Sprint time-4 vs. time-6	**5.88±0.62**	**0.10**	**1.73**
Sprint time-5 vs. time-6	**5.83±0.59 5.88±0.62**	**0.05**	**0.85**

Table 4. Mean ±SD of absolute & percent change in Power for different sprints

Variables	Mean±SD	Absolute	%percent
Power-1 vs. Power-2	**506.94±119.65 vs. 522.58±165.63**	**15.64**	**3.08**
vs. Power-3	**490.64±134.88**	**-16.3**	**-3.21**
vs. Power-4	**443.72±137.38**	**-63.22**	**-12.47**
vs. Power-5	**438.17±132.76**	**-68.77**	**-13.56**
vs. Power-6	**422.22±130.16**	**-84.72**	**-16.71**
Power-2 vs. Power-3	**522.58±165.63 vs. 490.64±134.88**	**-31.94**	**-6.11**
vs. Power-4	**vs. 443.72±137.38**	**-78.86**	**-15.09**
vs. Power-5	**vs. 438.17±132.76**	**-84.41**	**-16.15**
vs. Power-6	**vs. 422.22±130.16**	**-100.36**	**-19.20**
Power-3 vs. Power-4	**490.64±134.88 vs. 443.72±137.38**	**-46.92**	**-9.56**
vs. Power-5	**vs. 438.17±132.76**	**-52.47**	**-10.69**
vs. Power-6	**vs. 422.22±130.16**	**-68.42**	**-13.94**
Power-4 vs. Power-5	**443.72±137.38 vs. 438.17±132.76**	**-5.55**	**-1.25**
vs. Power-6	**vs. 422.22±130.16**	**-21.5**	**-4.84**
Power-5 vs. Power-6	**438.17±132.76 vs. 422.22±130.16**	**-15.95**	**-3.64**

Table 4 shows absolute and percent change in power for six different sprints of football players. It was found that the maximum absolute and percent increase value of power was 15.64 watts & 3.08% (Power-1 vs. Power-2). But it was found that the maximum absolute and percent decrease value of power was -100.36 watts & -19.20% (Power-2 vs. Power-6) followed by -84.72 watts & -16.71% (Power-1 vs. Power-6), -84.41 watts & -16.15% (Power-2 vs. Power-5), -78.86 watts & -15.09% (Power-2 vs. Power-4), -68.77watts -13.56% (Power-1 vs. Power-5), -68.42 watts & -13.94% (Power-3 vs. Power-6), -52.47 watts & -10.69% (Power-3 vs. Power-5), -46.92 watts & -9.56% (Power-3 vs. Power-4), -31.94watts & -6.11% (Power-2 vs. Power-4) -21.05watts & -4.84% (Power-4 vs. Power-6), -16.3watts & -3.21% (Power-1 vs. Power-3), -15.95watts & -3.64% (Power-5 vs. Power-6) and -5.55watts & -1.25% (Power-4 vs. Power-5). Thus, it was observed that the maximum value of power was 522.58±165.63watts for power-2 (i.e. during sprint-2) then there was a decrease in the value of power for the sprints i.e. power-1 (506.94±119.65watts), power-3(490.64±134.88watts), power-4 (443.72±137.38 watts), power-5(438.17±132.76 watts) and power-6(422.22±130.16watts). This may be due to more blood lactate production in the subsequent sprints in the football players that might have lead to fatigue in them.

The different repeated sprint ability (RSA) tests which have been performed in earlier studies involved 6x40 m sprints departing every 30 s *(Dawson et al., 1993).* These studies recorded mean performance decrements of 5.6% and

Date of Communication: Aug. 13, 2014
Date of Acceptance: Aug. 22, 2014

5.3%, respectively. The present study also provides a comparable mean performance decrement (i.e. sprint time) of 1.27%, 5.09%, 6.00% and 6.90% respectively. A greater depletion of creatine phosphate (CP) stores will be observed during a 40 m sprint as compared with a 20 m sprint *(Hirvonen et al., 1987).* During 6x40 m sprints departing every 30 s, approximately 2-3s of additional sprinting is performed for each sprint. This would be anticipated to deplete the creatine phosphate stores during each sprint to a greater extent than the protocol used in the present study. However, these previous repeated sprint ability test protocols also provide an additional 7- 8s of recovery. These longer recovery periods may counteract the additional 2-3s of sprinting and allow for similar proportions of phosphagen depletion and resynthesis when compared with the sprint protocol used in this study. For single high intensity efforts, of less than 5-10s duration, the largest contribution to the energy demands is made by the phosphagen energy system *(Hirvonen et al., 1987; Tesch et al., 1989; Gaitanos et al., 1993). Hirvonen et al., (1987)* found runners of higher sprinting ability were able to deplete a greater proportion of creatine phosphate stores when compared with runners of lower sprinting ability. Other studies that have used a repeated sprint protocol have also revealed similar findings as observed in the present study. *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. *Balsom et al., (1992)* have observed no significant increase in plasma hypoxanthine or uric acid concentrations during a repeated sprint ability test involving 40x 15 m sprints with 30 s recovery. Sprinting time was also not observed to vary much during these 40 sprints. An increase in these purines during exercise would be indicative of a net degradation of adenosine 5'-triphosphate (ATP) in the muscle. Their finding suggests that the phosphagen system coped with these energy demands and was adequately resynthesised during the recovery periods. The repeated sprint ability protocol in the present study is similar in sprint length and therefore likely to rely predominantly on the phosphagen system. The present study also involves shorter recovery periods which are less than the half life of creatine phosphate resynthesis *(Harris et al., 1976).* The creatine phosphate stores will not be adequately replenished during the repeated sprint ability test and a progressive decline in creatine phosphate stores and a slowing of the 35 m sprint times have ensued. Even though anaerobic glycolysis provides a significant contribution to the initial stages of the sprint test, its contribution appears to diminish over the latter stages of a repeated sprint test. *Gaitanos et al., (1993)* measured the change in muscle creatine phosphate, ATP, lactate and

Date of Communication: Aug. 13, 2014
Date of Acceptance: Aug. 22, 2014

pyruvate during 10×6 s maximal sprints on a cycle ergometer. They estimated that during the first sprint, anaerobic glycolysis was contributing approximately 50% to anaerobic ATP production. However, by the last sprint, anaerobic glycolysis was only contributing approximately 20 % to anaerobic ATP production. Based on these findings, *Gaitanos et al., (1993)* also suggested that it was likely aerobic metabolism increased its contribution during these last sprints. These studies suggest that the phosphagen system is the major anaerobic energy system during 3-5s of maximal sprinting and its importance appears to increase over the latter stages of a series of repeated sprinting efforts.

Conclusion; It was concluded from the results of this study that sprint time increased, power declined with a high fatigue index, the football players may need to focus on improving lactate tolerance and this could be a focus of their training programme.

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

References

Balsom, P.; Seger, J.; Sjodin, B.; & Ekblom, B. 1992. Physiological responses to maximal intensity intermittent exercise. *European Journal of Applied Physiology* **65:** 144.

Bangsbo J.; Graham T.E.; Kiens B.; and Saltin B. 1992. Elevated muscle glycogen and anaerobic energy production during exhaustive exercise in man. *J. Physiol.,* **451:** 205–27.

Bangsbo, J.; Nørregaard, L.; and Thørøe, F. 1991. Active profile of competition soccer. *Canad. J. Sport Sci.,* **16:** 110–16.

Dawson, B.; Fitzsimons, M.; & Ward, D. 1993. The relationship of repeated sprint ability to aerobic power and performance measures of anaerobic work capacity and power. *Australian Journal of Science and Medicine in Sport*, **25(4):** 88-93.

Derek Arsenault. 2007. Soccer fitness training. *www.pponline.co.uk*

Draper, N.; and Whyte, G. 1997. Here's a new running based test of anaerobic performance for which you need only a stopwatch and a calculator. *Peak Performance*, 96, p. 3-5.

Gaitanos, G.; Williams, C.; Boobis, L.; & Brooks, S. 1993. Human muscle metabolism during intermittent maximal exercise. *Journal of Applied Physiology,* **75(2):** 712-719.

Harris, R., Edwards, R., Hultman, E., Nordesjo, L. & Sahlin, K. 1976. The time course of phosphorylcreatine resynthesis during recovery of the quadriceps muscle in man. *Pflugers Archives,* **367:** 137-142.

Hirvonen, J.; Rehunen, S.; Rusko, H.; & Harkonen, M. 1987. Breakdown of high – energy phosphate compounds and lactate accumulation during short supramaximal exercise. *European Journal of Applied Physiology and Occupational Physiology,* **56:** 253-259.

Holmyard, D.; Cheetham, M.; Lakomy, H.; & Williams, C. 1988. Effect of recovery duration on performance during multiple treadmill sprints. In: T. ReiUy, A. Lees, K. Davids, and W.J, Murphy (eds.). Science and Football, London/New York: E. & F.N. Spon, 134-142.

Krustrup, P.; Mohr, M.; Amstrup, T.; Rysgaard, T.; Johansen, J.; Steensberg, A.; Pedersen, P.K.; and Bangsbo, J. 2003.The yo-yo intermittent recovery test: physiological response, reliability, and validity. *Med. Sci. Sports Exerc.,* **35:** 697–705.

Luhtanen, P. 1994. Biomechanical aspects. In: Football (soccer). Ekblom B. ed. *Oxford: Blackwell Scientific Publications* pp. 59–77.

Metaxas, T.I.; Koutlianos, N.A.; Kouidi, E.J.; and Deligiannis, A.P. 2005. Comparative study of field and laboratory tests for the evaluation of aerobic capacity in soccer players. *J. Strength Cond. Res.,* **19:** 79–84.

O'Donoghue, P. 2001. Time-motion analysis of work rate in elite soccer. In: *Notation analysis of sport* IV. TavaresMF, ed.

Date of Communication: Aug. 13, 2014
Date of Acceptance: Aug. 22, 2014

Porto, PT: Centre for team Sport Studies Faculty of Sport Science and Physical Education pp. 65–67.

Patton J.F.; and Duggan A. 1987. An evaluation of tests of anaerobic power. *Aviat. Space Envir. Med*,, **58:** 237-42.

Psotta, R.; Blahus, P.; Cochrane, D.J.; and Martin, A.J. 2005. The assessment of an intermittent high intensity running test. *J. Sports Med. Phys. Fitness,* **45:** 246–256.

Tesch, P.; Thorsson, A.; & Fujitsuka, N. 1989. Creatine phosphate in fiber types of skeletal muscle before and after exhaustive exercise. J. Appl, Physiol., **66(4):** 1756- 1759.

Tharp, G.D.; Newhouse R.K.; Uffelman L.; Thorland W.G.; and Johnson G.O. 1985. Comparison of sprint and run times with performance on the Wingate Anaerobic Test. *Res. Q. Exercise Sport*, **56(1):** 73-6.

Conflict of Interest: None declared.

Date of Communication: Aug. 13, 2014
Date of Acceptance: Aug. 22, 2014