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A Study of Speed, Power and Fatigue Index of Volleyball Players

Ramandeep Kaur and Ashok Kumar

Abstract

Aim: The aim of the study was to observe speed, power and fatigue index of male volleyball players. **Materials & Method**: Twenty-five healthy male volleyball players of participated and their age ranged 18 to 28 years. Each subject performed running based Anaerobic Sprint Test (RAST). **Result:** The mean age, height and weight of male volleyball players was 21.12±2.20 years, 180.84±8.28cm, and 71.36±9.68 kg. The mean sprint time 1, sprint time 2, sprint time 3, sprint time 4, sprint time 5, sprint time 6, power 1, power 2, power 3, power 4, power 5, power 6, power maximum, power minimum, power average and Fatigue index was 5.04±.0.35 seconds, 5.11±0.42seconds, 5.10±0.38 seconds, 5.27±0.43 seconds, 5.18±0.36 seconds, 5.27±0.37 seconds, 698.8±179.99 watts, 672.8±196.02 watts, 672.08±158.83 watts, 602.72±162.94 watts, 640.04±130.50 watts, 593.4±113.85watts, 758.88±158.15 watts, 542.04±125.47 watts, 646.76±141.34 watts and 7.02±3.18 watts/second. It was concluded from the results of this study that sprint time increased, power declined with a high fatigue index, the volleyball players may need to focus on improving lactate tolerance and this could be a focus of their training programme.

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Introduction

Volleyball is an amazing sport that includes fast sudden movements like jumping's, landings, which need high power and strength (DeAlmeida & Soares, 2003). During a volleyball match, players perform different types of physical activities such as the sprints, jumps, and high-intensity court movement (Häkkinen 1993). Anaerobic and aerobic capacities are the ability to organize energy during activities of strong nature i.e. executing intensive work with explosive action in short duration of time, such as, bursting speed, smash of volleyball, and take off in jumps. Volleyball can be described as interval sports, with the demands at high levels requiring intermittent bouts of high-intensity play interspersed with periods of submaximal effort, utilizing both aerobic and anaerobic energy systems. A special physiological ability is needed to perform volleyball skills (Kalinski et al., 2002). Volleyball players require the ability to perform these physical activities characterized by repeated maximal efforts with limited recovery during the match (Sheppard et al., 2007; Smith et al., 1992). Volleyball is a sport that not only requires a number of individual skill and technical abilities from each player but it also requires that players have a high degree of development in a number of physiological parameters in order to be successful (Thomas G.Tait 1989). The present study was conducted to observe speed, power and fatigue index (i.e. anaerobic power and capacity) of male volleyball players.

Materials and Methods

The present study was conducted on Twenty-five (n=25) male volleyball players who were participated in all India university level competitions from Punjabi University Patiala. All the risks involved in the various tests of the present study were told to them while collecting data. Method of testing was explained to each player and their voluntary consent was taken from them. Each player was first subjected to anthropometric measurements then anaerobic fitness data was collected. Draper and Whyte (1997) developed the Running-based Anaerobic Sprint Test (RAST) to test a runner's anaerobic performance. Each participant was required to perform six sprints each of 35 meters. A rest of 10 second was given to them between each sprint. RAST provided six sprint times, six power, power maximum, power minimum, power average and fatigue index of each volleyball player. Statistical analysis was performed with SPSS version 16.0 (free trial, SPSS Inc, Chicago). Mean and Standard Deviation was observed for age, height, weight, speed, power and fatigue index.

Results and Discussion

Table 1. Mean± SD of Age, Height, Weight, BMI, Sprint time (s), Power(s) and Fatigue index

Variables	Mean	Std. Deviation
Age (year)	21.12	2.20
Height (cm)	180.84	8.28
Weight (kg)	71.36	9.68
BMI (kg/m^2)	21.6	1.88
Sprint time 1 (seconds)	5.04	0.35
Sprint time 2 (seconds)	5.11	0.42
Sprint time 3 (seconds)	5.10	0.38
Sprint time 4 (seconds)	5.27	0.43
Sprint time 5 (seconds)	5.18	0.36
Sprint time 6 (seconds)	5.27	0.37
Power 1 (watts)	698.8	179.99
Power 2 (watts)	672.8	196.02
Power 3 (watts)	672.08	158.83

Power 4 (watts)	**602.72**	**162.94**
Power 5 (watts)	**640.04**	**130.50**
Power 6 (watts)	**593.4**	**113.85**
Power maximum (watts)	**758.88**	**158.15**
Power minimum (watts)	**542.04**	**125.47**
Power average (watts)	**646.76**	**141.34**
Fatigue index (watts/second)	**7.02**	**3.18**

Twenty-five male volleyball players (mean age 21.12±2.20 year) from Punjabi university Patiala (Punjab) participated in the present study. The mean height and weight of volleyball players was 180.84±8.28 cm and 71.36±9.68 kg respectively (Table 1).

The mean values of the time of 1st, 2nd, 3rd, 4th, 5th & 6th sprints of volleyball players were 5.04±.0.35seconds,5.11±0.42seconds,5.10±0.38seconds,5.27±0.43seconds,5.18±0.36seconds,5.27± 0.37seconds respectively (Table 1). 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 sprints in case of volleyball players was 698.8±179.99watts, 672.8±196.02watts, 672.08±158.83watts, 602.72±162.94watts, 640.04±130.50watts and 593.4±113.85watts respectively. In addition, the maximum power, minimum power and average power of volleyball players was 758.88±158.15watts, 542.04±125.47watts and 646.76±141.34watts respectively (Table 1). 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 volleyball players was 7.02±3.18 watts/second (Table 1).

Table 2. Mean ±SD of Absolute and Percent difference in different sprint time

Variables	Mean±SD	Absolute difference	%percent difference
Sprint time-1 vs. time-2	**5.04±.0.35 vs. 5.11±0.42**	**0.07**	**1.38**
Sprint time-1 vs. time-3	**5.04±.0.35 vs. 5.10±0.38**	**0.06**	**1.19**
Sprint time-1 vs. time-4	**5.04±.0.35 vs. 5.27±0.43**	**0.23**	**4.56**
Sprint time-1 vs. time-5	**5.04±.0.35 vs. 5.18±0.36**	**0.14**	**2.77**
Sprint time-1 vs. time-6	**5.04±.0.35 vs. 5.27±0.37**	**0.23**	**4.56**
Sprint time-2 vs. time-3	**5.11±0.42 vs. 5.10±0.38**	**0.01**	**0.19**
Sprint time-2 vs. time-4	**5.11±0.42 vs. 5.27±0.43**	**0.16**	**3.13**
Sprint time-2 vs. time-5	**5.11±0.42 vs. 5.18±0.36**	**0.07**	**1.36**
Sprint time-2 vs. time-6	**5.11±0.42 vs. 5.27±0.37**	**0.16**	**3.13**
Sprint time-3 vs. time-4	**5.10±0.38 vs. 5.27±0.43**	**0.17**	**3.33**
Sprint time-3 vs. time-5	**5.10±0.38 vs. 5.18±0.36**	**0.08**	**1.56**
Sprint time-3 vs. time-6	**5.10±0.38 vs. 5.27±0.37**	**0.17**	**3.33**
Sprint time-4 vs. time-5	**5.27±0.43 vs. 5.18±0.36**	**0.09**	**1.70**
Sprint time-4 vs. time-6	**5.27±0.43 vs. 5.27±0.37**	**0.00**	**0.00**

Sprint time-5 vs. time-6	**5.18±0.36 vs.5.27±0.37**	**0.09**	**1.73**

Table 2 shows the absolute and percent difference in time among six different sprint times. It was found that the maximum absolute and percent increase value of sprint time was 0.23 seconds & 4.56 % (sprint time-1 vs. sprint time-4 and sprint time-1 vs. sprint time-6) followed by 0.17 seconds & 3.33% (sprint time-3 vs. sprint time-4 and sprint time-3 vs. sprint time-6), 0.16 seconds & 3.13% (sprint time-2 vs. sprint time-4 and sprint time-2 vs. sprint time-6), 0.09 seconds & 1.73 % (sprint time-5 vs. sprint time-6), 0.09 seconds & 1.70 % (sprint time-4 vs. sprint time-5), 0.08 seconds 1.56 % (sprint time-3 vs. sprint time-5), 0.07 seconds & 1.38 % (sprint time-1 vs. sprint time-2), 0.07 seconds 1.36 % (sprint time-2 vs. sprint time-5) ,0.06 seconds 1.19% (sprint time-1 vs. sprint time-3) and0.01 seconds 0.19% (sprint time-2 vs. sprint time-3). Thus, it was observed that the time taken by the subjects for the completion of sprint-1 and 2 was minimum (5.04±.0.35 seconds and 5.11±0.42seconds) then there was an increase in the value of time for the subsequent sprint-3 (5.10±0.38 seconds), sprint-4 (5.27±0.43 seconds), sprint-5 (5.18±0.36 seconds) and sprint-6 (5.27±0.37 seconds). This may be due to more blood lactate production in the subsequent sprints in the volleyball players that might have led to fatigue in them.

Table 3. Mean ±SD of Absolute and Percent difference in Power for different sprints

Variables	**Mean±SD**	**Absolute difference**	**%percent difference**
Power-1 vs. Power-2	**698.8±179.99 vs. 672.8±196.02**	**26**	**3.72**
Power-1 vs. Power-3	**698.8±179.99 vs. 672.08±158.83**	**26.72**	**3.82**
Power-1 vs. Power-4	**698.8±179.99 vs. 602.72±162.94**	**96.08**	**13.74**
Power-1 vs. Power-5	**698.8±179.99 vs. 640.04±130.50**	**58.76**	**8.40**
Power-1 vs. Power-6	**698.8±179.99 vs. 593.4±113.85**	**105.4**	**15.08**
Power-2 vs. Power-3	**672.8±196.02 vs. 672.08±158.83**	**0.72**	**10.70**
Power-2 vs. Power-4	**672.8±196.02 vs. 602.72±162.94**	**70.08**	**10.41**
Power-2 vs. Power-5	**672.8±196.02 vs. 640.04±130.50**	**32.76**	**4.86**
Power-2 vs. Power-6	**672.8±196.02 vs. 593.4±113.85**	**79.4**	**11.80**
Power-3 vs. Power-4	**672.08±158.83 vs.602.72±162.94**	**69.36**	**10.32**
Power-3 vs. Power-5	**672.08±158.83 vs.640.04±130.50**	**32.04**	**4.76**
Power-3 vs. Power-6	**672.08±158.83 vs.593.4±113.85**	**78.68**	**11.70**
Power-4 vs. Power-5	**602.72±162.94 vs.640.04±130.50**	**37.32**	**6.19**
Power-4 vs. Power-6	**602.72±162.94 vs.593.4±113.85**	**9.32**	**1.54**
Power-5 vs. Power-6	**640.04±130.50 vs.593.4±113.85**	**46.64**	**7.28**

Table 3 shows absolute and percent difference in power for six different sprints of volleyball players. It was found that the maximum absolute and percent increase value of power was 105.4watts & 15.08% (Power-1 vs. Power-6). But it was found that the maximum absolute and percent decrease value of power was 96.08 watts & -13.74% (Power-1 vs. Power-4) followed by 79.4 watts & 11.80% (Power-2 vs. Power-6), 78.68 watts & - 11.70 % (Power-3 vs. Power-6), 69.36 watts & 10.32 % (Power-3 vs. Power-4), 58.76 watts 8.40 % (Power-1 vs. Power- 5), 46.64 watts & 7.28 % (Power-5 vs. Power-6), 32.76 watts & 4.86 % (Power-2 vs. Power-5), 32.04 watts & 4.76% (Power-3 vs. Power-5), 26.72 watts & 3.82 % (Power-1 vs. Power-3) 26 watts & 3.72 % (Power- 1 vs. Power-2), 9.32 watts & 1.54 % (Power-4 vs. Power-6), -37.32 watts & 6.19 %

(Power-4 vs. Power-5) and 0.72 watts & 10.70 % (Power-2 vs. Power-3). Thus, it was observed that the maximum value of power was 698.8±179.99 watts for power-1 (i.e. during sprint-1).
This may be due to more blood lactate production in the subsequent sprints in the volleyball players that might have led 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 5.3%, respectively. The present study also provides a comparable mean performance decrement (i.e. sprint time) of 1.38 %, 1.19 %, 4.56 % 2.77 % and 4.56 % 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). 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 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.

Conclusion

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

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Reference(s)

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.

DeAlmeida, T.A. and E.A. Soares, 2003. Nutritional and anthropometric profile of adolescent volleyball athletes. Revista Brasileira de Medicina do Esporte, 9: 198-203.

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.

Häkkinen K. (1993) Changes in physical fitness profile in female volleyball players during the competitive season. J. Sports Med. Phys. Fitness., 33(3): 223-232

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.

Kalinski MI, Norkowski H, Kerner MS, Tkaczuk WG, 2002. Anaerobic Power Characteristics of Elite Athletes in National Level Team-Sport Games. European Journal of Sport Science. 2(3): 1-14

Sheppard J.M., J. Cronin, T.J. Gabbett, M.R. McGuigan, N. Extebarria, R.U. Newton (2007) Relative importance of strength and power qualities to jump performance in elite male volleyball players. J. Strength Cond. Res., 22: 758-765.

Smith D.J., D. Roberts, B. Watson (1992) Physical, physiological and performance differences between Ca- nadian national team and Universiade volleyball players. J. Sports Sci., 10: 131-138

Thomas G. Tait FIVB chapter 19 Theory of physical preparation for volleyball Publisher Federation International de Volleyball, Lausanne, November 1989.

Conflict of Interest: None declared