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European Journal of Experimental Biology, 2014, 4(2):406-411

ISSN: 2248 –9215
CODEN (USA): EJEBAU

Differences between biomechanical variables of professional volleyball attackers due to game's position

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ABSTRACT

The aim of this study was to investigate biomechanical variables of elite male volleyball attackers and determines if differences exist in these characteristics between opposites, middle blockers and outside hitters. A group of 24 professional male team volleyball attackers participated in the study (age: 29.5 ± 2.6 years). Biomechanical characteristics including lower body power (CMJ), maximal dynamic strength of upper and lower body (Squat 1-RM and Bench Press 1-Rm) and agility were evaluated in all the subjects. Opposite attackers have the highest records of all biomechanical variables and middle blockers have the lowest, except in agility which belongs to outside attackers. There are significant differences between Squat, Bench Press and countermovement jump in different groups of attackers. No other significant differences were observed in agility results. Considering biomechanical variables related to performance in each position seems to be essential. Training session should be focused on improving middle blockers physical characteristics and different agility trainings should be designed for attackers due to their movement pattern.

Keywords: volleyball attackers, biomechanics, physical fitness

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INTRODUCTION

Team Volleyball, like several other ball games, requires not only technical and tactical skills but also great deal of physical fitness [1,2]. Volleyball involves frequent bouts of intense activities such as jumping, diving, and lateral movement, and these activities are coupled with short rest periods throughout match duration that is typically 60-120 minutes [3,4]. As one might expect, strength and power qualities as well as metabolic conditioning are important contributors to success in the sport [1-4]. As such, these qualities are the primary focus of the physical training program in most clubs and national teams. Modern volleyball is characterized by a very high outreach of male and female volleyball players above the net and high ball velocity on jump service and spiking [2]. A very high speed of reaction and agility are required to be able to control such balls on serve reception, especially in field defense. Many authors consider motor abilities, agility and explosive strength, along with pronounced longitudinal skeleton dimensionality, as the major characteristics for successful volleyball performance [1].

Several studies have been undertaken to ascertain specific biomechanical and physiological profiles of athletes in a variety of sports. Hertogh and Hue (2002) suggest that power output is an essential component of success in many sports. For volleyball players, exercises aimed at increasing strength are advocated to improve power output and thus maximal jump height [5]. Stamm (2003) suggested that it is essential for a successful volleyball player to possess greater speed and endurance, arms and upper body strength, and flexibility [6]. In volleyball, the majority of

the studies have reported the characteristics of women's or junior volleyball players as well as different physical abilities [2,3,7-14].

Volleyball athletes are characterized by positions based on the primary skill that is performed. These positions are setter, attacker and libero. The attack and block represent 45% of the total actions in a game and are attributable for 80% of the scores obtained in international match [15]. In modern volleyball attackers are also separated into three groups based mainly upon their anthropometric and Somatotype characteristics [16]. Opposite, middle and outside (wing) attackers are three different positions of attackers, each position have special tasks and well trained for a determined purpose.

Greater attention has been paid on physical characteristics in recruitment of potential players. However, according to the literature at present there are few reports on the physical and biomechanical profile of elite volleyball players. Particularly there is a paucity of information on the differences between players' specification at different playing positions.
It is well known that the lack of appropriate biomechanical characteristics might result in poor performance in top-level volleyball [1,2,16,17]. Although some of these characteristics can be improved through training, the basic ones required for the sport of volleyball may be essentially inherited. It is of paramount importance for coaches to understand the significance of taking into account these basic body characteristics for initial selection of young players [8]. Inappropriate initial selection of attacker without considering biomechanical features could become an obstacle for future developments for becoming top-level player. Main purpose of this study is to determine differences between selected biomechanical properties of volleyball attackers.

MATERIALS AND METHODS

The present study compares the differences between biomechanical variables of volleyball attackers according to game's position. This research completed over professional competition in-seasons. All players competed in 1-2 matches per week, combined with volleyball practice sessions as well as the strength and conditioning regimen in national team camps. The athletes were familiar with all of the testing and training exercises. They were in good overall physical condition and were adequately familiarized with all experimental procedures.

Subjects
A group of 24 professional male team volleyball players (mean ± SD, age: 29.5 ± 2.6 years) participated in the study. Players were categorized as middle blockers (n = 8, age: 29.5 ± 3.16), opposite hitters (n = 7, age: 31.57 ± 1.81), outside hitters (n = 9, age: 27.89 ± 1.36). The subjects were required to sign an information and informed consent form prior to the study that had been approved by the Institutional Review Committee Board of the local Committee for Medical Research Ethics and current Iranian law and regulations, and carried out according to the Helsinki Declaration.

The biomechanical variables of Agility (Sec), Maximal Dynamic strength (kg), lower body power (cm) were measured in each subject with an accuracy of 0.01Sec, 1 kg and 1 cm, respectively.

Agility: The objective of this test is to assess the athlete's ability to accelerate between marked lines and to rapidly change direction. Two lines were marked on the floor with a distance of nine meters between them, and labeled as "A" and "B". Two wooden blocks 5 cm x 5 cm x 10 cm are located at one end of considered distance at point "B". subject started from point "A" (a timer was started), then moved fast to point "B", picks up a block, returns the block to the ground behind the starting line, sprints back to the finishing line, picks up the 2nd block and sprints back to the start line. The stopwatch is stopped when the athlete's torso crosses the line on returning the 2nd block and the time is recorded. Each subject attempted the test twice with an interval of 2-3 minutes and the better time of the two trials was used in statistics. The test is restarted if the 1st block is dropped rather than placed on the floor or is not placed behind the line.

Countermovement jump: Countermovement jump (CMJ) height was measured using a scaled board. Subjects began from a standing position, performed a crouching action followed immediately by a jump for maximal height. Each subject completed three attempts with two minutes of rest allowed between trials. The best of three trials was used for analysis.

Maximal Dynamic Strength: The maximal strength tests for the upper and lower muscles were carried out using a 1-repetition maximum barbell bench press (1RM-BP) and a 1RM barbell squat (1RM-S). The 1RM-BP test was conducted on a standard bench and required the subject to perform an eccentric-concentric action. Beginning with the arms fully extended, the athletes lowered the bar towards the chest reaching 90º abduction of the shoulder joint

and 90º flexion of the elbow before returning to the start position. Repetitions performed incorrectly were not included in the count. All subjects performed 5-6 reps for each warm-up set. The protocol began with 40 kg and increased 5 kg during subsequent sets until one complete repetition could not be performed. A 3- to 5- minute rest period was allowed after each successive set. For the 1RM-S, subjects started with 120 kg, performing on command a series of one parallel squats. Subsequently, the weight was increased by 10 kg until the subject was unable to reach full extension of the legs. Also, a 3- to 5- minute rest period was allowed after each successive set. The high-bar squat (1RM-S) consisted of the barbell being placed on the superior aspect of the trapezius, while the feet were placed shoulder-width apart and angled laterally approximately 15–30°. Squat depth for this study consisted of the inguinal fold at the same level as the superior aspect of the knee. One hour rest intervals separated the 1RM-BP and 1RM-S tests.

Statistical Analyses: Statistical analysis followed the most important descriptive statistics, such as mean and SD. A one way Anova-test was used to determine significant differences of biomechanical variables among playing positions in volleyball attackers by SPSS ver. 18. The level of significance was set at $p < 0.05$ and all data are expressed as mean ± SD.

RESULTS

This study was performed on 24 elite male volleyball attackers in three different group of opposite, middle blocker and outside attackers. Figure1, 2, 3 and 4 shows Mean average and standard deviation of squat, Bench Press, Agility and CMJ test in different groups, respectively. According to figures, opposite attackers have the highest records of all biomechanical variables and middle blockers have the lowest, except in agility which belongs to outside attackers.

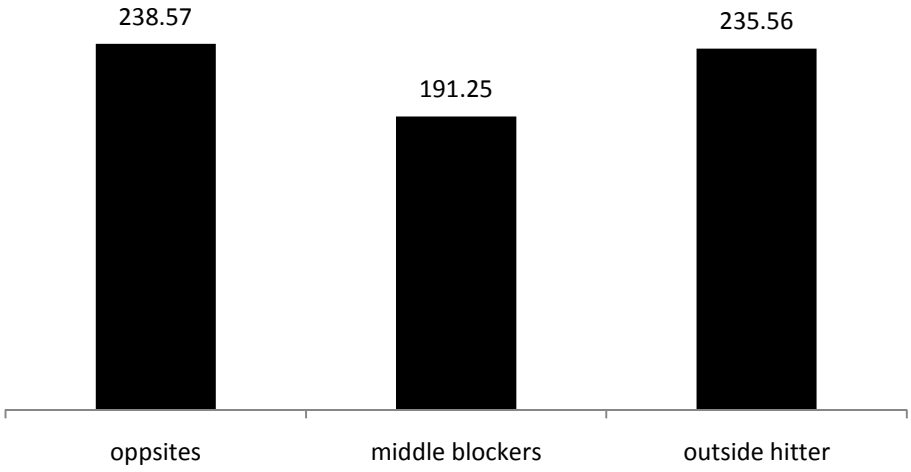

Figure 1- Squat (1RM-S) (Kg) Mean Average for volleyball attackers

Table 1 shows one way Anova test of biomechanical variables of volleyball attackers. According to the table there is significant difference between Squat, Bench Press and countermovement jump in different groups of attackers. No other significant differences were observed in agility results.

Table 1- One way -Anova for Biomechanical parameters of volleyball attackers

	opposite attackers	Middle Blockers	Outside attackers	F	P
Squat (1RM-S) (Kg)	238.57	191.25	235.55	18.28	0.31*
Bench Press (1-RM-BP) (Kg)	144.29	78.16	128.33	55.84	0.04*
CMJ (cm)	82.43	67.5	78.89	34.45	0.26*
Agility (Sec)	8.93	8.79	8.58	1.45	3.45

**p<0.05 (2- tailed)*

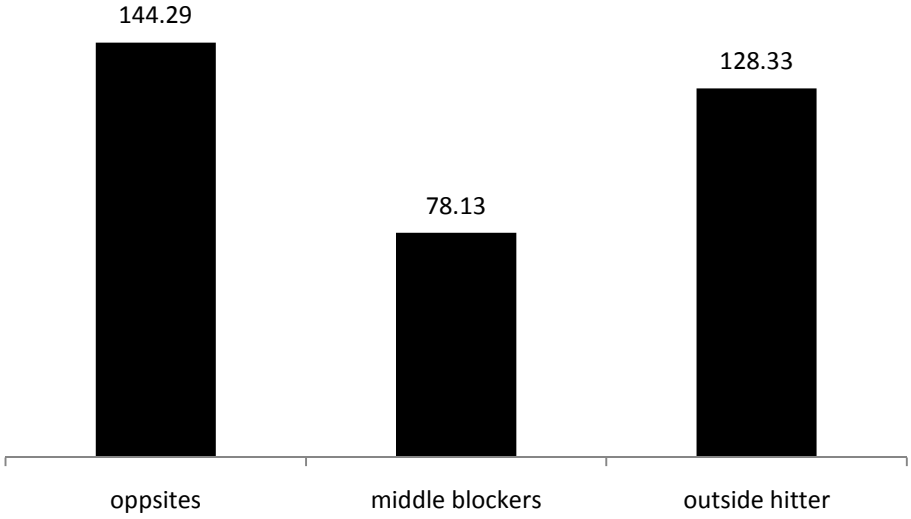

Figure 2- Bench Press (1RM-BP) (Kg) Mean Average for volleyball attackers

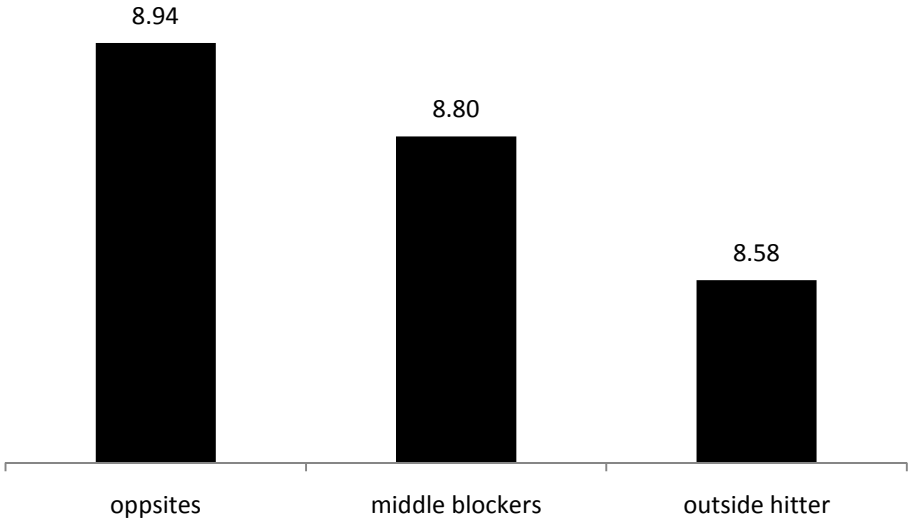

Figure 3- Agility (Sec) Mean Average for volleyball attackers

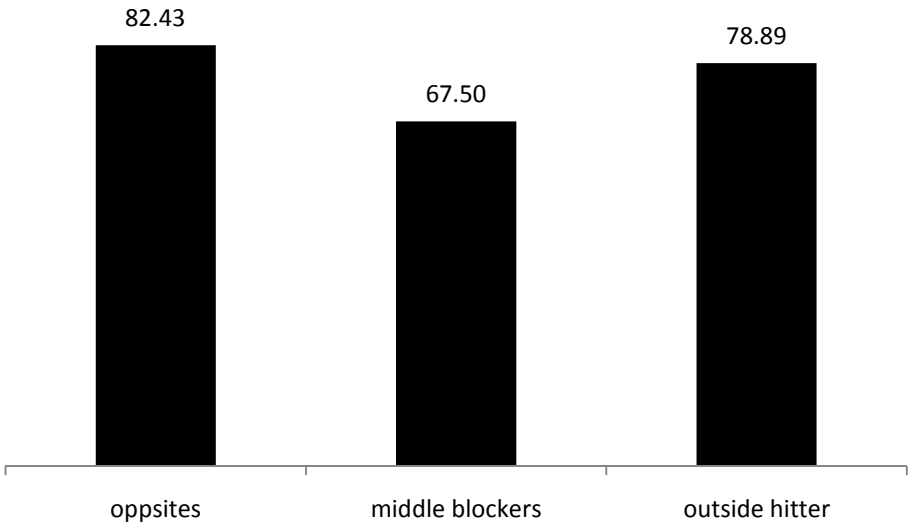

Figure 4- CMJ (cm) Mean Average for volleyball attackers

DISCUSSION

Volleyball is a team sport which requires specific biomechanical characteristics of players for elite performance, particularly in relation to dominance over the net. Volleyball players need to be physically competent in areas such as strength (jumping ability, explosive force) and agility which play important roles [15,18,19].

Physical performance requirements for volleyball include high levels of strength in shoulder, elbow and hands, which will be favorable for spiking, serving and saving ball; strength in knee extension, which will be favorable of jumping; and quick reaction time [15].

The present study analyzed the difference of biomechanical variables among the volleyball attackers at different volleyball positions

The results indicated that, in all the four biomechanical performance tests, differences were found in the variables of Squat, Bench Press and Countermovement jump and no significant differences were found in agility test. Results of biomechanical tests are not agreement with the other investigations. Marques et al. revealed that records of squat, bench press and countermovement much fewer than our study (143 kg, 90 kg and 45.5 cm) [2]. Marques et al. found that there are significant differences between players' position in groups of setter, libero and spiker but they didn't emphasize differences within the spikers [1]. Thought there is no similar study in differences between biomechanical variables of attackers, also the majority of the studies have reported the characteristics of women's or junior volleyball players as well as different physical abilities comparing results is not possible. Differences in upper and lower dynamic strength and power of attackers should be explained knowing their tasks and their characteristics [15,16]. Outside Hitter is the player who carries the serve receives responsibility along with the libero. Outside hitter most often attacks the balls which setter sets to the antenna to the left or right of the court. Playing on the outside hitter's position requires great all around skills because they play through the front row and the back row. Outside attackers or Wing spikers have to have the skills to pass, attack, block, serve and play defense. Wing spikers along with the opposites are often players who score the most points in the game. Outside hitter's passing responsibility makes them extremely important player for the team. The opposite hitter is the player who most often scores the most points in the team. In the rotation of players, they always play opposite the setter's position and that is where this name comes from. Opposite hitters don't have the passing responsibilities. The opposite usually get the most sets in the game. Opposites need to have great blocking skills since they play against the opposite hitter of the opponent or opponent's outside hitter when in the front row. Middle blockers main responsibility is to stop the opponent's offense. The middle blocker builds a block which stops the ball, or allows the team to dig the ball up. Middle blockers' job is to stop the opponent's middle hitters or wing hitters in co-operation with teammates. Middle blockers need to have great blocking, attacking and serving skills. There are obvious differences in arm swing as well as jumping during performance of attacking skills among spikers [3]. Opposites and outside hitters arm' swings include more hyper flexion and horizontal extension as it is quite different with middle blockers which are quick players and have to attack the ball with a lower shoulder hyper flexion immediately, so time is very important factor for them but opposites and outside hitters have enough time to perform attack and their main aim is attacking strongly [1,2,15]. Opposite and outside hitters have also enough time for jumping in block. For middle blockers, the first task in block is counteracting front middle hitter and the forming a double block with each other sides, they jump mainly with lower flexion angle in knee, however statistics show that middle blockers are much taller than other players, thus they can compromise their fewer jumping abilities through their height. Results show that there is no difference in agility records of attackers, maybe because the strength and conditioning programs for athletes are not position specific. When all of the athletes perform the same program, similar adaptations are expected [16,20]. Limited data is available for movement patterns required by player position. Another potential explanation for the lack of difference found between positions is that there may not be a large difference in movement patters. Typically opposites, outside and middle players all practice defensive footwork and movement patterns. While all attackers typically practice these skills, it would not be surprising that all positions performed statically similar in times to completion however attacking patterns are different for each position.

CONCLUSION

Volleyball requires athletes to be explosive in the lower limbs; this is especially emphasized in the front row hitting positions when attacking on offense or blocking on defense [17-20]. Among the attackers opposites and outside hitters have greater biomechanical variables comparing to middle blockers. There are significant differences between upper and lower body strength as well as lower body power between opposite, outside jitters and middle blockers. No significant differences were observed for agility in three groups. Considering biomechanical parameters related to performance in each position seems to be essential. Training session should be focused on

improving middle blockers physical characteristics and different agility trainings should be designed for attackers due to their movement pattern.

REFERENCES

[1] Marques MC, van den Tillaar R, Gabbett TJ, Reis VM, González-Badillo JJ, *J Strength Cond Res*, **2009**, 9, 121-129.
[2] Marques MC, Marinho DA, *Motricidade Fundação Técnica e Científica do Desporto*, **2009**, 5(3), 7-11.
[3] Sheppard JM, Cronin J, Gabbett TJ, Mc Guigan MR, Extebarria N, Newton RU, *J Strength Cond Res*, **2007**, 22, 758 – 765.
[4] Sheppard JM, Gabbett T, Borgeaud R, *Int J Sport Physiol Perform*, **2008**, 3, 397 – 400.
[5] Hertogh C, Hue O, *J Sports Med Physic Fitness*, **2002**, 42, 300-303.
[6] Stamm R, Veldre G, Stamm M, *J Sports Med Physic Fitness*, **2003**, 43, 291-299.
[7] Smith DJ, Roberts D, Watson B, *J Sports Sci*, **1992**, 10(2), 131-138.
[8] De Almeida TA, Soares EA, *Rev Bras Med Esporte*,, **2003**, 9, 198-203.
[9] Giatsis G, Kollias I, Panoutsakopoulos V, Papaiakovou G, *J Sports Sci*, **2004**, 3(1), 145-158.
[10] Amasay T, *J Strength Cond Res*, **2008**, 22(4), 1242-1248.
[11] Busko K, Wit B, *Acta Bioengin Biomech*, **2003**, 5:1, 67-72.
[12] Ziv VG, Lidor R, *Scand J Med Sci Sports*, **2010**, 20(4), 556-567.
[13] Koley SH, *J Hum Sport Exerc*, **2010**, 5(3), 389-399.
[14] Maly T, Mala L, Zahalka F, Balas J, Cada M, *Acta Univ. Palacki. Olumoc. Gymn.*, **2011**, 41(1), 15-22.
[15] Zhang, Y, *MSc thesis*, *Southern Cross University*, *Lismore*, *NSW*, **2010**.
[16] Schaal ML, *MSC Thesis*, *Boise State University*, **2011.**
[17] Sheppard JM, Gabbett TJ, Taylor K, Dorman J, Lebedew AJ, *Int J Sports Physiol Perform*, **2007**, 2: 292 – 304.
[18] Vescovi J, Mcguigan M, *J Sports Sci*, **2008**, 26(1), 97-107
[19] Stanganelli L, Dourado A, Oncken P, Mançan S, Da Costa SC, *J Strength Cond Res***, 2008,** 22, 741-749.
[20] Stojanovic T, Kostic R, *Physic Edu Sports*, **2002**, 1(9), 11-25.