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Relationships between acceleration, agility, and jumping ability in female volleyball players

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ABSTRACT

The aim of this study was to determine the relationships between acceleration, agility, and jumping ability in female volleyball players. A total of 12 female collegiate volleyball players were examined. The mean (SD) age was 20,10±1,197 years, height was 1,74±0,057 m, and wei ght was 61,30±4,244 kg for the 12 volleyball player s. In this study, the T test for agility, acceleration test, and vertical jump test were used. A significant negative correlation existed between vertical jump with acceleration and agility (P<0.01). Vertical jump was highly correlated with acceleration and agility (r = - 0.799, -0.777, respectively). In conclusion, the present research showed vertical jump performance for collegiate female volleyball players that positively affected acceleration and agility. Also, relationship between jump performance and acceleration, agility in volleyball is very important to produce high force and rapid stretch shortening cycle movements and high-speed whole body movements. Vertical jump performance, working with volleyball teams, need to be able to administer efficient, but relationship between vertical jump and acceleration, agility needs to be determined in longitudinal training investigations. Vertical jump and agility, acceleration development program can be designed with minimal cost and equipment. The results of this investigation show that coaches can utilize agility and acceleration training for vertical jump development.

Key words: Volleyball, Vertical jump, acceleration, agility

INTRODUCTION

In volleyball performance depends on well developed physical qualities, which are agility, acceleration, strength, and vertical jumping, and superior anticipation and decision-making skills. Volleyball performed on an area requires high-speed whole body movements. Many of these are in response to the motion of a ball, opposition players, or team-mates. Thus, volleyball is an intermittent sport that combines active and passive phases of play and requires players to compete in frequent short bouts of high-intensity exercise, followed by periods of low-intensity activity[1, 2] Also, volleyball is an intermittent sport that vertical jump is a fundamental part of the spike, the block, and the topspin and floating serves1 .The most effective spike in volleyball is likely dependent on vertical jump height and the body position adopted before ball contact. Specifically, a high vertical jump in volleyball is a critical component in hitting and blocking. Indeed, the vertical jump is a common tool used to assess explosive strength in volleyball athletes[3]. During volleyball competitive, players are involved in defensive and offensive jumping activities where power, strength, agility, and speed are required[4]. Generally, athletic performance coaches are responsible for the improvement of these movements. Speed, agility, and power are important components of sport performance[5]. Agility performance has been determine many ways, including ‘‘the whole body quick/accurate movement in response to a stimulus’’ [6] and ‘‘the ability to change direction, as well as to start and stop quickly’’[7, 8, 9]. Also, agility has been reported to be influenced by explosive strength, balance, muscular coordination, and flexibility[10, 11]. Agility deals with the changes in direction and the ability to effectively couple eccentric and concentric actions in ballistic movements [12]. The cognitive components involved in tasks that have traditionally been described as agility (e.g. athletics sprint start, shot put, zig-zag runs) differ greatly from tasks that contain significant uncertainty of time or space (e.g. reacting to a spike in volleyball, evading an opponent in football) [10]. Because the limiting factor in sprinting is the vertical jumping due to the acceleration of gravity and because high horizontal jumping production is requested[13], agility movements likely involve these same components. Acceleration is defined the rate of change in velocity that allows a player to reach maximum velocity in a minimum amount of time and is often measured by assessing sprint performance over short distances, such as 5 or 10 yards [14]. Maximum speed is the maximal velocity at which a player can sprint[15]. Human locomotion requires coordination of the upper and lower body. Linear actions such as acceleration and top end speed can be affected by changing the mechanics of the arms or legs[16]. As such, the ability to develop velocity in as short a time as possible (acceleration) may be of most importance to performance in many sporting activities [17]. Furthermore, it is thought that acceleration and maximum velocity are relatively separate and specific qualities[18, 19]. Thus, achieving maximum speed earlier or possessing greater acceleration has obvious advantages in many sports. Little studies have shown strong relationships between strength and power measures and vertical jump performance[20, 21, 22, 23] suggesting that to some extent, strength and power qualities influence performance in vertical jumping. Therefore, the aim of this study was to determine the relationships between acceleration, agility, and jumping ability in female volleyball players.

MATERIALS AND METHODS

Experimental Approach to the Problem

This investigation involved sectional design to evaluate the predictive power of explanation on vertical jump of acceleration, and agility ability. A total of 12 female collegiate volleyball players were obtained. The T test was used for agility and electronic device was used for vertical jump. Electronic timing gates were used to record completion times for acceleration test.

Subjects

A total of 12 female collegiate volleyball players were examined. The mean (SD) age was 20,10±1,197 years, height was 1,74±0,057 m, and weight was 61,30±4,244 kg for the 12 volleyball players. Before conducting the experiment, all subjects were informed of the risks of the study and gave informed consent. The study was approved by an ethics board and met the conditions of the Helsinki Declaration.

Procedures

In this study, the T test, acceleration test, and vertical jump test were used. All of the volleyball players included the study had the same physical fitness. The tests were applied in the contest season, and the aims of all tests were explained to the players before the tests were conducted. All tests were performed on an indoor synthetic pitch, and the tests were started with a 20-minute warm-up session. While the tests were conducted, the same weather conditions were taken into consideration. This was followed by the administration in this order: stationary 10-m, vertical jump test, and agility test. Subjects performed two trials of each test, with at least 3 minutes of rest between all trials. The best performances in each test were used for analysis. There was a 5-minute rest session between the each test. All tests were conducted >48 hours following a competition or hard physical training to minimize the influence of fatigue on test performance. Electronic device was used for vertical jump height; cone, stopwatch, and tape measure for distance were used for agility test. Electronic timing gates were used to record completion times for acceleration test. The methodology employed during the tests is summarized in the following paragraphs.

Testing

Agility T-test

The T-test (Figure 1) was used to determine speed with directional changes such as forward sprinting, left and right shuffling, and backpedaling. Based on the protocol outlined by Pauole et al. (2000) , subjects began with both feet behind the starting line A. At his or her own discretion, each subject sprinted forward to cone B and touch the base of it with the right hand. Facing forward and without crossing feet, they shuffled to the left to cone C and touch its base with the left hand. Subjects then shuffled to the right to cone D and touch its base with the right hand. They shuffled back to the left to cone B and touch its base. Finally, subjects ran backward as quickly as possible and return to line A. Any subject who crossed one foot in front of the other, failed to touch the base of the cone, and/or failed to face forward throughout had to repeat the test. The recorded score for this test was the better of the two last trials and times were recorded to the nearest one-hundredth of a second using an electronic timing system (Brower Timing Systems; accuracy of 0.01 second) placed 0.4 m above the ground.. Reliability and validity of the T-test were reported by Pauloe et al. (2000).

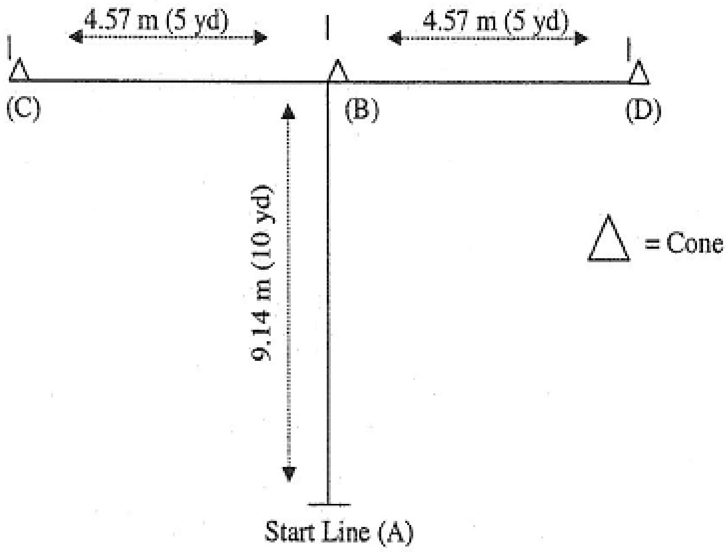

Figure 1: Agility T-test. The player runs forward from cone A to cone B, then shuffles to the left (cone C), then shuffles to the right (cone D), then shuffles back to point B, before running backwards to the start position (point A).

Acceleration test

Acceleration was evaluated using a 10-m test, involving sprinting 10 m as fast as possible from a stationary start position, as previously used by Wilson et al. (1993).

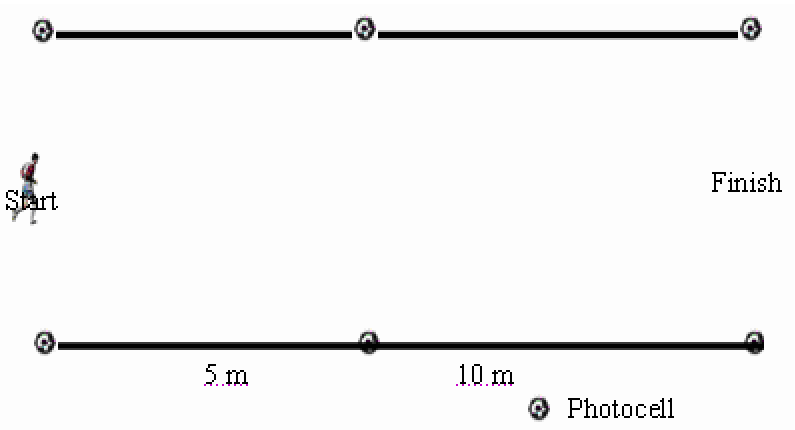

Figure 2. Acceleration test for 10 m. (9)

Vertical Jump Test

Vertical jump height was measured by a maximum vertical jump with a countermovement (CMJ). During the countermovement, subjects began in an erect standing position and moved into a semisquat position before jumping. The subjects stood on a rubber coated contact platform (120 cm 380 cm) connected by a cable to a digital timer that recorded the flight time of all jumps. The timer was triggered by the release of the subject's feet from the platform, and stopped at the moment of touchdown. The flight time was used to calculate the change in the height of the body's center of gravity. Subjects' hands remained on hips throughout all jumps.

Statistical Analysis

SPSS 16.0 statistical program was used for evaluation and calculation of the data. We summarized the data and evaluated the means and standard deviations. To explain relationship between measurements, Pearson correlation analysis was used according to the results of the test of normality, and linear regression analysis was used to predictive power of explanation on vertical jump of agility, acceleration and sprint ability. The significance level was taken as 0.05.

RESULTS

Table 1: Descriptive and performance characteristics for female volleyball players

Variables	N	Mean	Std. Deviation
Age (year)	12	20,10	1,197
Height (m)	12	1,74	0,057
Body weight (kg)	12	61,30	4,244
Vertical jump (cm)	12	34,20	7,969
Acceleration (sec)	12	2,04	0,141
Agility (sec)	12	11,14	0,823

The mean (SD) age was 20,10±1,197 years, height was 1,74±0,057 m, body weight was 61,30±4,244 kg, vert ical jump was 34,20±7,969 cm, acceleration was 2,04±0,141 seconds, and agility wa s 11,14±0,823 seconds for the 12 collegiate volleyb all players (Table 1).

Table 2: Analysis of regression between vertical jumping, acceleration and agility

Dependent variables	Variables	B	Standart hata	Beta	T	P
Vertical jumping	Acceleration	-45,191	12,010	-0,799	-3,763	0,006
		R = 0,799	R^2 = 0,639	F = 14,159	P = 0,006	
	Agility	-7,528	2,156	-0,777	3,492	0,008
		R = 0,777	R^2 = 0,604	F = 12,194	P = 0,008	

As shown Table 2 , he model is found to be meaningfull in the regresssion results of acceleration and agility for vertical jumping (P<0,05). A significant relationship existed between acceleration, agility and vertical jumping (P<0.05). A unit increase in agility lead to a change-7,528 unit in vertical jumping performance. Also, a unit increase in acceleration lead to a change -45,191 unit in vertical jumping performance.

DISCUSSION

The present study examined the relationships between sprinting, acceleration, agility, and jumping ability in female volleyball players, as these abilities are considered critical to success in volleyball. The mean (SD) vertical jump was 34,20±7,969 cm, acceleration was 2,04±0,141 seconds, sprinting was 2,87±0,179 seconds and agility was 11,14±0,823 seconds for the 12 collegiate volleyball players. The relationship between vertical jump and agility, acceleration, sprinting performance found in this study (P<0,05). Some sports like basketball and volleyball have high ground reaction forces when players land from a high jump. Vertical jumping is regarded as an important and attractive element of many sports such as basketball and volleyball**.** Many other factors have the potential to contribute to the success in a volleyball game; among them is agility, speed, acceleration, and quickly. Previous study found that the mean (SD) countermovement jump was 28,70±2,50 cm for first week, 30,67±2,54 cm for fourth week, 32,67±3,39 cm for eighth week, 34,29±3,57 cm for 24th week during season in female volleyball players. Also, the mean (SD) squat jump was 27,03±2,48 cm for first week, 28,72±2,46 cm for fourth week, 30,20±3,97 cm for eighth week, 32,68±4,06 cm for 24th week during season in female volleyball players[4]. Marques et al., (2008) found that the mean (SD) countermovement jump was 34,22±5,90 cm for before the experimental period and was 35,56±6,28 for after the 12-week experimental period in 10 professional female volleyball players playing in the national first division of Portugal and the European cup. Jumping ability is related to power production, it is important to remember that the effect of strength and speed on power is multiplicative. This means that the best gains in power will occur when there are increases in both strength and speed[27]. Mero et al., (1981) found a significant correlation between sprinting performance and jumping tests. They indicated that this relationship strongly related to the mechanical characteristics of fast twitch muscle fibers and notably that a higher fast twitch muscle fiber distribution was found in the sprinters tested.[29] found that the mean (SD) countermovement jump was 29,49±5,09 cm, agility was 11,92±0,52 seconds, and 10-m straight sprint value was 2,33±0,10 seconds for 34 women; they are licensed in various team sports (football, basketball, volleyball, and handball). They also explained that a low correlation was between agility and vertical jump, agility, and 10-m straight sprint tests in women. Other studies, sprint times reported were 1.05±0.05 seconds for a 5-m dash (Wnorowski, 2007) and 1.68±0.095 seconds for a 10-yard dash (9.91 m) (Morrow et al., 1980). Song (1982) studied the relationship between the defensive movements and physical performance among the players in Class "A" women's volleyball teams in China. From the regression analysis, he found that the defensive movements were significantly related with speed. T-test for agility was performed before the preseason, after the preseason, and at the end of the season's competition phase. During the 2005– 2006 season, T-test performance improved significantly at the end of the preseason (9,69±0,6 seconds) compared to baseline values (10,01±0,6) and continued to improve toward the end of the competition phase of the season (9,17±0,8) for women's intercollegiate volleyball[3]. Agility running times correlated significantly with countermovement jump heights (r = 0,58). In fact, jump height explained 34% of the variance in agility running times [33]. Barnes et al. (2007), found a correlation between jumping and agility performance. They also explained that countermovement jump height was highly correlated with drop jump height, reactive strength index, and isometric leg extensor action peak force. Young et al. (1996) found low and nonsignificant correlation between vertical jump and 20-m change of direction test. Peterson et al., (2006) reported a significant correlation between T-test and vertical jump in women. Pauole et al., (2000) reported low to moderate significant correlations ($p < 0.05$) between T-test for agility and a 40-yard sprint (r = 0.73 for women) and a vertical jump (r = 20.55 for women). Speed implies acceleration from a starting position. Acceleration implies power, and maintenance of speed requires muscular endurance (Sharkey and Gaskill, 2006). Vertical jump is affected by both neural aspects and muscular. In order to jump higher, the greatest vertical acceleration should be achieved before leaving the ground. This acceleration will create the greatest initial vertical velocity. The greater this velocity is, the higher the center of mass that will be reached. In order to achieve the greatest vertical acceleration, the player needs to create as much force as possible over the shortest period of time (Ziv and Lidor., 2010). In a study reported a low correlation between T-test and acceleration (20-yard as split time of 40- yard) and sprint velocity (40-yard) in women (Peterson et al., 2006).

CONCLUSION

In conclusion, the present research showed vertical jump performance for collegiate female volleyball players that positively affected sprint, acceleration and agility. Also, relationship between jump performance and sprint, acceleration, agility in volleyball is very important to produce high force and rapid stretch shortening cycle movements and high-speed whole body movements. Vertical jump performance, working with volleyball teams, need to be able to administer efficient, but relationship between vertical jump and sprint, acceleration, agility needs to be determined in longitudinal training investigations. Vertical jump, agility, acceleration and sprint tests measures are becoming increasingly important in the evaluation of performance for various sports. The goal in training to improve the vertical jump is to maximize the whole body's vertical velocity at the instant of takeoff. To achieve this goal, the coaches must to go into training more and more in agility, velocity, and acceleration for volleyball players who needs to produce greater force on the ground per unit of time or spend less time on the ground producing force before the takeoff. Vertical jump and agility, acceleration, sprint-development program can be designed with minimal cost and equipment. The results of this investigation show that coaches can utilize agility, acceleration and sprint training for vertical jump development.

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