

The Correlation between Leg-arm Muscle Power and Volleyball Players' Open Smash Ability

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Abstract: This study aims to determine the correlation between leg-arm muscle power and open smash ability. It employs descriptive method and measurement techniques using Microsoft Excel and SPSS 2.0 with simple correlation and multiple correlation test. The participants of this study were volleyball players (n=10, age 15 ± 17 years) selected by total sampling technique. In order to assess the leg, arm muscle power, and open smash ability, the researcher used vertical jump, medicine ball, and volleyball smash test. The results of R calculation showed that the $r_{\text{count}} \text{ value} = 0.822 > r_{\text{table}} = 0.632$ and $F_{\text{count}} = 7.301 > F_{\text{table}} = 4.74$. The correlational analysis was conducted and it indicated a very high correlation between all variables. It can be concluded that there was a positive and significant correlation between leg-arm muscle power with open smash ability on male volleyball players.

1 INTRODUCTION

Volleyball is a kind of sports which is played by two groups of people, where each group consists of six players. Volleyball is a widely known sport which can upgrade the sense of recreation and performance or competition. It has been proved in many volleyball competitions in any level. There are five techniques in volleyball, such as upper passing, lower passing, service, smash, and blocking (Palao, Santos, Ureña, 2017). This study focuses on open smash ability, where leg and arm power were the most affected object matters. Regarding to the techniques, power and speed are necessary for the players to support their physical fitness. The power of leg muscle is useful to create an optimal jump when the players perform an open smash, while the power from arm muscle is useful to improve power and speed when they hit the ball.

Palao, Valadés, Manzanares, Ortega (2014) suggested that in order to master the basic volleyball technique, the players have to be in good physical condition, since the condition will give an important contribution for the players. It will lead them to perform better in doing those techniques, which might ease them to gain several achievements. Irianto (2004:4) stated that “the factors which determine the

achievement in sports are good physical aspects such as power, speed, agility, coordination, power, muscle durability, healthy heart and lungs, accuracy, flexibility, reaction, and fitness”. Therefore, it can be concluded that volleyball is a kind of sports where good physical condition is the basic requirement to develop physical and mental condition. By having good physical condition, the players should implement intense, appropriate, programmed, and consistent training, in order to gain the optimal achievement.

Leg and arm muscle power are very important for volleyball players, especially for *smasher*, since leg muscle has the main role in doing an optimal jump, and arm muscle actively contributes in hitting the ball (McGown, Conlee, Sucec, Buono, Tamayo, M., Phillips, Beal, 2013). When the players' leg and arm muscle is in good condition, they will have optimal power, and their smash will be hard to block. In order to give a deadly smash to the opponents, the players have to make good position and power while smashing the ball, take the highest point to avoid opponents' block.

According to the results of observation and interview at 10th – 30th June, 2017 with trainer or education sports teacher it can be assumed that ten male volleyball players at Nurul Amaliyah vocational school Tanjung Morawa had gained three

times training in a week, at Tuesday, Thursday, and Saturday. Based on the observation, it had been known that several problems occurred during the training of basic techniques, such as too easy to take the smash, too easy to block the smash, and several failed and inaccurate smashes. The researcher assumed that the problems were caused by the weakness of leg power and arm power.

Based on the problems above, the researcher formulates a research question: What is the correlation between leg and arm muscle power with open smash ability among Volleyball players at Nurul Amaliyah Vocational School Tanjung Morawa, Sumatera Utara.”

Indra Kasih (2016) stated that “Smash is an action of hitting the ball in the pointed direction with great power, along with optimal jump, entering the opponents' field.” Gerhard Durrwacher (1982) also stated that “Smash is the main hit or the effort to create an offensive play, in order to win the game.” Nuril Ahmadi (2007) stated that “Smash is an action where the hands of players fully contacted the upper part of the ball, hitting the pointed lines of the ball's track within massive power and speed.”

It can be explained that smash is an effort to gain a score in the game, which is usually performed by the front line of the attack field since only in the area, players are easier to strike a smash through the net. Smash also can be done in the backfield; however, it must be done with the optimal jump from 3 meters of the backline.

Nuril Ahmadi (2007) stated that Smash could be done with several steps, such as steadiness, approaching, striking, and landing. Further detail of each step is explained as follow: 1) Steadiness Players stand with normal posture about 3-4 meters in the back distance of net. While players try to make a step forward, they make steady little steps in their place; 2) Approaching players step forward, then take a foothold along with the lowered body. Both arms already on each side of the body, then they pull the arms into the backside followed by an explosive jump, ready for striking the ball by posturing a swing from the back to front side; 3) Striking While in the air, players should be able to reach the ball and then hit the ball with great power from the dominant hand. The positioning must be focused on how palm of the hand can make a whip move. The hit can be optimized, if the whip movement followed by strong foothold, lowered body, and controlled standing. This position must be performed in one harmonic and explosive movement. 4) Landing After the ball has been successfully hit, the smasher is ready to land.

Landing must be done with good positioning using two legs and steadiness.

Analysis of smash movement involves process of steadiness, steadiness depends on the track of the passing ball, about 3 - 4 meters from the falling point. When the players jump, they must take a full awareness on how our legs have been positioned. The leg which serves as the foothold must be positioned in front of another leg. The movement is called lower leg flexi movement. Smash analysis also comprises process of jumping, which smasher continue the process with stepping movement after the process of steadiness. This process is an extended process from lower leg flexi movement using particular parts of the muscle (*extremities inferior muscle*) i.e.m. *Rectus femoris, m.vastus medialis, m.vastus lateralis, m.biceps femoris, dan m.gastronemius*. When players take an explosive jump, it must be performed continually. The starting step has to be coordinated with the arms which have been swung from behind the back of the body, bending the knee, then both arms must be massively jolted through the thigh, leading the legs to open. Shoulder follows the explosive movement. Shortly after jumping, the body floated in the air with position swelled backward, which is the hyperextension motion. The soles, ankles, pelvis, and toes moved in harmony to obtain a perfect range of motion to create explosive movements and vertical jumps. The analysis continues to examine process of striking which is the skill requiring hand-eye coordination to adjust the right time from the highest jumping range to the falling ball. The active wrist jerks forward with the palm and fingers closing the ball, which is a flexion of the wrist by involving the flexor *carpi radialis* muscle, the extensor *carpi ulnaris* muscle, and the *extensor digitorum*. After exposing to the ball, the beating arm makes a further movement with the midline of the body or the extended range of arms, which involves the *deltoid* muscle, the *pectoralis major* muscle, and the *Maximus Dorsi* muscle, followed by bending gestures involving the *abdominis*.

The correct strike will result in a hard and fastball going to the ground with a fast spin with the top (topspin). When striking, the muscles directly involved shoulder groups such as *deltoid, trapezius* and *triceps brachii* and lower arm muscles such as *flexor carpi radialis* muscle, *extensor carpi ulnaris* muscle, and *extensor digitorum*.

Lastly, process of Landing is also involved. The next move after striking the ball above the net is

slightly bending and landing with both legs (lower limb flexion motion). The way to land after performing each smash is similar to moment when the upper body bends forward, and feet are directed forward to maintain the balance of the athlete landing on both legs with a slight bend.

Open smash is a variation of attack techniques in volleyball that is quite difficult to do because it has complex moves. The movement consists of elements of speed when running the starting steps, jumping, coordinating with the ball when it hits the ball and the power when it lands. A mistake that often occurs is the absence of explosive power or power in making open smash/spike moves. Explosive power greatly affects the results of spikes where leg muscle power and arm muscle power are very important in volleyball games, especially for smasher. Thus, by having good leg and arm muscle power, the smash will be difficult to block. In order to produce a deadly strike to the opponent's field, the player must smash when the ball is at maximum height to avoid block from the opponent.

As stated by Kasih (2016), the special characteristics of a normal smash (open smash) are the ball (bait) is high enough to reach three meters above and the distance of the ball trajectory ranges between 20-50 cm from the net. The point of the falling point of the ball between the feeder and the smasher measured from the projection line of the smasher to the net. The first step starts after removing the feeder by looking at the ball, reaching and hitting the ball as high as the net.

From a number of opinions above, the writer concludes that the skill of open smash / open spike is one of the blows that have a fairly high ball characteristic, namely 3 to 4 meter height which means that a *spiker* must have a high enough jump quality so that the spike/smash results are at its best.

According to Harsono (1988), "explosive power (power) is the ability of muscles to exert maximum power in a very fast time". Then, Bompa (1994) states, "explosive power is the result of an alloy of the power and speed of muscle contraction". Whereas Sajoto (1988) argues that muscular "power is the ability of a person to carry out maximum power with his effort being deployed in the shortest amount of time".

Based on these opinions, it can be concluded that power is the result of power and speed, which is the ability of the muscle to exert or exert maximum power in a very short time. If every two individuals can lift a weight of 70 kg, but one can lift it faster than the others, then that person has better power than the person who lifts it more slowly.

Power of the leg muscles greatly determines the ability of a player to perform various movements in playing volleyball, which is one of his jumping moves when he wants to do a smash. In the volleyball game, the maximum speed of smash is determined by good explosive power. In other words, the player who has the explosive power of leg muscles is one component of a very important physical condition, which must be possessed in volleyball. The parts of the leg muscle (*inferior extremity* muscle) consist of *m.rectus femoris*, *medial vascular*, *lateral mucus*, *m.biceps femoris*, *m.gastronemius*, *m.soleus*. Doing a leap when doing a smash really needs good leg muscle power. By having good leg muscle power, most likely they will result in a high jump and overcome the net height so that it will be easier to smash when floating in the air.

The explosive power of the arm muscles is also a very important thing an athlete must have in carrying out volleyball smashes. It is where an athlete must be able to hit the ball quickly and strongly so that the opponent is difficult to return the ball.

Suharjana (2018) states, "power is the ability of muscles to contract strongly and quickly" while Kasih (2016) suggests that power is the ability to do business optimally in the shortest.

Thus, it can be stated that "power is one of the most important traits for skills (performance) in sports and maximum power or known as explosive power is the maximum combination of speed and power. Muscle explosive power is very important to do a motion activity in every sport. The explosive power of the arm muscles will determine how hard an athlete strikes and how far they throw the ball. The explosive power of the arm muscles is influenced by the ability of the arm muscles, while the part of the arm muscles (*superior extremity* muscle) is *m. Trapezius*, *m.deltoideus*, *m.pectoralis major*, *m.biceps brachii*, *m.triceps brachii*, *m.brachialis*, *m.brachioradialis*, *m.pronator teres*, *m. flexor carpi radialis*, *m.flexor digitorum superficialis tendines*.

1.1 The Correlation between Leg and Arms Muscle Power with Open Smash Ability

Based on the results of the analysis,, it takes a high jump and a strong and fast punch when doing a smash. To support good jumps and punches, power is also needed. Explosive power is the ability to overcome load resistance at high speed (Harre,

1982). High speed is defined as the ability of muscles to contract strongly and quickly. Thus the explosive power is influenced by strength and speed, both the speed of stimulation and the speed of muscle contraction (Fox et al, 1988).

Based on the opinion above, it can be concluded that power is the result of strength and speed, which is the ability of muscles to exert in a very short time.

When jumping, there needs to be leg muscle power. Good leg muscle power will help the spiker to produce a high jump to overcome the height of the net so that it will make it easier for the spiker to make a smash when floating in the air. Achmad Irfan (2016) states that leg muscle power is really needed by a spiker to do a smash in which making a strong and fast jump in order to hit the ball when the ball is above the air or the volleyball net.

Moreover, when doing a punch, there is a need of arm muscle power. Good arm muscle power enables to do strong and sharp strokes that will make it difficult for your opponent. Kasih (2016) states that arm muscle power is needed to produce punch power so that the ball falls at the high speed and dives sharply.

Leg and arm muscle power is very important in playing volleyball, especially for spiker, because leg muscle power plays a very significant role in jumping and arm muscle power plays a significant role in hitting the ball. Therefore, by having good leg and arm muscle power, smashes will be difficult to stop. In order to create a smash that kills the opponent's game, the player must smash when the ball is at maximum height in order to avoid damages made by the opponent.

2 RESEARCH METHODOLOGY

As stated earlier, this study aimed to determine the correlation of leg and arm muscle power with the results of the open smash ability on volleyball players. This study employed descriptive methods by conducting test and measurement techniques.

2.1 Instrument

The data in this study were variables which were correlated on leg muscle power, arm muscle power, and the results of open smash ability, collected by tests and measurements. The instruments used in this study were vertical jump, medicine ball, and volleyball smash.

2.2 Data Analysis Technique

The data obtained in this study were calculated using Microsoft Excel and SPSS 20 with simple correlation and multiple correlations test. Before testing hypotheses, the requirements tests were conducted, such as data normality test and linearity test.

3 FINDING AND DISCUSSION

3.1 Description of Research Data

This is a description of the raw data of the research results, which include data on number, average value, maximum value, minimum value, and standard deviation.

Table 1: The result data of leg muscle power test.

Statistic	X ₁
Maximum Value	62
Minimum Value	40
Average Value	50,2
Standard Deviation	7,35

Tabel 2: The result data of arms muscle power test.

Statistic	X ₂
Maximum Value	524
Minimum Value	424
Average Value	457,2
Standard Deviation	35,00

Table 3: The result data of open smash test.

Statistic	Y
Maximum Value	129,10
Minimum Value	73,16
Average Value	100
Standard Deviation	14,73

3.2 Analysis Requirements Test

Analysis for requirement test is required in the analysis of statistical data in order to make the data collection useful in this study. Requirements test for the data analysis were normality test and linearity test.

Table 4: Normality test.

Variable	L_o	L_{table}	α	Note
Leg Power	0.168	0.258	0,05	Normal
Arm Power	0,247	0.258	0,05	Normal
Result of Open Smash	0,210	0.258	0,05	Normal

Table 5: Linearity test.

No	Research Variable	F_{count}	Sig	Note
1	$(X_1) - (Y)$	84,736	0,083	Linier
2	$(X_2) - (Y)$	0,215	0,932	Linier

Normality test of the data using reliability test from table 4 showed that the values for each variable are higher than the L_{table} , $L_{table} = 0.258$ with $n=10$ and level $\alpha = 0,05$. because $L_{count} < L_{table}$. It can be concluded that the sample comes from a population was normally distributed.

Based on the data analysis, it can be seen that the correlation between leg muscle power and the open smash ability is linear, with an F value of 84.736 and significant 0.083 ($sig > 0.05$). The correlation between arm muscle power and the open smash ability is linear, with an F value of 0.215 and Sig 0.932 ($sig > 0.05$).

3.3 Hypothesis Test

3.3.1 The Correlation between Leg Muscle Power (X_1) with Open Smash Ability (Y).

Table 6: Correlation of coefficient X_1 with the Y variable.

Correlation	Correlation n=10		$\alpha = 0,05$		(R^2)
	r_{count}	r_{table}	t_{count}	t_{table}	
r_{x1y}	0,822	0,632	4,086	1,86	67,57%

The results of testing the first hypothesis obtained a correlation coefficient of $r_{x1y} = r_{count} 0.822 > r_{table} 0.632$ and $t_{count} = 4.086 > t_{table} = 1.86$. Based on the testing criteria of the hypothesis that H_0 is rejected and H_a accepted, then this study concluded that there is a positive and significant correlation between leg muscle power with the open smash ability of male volleyball players. The determination coefficient of 67.57% explaining that leg muscle power contributed 67.57% to the open smash ability.

3.3.2 The Correlation between Arm Muscle Power (X_2) with the Results Open Smash Ability (Y).

Table 7: Correlation of coefficient X_2 with the Y variable.

Correlation	Correlation, n=10		$\alpha = 0,05$		(R^2)
	r_{count}	r_{table}	t_{count}	t_{table}	
r_{x2y}	0,749	0,632	3,193	1,86	56,10%

By testing the second hypothesis, it was obtained a correlation coefficient of $r_{x2y} = r_{count} 0.749 > r_{table} 0.632$ and $t_{count} = 3.193 > t_{table} = 1.86$. Based on the testing criteria of the hypothesis that H_0 is rejected while H_a is accepted, it can be concluded that there is a positive and significant correlation between arm muscle power and the open smash ability among male volleyball players. The determination coefficient of 56.10% explained that arm muscle power contributed 56.10% to the results of open smash ability.

3.3.3 The Correlation between Leg (X_1) and Arms Muscle Power (X_2) with the Results Open Smash Ability (Y).

Table 8: Correlation of coefficient X_1 and X_2 with Y variable.

Correlation	Correlation n=10		$\alpha = 0,05$		(R^2)
	r_{count}	r_{table}	F_{count}	F_{table}	
r_{x1x2y}	0,822	0,632	7,301	4,74	67,57%

By testing the third hypothesis, it was obtained a correlation coefficient of $r_{x1x2y} = r_{count} 0.822 > r_{table} 0.632$ and $F_{count} = 7.301 > F_{table} = 4.74$. Based on the testing criteria of the hypothesis that H_0 is rejected while H_a is accepted, then it can be concluded that there is a positive and significant correlation between leg and arm muscle power with open smash ability of male volleyball players. The determination coefficient of 67.57% explained that leg muscle power and arm muscle power contributed 67.57% to the results of volleyball smash open ability while 32.43% was influenced by other variables.

4 DISCUSSION

Based on the results of this study, the leg muscle power and arm muscle power contribute positively to the ability of open smash results. There was a positive and significant correlation between leg muscle power and the open smash ability among

male volleyball players at Nurul Amaliyah vocational school Tanjung Morawa, North Sumatra. The limb muscle power plays a role when jumping, which will do open smash by having good leg muscle power. It is useful to help the smasher jump high and jump over the net. It will ease the spiker to smash when floating in the air. The movement during the jump to reach the high net is an anaerobic move that uses the ATP-PC energy system due to its explosive moves. In this case, Harsono (1988: 175) states that to produce a strike in the smash is very determined by the efficiency and the effectiveness of muscle movement which also involve the leg muscles, such as inferior *extremity muscles*, *m. rectus femoris*, *m. medial vascular*, *lateral mucus*, *m. biceps femoris*, and *m. gastronemius*. As a support for repelling, it is clear that leg muscle power contributes positively to open smash.

In addition, there was a positive and significant correlation between arm muscle power and open smash ability among male volleyball players at Nurul Amaliyah vocational school Tanjung Morawa, North Sumatra. Explosive muscle power is very important to do a motion activity in every sport. The explosive power of the arm muscles will determine how hard an athlete strike the ball, how far they throw the ball. The explosive power movement when hitting the ball is an anaerobic move that uses the ATP-PC energy system because of its explosive moves. The explosive power of the arm muscles is influenced by the ability of the arm muscles, and the part of the arm muscles (*superior extremity muscle*) involve *m.trapezius*, *m. deltoideus*, *m.pectoralis major*, *m.biceps brachii*, *m.triceps brachii*, *m.brachialis*, *m.brachioradialis*, *m.pronator teres*, *m.flexor carpi radialis*, *m.flexor digitorum superficialis tendines*. Power from the arm muscles is needed to produce punch power in which the ball falls at high speed and dives sharply. It is clear that arm muscle power contributes positively to open smash.

Another finding from this study is that there was a positive and significant correlation between both leg and arm muscle power with the open smash ability among male volleyball players at Nurul Amaliyah vocational school Tanjung Morawa North Sumatra. Explosive muscle power is very important to do a motion activity in every sport. Power from the leg muscles is useful to help the smasher produce a high jump over the net so that it will ease the player to smash when floating in the air. Meanwhile, the arm muscle power is needed to produce punch power, so the ball falls at high speed and dives sharply. Since it is clearly proven that smashing

requires several components, namely leg and arm muscle power, this shows that these two factors are inseparable and make a positive contribution.

5 CONCLUSIONS

Regarding the objectives of the study, it can be concluded that: 1) There is a positive and significant correlation between leg muscle power with open smash ability among male volleyball players; 2) There is a positive and significant correlation between arm muscle power with open smash ability among male volleyball players; 3) There is a positive and significant correlation between leg and arm muscle power with open smash ability among male volleyball players.

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