



## **The Relationship Between Leg Muscle Power, Arm Strength and Wrist Flexibility on Smash Accuracy for Volleyball Extracurricular Students at SMA 15 Bandar Lampung**

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### **Abstract**

This study aims to analyze the relationship between leg muscle power, arm strength and wrist flexibility on the Smash accuracy of male and female extracurricular volleyball students at SMA Negeri 15 Bandar Lampung. The method used in this research is quantitative correlational with a sample of 30 students, 15 male students and 15 female students. Data was collected through broad jump tests, push and pull dynamometer, goniometer, and position-based Smash tests. Data analysis was carried out using the Pearson correlation test, multiple correlation, as well as through the prerequisite tests for normality and linearity. The results of the multiple correlation test show that there is a strong relationship between leg muscle power, arm strength and wrist flexibility and smash accuracy for both male and female students. The results of the multiple correlation test show  $R = 0.740$  for boys and  $R = 0.693$  for girls, indicating a simultaneous relationship. The simultaneous contribution of these three variables to smash accuracy for male students was 55%, while for female students it was 48%, indicating a fairly strong contribution from the three variables to smash accuracy and significance ( $p < 0.05$ ).

**Keywords:** *Leg Power, Arm Strength, Wrist Flexibility, Smash*

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## **INTRODUCTION**

Sport is a physical fitness activity that is carried out through the process of movement and is carried out in the spare time between human activities. The aims of various kinds of sport include, among others, as a means of eliminating boredom or as a means of recreation, as a means of achieving achievements, as well as to obtain physical and spiritual fitness. Sports can also shape a person's personality into someone who is disciplined and sportsmanlike. Nowadays sports can be done in various places, one of which is at school.

At the school education level, sports activities are carried out through educational methods fostered by teaching staff, namely teachers, with the aim of knowledge and achievement. Sports

are used as a medium to shape behavior and improve students' character attitudes through the values of sportsmanship, cooperation and discipline. All of these activities are carried out by adapting existing regulations as well as adapted facilities and infrastructure so that students can achieve educational targets in accordance with the curriculum, apart from that there are also sports activities carried out outside school hours which are called extracurricular.

Extracurricular activities are activities held outside school hours that are listed in the program in accordance with school conditions and needs. Extracurricular activities include: arts, scouts, and sports, one of which is volleyball. According to Abadi & Andriawan (2025) Volleyball is an activity that involves facing each other between two different teams with each team consisting of six people. Meanwhile, according to Herawati in Pringsewu, 2024: 718) volleyball, it is a big ball game played in teams, volleyball is a game played by volleying the ball with the aim of preventing the ball from falling on the floor. To be able to play volleyball well, you must really master the basic techniques, because mastering the basic techniques for playing volleyball is one of the determining elements for whether a team wins or loses in a match, apart from physical, tactical and mental conditions.

In the game of volleyball, there are several basic volleyball techniques, namely, (1) basic serving techniques which consist of a bottom serve and top serve, (2) basic passing techniques which consist of a bottom pass and top pass, (3) basic Smash techniques, (4) basic block techniques. If the four basic techniques above can be mastered perfectly, then someone can practice playing volleyball (Adnyana in Pou et al., 2024:72). The smash technique is a technique that is considered to have a great chance of being able to smash well. Of course, not only good technique is needed, good physical components are also needed to support success in smashing, as stated by Oxendine in the book Khadijah & Amelia (2020) p. 11. Physical condition factors are physical skills that are developed through motor skills. Motor skills are skills that direct humans to move the human body, and for this reason biomechanics plays a role in it. Biomechanics is a science that applies the laws of mechanics to the structure of living things, especially the locomotor system of the body. What is meant by locomotor itself is an activity in which the entire body moves due to its own energy and is generally assisted by the force of gravity according to Kusumawati and Muhamad in (Daharis et al., 2022:3)

To be able to get good Smash accuracy results, a player is required to have a high level of accuracy, because someone who has a good level of accuracy does not need a lot of energy to spike

because it is very easy to direct the ball into an empty place. Smash accuracy is very important to outwit and avoid blocks from opponents (Ertanto 2020 in Setiawan et al., 2025: 255)

These physical condition factors include leg muscle power, arm strength, and wrist flexibility, as stated by Setiawan et al (2025). The stronger the leg muscle power, the higher the jump will be. then according to Beutelstahl (2001:24) in (Sumantri, 2020) high arm muscle strength causes the arm to stretch stiffly so that it touches the ball so it can hit hard, and Prambudi & Sasmarianto (2023) said in their research that there are several factors that can influence the success of a volleyball Smash, namely hitting the ball hard, and having a very high jump. The strength needed is the strength of the arm muscles, and the speed of the wrist in making the shot, then also the flexibility of the wrist itself so that the ball that is hit can dive hard into the opponent's area. Based on the results of observations made, researchers were interested in testing and proving the research entitled the relationship between leg muscle power, arm strength and wrist flexibility on the Smash accuracy of volleyball extracurricular students at SMA 15 Bandar Lampung.

## **METHOD**

Based on the research problem and objectives, this research method is quantitative and a correlation type of research, namely testing the relationship between variable X and variable Y for volleyball extracurricular students at SMA Negeri 15 Bandar Lampung. In this study there are 3 variables X and 1 variable Y so that the tests carried out are X<sub>1</sub> to Y, X<sub>2</sub> to Y and This study aims to determine the relationship between leg muscle power and wrist strength on the Smash accuracy results of volleyball extracurricular students at SMA N 15 Bandar Lampung.

According to Ali (2022) Quantitative research is an investigation of social problems based on testing a theory consisting of variables, measured with numbers, and analyzed with statistical procedures to determine whether the predictive generalization of the theory is correct. Whereas what is meant by correlation is research designed to determine the level of relationship between different variables in a population

1) Time: This research was carried out using direct tests carried out in the field.

2) Venue: Held at SMA 15 Bandar Lampung which is located at JL. Turi Raya. Labuhan Dalam Village. Tanjung Senang Bandar Lampung.

The population of this study used a total sampling technique of 30 volleyball extracurricular students at Sma n 15 Bandar Lampung who were active in the 2025/2026 academic year.

### **a. Data Measurement and Analysis Techniques**

The main instruments in this research were the exercise observation sheet which was used to record the consistency of the test implementation and the assessment sheet for the leg muscle power test which was carried out with the broad jump test, the arm strength test which was carried out with the push and pull dynamometer test, the wrist flexibility test using the goniometer, and the Smash accuracy test which was carried out with the Smash accuracy test.

**Table 1.** Broad Jump Score Criteria

<b>Man</b>	<b>Women</b>	<b>Criteria</b>
> 224	> 178	very well
195 – 223	153 – 177	Good
165 – 194	129 – 152	quite
136 – 164	104 – 128	Less
< 135	< 103	very less

TKSI phase D

**Table 2.** Arm Strength Criteria

<b>Man</b>	<b>Women</b>	<b>Criteria</b>
Prestasi (Kg)	Prestasi (Kg)	very well
44.00 – > Kg	44.00 – > Kg	Good
35.00 – 43.50 kg	35.00 – 43.50 kg	quite
26.00 – 34.50 kg	26.00 – 34.50 kg	Less
18.00 – 25.50 kg	18.00 – 25.50 kg	very less

test and measurement book

**Table 3.** Wrist Flexibility Criteria

<b>Man</b>	<b>Women</b>	<b>Criteria</b>
$\geq 80^\circ$	$\geq 80^\circ$	very well
$60^\circ - < 80^\circ$	$60^\circ - < 80^\circ$	Good
$40^\circ - < 60^\circ$	$40^\circ - < 60^\circ$	quite
$< 40^\circ$	$< 40^\circ$	Less
$\geq 80^\circ$	$\geq 80^\circ$	very less

(book of techniques for measuring joint range of motion) (Arovah, 2025)

**Table 4.** Smash Accuracy Score Criteria

Man	Women	Criteria
>22	>21	very well
18-21	16-20	Good
12-17	10-15	quite
8-11	7-9	Less
<7	<6	very less

(Depdiknas (1999:15) in Ulya 2023)

The data analysis methods in this research include the Pearson correlation test and the simultaneous multiple correlation test which is tested through the prerequisite normality test and linearity test.

The percentage formula used is:

- a. Pearson Correlation

$$r = \frac{n \sum XY - (\sum X)(\sum Y)}{\sqrt{[n \sum X^2 - (\sum X)^2][n \sum Y^2 - (\sum Y)^2]}}$$

r = Pearson correlation coefficient

n = Number of data pairs (number of samples)

X = Score of variable X

Y = Y variable score

$\sum X$  = Sum of all X scores

$\sum Y$  = sum of all Y scores

$\sum XY$  = The number of products of X and Y for each pair of data

$\sum X^2$  = Sum of squares of X scores

$\sum Y^2$  = Sum of squares of Y scores

- b. multiple correlation

$$R_{y.x_1x_2x_3} = \frac{\sqrt{r^2_{yx_1} + r^2_{yx_2} + r^2_{yx_3} - 2r_{yx_1}.r_{yx_2}.r_{yx_3}.r_{x_1x_2x_3}}}{1 - r^2_{x_1.x_2.x_3}}$$

Description =

$R_{y.x_1x_2x_3}$  = Multiple correlation coefficient between variables X1, X2, X3  
together with variable Y

$r_{yx1}$  = Correlation coefficient X1 with Y

$r_{yx2}$  = Correlation coefficient X2 with Y

$r_{yx3}$  = Correlation coefficient X3 with Y

c. Coefficient of Determination ( $R^2$ )

$$KD = r^2 \times 100 \%$$

Information

KD = Coefficient of Determination (in percent)

r = Pearson correlation coefficient

$r^2$  = Square of the correlation value

d. Test f

$$F = \frac{R^2 / k}{(1 - R^2)(n - k - 1)}$$

Information

F = calculated F value

$R^2$  = coefficient of determination (squared result of multiple correlation)

k = number of independent variables

n = number of samples

n-k-1 = denominator degrees of freedom (df2)

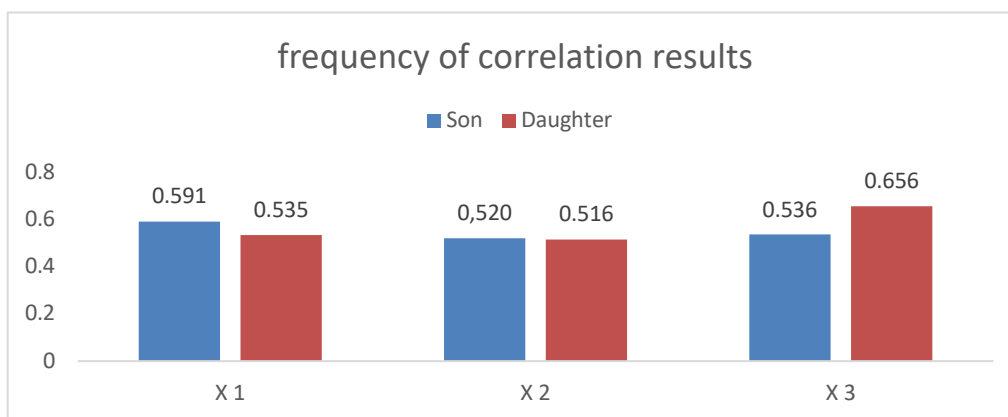
## RESULTS AND DISCUSSION

### Result

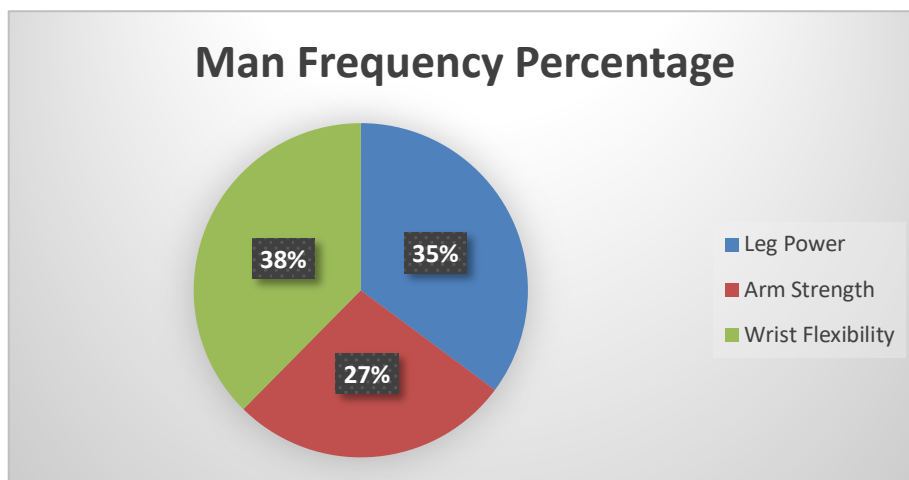
Based on the results of research that has been carried out, it proves that the power of the leg muscles, the strength of the arm muscles and the flexibility of the wrists have their respective roles in the implementation of the smash. This can be seen from the correlation grade results produced by these three variables for both men and women with the respective hypothesis test results as follows:

**Table 5.** correlation results

Category	X1	X2	X3	X1,X2,X3
Son	0,591	0,520	0,536	0,740
daughter	0,535	0,516	0,656	0,693
Rtab	0,514	0,514	0,514	0,514

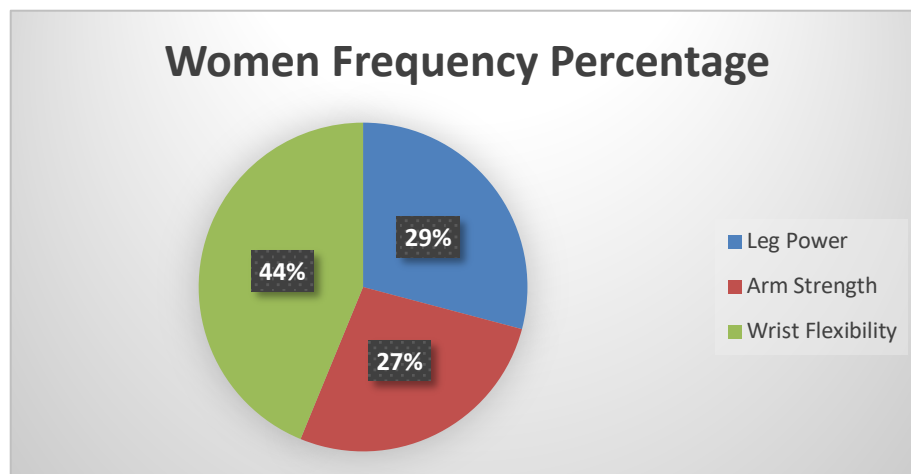


**Figure 1.** Frequency of correlation result



**Figure 2.** man frequency percentage

From the table and figure it can be seen that leg power has a 35% relationship, arm strength has a 27% relationship and wrist flexibility has a 38% relationship with smash accuracy.



**Figure 3.** *women frequency percentage*

From the table and figure it can be seen that leg power has a 29% relationship, arm strength has a 27% relationship and wrist flexibility has a 44% relationship with smash accuracy.

## **Discussion**

Based on the results of research that has been carried out, it is proven that the power of the leg muscles, the strength of the arm muscles and the flexibility of the wrists have their respective roles in the implementation of Smash. The stronger the power of the leg muscles, the strength of the arm muscles and the flexibility of the wrists that students have, the stronger the Smash blow will be, this can be seen from the results of the correlation grades produced by the three variables for both men and women with the respective hypothesis test results as follows: In X1 the calculated value  $> r$  table ( $0,591 > 0,514$ ) in man and ( $0,535 > 0,514$ ) in women,  $H_1$  is accepted, meaning there is a significant relationship between leg muscle power and Smash accuracy for volleyball extracurricular students at SMA 15 Bandar Lampung. In X2 the calculated value  $> r$  table ( $0,520 > 0,514$ ) in men and ( $0,516 > 0,514$ ) in women,  $H_2$  is accepted, meaning that there is a significant relationship between arm strength and Smash accuracy for volleyball extracurricular students at SMA 15 Bandar Lampung. And in X3 the calculated value  $> r$  table ( $0,536 > 0,514$ ) for men and ( $0,656 > 0,514$ ) in women,  $H_3$  is accepted, meaning that there is a significant relationship between wrist flexibility and Smash accuracy for volleyball extracurricular students at SMA 15 Bandar Lampung.

And the regression results test the variables together, The results of the multiple correlation test show an R value of 0.740, which means there is a strong relationship between leg muscle

power, arm strength and wrist flexibility and smash accuracy in male students. The R Square value of 0.550 shows that these three variables simultaneously contribute 55% to smash accuracy, while the remaining 45% is influenced by other factors outside the research. The results of the multiple correlation test show an R value of 0.693, which means there is a strong relationship between leg muscle power, arm strength and wrist flexibility and smash accuracy in female students. The R Square value of 0.480 shows that these three variables simultaneously contribute 48% to smash accuracy, while the remaining 52% is influenced by other factors outside the research.

So it is proven to be true that leg muscle power, arm and wrist strength are factors in good Smash accuracy, each factor has its own role when doing a Smash because strong leg power but not strong arm strength will cause the ball to be directionless, whereas if good arm strength is not balanced by good leg power then the ball will hit the net and if wrist flexibility is not good then the result of the ball being hit will not be directed and strong.

The results of this research are in line with several theories which state that the three independent variables are factors causing Smash accuracy, namely theories according to Journal of Cabarkapa et al., (2025) with the title "Inter-limb Asymmetries in Professional Male Basketball and Volleyball Players" states that leg muscle power is the main component for jumping, smashing and blocking abilities. CMJ (jumping using both feet) measures the contribution of both legs in producing vertical power. This research identifies the importance of power in the legs in the Smash and jumping performance of volleyball athletes. Journal Fuchs et al., (2019) with the title "Spike Jump Biomechanics in Male versus Female Elite Volleyball Players" this research discusses the differences in spike jump biomechanics in male and female volleyball athletes. Research shows that spike performance is greatly influenced by leg muscle power, because it determines the amount of pushing force and jump height. Additionally, arm strength contributes to swing speed and shot power upon ball contact. The final phase of the spike also demands wrist flexibility to provide directional control and ball accuracy. Thus, this journal supports that spike quality depends on a combination of leg power, arm strength, and wrist flexibility and prove the truth. Several previous studies have shown the positive influence of leg muscle power, arm strength and wrist flexibility on the results of volleyball games, especially in the Smash technique:

Research by Nur et al (2024) entitled The Effect of Standing Broad Jump Training on the High Jumping Ability of IBS Al-Hamra Malang Volleyball Players. It shows that there is a significant effect of jumping training which is measured using broad jumps. The results concluded

that standing broad jump training had a significant influence on increasing the jump height of volleyball players.

Joni et al's research (2024) entitled *The Relationship between Arm Muscle Strength and Hand Eye Coordination on Volleyball Smash Results in Building the Achievement of Untan Physical Education Students*. Showing that there is a correlation between arm muscle strength and hand eye agility and volleyball Smash results, this is in accordance with the results stated by the researchers. There is a significant correlation between arm muscle strength. The results show that there is a very strong relationship.

Research by Yanka et al (2023) entitled *Smash open volleyball ability in terms of explosive power of the arm muscles and flexibility of the wrist*. In their research, the researcher explains the results of his research. There is a significant contribution between wrist flexibility and Smash open ability. The conclusion of the research is that there is a contribution of wrist flexibility to the Smash open ability of SBV Abimanyu Club female players.

Ulya research (2023) entitled *The Relationship between Arm Muscle Strength and Smash Accuracy of Volleyball Extracurricular Students at SMK Negeri 1 Rambah*. In this study, researchers showed that there was a significant relationship between arm muscle strength and Smash accuracy among Volleyball Extracurricular Students at SMK Negeri 1 Rambah. In this study, the Smash accuracy test carried out was very clear and structured to see whether there was a relationship between variables X and Y.

## **CONCLUSION**

Based on the results of calculations and research results, several conclusions can be drawn, including: There is a significant relationship between leg muscle power and Smash accuracy for male and female extracurricular volleyball students at SMA 15 Bandar Lampung. There is a significant relationship between arm strength and Smash accuracy for male and female extracurricular volleyball students at SMA 15 Bandar Lampung. There is a significant relationship between wrist flexibility and Smash accuracy for male and female extracurricular volleyball students at SMA 15 Bandar Lampung. There is a significant relationship between leg muscle power, arm strength and wrist strength simultaneously on the Smash accuracy of male and female extracurricular volleyball students at SMA 15 Bandar Lampung.

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