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Analysis of the Contribution of Arm Muscle Strength and Leg Muscle Explosive Power in Students to their Smash Ability in Volleyball Games

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ABSTRACT

Purpose of the study: The importance of arm muscle strength and leg muscle explosive power in contributing to volleyball smash ability prompted researchers to analyze their magnitude in relation to student or athlete achievement in volleyball learning, which is part of the physical education curriculum program.

Methodology: This type of research is quantitative, using a correlational approach with a quasi-experimental method. The population in this study were volleyball athletes with a sample of 20 athletes. The instruments used in this research were the hanging elbow test, vertical jump test and smash ability test. Meanwhile, this research data analysis technique uses statistical data analysis through linearity and correlation tests.

Main Findings: Based on the research results, it was found that arm muscle strength and leg muscle explosive power make a significant contribution and have a big influence on the smash ability of athletes or students. Therefore, these findings require follow-up regarding the development of innovative teaching resources, such as textbooks or monographs, as a step to improve an athlete's or student's smashing ability in the volleyball learning process, thereby increasing students' motivation and learning outcomes.

Novelty/Originality of this study: This research provides an in-depth analysis of the athlete's arm muscle strength and leg muscle explosive power on their smash ability by designing a training program and strategy that are more effective and suitable for improving volleyball smash ability.

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1. INTRODUCTION

Exercise is a basic human need that plays an important role in shaping mental and bodily health. Sport has the aim of getting pleasure and excitement and overcoming boredom due to work [1]-[3]. Many types of sports are popular among the community, especially in rural areas which still lack sports facilities, one of which is volleyball [4]-[7]. This is in line with the statement that the scope of volleyball sports studies is actually used as an insight into physical education which focuses on sports to influence a person's growth towards a physical or physical life that is programmed and systematic in getting results or benefits from physical fitness [8]. In line with the important role of volleyball in the scope of physical education as a medium to encourage increased physical potential and healthy lifestyles to stimulate balanced growth and development, it is also necessary to understand that the promotion of volleyball in the academic environment is recommended to promote healthy living in order to avoid negative things, especially in relation to providing a positive effect on expanding aspects

of physical fitness. Apart from that, in this modern era, the study of physical education, especially regarding the game of volleyball, is actually experiencing very rapid research development, both at the national and international levels, including in Indonesia. Therefore, in general, the study of volleyball games in physical education, health and sports aims to analyze how a person maintains their body and personal productivity so that they remain in top condition and achieve the desired academic and educational achievements in various areas of sports education studies [9].

Volleyball games in general are one of the areas of physical education studies which involve two groups facing each other where each team consists of six players [10], [11]. This is also supported by the opinion that all studies of major ball games, including volleyball, are generally understood as a game that requires reliable movement coordination for all actions in a team's game [12]. Apart from that, it also needs to be understood that when studying the scope of big ball games in physical education, someone must of course understand the various components of technical material. One of the basic techniques that a student needs to master when studying volleyball material is the smash. In general, smash ability is the main basic technique which is essentially used as a theory of how to hit the ball as hard as possible towards the opponent's court in order to get points [13]. This is supported by the statement that through mastering the volleyball game smash technique, it is hoped that it will be able to increase the effectiveness of students' practice of hitting as hard as possible in the game so that it is hoped that the resulting achievements will be maximized through game points, thus being able to provide encouragement for motivation and interest in learning the game of volleyball [14]. Therefore, in the context of physical education learning, the ability to smash volleyball is an important aspect for students to develop.

The importance of mastering the smash technique in playing volleyball on the field is actually still very low. This is supported by a study which states that the low smash ability of students in learning volleyball at school is influenced by two factors, namely internal factors in the form of strength and explosive power, including strong physical and mental abilities that every athlete must have. Apart from that, there are also external factors that influence it, namely the lack of volleyball learning mastery patterns such as coaches, facilities, support from parents, organizations and others [15]. In the scope of physical education, these two factors greatly influence the determination and ability to play well as well as practice correct basic techniques, so it is appropriate that these two things are very important to understand [16]. The low performance and endurance of a student in relation to how to smash when learning volleyball are the two main aspects that are the focus of improvement towards maximum performance [17]. This is supported by the opinion that student performance and endurance during volleyball learning indirectly provides effectiveness in the quality and improvement of academic achievement and student learning outcomes [18]. In line with the above, we can also see that the lack of suitable strategies and training programs is one of the contributing factors to a student's low volleyball smash ability, so it is necessary to re-analyze the basic components in it, one of which is related to explosive power, strength and endurance during the learning period [19].

In this regard, it is necessary to create an alternative solution to analyze other components that play a significant role in achieving high volleyball smash abilities, one of which is analyzing the contribution of arm muscle strength and leg muscle explosive power when students smash in a volleyball game. This is supported by the opinion that the explosive power of a student's leg muscles and arm muscle strength are the most important measurement tools for categorizing the level of a student's smash ability when learning volleyball. This is also supported by the opinion which states that arm muscle strength makes a significant contribution to a student's smash results in volleyball [20]. The results of other research also state that leg muscle explosive power plays an important role when a student makes a vertical jumping movement to reach the ball at the highest point above the net in a volleyball learning process [21]-[23]. Therefore, the better the explosive power of the leg muscles and the strength of the arm muscles developed by a student, the higher the mastery of the smash technique in them [24]. This is certainly appropriate if done especially to provide motivation for learning and results in volleyball games which in the end can be directed precisely and more massively [25]-[27]. Therefore, based on the background above, the researcher tries to provide insight for teachers and students in an effort to improve smash performance in volleyball, namely by analyzing the contribution of arm muscle strength and leg muscle explosive power to students' smash ability in volleyball learning which hopefully can help design more effective training programs that emphasize the importance of physical composition which has a positive impact on students' smash performance on the field.

2. RESEARCH METHOD

This type of research is quantitative research using a correlational approach to determine the relationship and level of correlation between one or two variables without trying to influence these variables. The method used in this research is a quasi experiment to determine the relationship between variables and other variables through hypothesis testing. The population used in this research were POBVSA volleyball athletes. The sample in this study was 20 athletes selected using a sampling technique, namely random sampling. The

instruments used in this research were the hanging elbow test to determine arm muscle strength as well as the vertical jump test to determine the explosive power of leg muscles and the smash ability test with test instruments that had been tested for validity and reliability using the Cronbach's alpha formula. Below is a research instrument which aims to measure the hanging elbow test to determine arm muscle strength which is adopted from the TKJI instrument by implementing the research process through direct trials in the field. An overview of the elbow hanging test instrument is explained as in Figure 1.

1. Test (Pull Up) 60 Second

a. The purpose of this test is to measure the strength and strength of the arm and shoulder muscles.

b. Tools and equipment Single Bar Stopwatch, lime powder and test forms.

Test implementation:

1) Rub both hands with chalk
2) The initial attitude of the participants is standing under a single bar, both hands holding on to a single bar shoulder-width apart. The palm handle is facing backwards, (see picture below).

Figure 2.1 Relying on a single bar
Source: Physical freshness test (TKJI 2010)

3) Lift the body by bending both hands, so that the chin touches or is above the single bar, then return to the starting position.
4) During the movement, from head to toe there remains a straight line.
5) This movement is done repeatedly, without a break, as many times as possible for 60 seconds.

Figure 1. Elbow Hanging Test Instrument

Apart from that, an instrument is also provided to measure the vertical jump test using a test instrument adopted from Widiastuti, (2011). The instrument for measuring the vertical jump test is used to determine the height of the jump produced by an athlete when performing a smash. Below is an illustration of the test instrument related to its implementation and scoring as shown in Figure 2.

2. Test (Vertical Jump)

1) Purpose
   This test aims to measure explosive power / explosive power
2) Tools and Facilities
   1. Centimeter-scale boards, dark color, size 30 x 150 cm, installed
   2. on a flat wall or pillar. The distance between the floor and the number zero (0) on the test board is 150 cm.
   3. Lime powder
   4. Whiteboard eraser tool
   5. Stationery
3) Test Officer Observers and result loggers
   Test Execution Initial attitude :
   1. First, the participant's fingertips are smeared with Tools and Facilities
   2. lime powder/magnesium carbonate
   3. Participants stand upright near the wall, feet are tight, the scale board is on the right/left side of the participant's body. Raise the hand near the wall straight up,
   4. The palm of the hand is attached to the scale board until it leaves fingerprints.

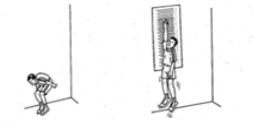

Figure 2.2 Initial and jumping attitudes
Source: Widiastuti, (2011)

4) Movement
   1. Participants take the prefix with a knee-bending attitude and the second
   2. arms swung back. Then the participants jump as high as possible while patting the board with the nearest hand so that it creates a mark
   3. Take this test three (3) times without a break or may be interspersed with other participants
5) Recording of Results
   1. The difference in jumps is reduced upright
   2. Third, differences in test results were recorded
   3. Enter the result of the largest difference

Figure 2. Vertical Jump Test Instrument

Then, an instrument was also used to measure the volleyball smash ability which was adopted from Nurhasan's theoretical study, 2015. This instrument was used to determine the results of the athlete's ability to smash as explained in Figure 3.

3. Test Smash

1. The testee is in the attack area or free on the playing field.
2. The ball is bounced or fed near the top of the net toward the testee.
3. With or without starting, the testee jumps and hits the ball over the net into the opposite court where there is a goal with points.
4. Each testee is given 5 times to do the test.
5. How to score: the score is the number where the ball fell. The ball that touches the target is counted as a higher score. Score = 0, if the ball touches the net or the ball falls outside the target area. Test achievement is the sum of all target scores from 5 occasions.

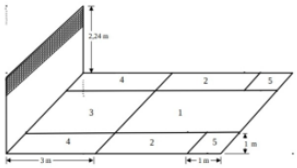

Figure 3. Smash attack test instrument (Lardika & Salam, 2019)

Table 1. Test Norms

Test scores	Value	Category
21-25	5	Very well
16-20	4	Well
10-15	3	Enough
5-9	2	Not enough
0-4	1	Less Once

Figure 3. Smash Test Instruments

Furthermore, to determine the classification of validity and reliability of the hanging elbow, vertical jump and smash ability test instruments, it was carried out using the Cronbach's Alpha formula based on the results of statistical analysis of the instrument's reliability values, then interpreted according to the classification as in Table 1.

$$r_{11} = \frac{n}{n-1}\left(1 - \frac{\sum s_i^2}{s_t^2}\right) \quad \text{... (1)}$$

Information :

r_{11} : instrument reliability coefficient
$\sum s_i^2$: the amount of variance in item scores
s_t^2 : total variance
n : number of respondents

Table 1. Classification of Reliability Coefficients

Validity Coefficient	Interpretation
$0.90 < r_{11} \leq 1.00$	Very High
$0.70 < r_{11} \leq 0.90$	High
$0.40 < r_{11} \leq 0.70$	Medium
$0.20 < r_{11} \leq 0.40$	Low
$0.00 < r_{11} \leq 0.20$	Very Low

Furthermore, the data analysis technique used to determine the results of the significance analysis and the contribution of the relationship between arm muscle strength and leg muscle explosive power to smash ability, is calculated using linear regression and multiple correlation tests with the hypothesis acceptance criteria if r_count > r_table, so that based on the results of these calculations it can also be seen that the size of the resulting variable contribution can be interpreted according to the calcification as explained in Table 2.

Table 2. Interpretation of Correlation Coefficients

Coefficient Interval	Relationship level
0.00 – 0.19	Very Low
0.20 – 0.39	Low
0.40 – 0.59	Medium
0.60 – 0.79	Strong
0.80 – 1.00	Very strong

3. RESULTS AND DICUSSION

This research was preceded by carrying out a trial phase to measure the level of reliability of the instrument to be used. This is intended to determine the level of validity of the instrument so that it can be seen whether the instrument has a very high, high, medium, low or very low level of reliability. Based on Table 1, it can be seen that the reliability coefficient value of the hanging elbow, vertical jump and smash ability test instruments is 0.549 > r_tabel = 0.359 so that the instruments can be said to be reliable in the medium category. Therefore, the instrument can be used to carry out tests related to smash ability in volleyball games.

Next, research data analysis will be carried out as a general overview to see the relationship between the ability to measure arm muscle strength and leg muscle explosive power on the smash ability of POBVSA volleyball club athletes. Data analysis in this study includes components of arm muscle strength with a total average value (mean) = 18.3000, standard deviation (standard deviation) = 619.932, lowest (minimum) value = 9.00, and highest (maximum) value = 31.00. Apart from that, for the leg muscle explosive power component, the average value (mean) = 464,000, standard deviation (standard deviation) = 595,067, lowest (minimum) value = 33.00, and highest (maximum) = 58.00. lowest (minimum) value = 3.00, and highest (maximum) value = 13.00. Based on these statistical data, it can be seen that arm muscle strength and leg muscle explosive power have the average, lowest and highest values for the POBVSA volleyball club smash ability, but it does not yet describe the link or relationship between variables significantly, namely between arm muscle strength and leg muscle explosive power, so further testing is needed, starting with a data normality test with a Sig value for the arm muscle strength normality test of 0.180 > 0.05, leg muscle explosive power obtained 0.748 > 0.05 and Sig obtained for smash ability. = 0.439 > 0.05 so that the data is declared to be normally distributed.

The next stage will be carried out to determine the form of relationship related to arm muscle strength and leg muscle explosive power. Based on the calculation of the linearity test for arm muscle strength, a Sig value of 0.196 > 0.05 was obtained, so there is a linear relationship between arm muscle strength and smash ability. Next, we can also test the linearity of leg muscle explosive power on smash ability to obtain a Sig value of 0.532 > 0.05, which means there is a linear relationship between leg muscle explosive power and smash ability as explained in Table 3 and Table 4.

Table 3. Linearity Analysis of Arm Muscle Strength

ANOVA Table

			Sum of Squares	Df	Mean Square	F	Sig.
Smash ability * arm muscle strength	Between Groups	(Combined)	139.333	12	11.611	4.133	.035
		Linearity	79.541	1	79.541	28.311	.001
		Deviation from Linearity	59.792	11	5.436	1.935	.196
	Within Groups		19.667	7	2.810		
	Total		159.000	19			

Table 4. Linearity Analysis of Leg Muscle Explosive Power

ANOVA Table

			Sum of Squares	Df	Mean Square	F	Sig.
Smash ability * Explosive power of leg muscles	Between Groups	(Combined)	129.000	12	10.750	2.508	.115
		Linearity	82.782	1	82.782	19.316	.003
		Deviation from Linearity	46.218	11	4.202	.980	.532
	Within Groups		30.000	7	4.286		
	Total		159.000	19			

Apart from that, the data analysis carried out also found a correlation between arm muscle strength and smash ability with an r value of 0.707 > 0.444 so it can be concluded that there is a significant relationship

between arm muscle strength and smash ability. Based on the analysis above, there is also a linear relationship between leg muscle explosive power and smash ability with an r value of 0.722 > 0.444, so it can be concluded that there is a significant relationship between arm muscle strength and smash ability. Based on the results of the linearity test between arm muscle strength and leg muscle explosive power, it was found that the amount of contribution between arm muscle strength to smash ability was with a value of R square = 0.500 or 50% so that there were 50% other factors that contributed to other variables so that it required detailed related analysis. Meanwhile, the magnitude of the contribution between leg muscle explosive power to smash ability was obtained by a value of R square = 0.521 or 52.10%, so that the contribution value of other factors was obtained at 47.90%, in which further analysis was needed to determine the correlation and causal relationship between muscle explosive power and the participant's smash ability. This can be seen in Table 5, Table 6 and Table 7.

Table 5. Coefficient of Determination of Arm Muscle Strength Against Smash

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.707[a]	.500	.472	2.101

a. Predictors: (Constant), Arm muscle strength

Table 6. Analysis of Determination Coefficient of Leg Muscle Explosive Power on Smash Ability

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.722[a]	.521	.494	2.058

a. Predictors: (Constant), Leg muscle explosive power

Table 7. Analysis of the Determination Coefficient of Arm Muscle Strength and Leg Muscle Explosive Power on Smash Ability

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.784[a]	.615	.570	1.897

a. Predictors: (Constant), Leg muscle explosive power, Arm muscle strength

Based on the results of research conducted, a significant relationship was found between leg muscle explosive power and arm muscle strength on smash ability in volleyball learning [28]-[32]. This of course has implications for the power or strength of the arm muscles and the explosive power of the leg muscles as a series of work processes in the volleyball learning process within the scope of physical education which produces two components with high value simultaneously [33]-[36]. The results of this research are also supported by theoretical studies and a framework of thinking which states that the game of volleyball in physical education learning material, including smash ability with analysis of arm muscle strength and leg muscle explosive power, is a complete unit that significantly influences students' mastery of volleyball learning which will ultimately lead to the pattern of achievement and quality of learning carried out by a student [37]-[41].

Apart from that, if we look at the contribution of arm muscle strength and leg muscle explosive power to a student's smash ability in learning the game of volleyball, it can be categorized as quite large or medium so that the smash ability and leg muscle explosive power and arm muscle strength possessed by a student actually make a big contribution to the improvement and development of high smash ability but have not yet had a significant impact on it [42]-[46]. This is also supported by the statement which states that increasing the explosive power of a student's leg muscles and arm muscle strength in smashing when learning volleyball makes an effective contribution to increasing the ability to smash to the maximum in the time or learning allocation that has been determined, but it is necessary to carry out some special treatment so that the impact becomes more significant and longer [47]-[51]. This is also supported by the statement that the ability of the arm muscles and the explosive power of the leg muscles have actually led to a high increase in smash ability in a short time, but stimulation needs to be carried out in order to obtain optimal momentum in the student's body or object when learning to achieve the desired goal so that it also makes a significant contribution to smash ability [52]-[56].

Therefore, based on the two results of the analysis above, it can be found that arm muscle strength and leg muscle explosive power have a strong correlation and linearity to students' smash ability when carrying out volleyball lessons in the classroom, which is clarified by the importance of these two factors in efforts to improve and develop volleyball learning materials in the scope of physical education in the future [57]. This can be seen from the significant contribution of both of them to the ability to smash so that it forms a complex

movement which starts with an initial step followed by a push then lands to hit the ball again as well as to increasing academic achievement and student learning outcomes [58]-[63]. Thus, this research can make a significant contribution in improving a student's volleyball smash ability and help a teacher or educator to develop a more effective training program in both physical education, health and sports subjects.

However, this research certainly has several limitations so it only includes theoretical analysis and smash ability in learning to determine the magnitude of the contribution and influence of arm muscle strength and leg muscle explosive power on students' smash ability with a small sample size of 20 students so it does not reflect the breadth of analysis using a wider population. This research also has not confirmed the extent to which other factors have resulted in the absence of a significant impact on students' smash ability on arm muscle strength and leg muscle explosive power even though tests have contributed to it. This may also be supported by the statement that the lack of control for other variables that might influence the results, such as the level of previous sports experience, student motivation, and frequency of training outside the program offered, resulting in biased results in them [66]-[67].

The implications of this research for the development of volleyball learning materials, especially regarding smash ability, through various empirical studies will later produce findings regarding further analysis of the influence of arm muscle strength and leg muscle explosive power in volleyball games. Apart from that, it is felt that this research is necessary to develop a learning model or learning innovation in the form of a book, monograph, or teaching module which integrates training for arm muscle strength and leg muscle explosive power in the game of volleyball so that it is hoped that it will become a study of learning material that is taught regularly or can help the performance of students or athletes in general in the scope of external education. The implications of this research also lie in designing a more effective and inclusive training program, the aim of which is to analyze the contribution of arm muscle strength and leg muscle explosive power to smash ability and provide new insights into sports teaching methods to make them more structured.

4. CONCLUSION

Based on the research results, it was found that arm muscle strength and leg muscle explosive power produced a significant contribution and had a fairly strong or moderate influence on a student's smash ability, although they did not have a significant influence on increasing cognitive abilities and more optimal learning outcomes. The implications of these findings in the future can be used to design the development of teaching resources as well as further innovative analytical steps, for example by carrying out the process of developing textbooks for teaching volleyball smash abilities or more in-depth and specific monographs on the development of smash abilities as an innovative step in the field of physical education, health and recreation, as an effort to improve the smash ability of an athlete or student in a volleyball learning process, so that it is hoped that it will make a maximum contribution to student or athlete achievement in the field of sports education.

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