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Relationship Of Arm Muscle Power And Hand–Eye Coordination With Overhand Serve Performance Among University Of Lampung Volleyball Players

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Abstract

This study seeks to examine the correlation between arm muscular power, hand–eye coordination, and overhand serve performance among participants of the Volleyball Student Activity Unit at the University of Lampung. A quantitative correlational method was utilized, involving 15 male participants selected through purposive sampling. In this study, arm muscle power was evaluated using the two-hand medicine ball throw test, the ball throw-and-catch test for hand-eye coordination, and the AAHPERD test to assess overhand serve capability. The Pearson Product–Moment correlation approach was employed for data analysis. The findings demonstrated a robust and statistically significant correlation between arm muscular strength ($r = 0.807$; $p = 0.001$) and hand–eye coordination ($r = 0.908$; $p = 0.001$) with overhand serve performance. Upon simultaneous examination, both variables exhibited a robust connection ($r = 0.759$; $p = 0.001$), with hand–eye coordination demonstrating a more pronounced effect. The efficacy of the overhand serve is contingent upon the interplay of arm muscular strength and hand–eye coordination. Consequently, volleyball training programs must prioritize muscular strengthening and coordination enhancement to maximize serving efficacy.

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INTRODUCTION

Volleyball is a popular team sport that has experienced rapid growth in Indonesia. Originating in 1895, the game was created by William G. Morgan, a physical education instructor from the United States, and has since spread widely across the globe (Singh et al., 2015). "Volleyball is a competitive sport played between two teams, each consisting of six players. The game's minimal equipment needs enable enjoyment across many demographics children and adults, males and females and facilitate play in both urban and rural settings (Endrawan et al., 2022).

The principal objective in volleyball is to send the ball into the opponent's court by performing a serve to initiate the game. Upon the ball crossing the net and being received by the other team, it is returned, so allowing the rally to persist (Jasmani et al., 2024). This process generally involves a sequence of three touches: the first touch is a forearm pass (underhand pass) used to receive the ball and direct it to the setter; the second touch is made by the setter to deliver a set to the spiker; and the third touch is completed with an attack hit (spike) aimed at the opponent's court (Hilmi et al., 2018)

A serve is a striking technique performed from the back-right region behind the end line (serving zone) aimed at propelling the ball over the net into the opponent's court. Serving occurs at the commencement of the game or following each error (Syaleh, 2017). A serve can also function as an attack when the ball is struck with both power and accuracy, as in a jump serve (Abdurahman et al., 2025). A powerful serve can serve as the first offensive move in a volleyball game (Saifudin et al., 2023). In general, serves are classified into two types: the overhand serve and the underhand serve (Evinora et al., 2020). The overhand serve is performed by striking the ball with the open and firm fingers together with the palm of the hand. The ball must be tossed upward above head height and hit before it passes over the head (Haprabu et al., 2024).

Observations in the Volleyball Student Activity Unit at the University of Lampung indicated that a limited number of members were proficient in performing successful overhand serves. This indicates the existence of specific factors affecting the inadequate mastery of the overhand serve technique among the trainees. Given these facts, it is essential to conduct a study to investigate the impact of fluctuations in arm muscle power and hand–eye synchronization on the accuracy of overhand serves in volleyball.

Arm muscle power, also known as explosive strength, is an essential physical ability that plays a vital role in enhancing performance across various sports disciplines (Widiastuti, 2011:100). Power is characterized by sudden and rapid movements in which the body propels upward (vertically), such as in one-foot or two-foot jumps, or forward (horizontally), utilizing maximum muscular strength. Essentially, power is defined as a person's capacity to generate maximum force within a very brief period, combining strength and speed as its key elements. (Ismawan et al., 2019). Arm muscle strength is a fundamental physical component necessary for generating an effective hit. In volleyball serving movements, this power is used to generate strong force on the ball at the

moment of contact. (Azhar Syafiul, 2021).

The coordination component is also an essential aspect for nearly every athlete, regardless of their sport discipline. Along with balance, coordination serves as a key supporting element that enables humans to stand, run, jump, kick, throw, and perform various other physical activities. This component can be measured by performing specific movements as quickly as possible, with the time recorded from the start of the activity until an error occurs (measured in seconds) (Agus, 2024). Coordination is a highly complex biomotor ability. It does not stand alone but is the result of interactions among various other biomotor capacities. The components related to coordination include speed, strength, endurance, agility, and balance Hermansyah, et al., (2017:46)

The novelty of this research lies in its focus on students who are members of the Volleyball Student Activity Unit at the University of Lampung. who have distinct physical characteristics, experience levels, and training intensities compared to professional athletes or school-level players. This study provides new empirical evidence regarding the influence of arm muscle power and hand–eye coordination on improving overhand serving performance among university-level volleyball players. Moreover, the results are expected to serve as a reference for designing more focused and student-centered training programs to improve volleyball technical skills, especially in the area of overhand serving.

METHODS

This study employs a correlational research design. Correlational research aims to determine whether there is a relationship between one or more variables and to what extent the relationship (correlation) exists among those variables. This type of research does not focus on cause-and-effect relationships but rather explains whether or not a relationship exists between the variables being studied (Ibrahim et al., 2018). The independent variables in this study consist of arm muscle power (X1) and hand–eye coordination (X2), while the dependent variable is the overhand serving ability in volleyball (Y). This research utilizes a survey method, with data gathered through testing and measurement procedures.

Population and Amount

Population

The population is characterized as a collection of items or persons exhibiting particular traits and properties as described by the researcher for analysis, from which conclusions are drawn (Sugiyono, 2013). The research population comprises members of the Volleyball Student Activity Unit of the University of Lampung.

Sample

A sample is described as a subset of the population selected by the researcher to represent the whole population in a study (Ibrahim et al., 2018). In this research, the sample was determined based on the following criteria:

a. Students who participate as members of the Volleyball Student Activity Unit at the University of Lampung.
b. Male students.

Based on these criteria, a total of 15 students were selected as the sample for this study.Based on these criteria, a total of 15 students were selected as the sample for this study.

Materials and Apparatus

The assessment of arm muscle power was conducted using the following materials and apparatus: a medicine ball weighing 2.72 kg (6 pounds), chalk or colored adhesive tape to mark the throwing distance, a soft rope to stabilize the participant's body during the test, a bench to support the standardized testing position, and a measuring tape to accurately measure the throwing distance. All equipment was prepared and calibrated prior to data collection to ensure consistency and measurement accuracy.

The hand–eye coordination test was conducted using a flat testing area with a smooth wall surface**.** A circular target made of paper with a 30 cm diameter was attached to the wall as the throwing target. Chalk or adhesive tape was used to mark the boundary line for the participants. A measuring tape was utilized to determine the throwing distance. Additional materials included ten tennis balls**,** data recording sheets**,** and writing instruments (pencils or pens) for documenting the test results. All materials were prepared prior to the testing session to ensure standardized test administration.

The overhand serve test was conducted on a standard volleyball court that was divided into designated target zones according to the scoring criteria. A volleyball was used as the main testing implement. Raffia string or chalk was utilized to mark the boundaries of each target zone. A measuring tape was employed to ensure accurate court measurements, and writing materials were used to record the test results. All equipment and facilities were prepared in advance to maintain consistency throughout the testing process.

Data Analysis

The data obtained from the test results were analyzed through descriptive and inferential statistical methods, followed by hypothesis testing. The data analysis procedures employed in this study are described as follows:

1. Descriptive statistical analysis is intended to obtain data such as the total score, score range, mean, standard deviation, minimum score, and maximum score.
2. Inferential statistical analysis is employed to examine the research hypotheses using regression analysis.

In this study, the Product–Moment correlation test (Darumoyo et al., 2024) was used to determine the presence of a linear relationship between the independent variables (X1 and X2) and the dependent variable (Y), with the data measured on an interval or ratio scale.

RESULT

Research conducted with members of the Volleyball Student Activity Unit at the University of Lampung involved data collection utilizing the two-hand medicine ball put test, the ball throw-and-catch test, and the overhand serve test. These evaluations were utilized to investigate the correlation among arm muscular power, hand-eye coordination, and the proficiency in executing an overhand serve in volleyball.

a. Arm Muscle Power Test Result

The assessment of arm muscle power was conducted through three trial attempts. The average

scores obtained by the participants are presented in the table 1 below:

Table 1. arm muscle power test result

Sample Size	15
Minimum Score	3,40
Maximum Score	5,02
Mean	4,41
Median	4,46
Standard Deviation	0,51562

Based on the categorization results, most respondents were in the very good category, totaling 7 participants (46.66%). Furthermore, 5 participants (33.33%) fell into the good category, while 3 participants (20%) were categorized as fair. Notably, none of the respondents were classified as poor.

The distribution of arm muscle power categories is presented in Table 2:

Table 2. Distribution of Categories Arm Muscle Power Test Result

Category	Frequency	Percentage
Very Good	7	46,66 %
Good	5	33,33 %
Moderate	3	20 %
Poor	0	0

The distribution of categories for arm muscle power is shown in the following diagram:

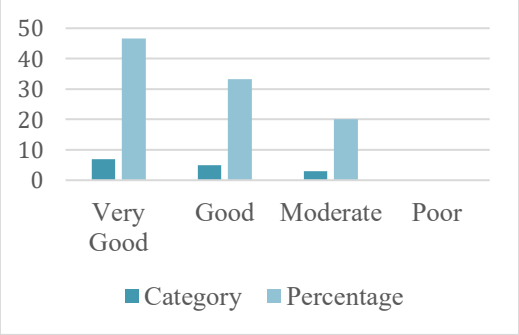

Figure 1. Distribution Chart of Arm Muscle Power.

Based on the categorization results, most respondents were in the excellent category, totaling 7 participants (46.66%), followed by the very good category with 5 participants (33.33%), and the good category with 3 participants (20%). No participants were classified in the fair category.

b. Hand-Eye Coordination Test Result

The hand–eye coordination test was conducted with 10 repetitions using one hand, followed by another 10 repetitions involving throwing with the right hand and catching with the left hand. The hand–eye coordination test results are displayed in Table 3.

Table 3. Hand-Eye Coordination Test Result

Sample Size	15
Minimum Score	7
Maximum Score	17
Mean	13,4
Median	14
Standard Deviation	2,87

Based on the descriptive analysis of 15 respondents, the scores ranged from 7 to 17, with a mean of 13.4 and a median of 14, indicating a relatively high and balanced level of ability. The standard deviation of 2.87 suggests a moderate variation among the respondents.

The distribution of categories for Hand-Eye coordination is shown in the table 4:

Table 4. Distribution of Categories Hand-Eye Coordination Test Result

Category	Frequency	Percentage
Very Good	0	0 %
Good	7	46,66 %

Fair	5	33,33%
Poor	3	20%
Very poor	0	0%

The distribution of categories for hand–eye coordination is shown in the following diagram:

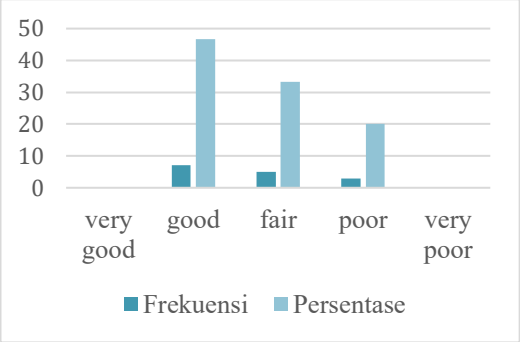

Figure 2. Distribution Chart of Hand–Eye Coordination.

Most respondents were in the good category (46.66%), followed by the fair category (33.33%) and the poor category (20%). No respondents were classified as very good or very poor, indicating that the majority of participants possessed hand–eye coordination abilities at a moderate to good level.

c. Overhand Serve Test Result

The overhand serve test was carried out in 10 repetitions, and the results are presented in Table 5.

Table 5. Overhand Serve Test Result

Sample Size	15
Minimum Score	16
Maximum Score	31
Mean	22,93
Median	23
Standard Deviation	4,19

Based on the test results of 15 samples, the scores ranged from 16 to 31, with a mean of 22.93 and a median of 23. This indicates a relatively balanced serving ability among the participants. The standard deviation of 4.20 suggests a moderate level of variation.

Table 6. Distribution of Categories Overhand Serve Test Result

Category	Frequency	Percentage
Very Good	2	13,33 %
Good	9	60 %
Fair	4	26,66%
Poor	0	0%
Very poor	0	0%

The distribution of categories for the overhand serve results is shown in the following diagram:

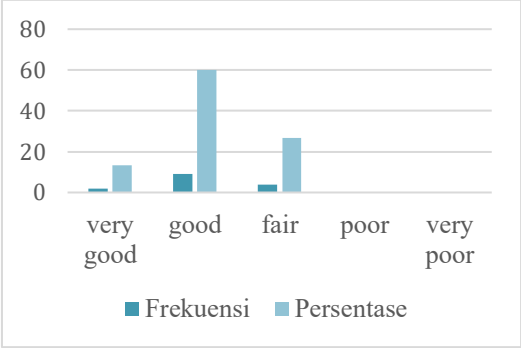

Figure 3. Distribution Chart of Overhand Serve Results.

The majority of participants were categorized as good (60%), followed by very good (13.33%) and fair (26.67%). No participants were classified in the poor or very poor categories, indicating that the overall overhand serving ability was generally good.

d. Data Analysis Result

The results of the hypothesis test form the basis for deciding whether to accept or reject the proposed hypotheses. A summary of the data analysis outcomes is presented in the table below.

Table 6. Hypotesis Test Result

Variable	*p*-Value *Pearson Correlation test*	*r correlation*
Arm Muscle Power and Overhand Serve	0,001	0,807
Hand-Eye Coordination and Overhand Serve	0,001	0,908
Arm Muscle Power, Eye-Hand Coordination and Volleyball Overhead Serve	0,001	0,922

Based on the Pearson correlation test results, a strong and significant relationship was found between arm muscle power and overhand serving ability ($r = 0.807$; $p < 0.001$). Furthermore, hand–eye coordination demonstrated an even stronger correlation ($r = 0.908$; $p < 0.001$). Additionally, the combined correlation between arm muscle power and hand–eye coordination with overhand serving ability also showed a strong relationship ($r = 0.759$; $p < 0.001$). These results suggest that both variables significantly influence overhand serving ability, with hand–eye coordination contributing more prominently.

DISCUSSION

The study's findings indicate a robust and substantial link between arm muscular strength and overhand serve performance in volleyball ($r = 0.807$; $p = 0.001$). This suggests that increased arm muscle strength enhances serving performance. This discovery aligns with the notion that characterizes power as a synthesis of strength and speed, which facilitates the production of explosive motions (Habibulloh & Permono, 2025). Training with a medicine ball seeks to enhance the muscular strength of the arms and fingers by throwing exercises that engage the entire arm (Hidayat et al., 2023). Conversely, inadequate arm muscle strength will lead to feeble strikes, facilitating the opponent's ability to receive and return the ball (Hameed & Alzubaidi, 2025). Furthermore, hand-eye coordination shown a more robust correlation with overhand serve performance ($r = 0.908$; $p < 0.001$). This skill is essential for maintaining appropriate timing, precision, and ball control during the serve. Players with superior coordination may anticipate the ball's trajectory and perform accurate, well-aimed serves, whereas inadequate coordination results in imprecise strikes (Mardiah et al., 2023).

Furthermore, the findings indicate that hand–eye coordination has a very strong correlation with overhand serve performance ($r = 0.908$; $p = 0.001$). This ability plays a crucial role in timing, accuracy, and ball control during the serving motion. Players with good hand–eye coordination can accurately judge the ball's direction and speed, enabling precise and effective serves. In contrast, poor coordination often results in improper contact, inaccurate ball placement, and errors in timing or trajectory, such as serves going out of bounds or failing to clear the net (Dwi Ananda et al., 2024; Mardiah et al., 2023). Consistent with previous studies, players with higher hand–eye coordination demonstrate superior overhand serving performance compared to those with lower coordination levels (Sari & guntur, 2017).

The study's findings reveal a substantial and robust link between arm muscular power, hand-eye coordination,

and overhand serving ability (r = 0.759; p = 0.001). Proper arm strength and coordination are crucial for executing precise and efficient overhand serves. The results correspond with the findings of Dwi Ananda et al. (2024), who identified a favorable association among arm muscular power, hand–eye coordination, and overhand serving proficiency in volleyball. Both variables are crucial for executing effective serves, considerably influencing players' serving accuracy (Saptiani et al., 2019). Moreover, Hikmah (2021) discovered that arm muscular power and hand–eye coordination significantly influence hitting accuracy, with players exhibiting superior strength and coordination demonstrating enhanced consistency in the direction and force of overhand serves.

The study's findings indicate a strong and significant correlation between arm muscle power, hand-eye coordination, and overhand serving performance in volleyball. Enhanced arm strength and superior coordination result in enhanced serving precision and efficacy. The strength of arm muscles aids in producing force and velocity in the serve, whereas hand–eye coordination governs the accuracy and control of the ball during execution. Consequently, enhancing overhand serving proficiency can be accomplished through resistance training with a medicine ball and ball throw-and-catch routines, which integrate arm muscle fortification with ongoing motor coordination training.

This study has several limitations, including a small sample size and a short research duration, which restrict the generalizability of the findings and limit long-term performance observation. Measurement constraints, environmental conditions, partial subjectivity in skill assessment, and uncontrolled external factors such as players' physical condition and motivation may have influenced the results. Therefore, future studies should involve larger samples and more comprehensive research designs.

CONCLUSION

This study shows that arm muscle power and hand–eye coordination are strongly associated with overhand serve performance in volleyball**.** Hand–eye coordination plays a crucial role in ensuring accuracy and proper timing during serve execution, while arm muscle power contributes to the strength and speed of the stroke. Overall, both variables demonstrate a significant relationship with overhand serving ability; however, hand–eye coordination exhibits a greater influence**,** highlighting its importance in achieving precise and effective serves.

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