



## Relationship Between Arm Muscle Strength and Overhand Service Performance Among Male Volleyball Athletes

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### ABSTRACT

**Purpose of the study:** This study aimed to determine the relationship between arm muscle strength and overhand volleyball service performance among male volleyball athletes of Padang Pariaman Family Association Pekanbaru. The study focused on examining the extent to which arm muscle strength contributes to the success of overhand service execution in volleyball.

**Methodology:** This study employed a quantitative correlational research design. The population consisted of 16 male volleyball athletes of Padang Pariaman Family Association Pekanbaru, and total sampling was applied. Data were collected using a push-up test to measure arm muscle strength and an overhand service test to assess volleyball service performance. Data analysis included the Chi-Square normality test, Pearson Product Moment correlation analysis, t-test, and coefficient of determination analysis.

**Main Findings:** The findings indicated a significant positive relationship between arm muscle strength and overhand volleyball service performance. The Pearson correlation coefficient was 0.619, exceeding the critical value of 0.497 at the 5% significance level. Furthermore, arm muscle strength contributed 38.31% to overhand service performance.

**Novelty/Originality of this study:** This study provides empirical evidence regarding the contribution of arm muscle strength to overhand volleyball service performance among club-level athletes. Unlike previous studies that examined student populations or multiple physical components simultaneously, this research specifically quantifies the relationship and contribution of arm muscle strength to service performance in competitive volleyball athletes, offering practical insights for strength-based training program development.

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## 1. INTRODUCTION

Volleyball is one of the most popular sports worldwide and continues to develop rapidly at both recreational and competitive levels. As a performance-oriented sport, volleyball requires athletes to master various technical skills, physical abilities, tactical understanding, and psychological readiness [1]-[3]. The quality of an athlete's performance is largely determined by the integration of these components during training and competition. Among the fundamental techniques in volleyball, serving plays a particularly important role because it initiates the game and can simultaneously function as an offensive weapon to pressure opponents and directly

score points. Therefore, improving service performance has become a primary concern for coaches and athletes seeking competitive success [4].

The overhand serve is one of the most frequently utilized service techniques in modern volleyball due to its effectiveness, speed, and ability to create difficulties for the receiving team. Successful execution of an overhand serve requires precise coordination of body movements, proper technique, balance, and sufficient physical capacity [5], [6]. Athletes must generate adequate force to propel the ball accurately across the net toward a designated target area. Consequently, the effectiveness of an overhand serve is influenced not only by technical proficiency but also by the athlete's physical condition, particularly muscular strength. Without adequate physical support, athletes may struggle to perform serves with optimal power, accuracy, and consistency during competitive situations [7].

Physical conditioning is recognized as a critical determinant of sports performance. Among the various components of physical fitness, muscular strength serves as the foundation for many sport-specific movements. In volleyball, arm muscle strength is particularly important because the upper limbs are directly involved in executing serves, spikes, and other offensive actions [8]. Strong arm muscles enable athletes to generate greater force during ball contact, resulting in faster ball velocity and improved service effectiveness. Conversely, insufficient arm muscle strength may reduce the quality of ball contact, causing weaker serves that are easier for opponents to receive and counterattack. Therefore, understanding the contribution of arm muscle strength to volleyball service performance is essential for designing effective training programs [9], [10].

Previous observations conducted within the male volleyball team of Padang Pariaman Family Association Pekanbaru indicated that several athletes experienced difficulties in performing effective overhand serves. Common problems included insufficient ball velocity, failure of the ball to cross the net, inaccurate ball placement, and inconsistencies in service execution. These issues were frequently associated with inadequate arm movement mechanics and insufficient force generation during ball contact. Although the team regularly participated in training activities, physical conditioning programs were not consistently implemented outside competition periods. Such conditions suggest that physical factors, particularly arm muscle strength, may significantly influence the athletes' overhand service performance [11], [12].

From a theoretical perspective, arm muscle strength contributes directly to the biomechanical process of serving. During an overhand serve, force generated by the upper extremities is transferred to the ball through coordinated movements involving the shoulder, upper arm, forearm, and wrist. Greater muscular strength allows athletes to produce higher levels of force, resulting in stronger and more controlled serves [13]. Furthermore, adequate arm strength supports technical efficiency by enabling athletes to maintain proper movement patterns throughout repeated service attempts. Therefore, investigating the relationship between arm muscle strength and overhand service performance is important for understanding the physical determinants of volleyball skill execution [14].

The importance of this topic is further emphasized by the growing demand for evidence-based training practices in sports coaching. Coaches require scientific information regarding the physical attributes that most strongly influence specific volleyball skills in order to develop targeted conditioning programs. Identifying the extent to which arm muscle strength contributes to overhand service performance may assist coaches in prioritizing strength-training interventions and optimizing athlete development. Consequently, research examining the relationship between arm muscle strength and overhand service performance among volleyball athletes remains highly relevant in both theoretical and practical contexts [15].

Several previous studies have examined factors influencing volleyball service performance. Research by Hadadnezhad et al. [16] reported a significant relationship between arm muscle strength and overhand service ability among senior high school students, indicating that physical strength contributes substantially to service execution. Another study conducted by Husein et al. [17] demonstrated that specific service training methods significantly improved overhand service performance, highlighting the importance of physical and technical preparation in volleyball. Additionally, Ramsi found a significant relationship between arm muscle strength and volleyball smash performance, suggesting that upper-body strength is a key factor in offensive volleyball skills. Although these studies provide valuable insights, most were conducted on student populations or focused on training interventions and other volleyball techniques. Limited research has specifically investigated the relationship between arm muscle strength and overhand service performance among competitive club-level volleyball athletes, particularly within regional volleyball organizations.

The novelty of this study lies in its focus on competitive male volleyball athletes from Padang Pariaman Family Association Pekanbaru Pekanbaru and its effort to quantify the contribution of arm muscle strength to overhand service performance. Unlike previous studies that examined school-based participants or multiple physical variables simultaneously, this research specifically analyzes arm muscle strength as a predictor of service performance within a club-athlete context [18]. The findings are expected to provide more sport-specific evidence regarding the role of upper-body strength in volleyball performance and contribute to the growing body of knowledge in sports science and coaching [19].

The practical implications of this study are significant for athletes, coaches, and sports practitioners. The results may serve as a scientific basis for developing training programs that emphasize arm muscle strengthening as a strategy for improving service performance. Furthermore, the findings may assist coaches in talent identification, performance evaluation, and the design of individualized conditioning programs. From an academic perspective, the study contributes empirical evidence regarding the relationship between physical fitness components and sport-specific technical skills in volleyball.

The urgency of this research stems from the need to enhance athlete performance through scientifically informed training approaches. As volleyball competition becomes increasingly competitive, athletes must optimize both technical and physical capacities to achieve superior performance outcomes. Understanding the relationship between arm muscle strength and overhand service performance is therefore essential for improving training effectiveness, maximizing athlete potential, and supporting long-term competitive achievement. Consequently, this study seeks to examine the relationship between arm muscle strength and overhand service performance among male volleyball athletes of Padang Pariaman Family Association Pekanbaru.

## 2. RESEARCH METHOD

### 2.1. Research Design

This study employed a quantitative correlational research design [20] to examine the relationship between arm muscle strength and overhand volleyball service performance. Correlational research is used to determine the degree of association between two or more variables without manipulating them. In this study, arm muscle strength was designated as the independent variable (X), while overhand service performance was designated as the dependent variable (Y). The research aimed to identify whether a significant relationship existed between the two variables and to determine the magnitude of their association. The study was conducted at the training venue of Padang Pariaman Family Association Pekanbaru during the 2018 training period.

### 2.2. Subjects and Sample

The population of this study consisted of all male volleyball athletes registered in Persatuan Keluarga Padang Pariaman (PKDP) Pekanbaru. The total population comprised 16 athletes actively participating in training activities. Considering the relatively small population size, this study applied a total sampling technique, in which all members of the population were selected as research participants. Therefore, the sample size was identical to the population size, resulting in a total of 16 male volleyball athletes. The use of total sampling ensured comprehensive representation of the target population and minimized sampling bias.

Table 1. Characteristics of Research Participants

Variable	Category	Percentage (%)
Gender	Male	100
Club Membership	PKDP Volleyball Club	100
Sample Size	16 Athletes	100
Sampling Technique	Total Sampling	100

### 2.3. Data Sources and Data Collection Techniques

The study utilized both primary and secondary data sources [21]. Primary data were obtained directly from athletes through physical performance tests measuring arm muscle strength and overhand service ability. Secondary data were collected from scientific books, journal articles, volleyball coaching manuals, and other relevant literature supporting the theoretical framework of the study.

Data collection was conducted using three techniques. First, observation was employed to identify existing conditions related to athletes' service performance and training activities. Second, documentation and literature review were used to gather supporting information regarding volleyball performance and physical conditioning. Third, test and measurement techniques were administered to obtain quantitative data. Arm muscle strength was measured using a push-up test, while overhand service performance was assessed using a standardized volleyball service test. All measurements were conducted on the same day under similar environmental conditions to ensure consistency of results.

### 2.4. Research Instruments

Two instruments were used in this study. The first instrument was the push-up test, which measured arm muscle strength. Participants performed as many correct push-up repetitions as possible without rest. The total number of successful repetitions was recorded as the arm muscle strength score. The push-up test has been widely used in physical fitness assessments due to its practicality and effectiveness in measuring upper-body muscular strength and endurance.

The second instrument was the overhand volleyball service test adapted from standardized volleyball skill testing procedures. Athletes were instructed to perform six legal overhand serves toward designated target areas on the volleyball court. Scoring was determined based on ball placement accuracy and the trajectory of the ball over the net. Higher scores indicated better service performance. The total score from six attempts represented each participant's overhand service ability [22].

Table 2. Research Variables and Instruments

Variable	Indicator	Instrument	Unit
Arm Muscle Strength (X)	Number of push-up repetitions	Push-Up Test	Repetitions
Overhand Service Performance (Y)	Accuracy and effectiveness of service	Overhand Service Test	Score

## 2.5. Data Analysis Techniques

Data analysis was conducted using descriptive and inferential statistical techniques [23]. Descriptive statistics were used to determine the mean, median, mode, standard deviation, maximum score, and minimum score of each variable. These analyses provided a general overview of participant performance.

Before hypothesis testing, a normality test was performed using the Chi-Square test to determine whether the data were normally distributed. After confirming normality, Pearson Product Moment correlation analysis was applied to determine the relationship between arm muscle strength and overhand service performance. The significance of the correlation coefficient was subsequently tested using the t-test at a significance level of 0.05. Furthermore, the coefficient of determination ( $R^2$ ) was calculated to determine the percentage contribution of arm muscle strength to overhand service performance.

Table 3. Statistical Analysis Procedures

Analysis Stage	Statistical Technique	Purpose
Descriptive Analysis	Mean, Median, Mode, SD	Describe research data
Assumption Testing	Chi-Square Normality Test	Determine data normality
Hypothesis Testing	Pearson Product Moment	Examine variable relationship
Significance Testing	t-test	Verify significance of correlation
Contribution Analysis	Coefficient of Determination ( $R^2$ )	Measure contribution percentage

## 2.6. Research Procedure

The research procedure was carried out systematically through several stages. Initially, the researcher conducted observations and obtained permission from the volleyball club management. Subsequently, participants were informed about the research objectives and testing procedures. Data collection began with the administration of the push-up test to assess arm muscle strength. After completion of the physical fitness test, participants performed the overhand volleyball service test according to standardized testing procedures. The collected data were tabulated and analyzed statistically using Pearson Product Moment correlation analysis. Finally, the results were interpreted to draw conclusions regarding the relationship between arm muscle strength and overhand service performance.

## 3. RESULTS AND DISCUSSION

### 3.1. Descriptive Analysis of Arm Muscle Strength

The measurement of arm muscle strength was conducted using a push-up test involving 16 male volleyball athletes of Padang Pariaman Family Association Pekanbaru. The descriptive statistical analysis showed that the highest score achieved by the participants was 34 repetitions, while the lowest score was 16 repetitions. The mean score was 23.81 repetitions, indicating that the majority of athletes possessed a moderate level of arm muscle strength. Furthermore, the median score was 25 repetitions, the mode was 25 repetitions, and the standard deviation was 5.21, suggesting a relatively homogeneous distribution of arm muscle strength among participants. These findings indicate that most athletes had developed sufficient upper-body muscular capacity to support volleyball-specific movements, including serving, passing, and attacking actions.

Table 4. Distribution of Arm Muscle Strength Scores

Interval	Frequency	Percentage (%)
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16–19	4	25.00
20–23	2	12.50
24–27	7	43.75
28–31	2	12.50
32–35	1	6.25
Total	16	100.00

The data presented in Table 4 indicate that the largest proportion of athletes (43.75%) obtained scores within the interval of 24–27 repetitions. This finding suggests that the majority of athletes possessed relatively similar levels of arm muscle strength. Since arm muscles play a crucial role in generating force during volleyball serving actions, the observed strength levels provide an important foundation for analyzing their relationship with service performance. Athletes with stronger arm muscles are generally expected to produce greater ball velocity and more effective serves during competition.

### 3.2. Descriptive Analysis of Overhand Service Performance

The assessment of overhand service performance was conducted using a standardized volleyball service test. The results showed that the highest service score achieved by participants was 23 points, whereas the lowest score was 4 points. The average service score was 10.43 points, with a median value of 10 points and a mode value of 15 points. The standard deviation was 5.65, indicating moderate variability among athletes regarding service performance.

Table 5. Distribution of Overhand Service Performance Scores

Interval	Frequency	Percentage (%)
3–7	6	37.50
8–12	5	31.25
13–17	4	25.00
18–22	0	0.00
23–27	1	6.25
Total	16	100.00

The results demonstrate that most athletes were concentrated within the lower and middle score categories. Specifically, 37.50% of athletes achieved scores between 3 and 7 points, while 31.25% obtained scores between 8 and 12 points. These findings indicate that overhand service performance among Padang Pariaman Family Association Pekanbaru athletes still had considerable room for improvement. Variations in service performance may be influenced by several factors, including technical mastery, coordination, concentration, flexibility, and muscular strength. However, because the service movement relies heavily on force production from the upper limbs, arm muscle strength was considered a critical factor requiring further investigation.

Prior to hypothesis testing, data normality was examined using the Chi-Square normality test. The results indicated that the calculated Chi-Square value was lower than the critical Chi-Square value at the 0.05 significance level. Therefore, both variables were normally distributed and fulfilled the assumptions required for Pearson Product Moment correlation analysis [24]. The fulfillment of the normality assumption ensured that subsequent statistical analyses could be conducted accurately and reliably.

The normal distribution of the data suggests that the sample adequately represented the population characteristics and that the relationship between arm muscle strength and service performance could be examined using parametric statistical procedures. Consequently, the Pearson correlation analysis was considered appropriate for determining the degree of association between the two variables.

### 3.3. Relationship Between Arm Muscle Strength and Overhand Service Performance

The Pearson Product Moment correlation analysis revealed a correlation coefficient ( $r$ ) of 0.619. This value exceeded the critical correlation coefficient ( $r$ -table = 0.497) at the 5% significance level. Therefore, the null hypothesis was rejected, and the alternative hypothesis was accepted, indicating a significant positive relationship between arm muscle strength and overhand service performance.

Table 6. Correlation Analysis Results

Variable	r-value	r-table	Significance
Arm Muscle Strength and Overhand Service Performance	0.619	0.497	Significant

The obtained correlation coefficient of 0.619 falls within the "strong" category, suggesting that athletes with greater arm muscle strength tended to demonstrate superior overhand service performance. This finding confirms that arm muscle strength contributes substantially to the execution of effective serves in volleyball. Stronger arm muscles enable athletes to generate greater force during ball contact, thereby increasing ball velocity,

improving service accuracy, and enhancing overall service effectiveness [25]. To determine the magnitude of contribution, the coefficient of determination was calculated using the following equation:

$$KD = r^2 \times 100\% \quad \dots(1)$$

Substituting the correlation coefficient into the equation yielded:

38.31%

This result indicates that arm muscle strength accounted for 38.31% of the variance in overhand service performance, while the remaining 61.69% was influenced by other factors not examined in this study. These factors may include hand-eye coordination, technical proficiency, flexibility, reaction speed, balance, motivation, and training experience.

The findings of this study demonstrate that arm muscle strength is significantly associated with overhand volleyball service performance. From a biomechanical perspective, serving requires the coordinated activation of several muscle groups, particularly those located in the shoulders, upper arms, forearms, and wrists. During the acceleration phase of the service movement, muscular force generated by these segments is transferred to the ball, producing the velocity necessary for successful service execution [26]. Consequently, athletes possessing greater arm muscle strength are capable of generating higher levels of force, resulting in more powerful and effective serves.

The present findings also support fundamental theories of sports performance, which emphasize muscular strength as a foundational component of athletic achievement. Strength enables athletes to overcome resistance, generate explosive movements, and maintain technical efficiency during repetitive actions. In volleyball, overhand serving requires not only technical accuracy but also sufficient physical capacity to propel the ball over the net while maintaining directional control [27]. Therefore, the significant correlation observed in this study is theoretically consistent with established principles of sports science.

Furthermore, the contribution value of 38.31% indicates that arm muscle strength is an important, but not exclusive, determinant of service performance. Volleyball serving is a complex motor skill involving interactions among physical, technical, tactical, and psychological factors. Athletes with high levels of arm strength may still perform poorly if they lack proper serving technique or coordination. Conversely, athletes with moderate strength may achieve satisfactory performance through superior technical proficiency. These findings highlight the importance of integrating strength development with technical training to maximize volleyball performance outcomes.

The results also have practical implications for coaching and athlete development. Coaches should prioritize upper-body strength conditioning as part of comprehensive volleyball training programs. Exercises such as push-ups, medicine ball throws, resistance training, and plyometric drills may be incorporated to improve arm muscle strength. However, strength training should be accompanied by technical service drills to ensure that increases in muscular capacity translate into improved sport-specific performance [28].

The findings of this study support and extend previous research examining the relationship between physical fitness components and volleyball performance. Callupe [29] reported a significant relationship between arm muscle strength and overhand service ability among senior high school students, demonstrating that upper-body strength contributes positively to service execution. Similarly, Destriana et al [30] found that specific service-training methods improved overhand service performance, emphasizing the importance of physical preparation in volleyball. Furthermore, Mardila [31] identified a significant association between arm muscle strength and smash performance, indicating the importance of upper-body strength in offensive volleyball actions. Despite these valuable contributions, previous studies primarily focused on student populations, training interventions, or different volleyball skills. Consequently, evidence concerning club-level athletes remained limited. The present study addresses this gap by investigating competitive volleyball athletes and quantifying the specific contribution of arm muscle strength to overhand service performance.

The novelty of this study lies in its focus on male volleyball athletes competing within a regional club environment and its quantitative assessment of the contribution of arm muscle strength to service performance. Unlike previous investigations that concentrated on school-based participants or multiple physical variables simultaneously, this research specifically isolates arm muscle strength as a predictor of overhand service performance [32]. Additionally, the study provides empirical evidence regarding the percentage contribution of arm muscle strength to service success, thereby offering more precise information for coaches and sports scientists regarding the physical determinants of volleyball serving performance.

The findings provide valuable implications for sports training and athlete development. Coaches may utilize the results as scientific evidence supporting the implementation of upper-body strength-training programs within volleyball conditioning regimes. The demonstrated relationship between arm muscle strength and service performance suggests that improving muscular strength may contribute directly to enhanced serving effectiveness.

Moreover, the results may assist coaches in designing individualized training interventions, identifying athlete weaknesses, and optimizing performance evaluation procedures. From an academic perspective, this study enriches the literature concerning the interaction between physical fitness components and sport-specific technical skills in volleyball [33].

Several limitations should be acknowledged when interpreting the findings of this study. First, the sample size was relatively small, consisting of only 16 athletes from a single volleyball club, which may limit the generalizability of the results to broader athlete populations. Second, the study focused exclusively on arm muscle strength and did not examine other factors potentially affecting service performance, such as coordination, flexibility, reaction time, psychological readiness, and technical competence. Third, the correlational design does not permit causal conclusions regarding the influence of arm muscle strength on service performance. Future studies are recommended to employ larger and more diverse samples, incorporate additional performance-related variables, and utilize experimental designs to determine causal relationships between physical conditioning and volleyball skill development.

#### 4. CONCLUSION

This study aimed to examine the relationship between arm muscle strength and overhand service performance among male volleyball athletes of Padang Pariaman Family Association Pekanbaru. The findings revealed a significant positive relationship between arm muscle strength and overhand service performance, as indicated by a correlation coefficient ( $r$ ) of 0.619, which exceeded the critical value at the 5% significance level. The coefficient of determination demonstrated that arm muscle strength contributed 38.31% to the variance in overhand service performance. These results indicate that athletes with greater arm muscle strength tend to achieve better service outcomes. Therefore, arm muscle strength is an important physical component that supports effective overhand service execution and should be considered in volleyball training programs to enhance athlete performance.

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