



Relationship between Arm Muscle Strength and Concentration with Volleyball Top Serve Results in Extracurricular

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Abstract

The purpose of this study was to reveal: The Relationship between Arm Muscle Strength and Concentration on the Success of Volleyball Overhead Serves in Extracurricular Students of Public Senior High School 08 Palembang. The research method used is a descriptive method. This study used total sampling on all students of Volleyball Extracurricular at Public Senior High School 08 Palembang with a total of 20 students. The research instrument was a set of tests to collect data as processing material, the tools selected and used by the researcher in his research were collected so that the activity would be systematic and facilitated by him by using instruments, namely arm muscle strength tests with push up and volleyball overhead serve tests. Based on the results of data analysis, it can be concluded that there is a significant relationship between arm muscle strength and the success of overhead serves in volleyball. This relationship is positive, which means that the stronger a person's arm muscles are, the ability to do overhead serves also tends to increase. This is supported by research data obtained in the field. In addition, a relationship was also found between arm muscle strength and concentration of students at Public Senior High School 08 Palembang on the ability to do overhead serves. Based on the significant value and correlation obtained, it can be concluded that the relationship between the variables of arm muscle strength (X₂) and upper serve ability (Y) is at a strong relationship level. The implication of this study is that arm muscle strength and concentration together have a significant influence on the success of upper serve in volleyball.

Keywords: arm muscle strength; concentration; top serve; volleyball.



Introduction

Sports represent a structured form of physical activity designed to enhance fitness, coordination, and overall health (Hartati, 2019). Beyond physiological benefits, sports contribute to psychological well-being by reducing stress, improving cognitive function, and fostering discipline (Eime et al., 2021). At a societal level, sports serve as a unifying force, promoting national pride and international recognition when athletes excel in competitive arenas (Khan et al., 2021). The global popularity of sports such as volleyball underscores their cultural significance, with millions of participants and spectators worldwide (FIVB, 2022).

Volleyball is a dynamic team sport played between two teams of six players, each aiming to outmaneuver the opponent by passing the ball over a net using strategic touches (Husni, 2015). Unlike many sports, volleyball demands a unique blend of explosive power, agility, and hand-eye coordination, making it both physically and tactically demanding (Sheppard & Newton, 2012). Success in volleyball hinges on mastering fundamental techniques, including serving, passing, setting, spiking, and blocking (Mu'arifuddin, 2018). Among these, the serve is particularly critical, as it not only initiates play but also functions as the first offensive opportunity to score points (Palao et al., 2015).

The overhead serve, a high-level serving technique, requires precise biomechanical execution to generate power and accuracy (Costa et al., 2018). Proper technique involves a coordinated sequence of movements: ball toss, arm swing, and controlled follow-through, all of which rely heavily on upper-body strength, particularly in the deltoids, triceps, and core muscles (Wagner et al., 2014). Research indicates that players with greater arm muscle strength exhibit significantly better serve performance, as strength directly influences ball velocity and placement (Khaidir & Aziz, 2020). However, mastering this skill remains a challenge for many developing athletes, particularly in school settings where training resources and individualized coaching may be limited (Giatsis et al., 2019).

Despite the known importance of strength and technique in serving, many young volleyball players struggle with executing effective overhead serves (Hartati et al., 2020). Observations at Public Senior High School 08 Palembang reveal recurring issues, including: 1) Insufficient power generation, leading to serves that fail to clear the net; 2) Poor ball control, resulting in inconsistent placement, and 3) Lack of explosive arm strength, reducing serve velocity and tactical effectiveness.

These challenges align with prior findings by Yupansi (2018), who identified a strong correlation ($r^* = 0.98$) between arm muscle strength and overhead serve accuracy among middle school athletes. However, this study focused on a younger demographic, leaving a gap in understanding how these relationships manifest among older adolescents with varying skill levels. Furthermore, while existing literature emphasizes strength as a key factor, few studies have explored how targeted training interventions could address these deficiencies in high school athletes (Ziv & Lidor, 2010).

Given the technical and physical demands of the overhead serve, this study aims to examine the relationship between arm muscle strength and serve performance among students at Public Senior High School 08 Palembang. By addressing these objectives, the study will provide empirical evidence to guide volleyball training programs, particularly in school-based settings where resource limitations often hinder skill development. The findings could inform coaching strategies, emphasizing strength conditioning alongside technical drills to improve serve proficiency. Ultimately, this research contributes to the broader discourse on optimizing athletic training for adolescent volleyball players in Indonesia and similar contexts.

Methods

Research Design

This study employed a quantitative descriptive correlational design to examine the relationship between arm muscle strength and concentration on overhead serve performance in volleyball. The design is based on the theoretical framework proposed by Sugiyono (2019).

Participants

The participants in this study were all male and female students aged 16–18 years who were actively involved in volleyball extracurricular activities at Public Senior High School 08 Palembang. A total sampling technique was applied, resulting in a sample size of 20 students ($N = 20$). All participants provided informed consent prior to participation.

Instrument

The study utilized two primary instruments:

1. Arm Muscle Strength Test (Push-Up Test)
This test was used to assess upper-body muscle strength. Participants were instructed to perform as many proper push-ups as possible following these steps:
 - a) Start in a prone position with legs straight and feet together.

- b) Place palms on the floor aligned with the chest, fingers pointing forward.
- c) Push the body upwards until the arms are fully extended, maintaining a straight body line from shoulders to heels.
- d) The number of correct push-ups completed was recorded as the strength score.

Reference: Pasaribu, 2020

2. Overhead Serve Test
 This test evaluated the effectiveness and accuracy of overhead volleyball serves. The procedure was as follows:

- a) Participants stood behind the serving line and performed an overhead serve toward a designated target area.
- b) Each participant executed 10 serves in a single test session.
- c) Scores were awarded based on where the ball landed in the scoring zone.
- d) Serves that touched the net or were out of bounds received no score.
- e) The total score from 10 attempts was used for analysis.

Reference: Pasaribu, 2020

Procedure

The testing procedure began with a general warm-up, followed by the administration of the push-up test to assess arm muscle strength. After a brief rest period, participants performed the overhead serve test. Each participant was evaluated individually to ensure consistent test conditions. Standard instructions and encouragement were provided during both tests. Data were collected and recorded systematically by the research team.

Data Analysis

Data were analyzed using SPSS version 22.0 for Windows. The following statistical procedures were conducted:

1. Descriptive Statistics
 Used to summarize the data by calculating the mean, standard deviation, minimum, and maximum values for each variable.
2. Correlation Test
 Pearson’s product-moment correlation was used to determine the relationship between arm muscle strength, concentration, and volleyball overhead serve performance.
3. Regression Analysis

A multiple regression analysis was conducted to determine the extent to which arm muscle strength and concentration predict the performance of the overhead serve.

A significance level of $p < 0.05$ was set for all statistical tests.

Results

The study involved 20 students from the volleyball extracurricular program at Public Senior High School 08 Palembang. Table 1 presents the relationship between arm muscle strength, concentration, and top serve performance was first examined through Pearson correlation analysis (Table 1). A moderate but statistically significant correlation was observed between arm muscle strength (X_1) and concentration (X_2) ($r^* = 0.528$, $*p^* = 0.017$), suggesting that athletes with greater strength tended to exhibit better focus during serves. More critically, both independent variables showed significant correlations with top serve performance (Y): arm strength (X_1) correlated at $*r^* = 0.510$ ($*p^* = 0.022$), while concentration (X_2) demonstrated a robust association ($*r^* = 0.847$, $*p^* < 0.001$). These results align with prior

Table 1
 Correlation Coefficients between Variables

Variables Compared	Pearson Correlation (r)	Sig. (2-tailed)	Interpretation
Arm Muscle Strength (X1) & Concentration (X2)	0.528*	0.017	Moderate and significant correlation
Arm Muscle Strength (X1) & Top Serve (Y)	0.510*	0.022	Moderate and significant correlation
Concentration (X2) & Top Serve (Y)	0.847**	0.000	Strong and significant correlation

Table 2
 Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.923	0.851	0.845	2.392

Table 3
ANOVA - F Test

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	956.875	2	478.438	83.647	0.000
Residual	167.625	17	9.860		
Total	1124.500	19			

Table 4
Correlation Matrix

Model	Variables	Unstandardized Coefficients (B)	Std. Error	t	Sig.
	Constant	27.276	2.431	11.221	0.000
	Arm Muscle Strength (X1)	0.349	0.132	2.651	0.016
	Concentration (X2)	0.714	0.103	6.932	0.000

studies emphasizing the dual importance of physical and psychological factors in volleyball serve execution (Wagner et al., 2014; Giatsis et al., 2019).

To quantify the combined influence of these variables, a linear regression analysis was conducted (see in Table 2). The model yielded an exceptionally high correlation coefficient ($R = 0.923$), indicating that arm strength and concentration collectively explain 85.1% of the variance in top serve performance ($R^2 = 0.851$). This finding surpasses earlier studies (e.g., Yupansi, 2018) that focused solely on strength, highlighting the added predictive value of concentration. The adjusted R^2 (0.845) further confirms minimal overfitting, reinforcing the model’s reliability for practical applications.

Table 3 shows the results of ANOVA validated the overall significance of the regression model ($F(2,17) = 83.647, *p < 0.001$). The large F -value relative to the critical threshold confirms that the combination of arm strength and concentration provides a statistically meaningful improvement over a null model in predicting serve performance (Tabachnick & Fidell, 2019). This supports the hypothesis that multidimensional training programs—integrating both physical and mental conditioning—are essential for optimizing serve outcomes.

Coefficient analysis in Table 4 revealed that both independent variables significantly influenced top serve performance, though their contributions differed. Concentration (X_2) had nearly double the impact ($\beta = 0.714, *p < 0.001$) of arm strength ($\beta = 0.349, *p = 0.016$). This suggests that while strength is foundational, psychological factors like focus and composure under pressure are paramount for elite serve execution. Practical implications include prioritizing concentration

drills (e.g., mindfulness training) alongside strength regimens in athlete development programs (Costa et al., 2018).

Discussion

The findings of this study indicate a significant positive relationship between arm muscle strength and the performance of overhead volleyball serves among students participating in extracurricular volleyball activities at SMA Negeri 8 Palembang. The results from the Kolmogorov-Smirnov normality test showed that the data for arm muscle strength (X_1) and overhead serve performance (Y) were normally distributed, with significance values of 0.632 and 0.135, respectively, both exceeding the 0.05 threshold. This suggests that parametric analysis was appropriate for testing the research hypothesis.

The data clearly support the hypothesis that arm muscle strength contributes to the success of overhead serve execution. The arm muscles play a central role in generating power during the follow-through phase of the serve, which impacts the force and velocity of the ball. Ertanto et al. (2021) emphasized that arm muscle strength is essential in generating the speed and power needed for an effective serve. Similarly, Nurjana (2021) found that stronger arm muscles positively influence the power applied during striking actions, and Bintara et al. (2021) argued that athletes with greater arm strength are at a distinct advantage when serving. A comparable study by Amalia et al. (2023) revealed a strong correlation ($r = 0.899, p < 0.05$) between arm muscle strength and serve performance in the Tabina volleyball club.

Syafuruddin (2019) highlighted that an athlete’s performance is influenced by both internal factors—such as physical health and muscle

strength—and external factors, including coaching, facilities, and support systems. Supporting this, Ija et al. (2023) reported a very high correlation ($r = 0.972$) between arm muscle strength and overhead serve performance, reaffirming the central role of physical conditioning in volleyball skill execution.

The results also indicate a strong and statistically significant relationship between concentration and overhead serve performance ($r = 0.847$, $p < 0.05$). This finding demonstrates that cognitive focus is a critical factor in successful volleyball performance. While Effendi (2020) discussed the biomechanical importance of arm muscle force in striking, the high correlation seen in this study suggests that concentration amplifies the effectiveness of the physical action by enhancing timing, accuracy, and motor control.

Previous research supports the significance of strength as a foundational attribute for athletic performance. Marwan et al. (2023) emphasized strength as a key physical quality, and Lutan et al. (2015) noted that muscular strength is essential for enhancing athletic capability. Nurhasan (2015) defined arm muscle strength as the capacity of the muscles to exert maximum force, reinforcing its importance in executing explosive movements such as overhead serves.

Normality testing using the Kolmogorov–Smirnov test confirmed that the variables—arm muscle strength (X1), concentration (X2), and overhead serve performance (Y)—were all normally distributed (Sig. values: 0.200, 0.188, and 0.200, respectively). This provided a solid basis for correlational analysis.

The findings suggest that both physical and cognitive components contribute significantly to overhead serve performance. Yanti et al. (2022) argued that without adequate strength, effective serving is unlikely. Sukmawati (2023) demonstrated that strength training, such as dumbbell exercises, improves arm muscle function and enhances volleyball serving capabilities. Amalia et al. (2023) further described arm muscle strength as the ability to perform a maximum contraction, particularly relevant in high-intensity sports like volleyball.

Additionally, Ertanto et al. (2021), Nurjana (2021), and Bintara et al. (2021) consistently noted the importance of muscular strength in executing powerful and accurate serves. These results collectively confirm that both arm muscle strength and concentration are integral to volleyball serve success, with concentration potentially optimizing the physical output during performance.

Conclusions

Based on the data analysis and discussion, the following conclusions can be drawn:

1. There is a significant and positive relationship between arm muscle strength and overhead volleyball serve performance. Students with greater arm muscle strength tend to perform better in serve execution.
2. A significant relationship also exists between concentration and overhead serve performance. High levels of focus and attention contribute positively to successful serve execution.
3. The combined influence of arm muscle strength and concentration demonstrates a strong, statistically significant relationship with overhead volleyball serve performance. These findings highlight the importance of integrating both physical conditioning and mental focus in volleyball training programs.

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