



An Analysis of the Relationship Between Arm Muscle Strength and Open Smash Ability in Volleyball Among Members of the Student Activity Unit at Makassar State University

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Abstract

Objectives. This study aims to examine the relationship between arm muscle strength and open smash ability among members of the Volleyball Student Activity Unit at Makassar State University. Specifically, it explores the extent to which upper-body strength contributes to performance in executing an open smash in volleyball.

Materials and Methods. A quantitative approach with a correlational research design was employed. The study involved 20 male members of the Volleyball Student Activity Unit at Makassar State University. Arm muscle strength was measured using a validated spring dynamometer (in kilograms), with a previously confirmed reliability coefficient of 0.92. Open smash ability was assessed using a standardized volleyball smash test, where participants completed 10 smash attempts. Data analysis involved simple linear regression and Pearson correlation, following normality and linearity testing.

Results. The results revealed no statistically significant relationship between arm muscle strength and open smash ability. The correlation coefficient ($r = 0.160$) was lower than the critical r -value ($r_t = 0.337$). Although not significant, arm muscle strength accounted for 2.5% of the variance in open smash performance.

Conclusions. It is concluded that arm muscle strength alone does not have a significant impact on open smash ability in volleyball. Nonetheless, its minor contribution suggests that additional factors may have a greater influence on performance. Future studies are encouraged to explore other physical, technical, or biomechanical variables that may affect open smash effectiveness.

Keywords: Arm Muscle Strength, Open Smash, Volleyball, Student Activity Unit, Physical Performance.

Introduction

Volleyball is a popular team sport that is widely played at various levels, from schools and universities to national competitions (Anggoro & Masrun, 2023). The modern development of volleyball has progressed rapidly, motivating many to create new training methods by combining more effective and efficient techniques. Many countries that were previously not considered strong competitors have now formed formidable and respected teams. In Indonesia, volleyball is widely enjoyed by people of all ages, from teenagers to adults (Aulia Ramadanisti et al., 2023)

The development of volleyball athletes in Indonesia must be carried out in a structured and well-planned manner in order to achieve optimal performance (Batez et al., 2021). The game of volleyball involves a variety of techniques, including service, setting, passing, blocking, and smashing (spiking) (Biróné Ilics, 2024). These techniques are essential to achieving success in the game, with smashing considered one of the most important and widely used due to its potential to score points and regain service.

The smash technique, particularly the open smash, is a powerful and strategic move that is not only effective in gaining points but also often used due to its ability to surprise and challenge opponents (Duhe, 2020). The basic principle of the smash is to hit the ball forcefully from above the net, aiming it accurately into the opponent's court. Open smash, as one of the types of smash techniques, is generally easier to learn because it produces a longer trajectory, allowing players to better anticipate the hitting point. The larger target area makes it easier for the smasher to place the ball effectively. However, to execute an effective open smash, a player must possess not only good posture and height but also significant physical strength, especially arm muscle strength (Gunawan et al., 2024).

Arm muscle strength is a vital physical component in volleyball, given that most of the game is played using the arms and hands (Hakim et al., 2024). Strength refers to the ability of muscles or muscle groups to resist and overcome loads using high force and speed. Muscles allow the human body to move and function properly. Maintaining muscle health is essential and requires knowledge about how muscles work and what can impair their performance (Saputra, 2022).

Specifically, arm muscle strength is the ability of the arm muscles to overcome resistance through quick contraction. This resistance can come in the form of body weight, wind direction, or the ball itself. Muscle contraction during a smash involves swinging the arm, snapping the wrist, and striking the ball. During an open smash, the movement requires both arm and finger strength and speed to ensure a powerful and accurate hit. The correct

form involves tensing the fingers slightly at the moment of contact, followed by a coordinated motion of the wrist and arm. The arm swing, from low to high, aids in jumping higher, which is crucial for a successful open smash (Pekas et al., 2019).

Based on field observations, open smash execution among student athletes in the Volleyball Student Activity Unit (UKM) at the State University of Makassar varies. Ideally, all participants should be able to perform an open smash. However, performance discrepancies remain, particularly among junior players who are not yet proficient. Some can perform powerful open smashes that land in the correct area, while others produce weak hits that fail to cross the net. Open smash requires coordination between arm and leg strength, along with full-body control, to generate an accurate and powerful strike. Nonetheless, many players still struggle to execute open smashes properly during matches.

Therefore, the purpose of this study is to examine how much arm muscle strength contributes to the ability to perform an open smash among members of the Volleyball Student Activity Unit at the State University of Makassar.

Materials and Methods

Study Participants.

This study focuses on the relationship between arm muscle strength and open smash ability in volleyball among male student-athletes. The research was conducted at the Volleyball Court of the State University of Makassar. The research population consisted of male members of the Volleyball Student Activity Unit (UKM) at the State University of Makassar. A total of 20 student-athletes participated in the study, selected using a total sampling technique, meaning all eligible members were included as participants.

Study organization.

This research employed a quantitative correlational method using measurement and testing procedures. The design aimed to assess the contribution of arm muscle strength to open smash performance. Data were collected through two main instruments: (1) an arm muscle strength test using a spring scale, with results recorded in kilograms (kg), and (2) an open smash ability test, based on the volleyball smash performance test developed by Laveaga, where each participant completed 10 smash attempts, and their scores were recorded.

Statistical analysis.

The collected data were analyzed using descriptive and inferential statistics. The analysis included a normality test, linearity test, and hypothesis testing. The main statistical method used was simple regression and Pearson's Product Moment correlation to determine

the strength and significance of the relationship between arm muscle strength and open smash ability.

Results

1. Arm Muscle Strength

The frequency distribution of arm muscle strength shows that most participants scored between 16–17 kg (34.78%), followed by 12–13 kg (26.09%). This indicates moderate to high strength levels among the volleyball student-athletes.

Table 1. Frequency Distribution of Arm Muscle Strength

No	Interval (kg)	Frequency	Relative Frequency (%)	Cumulative Frequency
1	10 – 11	1	4.35	1
2	12 – 13	6	26.09	7
3	14 – 15	4	17.39	11
4	16 – 17	8	34.78	19
5	18 – 19	2	8.70	21
6	20 – 21	2	8.70	23
Total		23	100.00	

2. Open Smash Ability

The majority of participants scored in the range of 56–70 (65.22%) in the open smash ability test. This suggests a fairly even distribution of open smash performance among the participants.

Table 2. Frequency Distribution of Open Smash Ability

No	Interval (Score)	Frequency	Relative Frequency (%)	Cumulative Frequency
1	50 – 55	4	17.39	4
2	56 – 60	5	21.74	9
3	61 – 65	5	21.74	14
4	66 – 70	5	21.74	19
5	71 – 75	2	8.70	21
6	76 – 80	2	8.70	23
Total		23	100.00	

3. Normality Test

Based on the Chi-square test, the variables of arm muscle strength ($\chi^2 = 7.130$) and open smash ability ($\chi^2 = 5.304$) were both lower than the critical values (15.51 and 12.59 respectively). Therefore, both variables are normally distributed.

Table 3. Summary of Normality Test

No	Variable	χ^2 calculated	df	χ^2 table ($\alpha = 0.05$)	Conclusion
1	Arm Muscle Strength	7.130	8	15.51	Normal
2	Open Smash Ability	5.304	6	12.59	Normal

4. Linearity Test

The regression equation obtained is $\hat{Y} = 57.250 + 0.495X$ with an F-value of 1.556, which is lower than the F-table value of 2.764. This indicates that the relationship between arm muscle strength and open smash ability is linear.

Table 4. Linearity Test Results

Regression Equation	F calculated	F table ($\alpha = 0.05$)	Conclusion
$\hat{Y} = 57.250 + 0.495X$	1.556	2.764	Linear

5. Hypothesis Testing

The correlation coefficient (r) between arm muscle strength and open smash ability is 0.160, which is lower than the r-table value of 0.337. This means there is no significant relationship between arm muscle strength and open smash ability among volleyball student-athletes at Universitas Negeri Makassar.

Table 5. Correlation Test Result

Variables	r calculated	df	r table ($\alpha = 0.05$)	Conclusion
Arm Strength–Smash	0.160	23	0.337	Not Significant

Discussion

The findings indicate that arm muscle strength among volleyball student-athletes at Universitas Negeri Makassar is generally in the moderate category. Similarly, the distribution of open smash ability demonstrates a fairly even spread across medium to high performance levels. However, the results of the correlation analysis show no significant relationship between arm muscle strength and open smash ability, as evidenced by the calculated correlation coefficient ($r = 0.160$) being lower than the critical value ($r_t = 0.337$).

This result suggests that although arm muscle strength is an essential component in volleyball—particularly in executing an open smash—it may not be the dominant factor influencing smash effectiveness among the observed participants. Previous research supports this view, indicating that technical performance in volleyball is multifactorial. Factors such as timing, coordination, biomechanical precision, explosive leg power, and vertical jump height have been identified as critical contributors to successful spiking or smashing actions (Marques et al., 2008; Ziv & Lidor, 2010).

The absence of a significant correlation may also stem from individual differences in technical proficiency and neuromuscular coordination, especially given the complexity of the open smash movement, which requires precise synchronization of the upper and lower body

(Sheppard et al., 2009). Moreover, muscle strength without proper technique may fail to translate into performance outcomes, particularly in tasks that are highly skill-dependent.

These findings align with studies emphasizing that volleyball performance—particularly in spike and smash actions—is not solely determined by muscular strength, but by the integration of strength, power, timing, and technical skill (Gabbett & Georgieff, 2007). As such, it is recommended that coaches adopt a holistic training approach that combines upper-body strength development with technical drills, neuromuscular coordination training, and plyometric exercises to enhance overall smash performance.

Conclusions

Based on the results of the study, it can be concluded that there is no significant relationship between arm muscle strength and the ability to perform an open smash among male volleyball student-athletes at Universitas Negeri Makassar. Although arm muscle strength plays a supporting role in volleyball performance, it is not the sole determinant of open smash ability. Other physical and technical factors may have a greater influence and should be considered in training programs to improve smash performance.

Acknowledgment

The researcher would like to express sincere gratitude to all members of the Universitas Negeri Makassar Volleyball Student Activity Unit (UKM) who participated in this study. Appreciation is also extended to the lecturers and academic staff who provided valuable support and guidance throughout the research process.

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