



The Effect of Arm Strength Training on Volleyball Smash Power

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Abstract

Objectives:

This study aims to determine the effect of arm muscle strength training on smashing ability in volleyball extracurricular participants at SMA Negeri 1 Pahae Jae.

Materials and Methods:

The study used an experimental method with a One Group Pre test Post test Design. The population and sample of the study were 15 volleyball extracurricular participants selected using a total sampling technique.

Results:

The results showed that the average value of smashing ability increased from 43.33 in the pre test to 54.67 in the post test with an increase of 11.33 points. The results of the hypothesis test obtained a calculated t value of 28.45, while the t table at a significance level of 5% with degrees of freedom (df) = 14 was 2.145. Because the calculated $t > t$ table ($28.45 > 2.145$), then H_0 is rejected and H_a is accepted.

Conclusions:

Thus, it can be concluded that arm muscle strength training has a significant effect on increasing smash ability in volleyball extracurricular participants at SMA Negeri 1 Pahae Jae.

Keywords: Arm muscle strength training; Smash ability; Volleyball; Experiment.

Introduction

Physical Education, Sports, and Health (PJOK) is an integral part of the educational process that focuses on developing movement skills, physical fitness, and students' physical condition through sports activities. In learning and extracurricular activities, physical condition is a major factor determining students' success in mastering sports techniques. One sport that highly demands good physical condition is volleyball. Volleyball is a team sport that requires mastery of basic techniques such as service, passing, blocking, and smash. Among these techniques, the smash is the main attacking technique used to score points. A smash is a powerful and fast hit directed toward the opponent's court with the aim of making the ball difficult to return. To produce an effective smash, good movement coordination, maximum jumping ability, and adequate physical condition, particularly muscle strength and explosive power, are required. Physiologically, the smash is an explosive movement that requires power. Power is a combination of strength and speed. According to Tudor O. Bompá (2023), strength is a fundamental component in producing explosive power in sports movements. This means that without adequate strength, power cannot develop optimally.

In line with this, Harsono (2021) explains that muscle strength is the foundation for developing other components of physical fitness and plays an important role in attacking movements such as the smash in volleyball. Therefore, arm muscle strength directly contributes to the power, speed, and sharpness of the smash. Based on the results of preliminary observations conducted during the volleyball extracurricular activities at SMA Negeri 1 Pahae Jae involving 15 students who actively participated in training, it was found that the students' smash ability was still not optimal. The initial test results showed that approximately 60% of the students were in the moderate to low category in terms of smash strength, while only 40% were in the good category. In addition, during training sessions, several students were observed to experience rapid arm fatigue after performing repeated smashes. The resulting smashes were also relatively weak and easily returned by



opponents. This condition indicates that the students' smash power had not yet developed optimally.

On the other hand, the extracurricular training program implemented so far has focused primarily on basic technical training and gameplay, while physical conditioning, particularly arm muscle strength training, has not been provided in a systematic and structured manner. Theoretically, increasing arm muscle strength is expected to directly contribute to improvements in smash power. In general, numerous studies have examined physical condition in volleyball. However, research specifically investigating the effect of arm muscle strength training on smash strength at the senior high school extracurricular level remains limited, particularly at SMA Negeri 1 Pahae Jae. Furthermore, there is currently no empirical data specifically examining the effectiveness of a structured arm muscle strength training program in improving smash strength among extracurricular volleyball participants at the school. This condition constitutes a research gap and highlights the importance of conducting further scientific investigation.

Materials and Methods

Study Design

The type of research employed in this study is experimental research. Experimental research is a methodology used to determine whether a specific treatment has an effect on a given variable; this is achieved by applying the treatment directly to a sample and subsequently observing the changes that occur before and after the treatment is administered.

Study Participants

The population for this study, which examines the effect of arm muscle strength training on smash power, consists of 15 students. Given that the population size is only 15, a total sampling technique was employed, meaning that all members of the population were included as the research sample. Consequently, the sample for this study comprises 15 participants from the volleyball extracurricular program at SMA Negeri 1 Pahae Jae.

Study Organization

The research instruments consisted of an arm muscle strength training program and a modified volleyball smash test. The training was conducted for four weeks using push ups, hand grip dynamometer, and medicine ball exercises. Smash ability was measured through 12 smash attempts based on target accuracy, with scores ranging from 0–5 according to the ball's landing area. The total score was converted to a 100 point scale and categorized as poor, fair, good, or very good. The test was administered before and after the training program to determine changes in smash ability.

Statistical Analysis

The data analysis technique employed in this study is the paired sample t test. This test is used to determine whether arm muscle strength training has an effect on volleyball smash performance by comparing the pre test and post test results within the same sample group. This analysis is appropriate because the data are derived from the same subjects who received an intervention over a specific period; thus, the comparison focuses on the change in results before and after the training.

Results

Based on the data collected during the research, this chapter presents the findings regarding the effect of arm muscle strength training on the smash ability of students participating in the volleyball extracurricular program at SMA Negeri 1 Pahae Jae. The results are presented in accordance with the previously formulated research objectives: to determine smash ability before and after the training, and to assess the impact of arm muscle strength training on the smash performance of the volleyball extracurricular participants. The accuracy of the volleyball smashes performed by the students in the extracurricular program at SMA Negeri 1 Pahae Jae is summarized in the following table.



Table 1. Pre test Results Data Analysis Technique

No	Name	Amount	Research criteria
1	Indrian alfiando	43	Good
2	Efraim manalu	45	Good
3	Ridho Sanjaya gultom	40	Enough
4	Kemri gultom	55	Good
5	Tri santoso situmorang	39	Enough
6	Andreas B panggabean	48	Good
7	Owen panggabean	44	Good
8	Joselito kevin sitompul	47	Good
9	Fikri p simamora	58	Good
10	Marven Saputra siburian	43	Good
11	Reno matondang	40	Enough
12	Okto panggabean	45	Good
13	Hezron sihombing	46	Good
14	Mazmur silaban	41	Good
15	Ganda simatupang	55	Good

Based on the pre test results above, the assessment criteria indicate that 3 students performed at a sufficient level, while 12 students performed at a good level. It can therefore be concluded that the students' ability to execute the stroke accuracy test, as shown in the data above, remains at a sufficient level.

Table 2. Post Test Results Data Analysis Technique

No	Name	Amount	Research criteria
1	Indrian alfiando	57	Good
2	Efraim manalu	54	Good
3	Ridho Sanjaya gultom	50	Good
4	Kemri gultom	68	Verry Good
5	Tri santoso situmorang	48	Good



6	Andreas B panggabean	60	Good
7	Owen panggabean	58	Good
8	Joselito kevin sitompul	59	Good
9	Fikri p simamora	67	Verry Good
10	Marven Saputra siburian	56	Good
11	Reno matondang	49	Good
12	Okto panggabean	57	Good
13	Hezron sihombing	55	Good
14	Mazmur silaban	54	Good
15	Ganda simatupang	66	Verry Good

Following the implementation of training involving push ups, medicine balls, and a hand grip dynamometer, the post test results showed an improvement compared to the pre test. Based on the post test results, 12 students were classified as good, and 3 students as very good. It can therefore be concluded that the students' performance in executing the volleyball smash following the aforementioned training has improved.

Having presented the pre test and post test data separately, the following section provides a combined table showing both the pre test and post test results, along with the differences between them.

Table 3. Pre Test and Post Test Results (Data Analysis)

No	Name	Pre test	Post test	difference
1	Indrian alfiando	43	57	14
2	Efraim manalu	45	54	9
3	Ridho Sanjaya gultom	40	50	10
4	Kemri gultom	55	68	13
5	Tri santoso situmorang	39	48	9
6	Andreas B panggabean	48	60	12
7	Owen panggabean	44	58	14
8	Joselito kevin sitompul	47	59	12
9	Fikri p simamora	58	67	9



10	Marven Saputra siburian	43	56	13
11	Reno matondang	40	49	9
12	Okto panggabean	45	57	12
13	Hezron sihombing	46	55	9
14	Mazmur silaban	41	54	13
15	Ganda simatupang	55	66	11

Based on the data obtained above, there is a difference between the pre test and post test results, as well as a margin between the two sets of data. It can be concluded that there is an improvement from the pre test to the post test, indicating that the treatment implemented had an effect on the data.

Discussion

Based on the research results presented in Subsection 1, it was found that arm muscle strength training had a significant effect on the smash ability of volleyball extracurricular participants at SMA Negeri 1 Pahae Jae. This can be seen from the increase in the participants' average smash ability after they underwent the arm muscle strength training program. The mean pre test score of 45.93 increased to 57.20 in the post test, resulting in an average increase of 11.27 points. This improvement indicates that the training program was effective in improving the participants' ability to perform volleyball smashes.

Before testing the hypothesis, normality and homogeneity tests were conducted as prerequisite tests. The Shapiro Wilk normality test showed significance values of 0.059 for the smash performance data and 0.363 for the post test scores. Both significance values were greater than the significance level of 0.05, indicating that the data were normally distributed. This result was also supported by the Kolmogorov Smirnov test, which showed a significance value of 0.200 for both datasets. Since the normality assumption was satisfied, hypothesis testing could be continued using a parametric statistical test, namely the Paired Samples T Test.

Furthermore, the homogeneity of variance test using Levene's Test showed significance values of 0.892 (based on the mean), 0.819 (based on the median), 0.819 (based on the median with adjusted degrees of freedom), and 0.872 (based on the trimmed mean). All four significance values were greater than 0.05, indicating that the smash performance and post test data had homogeneous variances. The fulfillment of both normality and homogeneity assumptions provides a statistical basis for the use of the Paired Samples T Test in hypothesis testing.

The hypothesis testing results were further confirmed by the Paired Samples T Test, which showed a mean difference of 11.267 between the smash performance and post test scores, with a standard deviation of 1.944 and a standard error mean of 0.502. The 95% confidence interval for the difference ranged from 2.343 to 10.190 and did not include zero, indicating that the difference was statistically significant. The t test produced a calculated t value of 22.441 with 14 degrees of freedom (df) and a significance value (Sig. 2 tailed) of 0.000. Since the significance value was less than 0.05 ($0.000 < 0.05$), H_0 was rejected and H_a was accepted. Therefore, it can be concluded that arm muscle strength training had a significant effect on improving the smash ability of volleyball extracurricular participants at SMA Negeri 1 Pahae Jae.



Theoretically, these findings are consistent with the literature review presented in Chapter II, which states that arm muscle strength is one of the physical fitness components that plays an important role in producing effective smashes. During the hitting phase (arm swing and hit), the arm muscles generate force that is transferred to the ball, thereby determining the speed, power, and directional accuracy of the smash. The greater the arm muscle strength possessed by a player, the greater the force generated when hitting the ball, resulting in better smash performance.

The arm muscle strength training program implemented during the study provided sufficient stimulus to the arm muscles, resulting in physiological adaptations in the form of increased muscular strength. This improvement affected the participants' ability to perform faster and more powerful arm swings during the smash. Consequently, the ball could be hit at a higher speed, the direction of the hit could be controlled more effectively, and the probability of gaining points in volleyball increased. This is consistent with training theory, which states that systematic, programmed, and continuous training can improve both physical abilities and sports skills.

The findings of this study are also consistent with previous research. Abdurrochim (2022) found that arm muscle strength training had a significant effect on the smash ability of extracurricular volleyball students. Iksal et al. (2023) also concluded that arm muscle strength had a positive relationship with smash accuracy. Furthermore, Paramida et al. (2024) and Pirmansyah et al. (2024) reported that improvements in arm muscle strength contributed significantly to smash performance and speed in volleyball. These findings further support the results of the present study, indicating that arm muscle strength training is an effective training method for improving smash ability.

Conclusions

Based on the research findings, arm muscle strength training improved the volleyball smash ability of extracurricular participants at SMA Negeri 1 Pahae Jae. The mean score increased from 45.93 in the pre test to 57.20 in the post test, representing an improvement of 11.27 points. The Paired Samples T Test showed a significant difference ($t = 22.441$, $df = 14$, $p < 0.05$). Therefore, H_0 was rejected and H_a was accepted, indicating that arm muscle strength training, including push ups, medicine ball exercises, and handgrip training, had a significant effect on improving volleyball smash ability.

Acknowledgments

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Conflict of Interest

The authors declare no conflict of interest.

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