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The Effect of Arm Muscle Training on Smash Ability in Badminton Athletes at PB. New Binatama

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Abstrac: This study aims to determine the effect of arm muscle training on the smash ability of badminton athletes at PB. New Binatama. This research used a quantitative approach with a one-group pretest-posttest experimental design. The sample consisted of six athletes selected through purposive sampling. Data were collected using smash ability tests conducted before and after four weeks of arm muscle training. The data analysis technique employed was the paired sample t-test and N-Gain analysis. The results showed a significant difference between the pre-test and post-test scores with a t-value of –12.011 and a significance level of 0.000 ($p < 0.001$). The average N-Gain score was 0.16 (15.7%), which falls into the low category. These findings indicate that arm muscle training significantly improves smash ability in badminton athletes, although the overall effectiveness remains limited. Longer training duration is recommended to achieve optimal results.

Keyword: Arm muscle training, Smash ability, Badminton, PB. New Binatama.

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INTRODUCTION

Badminton is one of the most popular sports in Indonesia and is enjoyed by all levels of society, of all ages and economic backgrounds, for a variety of purposes, ranging from recreation to sporting achievement (Ma'dum & Irawan, 2022). Badminton is a competitive sport because it has a structured, gradual, and sustainable training system for developing athletes. Badminton is a competitive sport because it has a structured, gradual, and sustainable training system for developing athletes. Therefore, this sport deserves serious attention from the Indonesian government. In badminton, there are several basic techniques that need to be mastered, including racket grip technique, shuttlecock hitting technique, and footwork technique (Edmizal, 2021). These technical exercises are usually given after physical training.

Arm muscle training, according to Iskandar et al., (2023), is a form of exercise that aims to develop arm muscles to their maximum potential. To increase arm muscle strength, you can use your own body weight (internal) and external weights. Arm muscle training can improve the ability of the arm muscles to contract. This ability is essential in almost all sports. An athlete with great strength will influence the explosive power of the muscles in performing a movement. Arm muscle training can increase power. According to Kuswanti et al., (2024), arm muscle training is one of the training methods suitable for improving smash skills in badminton. As an important biomotor component in sports activities, muscle training determines how hard a person can hit and jump. If a badminton athlete has well-trained arm muscles, the resulting swing will be maximized. There are many types of arm muscle exercises, such as push-ups, dips, and squat thrusts. Arm muscle training aims to strengthen the arm muscles, which can be done with various movements using one's own body weight or additional weights (Fauzi, 2025).

According to Putra et al., (2021), a smash is a powerful and sharp shot aimed at ending the game quickly by defeating the opponent as fast as possible. The smash is a very important shot in badminton, so every badminton player must master it. A hard and fast smash is very effective in defeating opponents. To generate a powerful smash, muscle power or explosive force is required, especially from the primary arm muscles involved in executing the smash(Antoni et al., 2024). The smash has the characteristics of a strong and fast shot, making it very suitable for use in doubles games to break through the opponent's defense. This is because in doubles games, the characteristics of play are speed and power (Arizzi & Kustoro, 2022). It can be concluded that the smash is an effective attacking shot to kill the shuttlecock in the opponent's area in badminton. This shot is performed by hitting the shuttlecock with full force, resulting in a fast and sharp downward strike (Anugrah et al., 2025). The smash is a hard and sharp shot, aimed at killing the opponent as quickly as possible. The smash movement is almost the same as a dropshot and lob, where the racket can be held straight or tilted (Putra et al., 2021). The function of a smash is to attack in order to score points and make the opponent's defense vulnerable (Hidayat et al., 2022). The smash also serves to disrupt the opponent's game strategy. The explosive force generated by the smash can penetrate the defense and put great pressure on the opponent, causing them to lose their rhythm. The smash technique is suitable for use when facing opponents with defensive characteristics in order to break down their defense (Hamid & Indah, 2025).

Based on interviews with PB.New Binatama coaches and observations during training, it was found that the athletes' smash skills were not yet optimal. Their smashes were often weak and easily returned by their opponents, with the shuttlecock always hanging on the net or even going out. This shows that the athletes' smash skills are still not optimal due to their low arm muscle strength, preventing them from producing strong and effective smashes. PB.New Binatama's achievements began in 2022 when PB.New Binatama athletes won 1 bronze medal in the boys' category. In 2023, PB.New Binatama won 2 medals, including 1 bronze in the men's beginner category and 1 bronze in the girls' category. In 2024, PB.New Binatama has not yet managed to contribute a medal in the boys' beginner category. Based on the above competition data, PB.New Binatama has not yet become a champion.

Based on the above explanation, the researcher is interested in conducting research to improve the smash ability of PB New Binatama athletes through arm muscle training. Based on the assumptions and description of the problem above, the researcher is interested in conducting

research on how arm muscle training can affect the badminton smash ability of PB New Binatama athletes and can scientifically prove the relationship in the smash results.

Therefore, the researcher is interested in addressing this issue with the title "The Effect of Arm Muscle Training on Badminton Smash Ability in PB. New Binatama Athletes." It is hoped that the results of this research will be beneficial for coaches and athletes of PB. New Binatama as a new training method that can be applied to improve smash ability in the future.

METHOD

This research method uses a quantitative approach with a one-group pretest-posttest pre-experimental design. This design was chosen to determine the extent of the effect of arm muscle training on badminton smash ability in the same group of athletes, by comparing the results before and after the treatment was given.

The research subjects consisted of six badminton athletes from PB. New Binatama who were selected using purposive sampling. This technique was chosen because the researcher needed a sample with specific criteria relevant to the research objectives. The criteria for sample selection were active athletes who were registered as members of PB. New Binatama, regularly participated in training programs at least three times a week, had participated in at least one local or regional badminton championship, and were willing to participate in the entire research process from start to finish. These criteria were established so that the research subjects would have an adequate level of experience and commitment to training, thereby ensuring that the research results would be more valid and representative.

The study was conducted from August to September 2025 at the PB New Binatama Training Center. Before the treatment, a pre-test was conducted to determine the athletes' initial smash ability. After that, the athletes underwent a four-week arm muscle training program (16 sessions). After the training program was completed, a post-test was conducted to assess the improvement in the athletes' smash ability. The instrument used in this study was a standard badminton smash ability test to measure the accuracy and power of smash shots. The test was conducted by having athletes perform 10 smash attempts at a target area on the opponent's court, which was divided into five scoring zones (see Figure 1).

The scoring criteria are determined based on the position where the shuttlecock lands, namely: Zone 1 = 1 point; Zone 2 = 2 points; Zone 3 = 3 points; Zone 4 = 4 points; Zone 5 = 5 points. If the shuttlecock lands on the boundary line between two zones, the higher score is awarded. If the athlete fails to hit the shuttlecock despite being served, the score is 0, while an imperfect serve from the tester may be repeated.

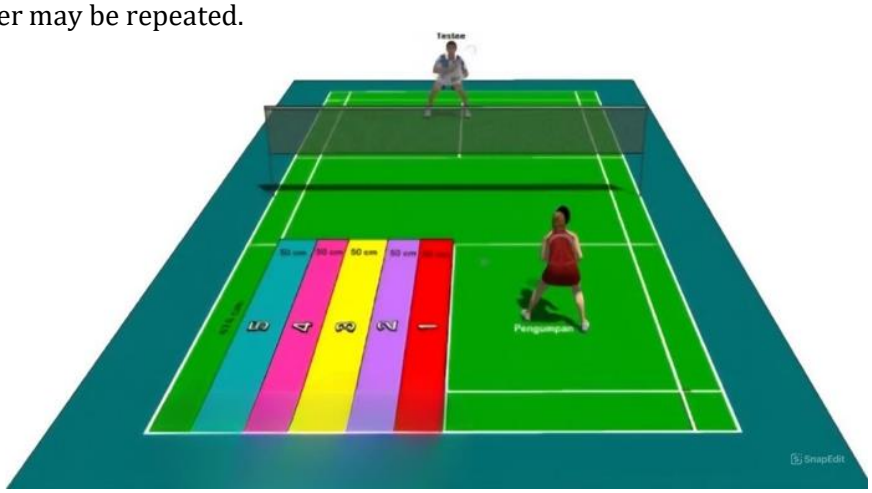

Figure 1. Target Smash Badminton court from behind that has been scored (Edmizal, 2021).

RESULT
Pre-test and Post-test Result

Table 1. Frequency Distribution of Smash Ability Scores

Score range	Category	Fr Pre-test	P Pre-test	Fre Post-test	P Post-test
>40,06	Very good	0	0,00%	3	50,00%
35,02-40,05	Good	0	0,00%	2	33,33%
30,00-35,01	Fair	3	50,00%	0	0,00%
24,96-29,99	Poor	0	0,00%	1	16,67%
<24,95	Very poor	3	50,00%	0	0,00%
TOTAL		**6**	**100%**	**6**	**100%**

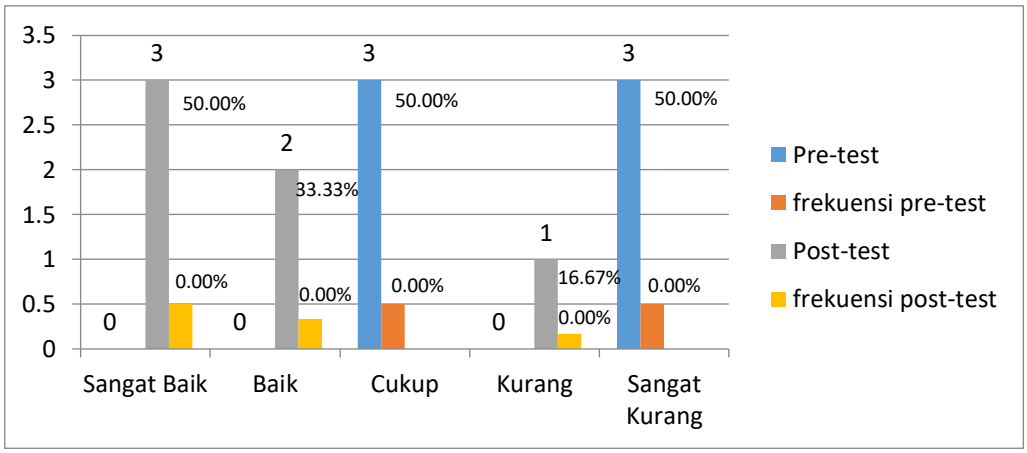

Figure 2. Smash Ability Diagram

From the table and diagram above, it can be seen from the pretest and posttest results of smash ability that from a sample size of 6 people, there were differences in smash ability. In the pretest, 3 athletes scored in the adequate category with a frequency of 50.00%, while the other 3 athletes scored in the very poor category with a frequency of 50.00%. The 3 athletes who scored “adequate” had poor smashes that still hit the net. Meanwhile, the other 3 athletes who scored “very poor” still had difficulty getting the right timing.

The post-test results showed an improvement in the athletes' smash skills after the treatment, with 3 athletes scoring in the excellent category with a percentage of 50.00%, 2 athletes scoring in the good category with a percentage of 33.33%, and 1 athlete scoring in the poor category with a percentage of 16.67%. From the post-test data, it can be seen that there was an improvement in the athletes' abilities after receiving the treatment.

The reason why three athletes received a satisfactory score and managed to achieve an excellent score after receiving treatment. This also shows an improvement in quality. This improvement in ability cannot be separated from the athletes' enthusiasm and perseverance in learning and seriously undergoing the training program so that their abilities can be maximized. They also already had strong basic techniques and high enthusiasm from the start. Then there were three athletes who initially received very poor scores, two of whom received good scores. This was because the athletes focused and followed the coach's instructions well during training even though they were physically weak at the beginning. They were quite disciplined in following the coach's technical instructions, and one athlete whose improvement lagged behind received a score that was less than the previous very poor score. This was because the basic smash technique was not fully mastered, so the new muscle strength gained was not utilized effectively. Low motivation, mental state, and enthusiasm, as mentioned by (Sin, 2016), as well as a lack of seriousness in the training process, resulted in suboptimal skill improvement. Motivation to enhance training can be triggered by clear goals (Purnomo, Eko; Jermaina, 2018).

Requirements Analysis Test

Before conducting hypothesis testing, a prerequisite analysis test, namely normality testing, must first be performed.

1. Normality Test

The normality test was conducted using Shapiro Wilk with a significance level (α) = 0.05. The data used were pretest and posttest data on the smash ability of PB New Binatama badminton athletes. This data was tested using the Shapiro-Wilk normality test with the SPSS 27.0 program. The following summarizes the results of the Shapiro-Wilk Normality Test.

Table 2. Frequency Distribution of Smash Ability Scores

Tests of Normality							
Result	Period	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
	Pre-tets	.246	6	.200	.925	6	.542
	Post-test	.233	6	.200	.823	6	.094

This is a lower bounch of the true significance

a. Lilliefors Significance Correction

From the table above, the pretest information in the Shapiro-Wilk test shows a significance of 0.542, while the posttest data shows a significance of 0.094. The basis for drawing conclusions from the Shapiro-Wilk normality test is that if the Sig value is 0.05, the data is not normally distributed. The results obtained in the pretest and posttest in the table above show that the pretest and posttest scores for the smash ability of PB. New Binatama badminton athletes have a significance level > 0.05. This indicates that the pretest and posttest smash scores of PB. New Binatama athletes are normally distributed or meet the normality test requirements.

2. Homogeneity Test

The homogeneity test is conducted to determine whether the pretest and posttest data have the same variance. The test is conducted using Levene's Test for Equality of Variances at a significance level of 0.05. The data is considered homogeneous if the significance value (sig) > 0.05.

Table 3. Data Homogeneity Test Results (Levene's test)

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
Result	Based on Mean	.166	1	10	.693
	Based on Median	.235	1	10	.639
	Based on Median and with adjusted df	.235	1	6.999	.643
	Based on trimmed mean	.211	1	10	.656

Based on the table above, a significance value of 0.693 was obtained. Because this value is greater than 0.05, the research data can be said to be homogeneous. Thus, the variance of the pretest and posttest data on the smash ability of PB New Binatama athletes is the same, thereby fulfilling the requirements for hypothesis testing with a paired sample t-test.

Hypothesis Testing (paired Sample t-test)
The results of the paired sample t-test analysis are shown in the following table:

Table 4. Paired Sample t-Test Results

Paired Samples Test									
		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	pre test - post test	-11.500	2.345	.957	-13.961	-9.039	-12.011	5	0,000 (p<.001)

The results of the hypothesis test using a paired sample test show a very significant difference between the smash ability scores before and after the arm muscle training treatment, with a t-value of – 12.011, a degree of freedom (df) = 5, and a p-value (Sig. 2-tailed) = 0.000 ($p < 0.001$). Because the p-value is much smaller than the predetermined significance level ($\alpha = 0.05$), H0 is rejected and Ha is accepted.

This means that the average smash ability of athletes after participating in the arm muscle training program was significantly different compared to before training. These findings show that the increase in athletes' smash ability after treatment did occur and was not caused by chance (statistically significant). However, to determine the extent or effectiveness of this increase, further analysis using the N-Gain Score is needed.

N-Gain Analysis

In addition to the paired sample t-test, the effectiveness of the improvement was calculated using N-Gain to determine the relative effectiveness of the arm muscle training program. N-Gain measures how much learning (or ability) has improved compared to the maximum potential improvement that can be achieved. N-Gain is a measure of exercise effectiveness that compares the increase in pretest scores before treatment to posttest scores after treatment to the maximum ideal score that can be achieved (Alarifi, 2021).

Table 4. N-Gain Analysis Results

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
NGain_Score	6	.11	.20	.1569	.02991
NGain_persen	6	11.25	19.74	15.6933	2.99066
Valid N (listwise)	6				

DISCUSSION

The average N-Gain value obtained was 0.16 (15.7%), which is classified as low based on the criteria (Sundayana, 2014). A value of 0.16 indicates that the training program produced 16% of the maximum potential improvement that could be achieved. This means that even though it is statistically significant at 0.000 ($p < 0.001$), the practical effectiveness of this program is still limited when compared to the ideal achievement.

However, the low N-Gain in this study can be explained by several factors. First, the duration of the training program was relatively short, so muscle adaptation was not optimal. Second, the sample size was only 6 athletes, so the improvements that occurred could not be generalized widely. Third, differences in the athletes' basic abilities also influenced the variation in the improvement in smash ability. According to Nkosi & Motlhabane, (2025) a low N-Gain value indicates that although there was an improvement, the effectiveness of the training program needs to be improved to be more optimal.

The results of this study are also consistent with the findings Sundayana (2014) which confirm that arm muscles are one of the dominant factors affecting the quality of smashes. This

improvement in smash ability is in line with the theory Harsono (2018) which states that arm muscle training can improve muscle contraction and explosive power, which play an important role in striking movements. Bompa, Tudor., & Buzzichelli (2019) also emphasize that weight training programs focused on arm muscles can improve performance in sports involving striking movements, including badminton.

Arm muscle training is a systematic weight training method that focuses on strengthening the biceps, triceps, and lower arm muscles to improve arm muscles (Sukadiyanto, 2010). This training aims to train muscle contraction ability to produce explosive muscle power. Arm muscle training is an exercise that can improve smash ability. This is because performing a smash involves a quick swing of the arm, which requires arm muscle strength.

A smash is an attacking shot in badminton. A smash shot is a shot that is performed with force and a sharp downward swing with a quick arm swing (Syaiuddin & Indardi, 2023). To perform a smash well, arm muscle contraction ability is required. Weak arm muscles will make it difficult for athletes to perform smashes.

The effectiveness of arm muscle training in improving arm muscle contraction ability is theoretically very helpful in improving the smash ability of PB New Binatama badminton athletes. The use of arm muscle training methods can help train muscle contraction through rapid loading of the muscles involved, resulting in strong and fast swing movements.

Figure 2. Flowchart and Logic Flow of Evidence and Limitations of Arm Muscle Training Program Effectiveness

The flowchart above presents the logical flow of the findings of this study. This flow begins with the intervention (box 1), which is an arm muscle training program conducted over four weeks. This action proved to be effective and successfully produced a significant increase in scores (box 2), which was confirmed by the results of a paired sample t-test with $p < 0.001$. This increase is also clearly seen in the bar graph of scores ($26.7 \rightarrow 38.2$). However, the logical flow continues with a critical analysis of Program Efficiency. The N-Gain Score Average data of 0.16 (box 3) provides a low category interpretation (box 4). This point is the main focus of discussion, because although the training statistically succeeded in increasing scores, the quality of the improvement was still not optimal. Therefore, (box 5) concludes that the effectiveness of the program is limited. This limitation is based on the strong assumption that the duration of the intervention (4 weeks) was not long enough to trigger the maximum physiological adaptation (increase in arm muscle) needed for the best smash performance.

It can be concluded that this flowchart confirms that arm muscle training is an important factor that has been proven to affect scores, but a more comprehensive program is needed to achieve greater effectiveness.

CONCLUSION

Based on the results of research and discussion regarding the effect of arm muscle training on the smash ability of PB New Binatama badminton athletes, it can be concluded that there was an increase in smash ability after arm muscle training. This can be seen from the

increase in the pre-test average score of 26.7 to 38.2 in the post-test. The results of the paired sample t-test showed a t-value of –12.011 with a significance of 0.000 ($p < 0.001$), which means that there was a significant difference between the results before and after the treatment. In addition, the average N-Gain value of 0.16 or 15.7% indicates that the increase is in the low category according to Sundayana's (2014) criteria. Thus, it can be concluded that arm muscle training has a significant effect on the smash ability of PB New Binatama badminton athletes, although the effectiveness of the improvement obtained is still not optimal.

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