

The Effect of Arm Strength Training on Underhand Passing Skills in Volleyball Among Students at Tutuyan Public Junior High School 2

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Keywords:

Arm Muscle Strength; Bottom Passing; Volleyball

Abstract

Volleyball underhand passing is a fundamental skill for receiving serves, controlling attacks, and initiating offensive plays. However, preliminary observations at Tutuyan Public Junior High School 2 showed that several students performed this technique inconsistently, indicating the need for physical conditioning, particularly arm muscle strengthening. This study aimed to determine the effect of arm muscle strength training on students' underhand passing ability. A true experimental method with a randomized control-group pretest–posttest design was employed. Twenty male students were randomly assigned to an experimental group and a control group, with ten participants in each group. Underhand passing performance was measured using a one-minute wall-passing test. The experimental group completed arm muscle strength training for eight weeks at a frequency of three sessions per week, while the control group received no specific treatment. Data were analyzed using an independent-samples t-test at a significance level of 0.05. The experimental group's mean score increased from 32.20 at pretest to 34.50 at posttest, producing a mean gain of 2.30, compared with 0.60 in the control group. The observed t-value of 3.553 exceeded the critical value of 1.734. These findings demonstrate that structured arm muscle strength training significantly improved students' volleyball underhand passing ability and enhanced their technical performance.

INTRODUCTION

Human beings cannot be separated from sports activities. Sports activities carried out by individuals aim to achieve performance, support educational development, and maintain healthy and fit physical conditions. Sports activities represent human efforts to improve the quality of Indonesian human resources, which are directed toward developing strong character, personality, discipline, sportsmanship, and achievement that can foster national pride. Various sports activities can be practiced by humans. Broadly speaking, sports activities consist of game sports, individual sports, and other categories (Chelladurai & Kim, 2022; Kretchmar et al., 2024; Ningning & Wenguan, 2023; Siedentop & Van der Mars, 2022).

Volleyball is one of the sports that has been recognized for a long time in Indonesia. Volleyball is one of the most popular big-ball games among Indonesian communities, ranging from school children to adults, both male and female. Volleyball is relatively easy to play because it requires only a court, a ball, and a net separating the playing areas of opposing teams (Berhanie, 2023; Jorge Rodrigues et al., 2022; Rebelo et al., 2025; Tsakiri et al., 2023; Xia et al., 2023).

Volleyball has spread widely, including to remote rural areas. However, the challenges in improving volleyball performance are complex; therefore, serious and systematic efforts are required.

Discussing sports achievement improvement is not as simple as turning the palm of one's hand. It requires various concrete efforts and commitment from all elements, including internal and external factors related to athletes. Current developments in science and technology have accelerated changes in human life, including efforts to improve sports achievements. This development has also intensified competition in achieving excellence, particularly in volleyball. Optimal achievement in volleyball is the aspiration of every athlete; however, achieving such performance requires careful planning through a systematic and sustainable training system.

Maximum achievement in every sport is determined by physical components, tactical skills, technical abilities, and psychological demands (Crespo et al., 2024; Hatfield, 2024; Kovalcuk et al., 2023; Kusuma et al., 2024; Sansone et al., 2023; Silva et al., 2023; Vidigal et al., 2022). To perform effectively in volleyball, one of the main aspects that must be mastered is fundamental technical skills. Mastery of basic techniques in volleyball is essential for every player because it enables athletes to demonstrate effective and efficient performance.

In volleyball, there are several basic techniques. According to Yunus (1992), the fundamental techniques in volleyball include service, passing, setting (set-up), smashing (spike), and blocking (block). Various service techniques and variations include the underarm serve, floating serve, hook serve, and jump serve. One of the fundamental techniques that must be mastered by every player to ensure an effective game is the passing technique. Passing in volleyball consists of two main types: the forearm pass (underhand pass) and the overhead pass.

According to Ahmadi (2007), passing is an effort made by a player using a specific technique to deliver the ball to a teammate so that it can be continued within their own court. Meanwhile, according to Abdoellah (1981), passing in volleyball is an effort made by a player using a specific technique to deliver the ball to teammates. Passing involves receiving, controlling, and directing the ball to teammates; however, when an opportunity occurs, the ball may be directly sent to the opponent's area. Passing is a technique used to deliver the ball to teammates and serves as the initial step in developing an attacking strategy against the opposing team. Passing can be performed using two techniques, namely the overhead pass and the forearm pass.

Evidence from previous research has demonstrated that systematically designed conditioning programs can improve the physical performance of young volleyball players. Hernández-Martínez et al. (2023), for example, randomly allocated 42 male youth volleyball players into groups receiving one weekly plyometric session, two weekly sessions, or a control condition. After eight weeks, both intervention groups demonstrated significant improvements in jumping performance, sprint performance, and service speed. The group completing one weekly session recorded improvements of 12.74% in squat-jump performance, 11.94% in countermovement-jump performance, and 8.17% in service speed. These findings indicate that structured training can generate meaningful adaptations in young volleyball players even when weekly training frequency is relatively modest. Nevertheless, the study focused primarily on lower-body explosive performance and service speed rather than arm-strength development

and forearm-passing proficiency. Therefore, its findings support the general value of conditioning interventions but do not directly establish whether arm muscle strength training improves underhand passing ability among junior high school students (Hernández-Martínez et al., 2023).

Previous studies have also investigated instructional exercises specifically designed to improve forearm passing. Martin et al. (2022) examined an individual training method among 22 volleyball extracurricular participants at SMP Negeri 5 Pangkalpinang. The intervention involved individual ball-control and wall-passing exercises conducted over 16 training sessions. The students' mean forearm-passing score increased from 7.091 in the pretest to 8.545 in the posttest, while statistical analysis produced a *t*-value of 10.168, indicating significant improvement. This study demonstrated that repetitive individual practice could strengthen students' familiarity with movement patterns and improve forearm-passing performance. However, the study used a one-group pretest–posttest design without a control group and focused mainly on technical repetition. Consequently, the improvement could not be attributed exclusively to a specific physical component, and the study did not directly evaluate whether arm strengthening contributed to improved passing outcomes (Martin et al., 2022).

More specific evidence concerning the physical determinants of forearm passing was reported by Fitriningsih and Wahyudi (2026). Their study involving 15 female volleyball athletes aged 10–15 years found a strong and statistically significant relationship between arm muscle strength and underhand-passing ability. The Pearson correlation coefficient was 0.614, while the coefficient of determination indicated that arm muscle strength accounted for 52.9% of the variation in passing performance. The findings confirmed that arm strength is meaningfully associated with the ability to maintain a stable contact platform and control ball direction. Nevertheless, the correlational design did not establish that structured arm-strength intervention caused the observed differences in passing ability. The participants were also female club athletes rather than male students participating in school-based volleyball activities. These differences in research design, participant characteristics, and training context limit the direct application of the findings to students at SMP Negeri 2 Tutuyan (Fitriningsih & Wahyudi, 2026).

The available literature consequently reveals an important research gap. Some studies have demonstrated the effectiveness of general physical-conditioning programs, whereas others have examined technical passing drills or documented associations between arm strength and passing ability. However, limited research has directly tested the causal effect of a structured arm muscle strength training program on students' forearm-passing performance by comparing an intervention group with a control group. Evidence from professional, club, female, or older athlete populations cannot automatically be generalized to male junior high school students because training experience, biological development, motor competence, and instructional environments may differ substantially. Furthermore, preliminary observations at SMP Negeri 2 Tutuyan indicated that several students continued to make errors when receiving serves and returning opposing attacks. Their forearm passes were not consistently controlled or accurately directed, suggesting the need for an intervention addressing both physical capacity and functional execution of the technique.

Addressing this gap is important because weaknesses in fundamental skills may restrict students' participation, confidence, and progression in volleyball. Repeating incorrect

movement patterns without sufficient physical preparation may reinforce ineffective techniques rather than improve performance. Conversely, interventions that are too demanding or disconnected from skill requirements may provide limited practical benefits in school environments. The novelty of the present study lies in evaluating targeted arm muscle strength training as a method for improving volleyball forearm-passing ability among male students at SMP Negeri 2 Tutuyan. Unlike correlational studies, this research applies a randomized pretest–posttest control-group design to compare changes between students receiving the training program and those who do not. This design provides stronger evidence regarding whether improvements are attributable to the intervention rather than repeated testing, regular practice, or initial participant differences.

Accordingly, this study aims to determine the effect of arm muscle strength training on forearm-passing ability in volleyball among students at SMP Negeri 2 Tutuyan. Specifically, it seeks to measure students' passing ability before and after the intervention, examine the magnitude of improvement in the experimental group, and compare changes with those observed in the control group. The study is expected to contribute empirical evidence to the literature on school-based volleyball conditioning by clarifying the role of arm-strength development in fundamental ball-control skills. Practically, the findings may assist physical education teachers and volleyball coaches in designing progressive, measurable, and resource-efficient training programs suitable for adolescent learners. Students may benefit from improved arm stability, passing control, participation, and confidence, while schools may use the evidence to strengthen extracurricular volleyball development and support the identification and preparation of promising young athletes.

METHODS

The method used in this study is the "true experiment" method, a research design with reference to the experimental design, namely "*randomized control groups group pre-test and post-test design*", with the following design.

Table 1. Research Design

Groups	Pre-Test	Treatment	Post-Test
(R) A	Y1	X	Y2
(R) B	Y1	-	Y2

Description:

- A : Experimental Group
- B : Control Group
- Y1 : Initial test for two groups
- Y2 : Final test for two groups
- X : Treat with arm muscle strength training
- ® : Random

The population consisted of all 20 male Grade 11 students at SMP Negeri 2 Tutuyan. The entire population was selected as the sample and divided into two groups: an experimental group (n = 10) and a control group (n = 10). The measurement instrument used was the volleyball underhand-passing test adapted from Paturusi (2025).

Data were collected through a one-minute wall-passing test. Participants performed continuous underhand passes against a target wall according to the established test procedures. The score was calculated based on the number of successful passes that entered the target area or hit the boundary line within one minute. Each successful pass received a score of 1, whereas unsuccessful passes received a score of 0. If a participant failed to control the ball, the test was resumed by throwing the ball back toward the target area, and the subsequent pass was counted according to the test criteria. The final test score represented the total number of valid underhand passes completed during the one-minute testing period.

Data were analyzed using univariate and bivariate analyses. The hypothesis testing was conducted using an independent-samples statistical test at a significance level of $\alpha = 0.05$, preceded by analysis prerequisite tests to ensure that the data met the required assumptions (Paturusi, 2024).

RESULTS AND DISCUSSION

This study can involve two main variables, namely the free variable in the form of arm muscle strength training and the bound variable, namely the improvement of the lower pasture ability in the game of volleyball. To find out that the results of the study are a result of the variables given treatment/training, the researcher uses the control group as a controller (comparator).

Based on the data score, the results of the measurement of the variables of the lower passing ability, both *pre-test* data and *post-test data*, as well as *the gain score/difference* of the experimental group in the male students of SMP Negeri 2 Tutuyan. For more details, the following table is presented the results of the measurement of the lower passing ability in the experimental group volleyball game and the recapitulation of the numbers based on basic statistical calculations.

Table 2. Results of Lower Passing Ability Experiment

Yes	Pre-test (Y1)	Post-test (Y2)	Differences
1	33	34	1
2	28	31	3
3	38	40	2
4	27	31	4
5	36	39	3
6	29	31	2
7	32	35	3
8	35	36	1
9	30	32	2
10	34	36	2

From Table 2. The statistical magnitude of the average value and standard deviation as well as the number of pre-test results or initial observation (Y1) and post-test or final observation (Y2) of the experimental group were obtained, and with the help of *Computerization of the SPSS statistical program series 26p* the results were as follows;

Table 3. Descriptive Statistics Experimental Group

	N	Minimum	Maximum	Red	Std. Deviation
Pre_Eksp	10	27.00	38.00	32.2000	3.64539
Post_Eksp	10	31.00	40.00	34.5000	3.30824
Selisih_Eksp	10	1.00	4.00	2.3000	0.94868
Valid N (listwise)	10	-	-	-	-

Description: (X) = Mean, (Std) = Standard deviation

Furthermore, the following are presented the results of measuring the ability of the bottom passing in volleyball in the control group and the recapitulation of the numbers based on the calculation of basic statistics, as follows.

Table 4. Results of Lower Passing Ability Kel. Control

Yes	Pre-test (Y1)	Post-test (Y2)	Differences
1	37	37	1
2	26	26	0
3	29	29	2
4	33	33	-2
5	36	36	1
6	30	30	0
7	28	28	1
8	32	32	2
9	33	33	0
10	33	33	1

From Table 4. the statistical magnitude of the average value and standard deviation as well as the number of pre-test results or initial observation (Y1) and post-test or final observation (Y2) of the control group were obtained, and with the help of *Computerization of the SPSS statistical program series 26p* the results were as follows;

Table 5. Descriptive Statistics_Kelompok Control

	N	Minimum	Maximum	Red	Std. Deviation
Pre_Kntrol	10	26.00	37.00	31.7000	3.46570
Post_Kntrol	10	26.00	37.00	31.7000	3.46570
Selisih_Kntrol	10	-2.00	2.00	0.6000	1.17379
Valid N (listwise)	10	-	-	-	-

Remarks: (X) = Mean., (Sd) = Standard deviation

From the results of hypothesis testing based on calculations using t-test statistics of two independent samples, an observation t-value of $t_{ob} = 3,553$ was obtained. Meanwhile, from the table of critical values t with a real level of $\alpha = 0.05$; $n_1 + n_2 - 2$ obtained a table t-value of $t_{tab} = 1,734$. This fact shows that the value of $t_{ob} = 3,553 > t_{tab} = 1,734$, thus the null hypothesis (H_0) is rejected and an alternative hypothesis (H_a) is accepted, which states that there is an effect of arm muscle strength training on the improvement of lower passing ability in volleyball games in the students of SMP Negeri 2 Tutuyan.

Table 6. Test Results of Pre-Test and Post-Test Gain Score Differences between Experimental and Control Groups

Pre & Post score gain/difference	Stuttgart	Table ($\alpha=0.05$, n-2)
<i>Eksp and Control</i>	3.553	1,734

The value of the coefficient is very significant $t_{hit} = t_{calculate} > t_{table}$

Table 7. Descriptive Statistics of Gain Scores for the Experimental and Control Groups
One-Sample Statistics

	N	Red	Std. Deviation	Std. Error Mean
GainScore_Eksp	10	2.3000	0.94868	0.30000
GainScore_Kontrol	10	0.6000	1.17379	0.37118

Table 8. One-Sample t-Test Results of Gain Scores for the Experimental and Control Groups
One-Sample Test

Test Value = 0						
	t	df	Sig. (2-tailed)	Red Difference	95% Confidence Interval of the Difference	
GainScore_Eksp	7.667	9	0.000	2.30000	Lower 1.6214	Upper 2.9786
GainScore_Kontrol	1.616	9	0.140	0.60000	-0.2397	1.4397

In terms of testing the requirements of the analysis, especially the normality test in this study, the researcher refers to the basic concept of the purpose of testing the normality of the data is to prove whether the sample comes from a normally distributed population. Considering that the sample taken is the entire population, in this study the researcher no longer conducts a data normality testing analysis. So it can be assumed that the data obtained in each group, both the experimental group and the control group, are normally distributed so that the fulfillment of the requirements of the normality test has been met.

Likewise in the homogeneity test where the two sample groups in the *pre-test* data showed homogeneous or equal variance, this means that the two sample groups before receiving different treatments have the same initial ability, so that if there is or there is a change in the experimental group when compared to the control group solely due to the treatment or training factor, in this case it is treatment with the approach of providing arm muscle strength training.

The results of the investigation showed that there was a difference between the pre-test and post-test values of the two experimental and control groups, where for the experimental group it was seen that the average pre-test = 32,200 and post-test value = 34,500 and the average difference value = 2,300, while in the control group with the average pre-test value = 31,700 and the post-test value = 32,700 and the average difference value = 0.600. These results show that the initial condition (pre-test) and the final condition (post-test) there are changes in the training process that are different from the two experimental groups and the control group which can also be seen in the difference value (*gain score*) of the two groups. Furthermore, the

difference in the average pre-test and post-test scores as well as *the gain score* of both the experimental group and the control group can be described in the form of the following bar chart.

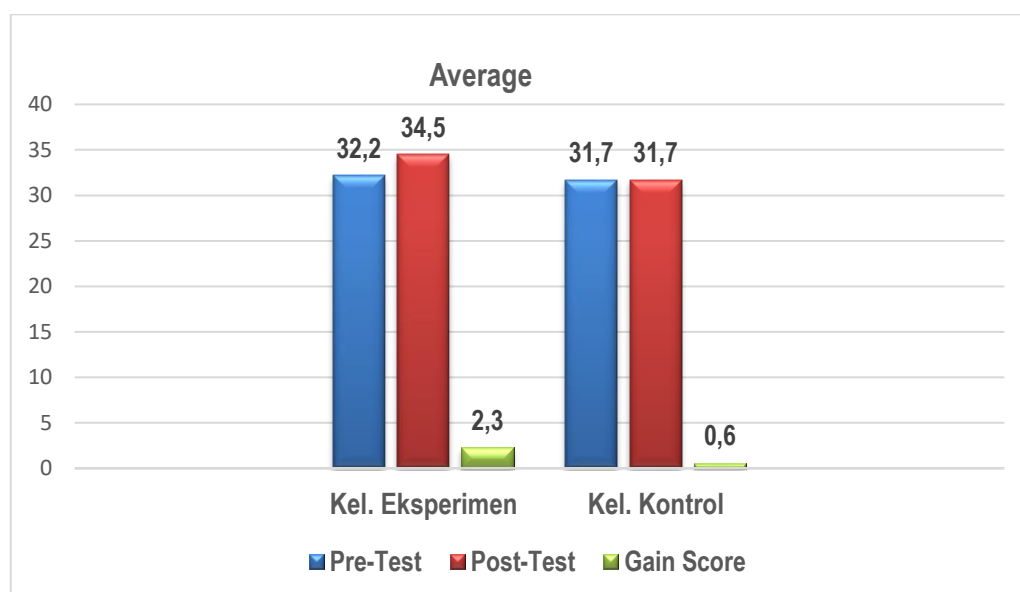


Figure 1. Pre-test & Post-test and Gain-Score of Both Groups

In relation to the process of arm muscle strength training, Harsono (2017) explained that "muscular *power* is the ability to perform explosive movements, *power* is the result of maximum multiplication with the time of execution of the movement, or the ability of a person to perform maximum force with the effort made in the shortest possible time". In another part, Suharno (1993) argues, "Explosive power is the ability of muscles to overcome load resistance with maximum strength and speed in one complete movement." Resistance strength always refers to the amount of strength of a muscle or a group of muscles in work activities. Muscle strength is also known as isometric strength or a maximum contraction against a maximum load or resistance (Gollnick et al., 1997).

As expressed by Bompa (1990), "the training process is none other than preparing athletes for the maturity of physical abilities, techniques, tactics and mentality." Considering that these factors play a role in achieving maximum achievement, it is absolutely essential to prepare athletes in various sports, both physical, technical, tactical and mental, with reference to the priority scale. In this study, the priority scale of training on arm muscle strength has an impact on the ability of the lower passing punch in the game of volleyball.

In relation to the basic technical aspects that must be mastered by a volleyball player/athlete. In practicing the basic techniques of the game of volleyball, especially the lower pass requires a special assessment of the student's physical condition, as well as the ability to perform the lower pass of the volleyball game. The uses of the volleyball bottom pass include receiving a service ball, receiving a smash ball or attack from the opponent, to take the ball after a block or bouncing ball from the net, to save the ball that bounces out away from the playing field and to take a low ball that comes suddenly. Therefore, every player/athlete must master these basic techniques (Paturusi, 2025).

Furthermore, specifically for mastering the skill of the ability of the player in the game of volleyball, is the effort or effort of a player by using a certain technique whose purpose is to pass the ball that is played to his teammates (Abdoellah, 1981). Taking the ball or passing the ball or passing the ball to a friend, but if there is a good opportunity, it is immediately forwarded to the opponent's area. Pasing is passing the ball to his teammate with a certain technique. As a first step to arrange an attack pattern to the opposing team. Pasing can be done in two ways, namely upper and lower layer.

The results in this investigation were strengthened by the difference / *gain score* between the experimental group and the control group with the achievement for *the gain score* of the experimental group was larger/higher change of $X1 = 2,300$, while the control group changed the change of $X2 = 0.600$, so this change was very measurable because in the initial condition or pre-test the two groups (experiment and control) had the same initial ability (as evidenced by the homogeneity test), while in the final condition or post-test of the two groups, where for the post-test value of the experimental group the score was higher or better than the score of the control group (as evidenced by the average value of the post-test of both groups). The following is presented the magnitude of the change in the increase of the two experimental and control groups in the form of a bar diagram.

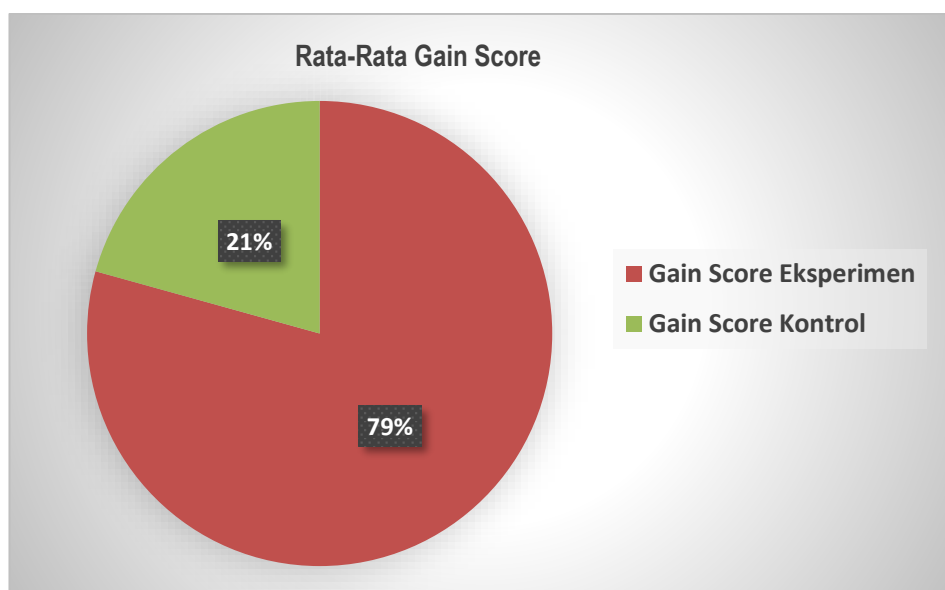


Figure 4. Circle Diagram of Gain Score Change of Both Groups

The above fact is reinforced by the results of the statistical analysis of the t-test of two independent samples, where the result of $t_{ob} = 3,553 > t_{tab} = 1,734$ so that H_0 is rejected and H_a merima which states that the average lower passing hitting ability in the experimental group given the arm muscle strength training program is greater than the average lower passing hitting ability in the control group. Thus, this means that the arm muscle strength training program given training for eight weeks with a frequency of training three times a week can have a significant effect on the improvement of the lower passing stroke ability in volleyball games in the students of SMP Negeri 2 Tutuyan.

CONCLUSION

This study concluded that arm muscle strength training significantly improved the volleyball underhand-passing ability of male students at Tutuyan Public Junior High School 2. The experimental group's mean score increased from 32.20 in the pretest to 34.50 in the posttest, with a mean gain of 2.30, compared with a gain of 0.60 in the control group. The independent-samples t-test produced an observed t-value of 3.553, which exceeded the critical value of 1.734 at the 0.05 significance level. These findings indicated that an eight-week arm muscle strength training program conducted three times per week effectively enhanced students' arm stability, ball control, and underhand-passing performance. Therefore, physical education teachers and volleyball coaches should consider integrating structured, progressive, and age-appropriate arm-strengthening exercises into school-based volleyball training programs.

Future research should involve larger and more diverse samples, including female students, participants from different schools, and athletes with varying levels of experience, to improve the generalizability of the findings. Researchers should also compare different training methods, durations, intensities, and frequencies to identify the most effective programs for improving underhand passing. Additional variables, such as hand-eye coordination, balance, arm power, movement accuracy, motivation, and technical proficiency, should be examined because passing performance is influenced by multiple factors rather than arm strength alone. Future studies could employ longer intervention periods, validated biomechanical measurements, and follow-up assessments to determine whether performance improvements are maintained after the training program concludes.

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