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The Effect of Arm Muscle Strength Training on the Forearm Passing Ability of Volleyball Players at P3B Club, Lima Puluh Kota

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Abstract

Forearm passing is a fundamental volleyball skill that requires technical proficiency and adequate physical capacity, particularly arm muscle strength. Although passing drills and technical training have been extensively studied, experimental evidence concerning arm muscle strength training among club-level volleyball players remains limited. This study examines the effect of arm muscle strength training on the forearm passing ability of volleyball players at P3B Club, Lima Puluh Kota. A quantitative pre-experimental approach using a one-group pretest–posttest design was employed. Ten male players were selected through purposive sampling. Forearm passing ability was assessed using the Brumbach Forearm Pass Wall-Volley Test, and the resulting data were analyzed using a paired-samples t-test. The mean forearm passing score increased from 29.50 at pretest to 37.60 at posttest, representing an improvement of 8.10 points. The analysis identified a statistically significant difference between the measurements, $t(9) = 25.758$, $p < .001$. These findings suggest that structured and progressive arm muscle strength training can support improved forearm passing performance, although the result should be interpreted within the limitations of a one-group pre-experimental design. The study provides preliminary empirical evidence regarding the contribution of arm strength training to technical volleyball performance at the club level. Practically, coaches are encouraged to integrate progressive arm-strengthening exercises with technical passing practice in regular training programs.

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Keywords: Arm Muscle Strength; Club-Level Players; Forearm Passing; Strength Training; Volleyball

INTRODUCTION

Sport development has an important role in improving physical fitness, personal capacity, and athletic achievement. In Indonesia, this role is formally recognized through Law of the Republic of Indonesia Number 11 of 2022 concerning Sports, which emphasizes the development of physical, mental, and social capacities as well as the achievement of sporting performance through systematic and sustainable development. Similar demands are evident in contemporary competitive sport at the international level, where athletes are expected to combine technical proficiency with appropriate physical preparation. Training theory therefore places physical conditioning, progressive adaptation, and sport-specific preparation as inseparable components of athletic development (Bompa & Buzzichelli, 2018; Kenney et al., 2019; McArdle et al., 2023). Evidence from resistance-training research also indicates that properly designed strength programs can contribute meaningfully to sport-specific performance, although their effects depend on the characteristics of the athlete, training load, and performance demands (Makaruk et al., 2024).

Volleyball represents a sport in which technical execution and physical readiness continuously interact throughout a match. The game requires players to maintain ball control while responding rapidly to serves, attacks, blocks, and transitions between defensive and offensive situations. Bumburo et al. (2023) describe volleyball as a widely accessible and enjoyable sport that has developed from recreational activity into organized competitive participation. Technical proficiency consequently becomes increasingly important as the level of competition rises. Several basic techniques, including service, passing, setting, blocking, and attacking, shape the continuity of play, but passing has a particularly important function because it frequently initiates the organization of subsequent actions (Bumburo et al., 2023; Mulyadi & Pratiwi, 2020). The quality of the first contact may determine whether a team is able to maintain possession and develop an effective attack.

Forearm passing is particularly important when players receive serves, defend against opposing attacks, and direct the ball toward the setter. Effective execution requires an appropriate starting position, stable body posture, coordinated movement of the lower and

upper body, correct forearm contact, and controlled ball direction (de Leeuw et al., 2022; Komalasari & Budi, 2024). Anatomical and movement analyses further indicate that forearm passing involves coordinated actions across several body segments rather than isolated movement of the arms. Valensi et al. (2024) emphasize the contribution of anatomical, physiological, and biomechanical components to the execution of this skill. Players who cannot consistently establish a stable contact platform may experience difficulty controlling ball trajectory, especially when receiving balls with different speeds and directions. Passing proficiency therefore reflects not only knowledge of the technique but also the physical capacity to reproduce the movement accurately under changing game situations.

Arm muscle strength represents one of the physical components that may support this technical execution. Strength enables muscles to generate and control force during movement, while appropriate conditioning allows athletes to maintain movement quality under repeated demands (Herlina & Irawan, 2019; Kraemer & Fleck, 2007). During forearm passing, the arms and shoulders contribute to maintaining the forearm platform and controlling the impulse transferred to the ball, while trunk stability supports the organization of the movement as a whole. Resistance-training principles suggest that muscular adaptation is best developed through structured stimuli that are gradually adjusted according to the athlete's capacity (Bompa & Buzzichelli, 2018; Schoenfeld, 2021; Stone et al., 2007). A strength program for volleyball players therefore should not merely increase exercise volume, but should consider movement quality, progressive overload, recovery, and the specific physical requirements of volleyball skills.

The condition observed among players at P3B Volleyball Club in Lima Puluh Kota provides a practical reason for examining this relationship more closely. P3B is a community volleyball club established in Jorong Padang Batang Korong Bukik Tongah, Mungka District, and has participated in volleyball development and competition for many years. Field observations during training sessions and matches showed that several players still experienced difficulties in performing consistent forearm passes. Errors were visible in service reception, ball-direction accuracy, body positioning, forearm contact, and control of the resulting pass. Some movements also appeared hurried and insufficiently coordinated, causing the ball to deviate from the intended target. The existing training process had not consistently placed specific and structured emphasis on arm muscle strength development, even though physical conditioning is an important element of sport preparation (Harsono,

2017). These conditions suggest that technical repetition alone may not fully address the difficulties experienced by the players.

Previous studies have demonstrated that forearm passing can be improved through different forms of training. Herlina & Irawan (2019), for example, reported that a play-based training method improved volleyball forearm passing performance. Martin et al. (2022)) similarly found that individual training contributed to improved forearm passing skills among students participating in volleyball extracurricular activities. Lumbantoruan & Hadinoto (2024) reported improvement following variations of passing exercises among club athletes, while Rahmayudi (2025) showed that participation in organized volleyball extracurricular activities was associated with better basic forearm passing performance. These findings confirm the importance of structured practice, yet most of these studies primarily emphasize technical practice, instructional arrangements, or participation in volleyball activities rather than examining a physical conditioning intervention specifically designed to strengthen the upper extremities.

Studies addressing physical determinants provide further evidence that strength deserves specific attention. Ishak et al. (2023) identified arm strength as one of the physical characteristics associated with underhand passing performance, together with leg strength and flexibility. More recent evidence from Febrio et al. (2025) showed a significant direct contribution of arm muscle strength to underhand passing performance, alongside hand–eye coordination and concentration. Research on elite volleyball also indicates that training load and strength-training characteristics are related to match performance, suggesting that physical preparation should be carefully aligned with the demands faced by players (de Leeuw et al., 2022). These findings support the theoretical relationship between physical capacity and passing performance, but correlational evidence cannot fully establish whether systematically increasing arm muscle strength produces a meaningful improvement in forearm passing ability.

The distinction between the present study and previous research lies in its intervention-oriented approach. Existing studies have largely examined passing drills, learning methods, extracurricular participation, or statistical relationships between physical attributes and passing outcomes. Evidence remains comparatively limited regarding the direct effect of a structured arm muscle strength program on forearm passing performance among community-based volleyball club players. The present intervention incorporates

exercises such as *wall push-ups, push-ups, planks, dips, pull-ups, burpees,* and ball throwing and catching, organized according to progressive training principles. Progressive overload allows training demands to be adjusted gradually through changes in repetitions, sets, intensity, recovery periods, duration, and exercise difficulty (Bompa & Buzzichelli, 2018; Schoenfeld, 2021; Stone et al., 2007). The inclusion of several complementary exercises is intended not only to develop the muscles of the arms and shoulders but also to support trunk stability, movement coordination, and controlled force production required during forearm passing. This intervention therefore provides a more specific examination of how physical conditioning can be integrated with the technical demands of volleyball.

The present study is consequently focused on determining whether structured arm muscle strength training can improve the forearm passing ability of players at P3B Volleyball Club, Lima Puluh Kota. The study responds to an observed performance problem within an actual club-training environment while also addressing the limited experimental evidence connecting progressive upper-body strength conditioning directly with forearm passing performance. The findings are expected to provide empirical information for coaches when designing training programs that balance technical repetition with relevant physical preparation. Accordingly, this study aims to examine the effect of arm muscle strength training on the forearm passing ability of volleyball players at P3B Club, Lima Puluh Kota.

METHODS

This study employed a quantitative approach using a pre-experimental method to examine the effect of arm muscle strength training on the forearm passing ability of volleyball players at P3B Club, Lima Puluh Kota. Experimental research is appropriate when the researcher intends to determine the effect of a particular treatment on another variable under controlled conditions (Sugiyono, 2022). Fraenkel et al. (2019) also explain that experimental research is designed to investigate causal relationships by administering a treatment and observing the resulting changes. A one-group pretest–posttest design was applied, represented as O_1–X–O_2, in which the participants completed an initial forearm passing test, received an arm muscle strength training intervention, and subsequently completed a final test. No control group was included; therefore, the effect of the intervention was examined by comparing participants' pretest and posttest scores. The study was conducted from May to June 2026 at the P3B Volleyball Club court in Lima Puluh Kota.

The population consisted of 18 male players registered with P3B Volleyball Club. Ten players were selected through purposive sampling based on predetermined inclusion criteria. Purposive sampling allows participants to be selected according to specific characteristics that are considered relevant to the objectives of a study (Etikan et al., 2016; Sugiyono, 2022) . Eligible participants were active club members aged 18–22 years, had trained regularly at least three times per week, had been members of the club for at least one year, were willing to participate in the entire research process, were physically able to undertake the training program, and were not participating in another specialized training program that could influence arm muscle strength. Forearm passing ability was measured using the Brumbach Forearm Pass Wall-Volley Test adapted from (Cox, 1980). Participants performed as many valid forearm passes as possible against a marked wall during a one-minute testing period. Before the main test, each participant completed a 20-second familiarization trial. Three test attempts were then administered, with the two highest scores averaged to obtain the final score. The instrument has a reported validity coefficient of 0.80 and a reliability coefficient of 0.89.

Data collection was conducted in three stages: pretest, treatment, and posttest. The pretest was administered on the first day to establish participants' initial forearm passing ability. The intervention consisted of 16 arm muscle strength training sessions conducted over a 35-day period, with four sessions per week on Monday, Tuesday, Thursday, and Saturday. The training program was arranged systematically and progressively and included exercises intended to strengthen the arms and supporting muscle groups. Following completion of the 16 training sessions, the posttest was administered on day 35 using the same forearm passing instrument. The pretest and posttest scores were subsequently analyzed to determine whether a significant improvement occurred after the intervention. A normality test was first conducted to determine whether the data met the assumptions for parametric analysis. The hypothesis was then tested using a paired-samples *t*-test by comparing the mean difference between the pretest and posttest scores at $df = N - 1$.

RESULTS

1. Forearm Passing Performance Before and After Arm Muscle Strength Training

The study involved 10 male volleyball players from P3B Club, Lima Puluh Kota, who completed the entire research procedure, including the pretest, 16 arm muscle strength

training sessions, and the posttest. Forearm passing ability was assessed using the *Brumbach Forearm Pass Wall-Volley Test*. The pretest was administered before the training intervention to establish the players' initial performance, whereas the posttest was conducted after all training sessions had been completed.

The descriptive results showed a clear increase in forearm passing performance after the intervention. As presented in Table 1, the pretest scores ranged from 27 to 32, with a mean of 29.50 and a standard deviation of 1.58. Following the 16-session arm muscle strength training program, the posttest scores ranged from 36 to 41, with a mean of 37.60 and a standard deviation of 1.71. The difference between the pretest and posttest means was 8.10 points. Individual score comparisons also showed that all 10 participants achieved higher scores in the posttest than in the pretest, with individual improvements ranging from 7 to 9 points. These results indicate a consistent improvement in forearm passing performance across the participants after the training period.

Table 1. Descriptive Statistics of Pretest and Posttest Forearm Passing Scores

Measurement	N	Minimum	Maximum	Mean	SD	Mean Increase
Pretest	10	27	32	29.50	1.58	–
Posttest	10	36	41	37.60	1.71	8.10

The relatively small standard deviations in both measurements indicate that the participants' scores were distributed fairly close to their respective means. The pretest standard deviation of 1.58 suggests that the participants entered the intervention with relatively comparable levels of forearm passing ability. A similar pattern was observed in the posttest, where the standard deviation was 1.71. Although the overall mean increased substantially, the distribution of posttest scores remained relatively compact, showing that the improvement was not restricted to only a small number of players.

2. Normality Test

Prior to hypothesis testing, the normality of the pretest and posttest data was examined using the Shapiro–Wilk test because the study involved a relatively small sample (N = 10). The criterion used was a significance level of .05, whereby a significance value greater than .05 indicated that the data did not significantly deviate from a normal distribution. The results are presented in **Table 2**.

Table 2. Shapiro–Wilk Normality Test for Pretest and Posttest Scores

Data	N	Sig.	Interpretation
Pretest	10	.849	Normally distributed
Posttest	10	.074	Normally distributed

As shown in **Table 2**, the pretest produced a significance value of .849, while the posttest yielded a significance value of .074. Both values exceeded the .05 significance threshold. The pretest and posttest data were therefore considered normally distributed. This result satisfied the normality assumption required for subsequent parametric analysis using a paired-samples *t*-test.

3. Effect of Arm Muscle Strength Training on Forearm Passing Ability

A paired-samples *t*-test was conducted to determine whether the difference between the pretest and posttest scores was statistically significant. This analysis compared the forearm passing performance of the same participants before and after the 16-session arm muscle strength training program. The hypothesis-testing results are presented in **Table 3**.

Table 3. Paired-Samples t-Test of Pretest and Posttest Forearm Passing Scores

Comparison	Pretest Mean	Posttest Mean	Mean Difference	t	df	p
Pretest–Posttest	29.50	37.60	8.10	25.758	9	< .001

Table 3 shows that the paired-samples *t*-test produced a *t* value of 25.758 with 9 degrees of freedom and a significance value below .001. Since the probability value was lower than the predetermined significance level of .05, the null hypothesis was rejected and the research hypothesis was supported. A statistically significant difference was therefore found between the players' forearm passing scores before and after the arm muscle strength training program.

The empirical pattern was also evident from the increase in the mean score from 29.50 in the pretest to 37.60 in the posttest, representing an average improvement of 8.10 points. No participant recorded a lower posttest score than pretest score. Taken together, the descriptive and inferential findings demonstrate a significant within-group improvement in forearm passing ability following the 16-session arm muscle strength training program among volleyball players at P3B Club, Lima Puluh Kota.

DISCUSSION

The findings indicate that forearm passing performance improved after the players completed the arm muscle strength training program. The mean score increased from 29.50 in the pretest to 37.60 in the posttest, representing an average improvement of 8.10 points. The paired-samples *t*-test also showed a statistically significant difference between the two measurements, $t(9) = 25.758$, $p < .001$. These results suggest that the players demonstrated better forearm passing performance following the 16-session training program. Given the one-group pretest–posttest design used in this study, the improvement should be interpreted as a significant within-group change associated with the intervention rather than as definitive evidence that the training program was the sole cause of the improvement.

The increase in passing performance can be understood from the physical demands involved in performing a forearm pass. Successful forearm passing requires players to establish a stable contact platform, control the direction of the ball, and coordinate the arms with the shoulders, trunk, and lower body. Arm muscle strength contributes to the ability to maintain stability during ball contact and regulate the force transferred to the ball. Bompa & Buzzichelli (2018) explain that muscular strength constitutes an important component of physical conditioning that supports the efficient execution of sport-specific techniques. Kenney et al. (2019) similarly emphasize that improvements in muscular capacity contribute to force production, movement stability, and the efficiency with which athletes perform physical tasks. The increase observed in the present study therefore indicates that strengthening the muscles involved in the passing movement may have supported players in controlling the ball more consistently.

Neuromuscular adaptation provides another explanation for the observed improvement. Strength training does not merely increase the capacity of the muscles to generate force; repeated and structured exercise can also improve motor-unit recruitment, coordination, and control of movement. Schoenfeld (2021) notes that systematically programmed resistance training promotes neuromuscular adaptations that contribute to improved force production and movement efficiency. The intervention in the present study included exercises such as *wall push-ups, push-ups, planks, dips, pull-ups, burpees,* and ball throwing and catching. These exercises involved the arms, shoulders, chest, and supporting trunk musculature while also requiring coordination and body control. Such characteristics are

relevant to forearm passing because the technique depends on maintaining an appropriate body position while controlling the direction and rebound of the ball.

The findings are also consistent with previous research suggesting that physical capacity and structured training are associated with volleyball passing performance. Herlina & Irawan (2019) reported that systematic training improved players' forearm passing ability, although their intervention emphasized a play-based training method rather than a specific strength program. Studies focusing on physical characteristics have provided complementary evidence. Ishak et al. (2023) identified arm strength as one of the physical attributes associated with underhand passing performance, while Febrio et al. (2025) reported a direct contribution of arm muscle strength to underhand passing performance alongside other factors such as hand–eye coordination and concentration. These findings support the present result by indicating that forearm passing should not be viewed exclusively as a technical skill but as an outcome influenced by the interaction between technical proficiency and physical capacity.

The present findings also extend earlier studies by examining arm muscle strength through an intervention rather than merely through correlational analysis. Previous research has frequently investigated passing drills, instructional methods, or the relationship between physical characteristics and passing outcomes. The current study provides additional empirical evidence from a club-based training environment in which players received a structured physical conditioning program over 16 sessions. This distinction is important because identifying a relationship between arm strength and passing performance does not necessarily demonstrate that strengthening exercises will improve the skill. The observed increase from the pretest to the posttest suggests that systematically incorporating upper-body strength training into regular volleyball practice may be beneficial for players whose passing performance is limited by physical readiness.

Progressive and consistent training may also have contributed to the improvement. Stone et al. (2007) argue that resistance training is most effective when training demands are systematically manipulated to allow adaptation while maintaining appropriate recovery. Bompa & Buzzichelli (2018) similarly emphasize progressive overload as an important principle in athletic training. The intervention used in this study was arranged progressively across 16 sessions, allowing players to repeatedly experience physical stimuli while gradually adapting to the demands of the exercises. Such a training structure may have improved not

only muscular strength but also players' familiarity with controlled upper-body movement. This combination is particularly relevant in volleyball because excessive force is not always desirable during forearm passing; players must instead regulate force accurately according to the speed and direction of the incoming ball.

From a practical perspective, the findings suggest that volleyball coaches should consider integrating physical conditioning with technical training rather than treating the two components separately. Passing practice remains essential for developing appropriate body position, ball contact, accuracy, and decision-making, but technical repetition may be less effective when the supporting physical capacities are insufficient. An arm-strength program can therefore be positioned as a complementary component of forearm passing development. Coaches at community and developmental clubs may employ exercises such as *push-ups, dips, planks,* and controlled ball-throwing activities as part of a progressive program, provided that the exercises are adapted to players' age, training status, and physical readiness. Such integration may help players maintain a more stable passing platform and perform the technique more consistently during training and competition.

Several limitations should be considered when interpreting these findings. First, the study involved only 10 male players from P3B Volleyball Club, Lima Puluh Kota, which limits the extent to which the findings can be generalized to volleyball players with different ages, competitive levels, or training backgrounds. Second, the pre-experimental one-group pretest–posttest design did not include a control group. Consequently, improvements between the two measurements cannot be attributed exclusively to the arm muscle strength intervention because other influences, including regular volleyball practice, learning effects, or natural performance variation, may also have contributed. Third, the intervention consisted of 16 training sessions, and this duration may not represent the effects of longer-term strength development. Fourth, external factors such as additional physical activity, daily fitness condition, sleep, motivation, and nutritional intake were not fully controlled. Finally, forearm passing performance was measured only with the *Brumbach Forearm Pass Wall-Volley Test*. Although the instrument provides a standardized measure of passing performance, it does not fully represent the complex demands of passing during actual match situations. Future studies should therefore employ larger samples, include control or comparison groups, extend the intervention period, and combine standardized passing tests with game-based performance measures to provide stronger evidence regarding the contribution of arm muscle strength training to volleyball performance.

CONCLUSION

Based on the research findings and discussion, arm muscle strength training was associated with a significant improvement in the forearm passing ability of volleyball players at P3B Club, Lima Puluh Kota. The mean pretest score of 29.50 increased to 37.60 in the posttest, indicating an average improvement of 8.10 points after the completion of the 16-session training program. The paired-samples *t*-test showed a significance value of $p < .001$, confirming a statistically significant difference between the pretest and posttest scores. These findings indicate that a structured and progressive arm muscle strength training program can support the development of forearm passing performance when integrated into regular volleyball training.

The findings provide practical implications for coaches and players, particularly in designing training programs that combine technical practice with appropriate physical conditioning. Arm muscle strength exercises may be incorporated into routine training to support more stable, controlled, and accurate forearm passing performance. Future studies are recommended to involve larger samples, include a control group, extend the duration of the intervention, and examine other physical components such as leg strength, upper-body power, hand eye coordination, and agility. Further research may also combine standardized passing tests with game-based performance measures to provide a broader understanding of how physical conditioning contributes to volleyball skill development.

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