Gorontalo Sport Science, (2026)
ISSN (e): 2807-1344
Vol 6 No 1, May 2026, page (1-15)
https://journal.umgo.ac.id/index.php/gss

Effect of Push-Up Training on Overhead Passing Ability in Volleyball Among Eighth-Grade Students at SMP Negeri 02 Paguyaman

Adi Iswanto Tamu[1ABCDEF*], Giofandi Samin[2ABCDE], Iwan Fataha[3ABCDE] and Ardin Abdul Gani[4ABCD]

[1,2,3,4] **Universitas Muhammadiyah Gorontalo**

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Adi Iswanto Tamu, e-mail: aditamu19@gmail.com
Accepted for Publication: February 15, 2026
Published: March 8, 2026

DOI: http://dx.doi.org/10.31314/gss.v6i1.5514

Abstract

Volleyball is one of the most widely taught sports in school physical education programs, and overhead passing is a fundamental skill that requires adequate upper-body strength and coordination. This study aimed to examine the effect of push-up training on students' overhead passing ability in volleyball. The research employed an experimental approach using a one-group pre-test–post-test design. The participants consisted of 44 eighth-grade students from SMP Negeri 2 Paguyaman. Data were collected using an overhead passing skill test administered before and after an 18-session push-up training program conducted three times per week. Descriptive statistics, normality testing, homogeneity testing, and paired sample t-tests were used to analyze the data. The results showed that the mean overhead passing score increased from 7.35 in the pre-test to 10.39 in the post-test. Statistical analysis revealed a significant improvement in passing performance ($t = 32.43$, $p < 0.05$). These findings indicate that push-up training effectively improves upper-body strength and contributes to better execution of overhead passing techniques. The improvement is likely related to enhanced arm power, shoulder stability, and neuromuscular coordination, which support accurate ball control during passing actions. The study suggests that simple bodyweight strength exercises such as push-ups can be effectively integrated into school volleyball instruction to improve technical performance and support students' physical development.

Keywords : *push-up training; overhead passing; volleyball skill development; physical education training; upper-body strength.*

Introduction

Volleyball is widely recognized as one of the most popular sports incorporated into school-based physical education programs. In many educational systems, volleyball is used not only to promote physical fitness but also to develop students' coordination, teamwork, and motor skills. The successful execution of volleyball gameplay depends heavily on the mastery of fundamental technical skills, including serving, passing, setting, attacking, and blocking. Among these, overhead passing represents a foundational technical action that enables players to control the ball and organize offensive plays. The effectiveness of overhead passing is closely linked to biomechanical coordination, neuromuscular control, and upper-body strength, all of which contribute to the quality and accuracy of ball distribution during play (Rustiawan

et al., 2024; Zhou, 2023; Rahayu et al., 2024). Consequently, developing overhead passing skills among school-aged students is a crucial objective within physical education curricula.

From a motor learning perspective, the performance of overhead passing relies on an integrated combination of technical execution and physical conditioning. The movement requires coordinated activation of the shoulder complex, elbow extension, and wrist control, accompanied by stable trunk positioning and visual coordination with the ball trajectory. Research has indicated that arm power and eye–hand coordination significantly influence the effectiveness of overhead passing performance (Rustiawan et al., 2024). Furthermore, physical conditioning programs that enhance muscular strength, balance, and neuromotor control can accelerate skill acquisition and improve technical consistency among adolescent learners (Hammami et al., 2021; Gao et al., 2025). These findings highlight that the development of volleyball skills in school contexts should not rely solely on technical drills but should also incorporate conditioning elements that support the physical demands of the skill.

Despite the recognized importance of overhead passing, many students in school-based volleyball instruction encounter difficulties in performing this technique accurately and consistently. Observations in physical education classes frequently reveal that students struggle to generate sufficient force and stability during overhead passing movements. These limitations are often associated with insufficient upper-body strength, poor coordination, and limited exposure to structured physical conditioning activities. As a result, students may fail to direct the ball effectively toward teammates or maintain the continuity of gameplay. Such limitations can hinder not only individual skill development but also the overall effectiveness of team-based learning activities in volleyball instruction.

To address these challenges, educators and sports scientists have emphasized the importance of integrating physical conditioning with technical skill training. Conditioning programs that improve strength, balance, and coordination can provide the physical foundation required for executing volleyball techniques effectively. Studies have shown that conditioning interventions, including functional strength training and balance exercises, can enhance neuromuscular control and movement efficiency in youth volleyball players (Hammami et al., 2021; Gao et al., 2025). When these physical attributes improve, students are better able to stabilize their body posture, coordinate limb movements, and generate the necessary force to perform technical skills such as overhead passing.

Previous research has explored various approaches to strengthening the physical capacities underlying volleyball skills. Functional and multi-joint strength training programs have demonstrated positive effects on volleyball performance by improving power generation, agility, and overall athletic readiness (Gao et al., 2025). Similarly, training models that combine technical practice with strength-oriented tasks have been shown to enhance passing-related actions among young volleyball players (Smolyuk et al., 2023; Faihan, 2025). These studies suggest that conditioning exercises aligned with volleyball movement patterns can improve the transfer of physical capacity to technical performance on the court.

Another line of research highlights the importance of contextualized training methods that integrate conditioning with skill practice. Game-like training environments and small-sided drills have been reported to accelerate skill acquisition by promoting perceptual–motor coupling and decision-making during play (Risma et al., 2025; Iqbal et al., 2025). Furthermore, balance and neuromuscular conditioning programs can improve dynamic stability and movement control, which are essential for precise ball handling and passing accuracy (Hammami et al., 2021). Together, these findings suggest that volleyball skill development benefits from training strategies that combine physical conditioning with technical practice in meaningful learning contexts.

However, despite the growing body of literature on conditioning and volleyball performance, several challenges remain in school-based physical education programs. Schools

often face limitations in terms of equipment, space, and training time, which restrict the implementation of complex strength-training programs. Moreover, students in junior secondary schools typically exhibit considerable variability in physical maturity and motor ability, making it difficult to standardize training approaches (Doroshenko et al., 2022; Nagovitsyn et al., 2020). As a result, there is a need for training methods that are simple, accessible, and easily implemented within the constraints of school environments while still contributing to the improvement of technical volleyball skills.

One practical approach that has the potential to address these limitations is the incorporation of bodyweight strength exercises into volleyball training programs. Among such exercises, push-ups represent a widely used and accessible method for developing upper-body strength. Push-up training primarily targets the chest muscles, shoulder stabilizers, triceps, and core musculature, all of which contribute to upper-body stability and force generation during overhead passing movements. Because push-ups require minimal equipment and can be performed in various settings, they are particularly suitable for school-based physical education programs where resources may be limited.

Despite the potential relevance of push-up training for volleyball skill development, empirical research directly examining its influence on overhead passing performance among junior secondary school students remains limited. Many existing studies focus either on advanced athletes or on broader conditioning strategies rather than on simple bodyweight exercises integrated into school-based instruction. This gap highlights the need for empirical investigation into whether a structured push-up training program can contribute to improvements in overhead passing ability among adolescent learners.

Therefore, the present study aims to examine the effect of push-up training on overhead passing ability in volleyball among junior secondary school students. The study is based on the hypothesis that strengthening the upper-body musculature through push-up exercises can enhance the stability, force production, and coordination required for effective overhead passing. By evaluating the outcomes of a structured push-up training intervention, this research seeks to provide evidence-based insights into a practical and low-cost training approach that can be implemented within physical education programs to support the development of fundamental volleyball skills.

Materials and methods

Research Design

This study employed an experimental research approach to examine the effect of push-up training on students' overhead passing ability in volleyball. Experimental methods are widely used in sports education research to evaluate the causal impact of instructional or conditioning interventions on athletic performance and skill development. In educational settings where randomization may be difficult to implement, researchers frequently adopt a one-group pretest–posttest design to assess the change in performance before and after a specific training intervention (Apidogo et al., 2021; Rahayu et al., 2024; Feryantono et al., 2024). Following this approach, the present study utilized a one-group pretest–posttest experimental design in which participants completed an initial performance assessment, received a structured push-up training intervention, and subsequently completed a posttest evaluation. The structure of the experimental design followed the sequence of Pretest–Treatment–Posttest. During the pretest stage, students' initial overhead passing ability was measured using a standardized volleyball passing assessment. The treatment phase consisted of a structured push-up training program designed to strengthen the upper-body musculature relevant to overhead passing performance. After the intervention period, a posttest was conducted using the same testing procedures as the pretest to evaluate performance improvements. This design allows researchers to compare changes in performance within the

same group of participants and determine whether the intervention produced measurable effects on volleyball passing ability.

Population and Sample

The population of this study consisted of all eighth-grade students enrolled at SMP Negeri 2 Paguyaman. In total, the population included 52 students who participated in the physical education program during the academic year in which the research was conducted. School-based sports education studies often rely on intact class populations because students participate in physical education activities as part of their regular curriculum (Aini et al., 2021; Rahayu et al., 2024). From this population, a sample of 44 students was selected to participate in the experiment. The sample represented students who were actively involved in the volleyball learning activities conducted within the physical education curriculum. The selection of a student sample from the same grade level ensured a relatively homogeneous group in terms of age, educational background, and exposure to volleyball instruction. Such homogeneity is important in school-based experimental studies because differences in developmental stage and prior sport experience can influence skill acquisition outcomes. By focusing on students from the same grade cohort, the study aimed to minimize variability that might otherwise confound the effects of the training intervention.

Research Variables

The research investigated two main variables. The independent variable was the push-up training program implemented during the treatment phase of the experiment. Push-up exercises are widely used as a bodyweight training method to develop upper-body muscular strength, particularly targeting the pectoral muscles, triceps, shoulder stabilizers, and core musculature. Strength development in these muscle groups is considered essential for supporting the force production and body stability required during overhead passing actions (Rustiawan et al., 2024; Gao et al., 2025). The dependent variable in this study was the students' overhead passing ability in volleyball. Overhead passing is a fundamental technical skill used to control the ball and organize offensive play. The quality of this skill is influenced by factors such as arm power, coordination, and neuromuscular control, making it a relevant indicator for evaluating the effectiveness of strength-based training interventions in volleyball education (Rustiawan et al., 2024).

Research Instruments

Data on overhead passing ability were collected using a volleyball overhead passing skill test. Measurement protocols for volleyball passing performance commonly involve accuracy-based assessments in which participants perform repeated overhead passes toward a target area such as a wall or designated zone (Salamanang & Hakim, 2025; Widodo et al., 2025). These testing procedures are widely used in school-based research because they provide practical, reliable, and valid measurements of passing accuracy and control under standardized conditions. During the test, each participant performed a series of overhead passes according to predetermined instructions. The number of successful passes that met the scoring criteria was recorded as the participant's performance score. The same instrument and scoring procedures were used in both the pretest and posttest phases to ensure measurement consistency and to allow direct comparison of results before and after the intervention.

Training Procedure

The experimental intervention consisted of a structured push-up training program implemented during physical education sessions. Push-up exercises were selected because they represent a practical and accessible form of strength training that can be easily incorporated into school-based sports instruction without requiring specialized equipment. Previous research has highlighted that integrating strength conditioning with technical skill training can

enhance performance outcomes in volleyball players by improving the physical capacities that support technical execution (Gao et al., 2025; Doroshenko et al., 2022). The training program was conducted three times per week and consisted of a total of eighteen training sessions. Each training session was incorporated into the physical education learning activities and supervised by the instructor to ensure correct exercise technique and safe participation. Throughout the intervention period, students performed push-up exercises according to a structured progression designed to stimulate upper-body muscular adaptation while maintaining appropriate workload for adolescent participants. Following the completion of the training program, a posttest was administered using the same overhead passing assessment as the pretest. The purpose of the posttest was to measure any improvements in passing performance resulting from the push-up training intervention.

Data Analysis

The collected data were analyzed using a paired-sample t-test to determine whether significant differences existed between the pretest and posttest scores. The t-test is commonly applied in experimental sports education research to evaluate changes in performance outcomes following training interventions (Apidogo et al., 2021; Rahayu et al., 2024). By comparing the mean scores obtained before and after the intervention, the statistical analysis allowed the researchers to determine whether push-up training produced a significant improvement in students' overhead passing ability. The level of significance for the statistical test was set at the conventional threshold used in educational and sports science research. If the calculated t-value exceeded the critical value from the t-distribution table, the null hypothesis was rejected, indicating that the push-up training program had a statistically significant effect on volleyball overhead passing performance.

Results

The present study examined the effect of a push-up training program on students' overhead passing ability in volleyball. The training program was implemented with students of class VIII at SMP Negeri 2 Paguyaman. The effectiveness of the program was evaluated using a one-group pre-test–post-test design in which students' passing performance was measured before and after the push-up training intervention. The evaluation focused on the improvement of overhead passing ability as the dependent variable, while push-up training served as the independent variable.

Results of the Pre- and Post-Test Descriptive Statistics

Table 1 presents a summary of the descriptive statistics for the pre-test and post-test results of students' overhead passing ability. The table summarizes the number of participants, minimum and maximum scores, mean values, standard deviations, and variances obtained before and after the implementation of the push-up training program. Descriptive statistics are used to illustrate the general distribution of performance data and to show the magnitude of change that occurred following the intervention.

Table 1. Descriptive Statistics of Overhead Passing Results

Group	Variable	N	Minimum	Maximum	Mean	Std. Dev	Variance
Experimental Group	Passing Pre-test (score)	44	5	12	7.35	1.67	2.7839
Experimental Group	Passing Post-test (score)	44	7	15	10.39	1.87	3.5047

The results presented in Table 1 show that students' overhead passing ability improved after participating in the push-up training program. The mean score increased from 7.35 ± 1.67 during the pre-test to 10.39 ± 1.87 during the post-test. In addition, the minimum score

increased from 5 to 7, while the maximum score increased from 12 to 15. These results indicate that students demonstrated better passing performance after completing the training program.

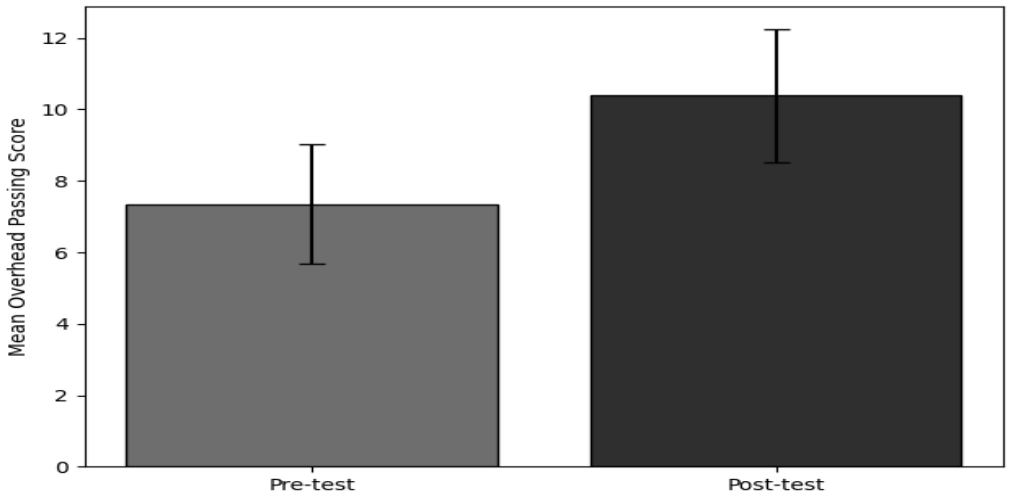


Figure 1. Comparison of the mean overhead passing scores between pre-test and post-test measurements. Students who participated in the push-up training program showed a clear improvement in passing performance after the intervention (*p < 0.05). Data are presented as mean values with standard deviations.

Table 1 and Figure 1 show that the overhead passing performance of the students improved after the implementation of the push-up training program. The increase in the mean score from 7.35 to 10.39 indicates that students were able to perform more accurate and controlled overhead passes following the training intervention. This improvement reflects the contribution of upper-body strength development to volleyball technical performance, particularly in executing overhead passing movements.

Testing for Normality in Pre- and Post-Test Data

Before conducting hypothesis testing, a normality test was carried out to determine whether the pre-test and post-test data followed a normal distribution. The Liliefors test was used to evaluate the normality of the data distribution.

Table 2. Normality Test Results

Variable	Lcount	Ltable	Conclusion
Passing Pre-test	0.0107	0.886	Normal
Passing Post-test	0.0107	0.886	Normal

The results indicate that the calculated L value (0.0107) was smaller than the critical value in the Liliefors table (0.886) at the significance level $\alpha = 0.05$ with a sample size of 44. Because the calculated value was smaller than the table value (Lcount ≤ Ltable), the data were considered normally distributed. This result indicates that the dataset satisfies the assumptions required for parametric statistical testing.

Homogeneity Test

A homogeneity test was conducted to determine whether the variance of the pre-test and post-test data was homogeneous. The test was performed using the F-test method by comparing the largest variance with the smallest variance.

Table 3. Homogeneity Test Results

Variable	Variance	Fcount	Ftable	Conclusion
Pre-test	2.7839	1.2589	2.61	Homogeneous
Post-test	3.5047			

The results show that the calculated F value was 1.2589, while the critical F value at the significance level $\alpha = 0.05$ with degrees of freedom (43, 43) was 2.61. Because the calculated value was smaller than the critical value (Fcount ≤ Ftable), the data were considered homogeneous. Therefore, the variance of the pre-test and post-test data was assumed to be equal.

Paired t-Test Results

A paired sample t-test was conducted to determine whether the push-up training program significantly improved students' overhead passing ability.

Table 4. Paired t-Test Results

Variable	Mean Difference	t	df	Sig. (2-tailed)
Passing Pre-test – Passing Post-test	3.02	32.43	43	0.000

The results show that the calculated t value was 32.43, while the critical t value at the significance level $\alpha = 0.05$ with degrees of freedom (df = 43) was 1.684. Because the calculated t value was significantly greater than the critical value (32.43 > 1.684), the null hypothesis was rejected and the alternative hypothesis was accepted.

These findings indicate that the push-up training program had a statistically significant effect on improving students' overhead passing ability. The mean difference between the pre-test and post-test scores was 3.02, indicating that students experienced a measurable improvement in their volleyball passing performance after participating in the push-up training program.

Discussion

The findings of this study demonstrate that the implementation of a push-up training program significantly improved students' overhead passing ability in volleyball. As shown in Table 1 and Figure 1, the mean passing score increased from 7.35 ± 1.67 in the pre-test to 10.39 ± 1.87 in the post-test, indicating a substantial improvement in technical performance after the intervention. Statistical analysis using a paired sample t-test revealed a significant difference between pre-test and post-test results ($t = 32.43$; $p < 0.05$), confirming that the push-up training program had a meaningful impact on students' passing ability. These results suggest that the improvement in passing performance was associated with enhanced upper-body muscular strength, particularly in the arms and shoulders. Push-up exercises primarily target the pectoralis major, triceps brachii, and shoulder stabilizing muscles, which play an essential role in generating the force required for overhead passing. Previous research indicates that upper-body strength contributes to improved ball control, passing stability, and the ability to maintain accurate ball trajectories during volleyball actions (Faisal et al., 2025; Zhao et al., 2023; Pashaei et al., 2022). Therefore, the significant increase in post-test scores observed in this study can be interpreted as evidence that strength development supports the execution of volleyball technical skills.

Overhead passing in volleyball requires a coordinated movement pattern involving arm propulsion, wrist control, and body stability. Effective execution of this technique depends on the ability to transfer force through the kinetic chain from the lower body and trunk to the upper limbs. Strengthening the muscles involved in this movement enhances the efficiency of energy transfer, which contributes to greater control and accuracy during the passing motion. Studies in volleyball biomechanics have demonstrated that upper-body strength plays a critical role in stabilizing the shoulder girdle and enabling precise ball direction during overhead passes (Hua et al., 2023; Nunes et al., 2021; Zhou, 2023). Push-up training contributes directly to these biomechanical components by strengthening the arm extensors, shoulder stabilizers, and core muscles that support body balance. As a result, students who participated in the push-up

training program were better able to generate controlled upward force while maintaining proper body alignment during the passing movement. Similar findings have been reported in volleyball training studies showing that functional strength development enhances passing accuracy and consistency when exercises replicate sport-related movement patterns (Gao et al., 2025; Faisal et al., 2025). In this context, the push-up exercise serves as a functional strength training method that supports the mechanical requirements of overhead passing.

In addition to strength development, push-up training may also contribute to improvements in neuromuscular coordination. Strength training has been shown to enhance neural activation and motor unit recruitment, which improves the timing and synchronization of joint movements involved in volleyball skills (Baena-Raya et al., 2023; Nunes et al., 2021). Improved neuromuscular efficiency allows athletes to execute technical movements more consistently and with greater control. Consequently, the improved passing scores observed in the post-test may reflect both muscular adaptations and enhanced coordination between the shoulder, elbow, and wrist joints during ball contact. The results of this study have important implications for physical education instruction, particularly in the context of volleyball learning in schools. Push-up exercises represent a simple and practical training method that can be easily incorporated into physical education classes. Unlike many specialized strength training exercises, push-ups require no equipment and can be performed in limited space, making them highly suitable for school environments with limited resources.

Integrating push-up exercises into volleyball learning sessions may help students develop the physical capacity necessary to perform technical skills more effectively. Previous research has emphasized that combining strength development with skill practice enhances the transfer of training effects to sport performance (Gao et al., 2025; Rustiawan et al., 2024). In physical education contexts, this integrated approach allows teachers to simultaneously develop students' physical fitness and technical skills. For example, push-up exercises can be incorporated into warm-up routines or conditioning circuits before practicing passing drills or small-sided volleyball games. Moreover, strength-based conditioning can contribute to injury prevention in youth volleyball players. Strengthening the shoulder complex and scapular stabilizing muscles improves joint stability and reduces the risk of overuse injuries associated with repetitive overhead movements (Sivaraman et al., 2024; Nur et al., 2023). Consequently, incorporating push-up exercises into school volleyball programs may support both performance improvement and long-term athlete safety.

One of the main advantages of the push-up training program used in this study is its simplicity and accessibility. Push-ups are easy to perform, require minimal supervision, and can be adapted to different levels of student ability. In addition, the exercise provides an effective stimulus for strengthening multiple muscle groups simultaneously, including the arms, shoulders, chest, and core muscles. Another advantage is the low cost associated with this training method. Unlike resistance machines or specialized equipment, push-ups rely solely on body weight resistance, making them highly feasible for implementation in school physical education settings. These characteristics make push-up training a practical method for improving upper-body strength in volleyball learning environments. Despite the positive findings of this study, several limitations should be acknowledged. First, the research design employed a one-group pre-test–post-test approach without a control group. Although this design is commonly used in educational settings, it limits the ability to fully attribute the observed improvements solely to the training intervention, as other factors such as learning effects or maturation may also contribute to performance changes (Apidogo et al., 2021; Rohman, 2025).

Second, the sample consisted of students from a single school, which may limit the generalizability of the findings to other populations or educational contexts. Differences in training experience, physical fitness levels, and instructional methods could influence the

effectiveness of the training program in other settings. Future research could address this limitation by involving larger samples from multiple schools. Another limitation relates to minor inconsistencies in the reporting of post-test averages during data processing, which should be carefully reviewed in future analyses to ensure accuracy and consistency in statistical reporting. Accurate data management is essential for maintaining the reliability of experimental research findings. Future studies may also expand the scope of investigation by comparing push-up training with other strength training methods, such as resistance band exercises, plyometric training, or functional strength programs. Comparative experimental designs involving control groups could provide deeper insights into which types of strength training are most effective for improving volleyball passing performance in school-aged athletes. In addition, future research could examine how integrated training programs that combine strength development with technique-focused drills influence skill acquisition and long-term performance outcomes in volleyball learning environments.

Conclusions

This study investigated the effect of push-up training on the overhead passing ability of junior secondary school students participating in volleyball learning activities. The findings demonstrate that the push-up training program produced a significant improvement in students' passing performance, as indicated by the increase in mean scores from the pre-test to the post-test and the statistical significance of the paired t-test results. These outcomes suggest that strengthening exercises targeting the arms and shoulders can play an important role in supporting the technical execution of volleyball skills, particularly overhead passing. The improvement observed in this study highlights the contribution of upper-body muscular strength to the stability, control, and accuracy required for successful passing movements. Push-up exercises appear to enhance the ability of students to generate controlled force through the arms while maintaining body stability during ball contact. As a result, students were able to perform overhead passes with greater consistency and precision after completing the training program. From a pedagogical perspective, the findings demonstrate that push-up training can be considered an effective and practical method for strengthening students' physical capacity in school volleyball programs. Because push-up exercises require no specialized equipment and can be easily implemented in physical education classes, they provide a cost-effective strategy for improving both physical fitness and technical skill performance. The study also contributes to the growing body of research emphasizing the importance of integrating strength development with skill-based training in sports education. Future studies are recommended to employ experimental designs involving control groups, larger and more diverse samples, and comparisons between different strength-training methods in order to further explore the relationship between physical conditioning and volleyball skill performance in school settings.

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