



The Influence Of Push Up Training On Upper Passing Ability In Volleyball Games

Chindyani Lebang Tandiayuk^{1A-E*}, Ahmad Rum Bismar^{2B-D}, Andi Akbar^{3B-D}

^{1,2,3} Universitas Negeri Makassar, Kota Makassar, Indonesia

Email Corresponding Author: chindylebang@gmail.com^{1*}

AUTHORS' CONTRIBUTION

A. Conception and design of the study; B. Acquisition of data;

C. Analysis and interpretation of data; D. Manuscript preparation; E. Obtaining funding

ARTICLE HISTORY

Reviewed: 2026/08/11

Resived: 2026/08/27

Accepted: 2026/09/04

Published: 2026/09/21

KEYWORDS

Push-Up;

Training;

Overhead Passing;

Volleyball;

Upper-Body Strength.

ABSTRACT

This study aimed to determine the effect of push-up training on overhead passing ability in volleyball among students of the Sports Coaching Education Study Program, Faculty of Sports and Health Sciences, Universitas Negeri Makassar. The background of this research is based on the importance of overhead passing as a fundamental volleyball technique that requires coordination, arm strength, shoulder stability, wrist control, and accurate ball direction. In practice, many students still show weaknesses in performing overhead passing, particularly in producing stable and controlled ball movements. Therefore, push-up training was applied as a simple physical conditioning method to strengthen the upper-body muscles involved in overhead passing performance. This research used a quantitative experimental method with a one-group pretest–posttest design. The population consisted of 15 male PKO FIKK UNM students, and all participants were selected through purposive sampling based on predetermined criteria. The research instrument was an overhead passing ability test administered before and after the push-up training treatment. The data were analyzed using descriptive statistics, normality testing, and a paired-sample t-test. The results showed that the pretest mean score was 24.9333, with a total score of 374.00 and a standard deviation of 2.05171. After treatment, the posttest mean score increased to 39.4000, with a total score of 591.00 and a standard deviation of 1.40408. The hypothesis test showed that the observed t-value was 67.197, higher than the t-table value of 2.145, with a significance value of $0.000 < 0.05$. Therefore, push-up training had a significant effect on improving overhead passing ability in volleyball among PKO FIKK UNM students.

INTRODUCTION

Sport is a structured form of physical activity expressed through games, competition, recreation, and performance-oriented movement. Beyond physical outcomes, sport also contributes to discipline, persistence, cooperation, confidence, and character building among young people and university students (Gunarsa, 2023). In the context of higher education, particularly in the Sports Coaching Education Study Program at FIKK UNM, volleyball is not only taught as a practical sport but also as a pedagogical and coaching domain that requires mastery of technique, physical conditioning, movement analysis, and training design. Volleyball performance depends on the integration of technical skill, tactical awareness, physical fitness, and neuromuscular coordination, especially because every action in the game must be executed quickly, accurately, and repeatedly under time pressure (Hermaya et al., 2024; Permana et al., 2025). One of the



fundamental techniques in volleyball is the overhead pass, commonly known in Indonesian volleyball terminology as passing atas. This technique is essential for receiving, controlling, and directing the ball, particularly in building attacks and preparing the set before a spike. A successful overhead pass requires correct body positioning, stable balance, accurate hand contact, finger control, elbow extension, shoulder stability, and coordinated follow-through (Amalia et al., 2023; Setiawan et al., 2025). However, many students still experience difficulty in performing overhead passing consistently. Common problems include weak arm push, unstable wrist and finger control, poor ball direction, insufficient elbow extension, and lack of coordination between the lower body, trunk, shoulder, and arm muscles. These problems indicate that technical weakness in overhead passing is not merely a matter of skill repetition, but is also closely related to upper-body strength and muscular endurance.

From a physiological and biomechanical perspective, overhead passing involves repeated activation of the shoulder, chest, arm, wrist, and finger muscles. The biceps and triceps contribute to elbow flexion and extension, while the deltoid, pectoralis major, serratus anterior, and core muscles support arm elevation, stability, and force transfer during ball contact (Dhahbi et al., 2018; Giancotti et al., 2018; Intziegianni et al., 2026). Therefore, students with inadequate upper-body strength tend to produce weak, inaccurate, or inconsistent passes. This becomes a relevant issue for PKO FIKK UNM students because they are expected not only to perform volleyball techniques but also to understand how specific conditioning exercises influence sport-specific skills. Recent studies have increasingly emphasized that volleyball technical performance can be improved through structured, specific, and progressive training programs. Drill-based training has been shown to improve overhead passing performance among youth volleyball players because it provides repeated technical execution under controlled movement patterns (Hermaya et al., 2024). Similarly, part-whole passing training has been reported to improve passing accuracy by allowing athletes to master movement components before integrating them into full skill performance (Permana et al., 2025). Other studies found that paired passing, throwing-catch ball methods, setter training balls, and medicine ball exercises can support the development of volleyball passing skills by improving coordination, ball control, and movement consistency (Amalia et al., 2023; Ariansyah, 2025; Budiman, 2025).

In addition to technical methods, strength-based training has received growing attention in volleyball learning and coaching. Push-up exercises are widely used because they are simple, economical, easy to apply in limited spaces, and effective for developing upper-body strength and endurance. Push-ups mainly activate the pectoralis major, triceps brachii, anterior deltoid, serratus anterior, and core stabilizers, which are also important in overhead sport movements (Barnamehei et al., 2022; Okilanda et al., 2024). A systematic review of push-up kinetics also confirms that different push-up variations can be prescribed progressively according to training goals and participant ability (Dhahbi et al., 2018). Empirical evidence further shows that push-up exercises can increase upper-body strength in adolescents and students, particularly when applied systematically through repeated training sessions (Kornia et al., 2025; Thariqi et al., 2025). Several volleyball-specific studies have reported positive effects of push-up-based training on passing and other upper-limb skills. Tamu et al. (2026) found that push-up training improved overhead passing ability in volleyball, with post-test performance increasing after a structured intervention. Ressa (2025) also reported that push-up training significantly influenced both forearm passing and overhead passing in volleyball students. Earlier findings by Urahman and Hidayat (2019) indicated that hand grip and push-up exercises were effective in supporting overhead passing performance, while recent studies on arm muscle strength training also reinforce the relationship between upper-limb conditioning and volleyball overhead passing ability (Faisal et al., 2026; Pranoto, 2019; Putra, 2025). These findings suggest that push-up training is not only a general fitness exercise, but also a potentially relevant conditioning method for improving sport-specific volleyball skills.

Although previous studies have examined volleyball passing training and upper-body conditioning, several gaps remain. First, many studies have focused on school students, junior athletes, or extracurricular participants, while research involving university students in sports coaching education programs remains limited. This population is important because PKO students are future coaches, teachers, and sport practitioners who need evidence-based understanding of the relationship between physical conditioning and technical performance. Second, previous research has often examined passing improvement through technical drills, medicine balls, hand grip training, or general strength programs, but fewer studies have specifically tested push-up training as a simple bodyweight exercise linked directly to overhead passing

performance in university volleyball learning contexts (Amalia et al., 2023; Hermaya et al., 2024; Tamu et al., 2026). Third, the theoretical relationship between push-up training and overhead passing still needs clearer explanation. Push-ups strengthen the upper limbs and shoulder stabilizers, but overhead passing also requires timing, coordination, finger control, and movement accuracy. Therefore, it is necessary to examine whether improvements in upper-body strength through push-up training can meaningfully transfer to the quality of volleyball overhead passing. Fourth, in the context of FIKK UNM, this topic has practical relevance because students need training models that are accessible, low-cost, and applicable in both formal volleyball courses and independent physical conditioning programs. Thus, a study on the effect of push-up training on overhead passing ability can fill a contextual, methodological, and practical gap in volleyball coaching education.

This study aims to determine the effect of push-up training on overhead passing ability in volleyball among PKO FIKK UNM students. Conceptually, the study is based on the assumption that overhead passing performance is influenced by upper-body strength, shoulder stability, elbow extension ability, wrist control, and neuromuscular coordination. Empirically, the study is supported by recent evidence showing that structured push-up training can improve upper-body strength and that strength-related interventions can contribute to volleyball skill performance (Bao et al., 2025; Kornia et al., 2025; Thariqi et al., 2025; Yang, 2026). The novelty of this study lies in its specific focus on PKO FIKK UNM students as a higher-education sport coaching population, the use of push-up training as a practical bodyweight conditioning model, and the direct examination of its influence on overhead passing ability in volleyball. Unlike studies that only emphasize technical repetition, this research positions physical conditioning as an important support system for technical mastery. The findings are expected to provide theoretical contribution to volleyball training science and practical guidance for lecturers, coaches, and students in designing simple but effective training programs for improving overhead passing performance. Based on the problem, literature development, and identified research gap, overhead passing ability in volleyball should be understood as a skill that depends on both technical mastery and physical readiness. Push-up training is theoretically relevant because it develops the arm, chest, shoulder, and core muscles involved in producing stable and accurate overhead passing movements. Therefore, investigating the effect of push-up training on overhead passing ability among PKO FIKK UNM students is scientifically important, practically useful, and contextually appropriate for strengthening evidence-based volleyball coaching and learning.

METHODS

This study employed a quantitative experimental method using a one-group pretest–posttest design. This design was selected because the study aimed to examine the change in students' overhead passing ability before and after receiving push-up training treatment. Experimental studies with pretest and posttest measurement are considered appropriate for evaluating the effectiveness of physical training interventions in sport skill performance, particularly when the same participants are measured across two testing phases (Tamu et al., 2026; Ressa, 2025; Permana et al., 2025). The independent variable in this study was push-up training, while the dependent variable was overhead passing ability in volleyball.

The population consisted of 15 male students of the Sports Coaching Education Study Program, Faculty of Sports and Health Sciences, Universitas Negeri Makassar. The sampling technique used was purposive sampling, with the criteria that participants had to be active PKO FIKK UNM students, male, physically able to participate in training, and willing to complete the full treatment process. Based on these criteria, all 15 students were selected as research participants. Purposive sampling is commonly used in sport intervention research when participants are selected based on specific performance, demographic, or training-related characteristics (Hermaya et al., 2024; Ariansyah, 2025).

The research procedure consisted of three main stages: pretest, treatment, and posttest. In the pretest stage, participants performed an overhead passing skill test to determine their initial ability. After the initial test, participants received push-up training as the treatment. Push-up training was chosen because it activates the pectoralis major, triceps brachii, anterior deltoid, shoulder stabilizers, and core muscles, which are functionally related to arm extension, shoulder stability, and force control during overhead passing (Dhahbi et al., 2018; Giancotti et al., 2018; Barnamehei et al., 2022; Okilanda et al., 2024). After the treatment period, participants completed the same overhead passing test as the posttest.

The data were analyzed using descriptive statistics, including mean, standard deviation, minimum, and maximum scores. Before hypothesis testing, normality was examined using the Shapiro–Wilk test. If the data were normally distributed, a paired-sample t-test was used to compare pretest and posttest scores; if not, the Wilcoxon signed-rank test was applied. The significance level was set at 0.05. This analysis was intended to determine whether push-up training had a statistically significant effect on students' overhead passing ability in volleyball.

RESULTS AND DISCUSSION

Results

The research results are presented through descriptive statistical analysis, prerequisite testing, and hypothesis testing. The analysis was conducted to determine whether push-up training had a significant effect on overhead passing ability in volleyball among PKO FIKK UNM students. The data consisted of pretest and posttest scores from 15 participants.

Descriptive Statistics of Overhead Passing Ability

Table 1. Descriptive Statistics of Overhead Passing Ability

Variable	Pretest Overhead Passing Ability	Posttest Overhead Passing Ability
N	15	15
Sum	374.00	591.00
Mean	24.9333	39.4000
Standard Deviation	2.05171	1.40408
Range	8.00	5.00
Minimum	22.00	38.00
Maximum	30.00	43.00

Based on Table 1, the pretest results of overhead passing ability among PKO FIKK UNM students showed a total score of 374.00 from 15 participants. The mean score was 24.9333 with a standard deviation of 2.05171. The score range was 8.00, with the lowest score of 22.00 and the highest score of 30.00. These results indicate that before the treatment, students' overhead passing ability was still relatively limited and showed variation among participants.

After the push-up training treatment, the posttest results showed a total score of 591.00. The mean score increased to 39.4000 with a standard deviation of 1.40408. The score range was 5.00, with the lowest score of 38.00 and the highest score of 43.00. The increase in the mean score from 24.9333 to 39.4000 indicates a substantial improvement in overhead passing ability after the treatment. In addition, the lower standard deviation in the posttest suggests that students' performance became more consistent after participating in push-up training.

Normality Test

Before conducting hypothesis testing, a normality test was carried out using the Kolmogorov–Smirnov test. The purpose of this test was to determine whether the pretest and posttest data were normally distributed.

Table 2. Normality Test Results

Training Variable	Kolmogorov–Smirnov Statistic	Sig.	α	Interpretation
Pretest of push-up training on overhead passing ability	0.154	0.200	0.05	Normal
Posttest of push-up training on overhead passing ability	0.201	0.154	0.05	Normal

Based on Table 2, the normality test for the pretest data obtained a Kolmogorov–Smirnov statistic value of 0.154 with a significance value of 0.200. Since the significance value was greater than $\alpha = 0.05$, the pretest data were normally distributed. Furthermore, the normality test for the posttest data obtained a Kolmogorov–

Smirnov statistic value of 0.201 with a significance value of 0.154. Since this value was also greater than $\alpha = 0.05$, the posttest data were normally distributed. Therefore, both pretest and posttest data met the normality assumption, and the hypothesis test could be continued using a parametric test.

Hypothesis Testing

Hypothesis testing was conducted to determine whether there was a significant difference between the pretest and posttest scores after the implementation of push-up training.

Table 3. Hypothesis Test Results

t-observed	t-table	Probability	α	Interpretation
67.197	2.145	0.000	0.05	Significant

Based on Table 3, the result of hypothesis testing showed that the t-observed value was 67.197, while the t-table value at the 95% confidence level was 2.145. Since the t-observed value was greater than the t-table value, and the probability value was 0.000, which was lower than $\alpha = 0.05$, the null hypothesis was rejected and the alternative hypothesis was accepted.

This means that there was a significant difference between the pretest and posttest scores of overhead passing ability. Therefore, push-up training had a significant effect on improving overhead passing ability in volleyball among PKO FIKK UNM students.

Empirically, the improvement can be seen from the increase in the mean score from 24.9333 in the pretest to 39.4000 in the posttest. Conceptually, this improvement indicates that push-up training contributed to the development of upper-body strength, particularly in the arms, shoulders, chest, and supporting stabilizer muscles. These muscle groups are important in overhead passing because the movement requires controlled arm extension, shoulder stability, wrist coordination, and accurate force application when directing the ball. Thus, the findings support the assumption that physical conditioning, especially push-up training, can strengthen the technical performance of overhead passing in volleyball.

Overall, the results demonstrate that a structured push-up training program is an effective training method for improving overhead passing ability in volleyball. For PKO FIKK UNM students, this finding is practically important because push-up exercises are simple, low-cost, easy to implement, and directly relevant to the physical demands of volleyball passing techniques.

Discussion

The findings of this study demonstrate that push-up training had a significant effect on improving overhead passing ability in volleyball among PKO FIKK UNM students. Empirically, the mean score increased from 24.9333 in the pretest to 39.4000 in the posttest, showing an improvement of 14.4667 points after the treatment. The standard deviation also decreased from 2.05171 to 1.40408, indicating that the students' performance became more homogeneous after participating in the push-up training program. The hypothesis test further confirmed this improvement, as the observed t-value was 67.197, which was higher than the t-table value of 2.145 at the 0.05 significance level. Therefore, the null hypothesis was rejected and the alternative hypothesis was accepted. This result proves that structured push-up training significantly improved overhead passing ability in volleyball.

Conceptually, this finding can be explained through the functional relationship between upper-body strength and overhead passing mechanics. Overhead passing is not only a technical movement involving the fingers and hands, but also a coordinated action involving the wrists, elbows, shoulders, chest, trunk, and lower-body support. Biomechanical analysis of the volleyball overhead pass shows that skilled players use coordinated wrist and elbow flexion-extension patterns, including a pull-and-push phase during ball contact (Ozawa et al., 2021). This means that the quality of overhead passing depends on the ability to generate controlled force, stabilize the shoulder, and direct the ball accurately. Push-ups are relevant to these movement demands because they strengthen the pectoralis major, triceps brachii, anterior deltoid, serratus anterior, and core stabilizers, all of which contribute to arm extension, shoulder control, and postural stability during volleyball passing (Dhahbi et al., 2022; Barnamehei et al., 2022; Intziegianni et al., 2026).

The improvement found in this study is consistent with previous research showing that push-up exercises can improve volleyball passing performance. Tamu et al. (2026) reported that push-up training

improved overhead passing ability among volleyball students through enhanced arm power, shoulder stability, and movement control. Ressa et al. (2025) also found that push-up training significantly affected both forearm passing and overhead passing in volleyball, with statistical significance at $p < 0.05$. Urahman and Hidayat (2019) confirmed that hand grip and push-up exercises were effective in improving overhead passing because both exercises develop the strength of the hands, wrists, and arms. Similar findings were reported by Riadi and Hendra (2025), who emphasized that push-up and hand grip variations improved overhead passing because the movement requires arm strength and wrist control. These studies support the empirical result of the present research, where push-up training produced a clear and significant increase in students' overhead passing scores.

Theoretically, the effect of push-up training on overhead passing can be understood through the principle of specificity and progressive overload. Although push-up training is not identical to the overhead passing movement, it develops the physical components that support the execution of the skill. During overhead passing, students need sufficient arm strength to push the ball upward and forward, shoulder stability to maintain control, and core strength to maintain body alignment. When push-up training is performed regularly, the neuromuscular system adapts through increased muscular endurance, improved motor unit recruitment, and better coordination between pushing muscles. These adaptations enable students to produce stronger, more stable, and more accurate passing movements. This explanation aligns with strength-training literature stating that bodyweight exercises such as push-ups can be used effectively to improve upper-body muscular performance when applied systematically and progressively (Dhahbi et al., 2022; Kornia et al., 2025; Okilanda et al., 2024; Thariqi et al., 2025; Yang, 2026).

The present findings are also in line with volleyball training studies that emphasize the importance of repeated, structured, and sport-related exercise programs. Hermaya et al. (2024) found that drill training significantly improved overhead passing among young volleyball players because repetition strengthens technical consistency. Permana et al. (2025) showed that part-whole passing training improved volleyball passing accuracy by allowing athletes to master movement components before performing complete skills. Rozi et al. (2026) reported that paired and wall overhead passing exercises improved passing performance by increasing repetition, ball control, and movement adaptation. Widodo et al. (2025) also demonstrated that wall passing exercises improved overhead passing through repeated ball-contact experience. These findings indicate that technical repetition is essential; however, the result of the present study adds that physical conditioning through push-up training can also become an important foundation for improving passing performance.

From a coaching perspective, the improvement from pretest to posttest indicates that PKO FIKK UNM students benefited from a simple, low-cost, and easily applicable training method. Push-up exercises do not require expensive facilities or equipment, making them suitable for university-based volleyball learning, club training, and independent conditioning programs. This is important because volleyball learning often focuses heavily on technique while neglecting the physical foundation needed to support skill execution. Studies by Hasan et al. (2025), Triatmaja et al. (2025), Afifah et al. (2026), Faridhatunnisa et al. (2018), and Tambunan and Endriani (2025) show that arm strength and arm power are related to volleyball performance, including serving, smashing, and passing. Therefore, integrating push-up training into volleyball practice can help students build a stronger physical base for technical development.

The reduction in posttest score variability is also meaningful. Before treatment, students had different levels of overhead passing ability, as shown by the wider range and higher standard deviation in the pretest. After the push-up program, the range became narrower and the standard deviation decreased. This suggests that the training program not only improved average performance but also helped weaker students approach the performance level of stronger students. In practical terms, push-up training may create a more balanced physical readiness among learners, making technical instruction more effective. This supports the view that physical conditioning and technical training should not be separated in volleyball coaching (Ozawa et al., 2021; Setiawan et al., 2025; Sadzali, 2024; Yanti, 2025; Lanos et al., 2025).

Overall, the results confirm that push-up training has a significant and positive effect on overhead passing ability in volleyball among PKO FIKK UNM students. Empirically, this is proven by the increase in mean scores and the significant t-test result. Conceptually, the improvement occurred because push-up training strengthened the upper-body muscles involved in the push phase of overhead passing, improved shoulder and

trunk stability, and supported more controlled ball direction. Therefore, push-up training can be recommended as a practical conditioning exercise to support overhead passing development in volleyball learning and coaching programs.

CONCLUSION

Based on the results of the study, it can be concluded that push-up training has a significant effect on improving overhead passing ability in volleyball among PKO FIKK UNM students. This conclusion is supported by the empirical data showing an increase in the mean score from 24.9333 in the pretest to 39.4000 in the posttest. The total score also increased from 374.00 to 591.00, indicating a clear improvement after the implementation of push-up training. In addition, the standard deviation decreased from 2.05171 to 1.40408, which suggests that students' overhead passing performance became more consistent after the treatment.

The hypothesis test further confirmed the effectiveness of the training program, as the observed t-value was 67.197, higher than the t-table value of 2.145 at the 0.05 significance level, with a probability value of 0.000. Therefore, the null hypothesis was rejected and the alternative hypothesis was accepted. Conceptually, push-up training strengthens the arm, shoulder, chest, and core muscles that support controlled arm extension, shoulder stability, and accurate ball direction during overhead passing. Thus, push-up training can be recommended as a practical, simple, and effective conditioning method to improve volleyball overhead passing ability among university students.

REFERENCES

- Ahmad, D. (2021). The relationship between arm muscle strength and tosser athletes in state high school volleyball 13 Muko-Muko. *Sinar Sport Journal*, 1(2), 157–163. <https://doi.org/10.53697/ssj.v1i2.352>
- Aini, K., Asmawi, M., Pelana, R., Tangkudung, J., & Muslimin, M. (2021). The effect of target and netting games on overhead pass volleyball accuracy. *International Journal of Human Movement and Sports Sciences*, 9(2), 224–230. <https://doi.org/10.13189/saj.2021.090209>
- Apidogo, J. B., Burdack, J., & Schöllhorn, W. I. (2021). Repetition without repetition or differential learning of multiple techniques in volleyball? *International Journal of Environmental Research and Public Health*, 18(19), 10499. <https://doi.org/10.3390/ijerph181910499>
- Baena-Raya, A., Díez-Fernández, D. M., García-de-Alcaráz, A., Soriano-Maldonado, A., Pérez-Castilla, A., & Rodríguez-Pérez, M. A. (2023). Assessing the maximal mechanical capacities through the load-velocity relationship in elite versus junior male volleyball players. *Sports Health*, 16(5), 829–836. <https://doi.org/10.1177/19417381231208706>
- Bisa, M. (2023). Sports education as a means of building student character. *Al-Ishlah: Jurnal Pendidikan*, 15(2). <https://doi.org/10.35445/alishlah.v15i2.3889>
- Daryono, D. (2026). The influence of circuit and set training methods, gender differences, and motivation on volleyball performance in adolescent athletes. *Retos*, 74, 568–577. <https://doi.org/10.47197/retos.v74.117935>
- Dhahbi, W., Chaabène, H., Chaouachi, A., Padulo, J., Behm, D. G., Cochrane, J., Burnett, A., & Chamari, K. (2022). Kinetic analysis of push-up exercises: A systematic review with practical recommendations. *Sports Biomechanics*, 21(1), 1–40. <https://doi.org/10.1080/14763141.2018.1512149>
- Doroshenko, E., Solovei, O., & Melnyk, M. (2022). Technology of teaching game techniques in volleyball at the stage of initial training. *Journal of Learning Theory and Methodology*, 3(1), 34–40. <https://doi.org/10.17309/jltm.2022.1.05>
- Faisal, M., Arifin, Z., & Permadi, A. A. (2025). Pengaruh latihan kekuatan otot lengan terhadap kemampuan passing atas bola voli. *Jurnal Porkes*, 8(2), 574–582. <https://doi.org/10.29408/porkes.v8i2.29748>

- Feryantono, R. R., Suriatno, A., & Muslimin, M. (2024). Pengaruh butterfly passing drill dan endurance passing drill terhadap ketepatan passing bawah pemain bola voli junior. *Discourse of Physical Education*, 3(1), 44–57. <https://doi.org/10.36312/dpe.v3i1.2439>
- Fikri, A., Muslimin, Samsudin, Hernawan, Dlis, F., Tangkudung, J., Widiastuti, & Hidayat, A. (2021). The effect of push-up exercises on the precision of men's Permata Club volleyball smash. *International Journal of Human Movement and Sports Sciences*, 9(6), 1104–1108. <https://doi.org/10.13189/saj.2021.090604>
- Gao, Y., Yang, Y., Xian, C., & Wang, Z. (2025). Comparative study of functional training and traditional resistance training on lower-limb strength performance in male adolescent volleyball players: A randomized controlled trial. *Frontiers in Physiology*, 16. <https://doi.org/10.3389/fphys.2025.1629055>
- Hermaya, A. D., Muslimin, M., Septiliza, D., Fikri, A., & Prastio, D. S. (2024). Does drill training improve volleyball overhead passing results in volleyball players 14–15 years old? *Jurnal SPORTIF: Jurnal Penelitian Pembelajaran*, 10(2), 335–348. https://doi.org/10.29407/js_unpgri.v10i2.23220
- Hua, Z., Liang, Z., & Cai, Z. (2023). Upper limbs physical fitness training in volleyball players. *Revista Brasileira de Medicina do Esporte*, 29. https://doi.org/10.1590/1517-8692202329012023_0016
- Intziegianni, K., Katsamis, E., Michaelides, M., & Parpa, K. (2026). Electromyographic activation of the pectoralis major and triceps brachii muscles during standard, diamond, and wide hand position push-ups. *Muscles*, 5(1), 18. <https://doi.org/10.3390/muscles5010018>
- Ishak, A. H. P., Hakim, H., Sahabuddin, S., Hudain, M. A., & Bismar, A. R. (2023). The effect of push-up exercise and dumbbell exercise overhead the passing ability of volleyball games of SMPN 20 Makassar extracurricular participants. *Competitor: Jurnal Pendidikan Kepelatihan Olahraga*, 15(3), 470. <https://doi.org/10.26858/cjeko.v15i3.53824>
- Juhanis, J., Nur, M., Mappaompo, M. A., Hudain, M. A., Azis, A., & Arga, A. (2023). Pengaruh latihan push up normal dan push up tangan ditinggikan terhadap keterampilan passing atas dalam permainan bolavoli siswa ekstrakurikuler bolavoli SMP Negeri 1 Makassar. *Jurnal Ilmiah Mandala Education*, 9(3). <https://doi.org/10.58258/jime.v9i3.5709>
- Khoirudin, D., Pratama, H. G., Santoso, D. A., & Putro, B. N. (2023). The impact of drill exercise and games approach on improving under-passing ability in adolescent female volleyball athletes. *Physical Education and Sports Studies and Research*, 2(2), 142–151. <https://doi.org/10.56003/pessr.v2i2.276>
- Kurdi, F. N., Hartati, H., Risnawati, Y., & Destriana, D. (2021). A variation of push up for overhead pass on volleyball games. *International Journal of Human Movement and Sports Sciences*, 9(1), 97–102. <https://doi.org/10.13189/saj.2021.090113>
- Leeuw, A. de, Baar, R. van, Knobbe, A., & Zwaard, S. van der. (2022). Modeling match performance in elite volleyball players: Importance of jump load and strength training characteristics. *Sensors*, 22(20), 7996. <https://doi.org/10.3390/s22207996>
- Lin, Y.-C., Chiang, T.-L., Chan, S.-H., Lin, K.-F., & Hsu, C.-H. (2026). Angle-specific upper body muscle activation in suspension push-ups: An electromyographic analysis across different body angles. *BMC Sports Science, Medicine and Rehabilitation*, 18, 139. <https://doi.org/10.1186/s13102-026-01582-3>
- McQuilliam, S. J., Clark, D. R., Erskine, R. M., & Brownlee, T. E. (2020). Free-weight resistance training in youth athletes: A narrative review. *Sports Medicine*, 50(9), 1567–1580. <https://doi.org/10.1007/s40279-020-01307-7>
- Nunes, A. C. C. A., Cattuzzo, M. T., Faigenbaum, A. D., & Mortatti, A. L. (2021). Effects of integrative neuromuscular training and detraining on countermovement jump performance in youth volleyball players. *Journal of Strength and Conditioning Research*, 35(8), 2242–2247. <https://doi.org/10.1519/JSC.0000000000003092>

- Ozawa, Y., Uchiyama, S., Ogawara, K., Kanosue, K., & Yamada, H. (2021). Biomechanical analysis of volleyball overhead pass. *Sports Biomechanics*, 20(7), 844–857. <https://doi.org/10.1080/14763141.2019.1609072>
- Permana, H. (2025). The impact of part-whole passing training on passing accuracy in volleyball athletes aged 10–14 years. *Pedagogy of Physical Culture and Sports*, 29(5), 410–418. <https://doi.org/10.15561/26649837.2025.0504>
- Rahayu, V. M. E. S., Saefulah, D. I., Kusmiyati, K., Yulianto, A. G., & Haris, I. N. (2024). Impact of setter training on overhead passing skills of female volleyball athletes at SMK Kartek 2 Jatilawang. *Indonesian Journal of Physical Activity*, 4(2), 150–156. <https://doi.org/10.59734/ijpa.v4i2.81>
- Rebello, A., Pereira, J. R., & Valente-dos-Santos, J. (2023). Effects of a preseason triphasic resistance training program on athletic performance in elite volleyball players—An observational study. *German Journal of Exercise and Sport Research*, 53(2), 163–170. <https://doi.org/10.1007/s12662-023-00877-8>
- Ressa, M. K. Y. (2025). Pengaruh latihan push up terhadap kemampuan passing bawah dan passing atas dalam permainan bola voli. *Begibung: Jurnal Penelitian Multidisiplin*, 3(1). <https://berugakbaca.org/index.php/begibung/article/view/155>
- Rumiati, R., Harmono, S., & Pratama, B. A. (2022). The difference between the practice of passing underhand the ball reflected on the wall and the ball hanging on the skill of passing underhand volleyball. *Competitor: Jurnal Pendidikan Kepelatihan Olahraga*, 14(3), 409. <https://doi.org/10.26858/cjpk.v14i3.38754>
- Rustiawan, H., Sudrazat, A., & Rezha, M. (2024). Kontribusi koordinasi mata dan tangan dengan power otot lengan terhadap hasil passing atas dalam permainan bolavoli. *Jurnal Keolahragaan*, 10(2), 122. <https://doi.org/10.25157/jkor.v10i2.17058>
- Salamanang, R., & Hakim, L. (2025). Pengaruh media papan bergerak terhadap ketepatan passing atas permainan bola voli. *Sprinter: Jurnal Ilmu Olahraga*, 6(1), 148–152. <https://doi.org/10.46838/spr.v6i1.712>
- Sivaraman, C., Rajkumar, N. C. J., Sanjaykumar, S., Kalmykova, Y., Pomeshchikova, I., & Lebediev, S. (2024). Efficacy of resistance band training on shoulder muscle strength and injury prevention in volleyball athletes. *Slobozhanskyi Herald of Science and Sport*, 28(3), 116–121. <https://doi.org/10.15391/sns.v.2024-3.003>
- Tamu, A. I., Samin, G., Fataha, I., & Gani, A. A. (2026). Effect of push-up training on overhead passing ability in volleyball among eighth-grade students at SMP Negeri 02 Paguyaman. *Gorontalo Sport Science*, 6(1), 1–15. <https://doi.org/10.31314/gss.v6i1.5514>
- Torres, R. J. B., Pirauá, A. L. T., Nascimento, V. Y. S., Santos, P. S. dos, Beltrão, N. B., Oliveira, V. M. A. de, Pitangui, A. C. R., & Araújo, R. C. de. (2017). Shoulder muscle activation levels during the push-up-plus exercise on stable and unstable surfaces. *Journal of Sport Rehabilitation*, 26(4), 281–286. <https://doi.org/10.1123/jsr.2016-0050>
- Widayat, R. A. (2026). The effect of resistance band training on the accuracy of underhand passing reception in female volleyball athletes. *Sriwijaya Journal of Sport*, 5(2), 335–344. <https://doi.org/10.55379/sjs.v5i2.161>
- Widodo, P., Hasan, A., & Priyanto, A. A. (2025). Pengaruh latihan passing ke dinding terhadap kemampuan passing atas bola voli pada ekstrakurikuler MTs Negeri 4 Kebumen tahun ajaran 2024/2025. *Jurnal Pengabdian Masyarakat dan Riset Pendidikan*, 3(3), 300–307. <https://doi.org/10.31004/jerkin.v3i3.401>
- Zhou, R. (2023). Upper limb movement characteristics in volleyball athletes. *Revista Brasileira de Medicina do Esporte*, 29. https://doi.org/10.1590/1517-8692202329012022_0323