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The effect of push-up and pull-up exercises on shooting performance of extracurricular handball players

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ABSTRACT

Handball is a sport that requires a combination of physical, technical, tactical and mental skills. One of the fundamental techniques that determines success in handball is shooting ability. This study aimed to analyse the effect of combining push-up and pull-up exercises on the shooting ability of extracurricular handball players. An experimental method with a pre-test–post-test control group design was employed. The participants consisted of 12 extracurricular handball players from SMA Negeri 3 Kotabumi, selected through purposive sampling and randomly assigned into two groups: an experimental group that received push-up and pull-up training and a control group that followed regular training. The intervention was conducted over six weeks with three training sessions per week. Shooting performance was evaluated using indicators of throwing distance and shooting accuracy. The results of paired sample t-tests indicated significant improvements in both throwing distance ($t = 16.52$) and shooting accuracy ($t = 14.77$) in the experimental group ($p < 0.05$), accompanied by large effect sizes (Cohen's $d > 0.80$). Furthermore, independent sample t-tests revealed significant differences between the experimental and control groups ($p < 0.05$). These findings demonstrate that the combined push-up and pull-up training program is effective in enhancing shooting performance among extracurricular handball players.

Keywords: push-up; pull-up; shooting; extracurricular; handball

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Authors' Contribution : a – Study Design; b – Data Collection; c – Statistical Analysis; d – Manuscript Preparation; e – Funds Collection

INTRODUCTION

Handball is a sport that demands a combination of physical, technical, tactical and mental abilities (Deshinta, 2024; Oyok, 2024). The basic technique that determines success in handball is the ability to shoot or throw the ball towards the goal with power and accuracy (Atmojo et al., 2023). Strong and effective shooting requires good physical conditioning, particularly in the muscles of the arms, shoulders, chest and upper back. Proper and programmed physical training is necessary to improve handball players' shooting performance. Push-ups and pull-ups are two common forms of

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strength training that increase muscle strength in the upper body. Push-ups primarily target the chest, shoulder, and triceps muscles, while pull-ups primarily target the back, biceps, and shoulder muscles (Amrin & Jumareng, 2023; Kencana et al., 2015; Sudiadharma & Rahman, 2023).

It is believed that combining the two exercises increases the strength associated with throwing activities, including shooting in handball games. Previous research has examined the relationship between upper body muscle strength training and shooting ability in several sports, including basketball and handball. Several studies have demonstrated the significant impact of resistance training exercises on increasing shooting strength (Junge et al., 2023; Moreno, 2024). Another study found that calisthenics exercises, including push-ups and pull-ups, increased arm muscle strength and throw technique performance in novice athletes (Mao, 2022). However, most of these studies used weight training methods or long-term structured physical programmes. Research specifically investigating the impact of a combination of push-ups and pull-ups on the shooting skills of extracurricular handball athletes is still limited.

The basic theory underpinning this research stems from the principles of exercise physiology, which state that an increase in physical ability occurs when muscles are consistently trained in accordance with the demands of the exercise (Hanafi, 2024; Hasruddin, 2021). In handball, shooting requires strength in the shoulder, arm and back muscles to stabilise the throwing movement (Spancken, 2021). Push-ups put pressure on the pectoralis major, deltoid and triceps brachii muscles, while pull-ups stimulate the latissimus dorsi, trapezius and biceps brachii (Mulyono et al., 2021). Biomechanically, both exercises are directly related to the motion component of shooting and could therefore contribute to improved shooting performance in players.

This study differs significantly from previous studies. One of the main differences is that the research subjects are extracurricular handball players at school level rather than professional athletes or academy teams that already have a structured training programme. Additionally, this study employed a combination of push-up and pull-up exercises as a form of calisthenics-based training, as opposed to previous studies which generally employed weight-based exercise programmes or conventional strengthening methods. The evaluation approach is also different: a pre-test and post-test design was used, incorporating shooting test measurement instruments that simultaneously consider aspects of accuracy and strength of the throw, so the results are expected to be more representative of handball players' shooting performance.

This study is urgent because there is still a lack of simple, inexpensive and easy-to-implement exercise guidelines based on the needs of athletes in a school environment, especially for improving the shooting ability of handball players who are still developing basic skills. This study seeks to provide an alternative, realistic and applicable exercise model in line with the facilities commonly used for school extracurricular activities.

Previous research studies have widely investigated the effectiveness of strength training and throwing performance, but there are gaps in the research related to the impact of simple calisthenics exercises, such as push-ups and pull-ups, on the shooting ability of school-level handball players. This study contributes a practical and easily replicable exercise model that can be used by physical education teachers, coaches and extracurricular coaches to develop targeted exercise programmes. The study aims to analyse the effects of push-up and pull-up training on the shooting power of extracurricular handball players, and the effect of combining these two exercises.

METHOD

This study employs an experimental approach with a pre-test and post-test control group design

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to evaluate the impact of push-up and pull-up exercises on the shooting strength of extracurricular handball players (Apriani et al., 2021; Rahman, 2018). This design was selected because it allows objective evaluation of changes before and after the intervention and enables comparison between experimental and control groups, thereby strengthening causal inference.

The participants were 12 extracurricular handball players from SMA Negeri 3 Kotabumi, selected using a purposive sampling technique based on actively practising and willingness to follow the entire research process. Participants were randomly assigned into two groups using simple random allocation: an experimental group (n = 6), who performed push-up and pull-up exercises, and a control group (n = 6), who did not receive additional strength training. This clarification ensures consistency in the number of groups across the design, procedures, and results sections.

To control for external exercise influences, all participants were instructed not to engage in additional upper-body strength training outside the scheduled extracurricular handball activities during the intervention period. Regular technical and tactical handball training was maintained equally for both groups, with the only difference being the push-up and pull-up exercises applied to the experimental group.

The research instruments consisted of an exercise programme as the treatment and a Shooting Power Test as the main measuring instrument. This test assesses shooting power through throw distance and shooting accuracy indicators. The equipment used included a standard handball, a measuring tape, a goal with a score zone of 1–5, and a stopwatch. Participants were asked to perform three shots from a predetermined distance. Throw distance was recorded using a measuring tape, while accuracy was determined based on the scoring zone hit on the target. The final score was calculated as the average of the three attempts.

The shooting performance instrument demonstrated good reliability, as indicated by a test–retest reliability coefficient of r = 0.80. Construct validity was supported empirically by the alignment of the measured indicators (throwing distance and target accuracy) with biomechanical and performance-based components of handball shooting, which emphasise force production and movement control as key determinants of shooting effectiveness.

Table 1. Target Zone Instrument

Zone Target	Score
Central Zone	5
Second Zone	4
Third Zone	3
Outer Zone	2
On goal but did not enter	1

This instrument was deemed feasible because it has construct validity in line with the characteristics of handball shooting ability, and demonstrated good reliability in initial test-retest trials with a reliability coefficient of 0.80. The research procedure was carried out in four stages: (1) preparation, including preparation of instruments, licensing and socialisation with participants; (2) implementation of a pre-test to measure initial shooting ability; (3) provision of treatment in the form of push-up and pull-up exercises for the experimental group only during the study period; and (4) implementation of a post-test to evaluate changes in shooting ability after treatment. All research activities were conducted with systematic monitoring and recording to maintain consistency of implementation and data validity.

The training programme applied the principles of overload and progressive load increases by gradually increasing the number of sets and repetitions while reducing rest intervals across weeks. To describe relative training intensity, push-up exercises were performed at approximately 60–80% of the participants' maximal repetition capacity per set, while pull-up exercises were performed at approximately 50–70% of maximal repetition capacity. Training intensity was also controlled using

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the Borg Rating of Perceived Exertion (RPE), with participants instructed to maintain an exertion level of 6–8, indicating moderate to high intensity

The data were analysed using a quantitative statistical approach. Descriptive analysis was used to describe the pre- and post-test data, while inferential analysis used paired-sample t-tests to compare changes within groups and independent-sample t-tests to compare changes between groups. A hypothesis test was conducted at a significance level of 0.05 to determine the effect of push-up and pull-up exercises on increasing the shooting power of handball players.

Table 2. Push-up and pull-up training programme plan

Week To-	Frequency / Week	Types Of Exercises	Set	Reps (Rep)	Duration Of Rest
1	3x	Push-Up	3 set	10–12 rep	60 seconds between sets
		Pull-Up	3 set	5–7 rep	60 seconds between sets
2	3x	Push-Up	3 set	12–15 rep	60 seconds
		Pull-Up	3 set	6–8 rep	60 seconds
3	3x	Push-Up	4 set	12–15 rep	45-60 seconds
		Pull-Up	4 set	6–8 rep	45-60 seconds
4	3x	Push-Up	4 set	15–20 rep	45 seconds
		Pull-Up	4 set	8–10 rep	45 seconds
5	3x	Push-Up	4 set	20–25 rep	30-45 seconds
		Pull-Up	4 set	10–12 rep	30-45 seconds
6	3x	Push-Up	5 set	20–25 rep	30 seconds
		Pull-Up	5 set	10–12 rep	30 seconds

RESULTS AND DISCUSION

Based on the results of the study, the shooting distance measurements showed an improvement in ability following the push-up and pull-up exercise programmes. The average pretest shooting distance was 12.4 metres, whereas the average posttest distance increased to 15.0 metres. This represents an average increase of 2.6 metres, or about 21.2%. All participants showed an increase in shooting distance, with individual increases ranging from 2.3 to 3.2 metres. These data show that training programmes have a positive and consistent effect on players' long-range shooting ability, indicating a practically meaningful improvement in shooting performance for school-level handball players.

Accuracy shooting ability also improved after the programme. The average accuracy value at the time of the pre-test was 4.2, increasing to 6.6 after the exercise programme. The average increase was 2.4 points (57.1%). Improved accuracy was observed in all participants, with an increase in score of 2–3 points. This demonstrates that push-ups and pull-ups not only enhance shot power, but also promote improved shooting stability and control, resulting in greater accuracy, which is particularly relevant for improving scoring effectiveness in game situations.

Table 3. Pretest and Posttest Shooting results (range & accuracy)

Measured variables	Average Pretest	Average Posttest	Increment Difference	Percentage Increase
Shooting distance (meters)	12.4 m	15.0 m	+2.6 m	21.2%
Shooting Accuracy	4.2	6.6	+2.4	57.1%

Table 4. Statistical Test Results

Variable	Test Type	t-count	t-table (α=0.05)	Description
Shooting Distance	Paired Sample t-test	16.52	2.20	Signifikan
Shooting Accuracy	Paired Sample t-test	14.77	2.20	Signifikan

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Table 5. Comparison Between Groups (Independent t-test)

Variable	Mean Treatment Group	Mean Control	t-count	t-table
Shooting Distance	15.0	12.4	5.87*	2.20
Shooting Accuracy	6.6	4.2	6.11*	2.20

Analysis using a paired-sample t-test showed significant increases in both the shooting distance ($t = 16.52$; $p < 0.05$) and shooting accuracy ($t = 14.77$; $p < 0.05$) variables between the pre-test and post-test values. These results were accompanied by large effect sizes (Cohen's $d > 0.80$), indicating a strong practical impact of the intervention. Prior to hypothesis testing, data normality and homogeneity assumptions were examined and met, supporting the appropriateness of parametric statistical analysis. This indicates that push-ups and pull-ups significantly enhance shooting ability in this group. Furthermore, an independent t-test comparing the treatment and control groups also showed significant results for both variables ($p < 0.05$). These results indicate that the observed improvements were associated with the given exercise programme rather than routine extracurricular training. Therefore, the research hypothesis is supported within the context and limitations of the present sample.

Biomechanically, the handball shooting movement requires the coordination of arm, shoulder, back and upper body strength. Bhakti, (2024) explained that shooting performance is influenced by the kinetic chain of motion between the shoulder, arm and torso muscles that contribute to the production of throwing force. Push-ups exercise the pectoralis major, triceps and deltoid muscles, which play a role in propelling the ball forward, while pull-ups strengthen the latissimus dorsi, rhomboids and biceps brachii, which affect shoulder stability and motion control when shooting. This explains the consistent improvement in both performance indicators.

This finding is also consistent with the research of Dolebo, (2021) and (Ethiraj, 2024) who found that specific strength training programmes can enhance power and motor coordination components related to handball players' shooting performance. Furthermore, (R. Hammami, 2022) research showed that resistance exercises involving the upper body could significantly enhance technical skills, such as passing and shooting, in adolescent players. This supports the results of this study, which found that simple bodyweight exercises are also effective in improving shooting ability.

Anthropometric factors also influence the effectiveness of shooting (Azizah & Nurrochmah, 2024; Prayoga & Nurrochmah, 2024). Abdel-aziem, 2024) states that body characteristics such as height and plantar pressure distribution affect the mechanics of shooting movements in handball players. While this study did not analyse anthropometric aspects, the relatively consistent improvement across participants suggests that the training programme may be beneficial for players with varying physical characteristics, although this interpretation should be made cautiously.

An increase in shooting accuracy that exceeds an increase in distance suggests that this exercise increases muscle strength and supports motor stability. Köse, (2023) states that shoulder joint stability and movement control are important factors affecting shooting accuracy in handball games. Thus, the improved accuracy observed in this study may be associated with enhanced neuromuscular control resulting from structured, repetitive exercise.

Additionally, consistent improvements in performance across the sample demonstrated the effectiveness of simple, inexpensive, calisthenics-based exercises, even when professional devices such as resistance bands or weight machines were not used, as in the study by Negra et al., (2024). This is particularly relevant in the context of sports coaching in schools with limited training facilities and resources. The results of this study have important implications for developing handball training programmes in a school environment, particularly in extracurricular contexts with limited facilities. However, claims of effectiveness should be interpreted carefully due to the small sample size and short intervention duration.

This is important because shooting ability is a key technical element in handball performance, strongly influenced by the strength of the arms, shoulders, and upper back, as described in biomechanical studies (Arabaci et al., 2024) These studies affirm the importance of body stability

and control in shooting performance. The findings of this study also reinforce the recommendation of simple, resistance-based training (M. Hammami & Zmijewski, 2024), that strengthening the upper body contributes directly to improving the technical abilities of teenage handball players.

From a training perspective, development can form the basis of progressive training models, which can then be combined with other methods, such as plyometric or circuit training. This approach is recommended by (Ethiraj, 2024) and (Agualimpia, 2025) to achieve more comprehensive performance improvement. Nevertheless, further studies involving larger samples and longer intervention periods are required to confirm and generalise these findings. This study theoretically extends the empirical evidence that simple exercises can produce significant motor and physical adaptations while encouraging further research to evaluate the relationships between exercise duration and intensity and anthropometric factors that influence shooting performance. This study's implications not only support the implementation of practical exercises in schools but also enrich the scientific literature on the effectiveness of calisthenics-based training methods in developing beginner handball performance.

CONCLUSION

Push-ups and pull-ups have been proven to increase muscle strength in the arms, shoulders and back, as well as improving body coordination and stability, which supports distance and shooting accuracy. This exercise programme is effective, simple and inexpensive, and can be used in school PE lessons or in environments with limited facilities. Therefore, the research hypothesis that push-up and pull-up exercises can improve the shooting performance of handball players is accepted. Further research is recommended to investigate the effects of variations in duration and intensity, as well as combinations of exercise methods such as plyometric, resistance band, or circuit training. Additionally, it is important to analyse the influence of anthropometric factors, training age, and the basic abilities of athletes in order to understand the effectiveness of training for groups of players with different characteristics.

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