Vol. 13 No. 2 September 2026
e-ISSN: 2807-2227
p-ISSN: 2355-4355

Changes in Petanque Shooting Accuracy Following Imagery Training Among Regional Athletes

Josia Familya Hidayah[1], Susi Yundarwati[2], Sri Erny Muliyani[3]
Program Studi Pendidikan Olahraga dan Kesehatan, Fakultas Ilmu Keolahragaan dan Kesehatan Masyarakat, Universitas Pendidikan Mandalika, Mataram, Indonesia

Authors Email: josia20266@gmail.com, susiyundarwati@undikma.ac.id, sriernymuliyani@undikma.ac.id

Correspondent Author: susiyundarwati@undikma.ac.id

Received: May 11, 2026; Accepted: August 21, 2026; Published: September 30, 2026
Ed:2026: 591-607

Abstract

Shooting accuracy is an important component in petanque performance that requires technical coordination and mental readiness. Imagery training has the potential to support movement preparation, but evidence regarding changes in shooting accuracy in regional athletes still requires strengthening. This study aims to analyze changes in petanque shooting accuracy before and after the imagery training program in Pelatda athletes in North Lombok Regency. The study used a quantitative approach with a one-group pretest–posttest pre-experimental design. A total of 11 athletes participated in a structured imagery training program over 16 meetings. Shooting accuracy was measured using a precision shooting test consisting of five stations with throws distances of 6–9 meters. Data were analyzed using descriptive statistics, Shapiro–Wilk normality test, paired t-test, and Cohen's effect size dz. The average shooting score increased from 13.273 ± 5.985 in the pretest to 23.818 ± 6.493 in the posttest. The paired t-test showed a significant difference in overall scores, $t(10) = -17.773$; $p < 0.001$, with an average increase of 10.545 points. Significant changes were found at Stations 1, 2, and 3, while Stations 4 and 5 showed no significant differences. All athletes experienced an overall increase in scores. Petanque shooting accuracy showed improvement after the imaging training period, but the changes between stations were not uniform. Because the study did not use a control group, these results could not prove the causal contribution of imagery training separately from other training factors.

Keywords: shooting accuracy; petanque athletes; imagery; mental training; precision shooting.

INTRODUCTION

Petanque is a branch of precision sport whose throwing success depends on precise target identification, movement control, and adjusting the ball's trajectory to the task conditions. In competitions, athletes use the pointing technique to place the ball as close as possible to the target ball (jack), while the shooting technique aims to shift the opponent's ball or a specific target. Performing precision shooting demands consistent body position, arm movement coordination, ball release timing, and regulation of throwing power. These technical demands become more complex when athletes face variations in distance and target configuration. Previous research has examined physical characteristics, movement control, and special shooting training as relevant factors to petanque athlete performance (Kurniawan et al., 2022; Phytanza et al., 2022; Syahwira et al., 2022) . Clanet and Maillet (2025) also examined the relationship between throwing distance and accuracy in petanque, reinforcing the importance of considering distance in evaluating the performance of directed movements on targets.

Shooting accuracy is not only determined by physical readiness. Posture stability and coordination of upper limb movements are related to attention demands during preparation and execution of throws. Several studies on petanque athletes have examined balance, concentration, as well as technical and physical characteristics related to shooting performance (Solihin et al., 2022; Rhamadhan et al., 2023). Research on quiet eye behavior also examines the components of visual attention in petanque performance (Selva et al., 2023). These findings provide a basis for examining

the importance of psychological readiness, but the correlation between attention characteristics and performance does not directly prove that changes in psychological skills will improve shooting accuracy. Therefore, intervention research needs to distinguish shooting skill results measured directly from psychological mechanisms that have not yet been measured.

Within the regional training center (Pelatda) environment of North Lombok Regency (KLU), initial research documentation shows inconsistency in the implementation of shooting techniques, especially when athletes face competition situations that require high readiness. These observations illustrate difficulties in maintaining focus on targets, controlling technique execution, and producing accurate throws under pressure situations. This issue indicates a practical need in the coaching process but is not yet supported by separate initial measurements of attention, anxiety, self-confidence, and emotional regulation. Thus, the empirical problem that can be measured in this study is the change in shooting accuracy between measurements before and after the implementation of the imagery-based training program. This distinction is important so that the trainer's observations regarding psychological readiness are not treated as intervention outcomes that have been measured directly.

Motor imagery is a form of mental training where individuals build sensory representations and movement characteristics without having to perform actual physical actions. In the context of sports, athletes can imagine movement sequences, estimate contact with targets, and represent coordination and timing of technique execution. This approach is relevant to petanque shooting because the skill involves directed actions on targets that can be mentally trained before physical practice. Mao et al. (2022) examine differences in imagery ability based on the level of movement mastery, while Corrado et al. (2024) and Lee et al. (2023) highlight the potential of structured cognitive strategies in the psychological preparation of precision sports. Nevertheless, imagery training cannot be directly assumed to improve concentration or self-confidence in a particular group of athletes if these two variables are not specifically measured.

Empirical research directly involving petanque athletes provides a more specific foundation regarding the application of mental training to shooting performance. Rony et al. (2021) studied the relationship between mental imagery and petanque shooting accuracy through a pretest–posttest approach, while Wijaya et al. (2024) examined internal imagery and external imagery ttraining inpetanque athletes. Perdana et al. (2022) developed imagery and self-talk training for petanque athletes, while Rizal et al. (2021) studied self-talk as a different mental training strategy. Additionally, Abdurrahman et al. (2024) conducted a literature review on the application of imagery in petanque shooting skills. Overall, the study shows that mental training is not a completely new approach in petanque. Previous research also shows differences between the application of imagery alone and multicomponent psychological interventions, which cannot be considered to have identical mechanisms or contributions.

Research evidence from other sports that require target accuracy provides additional perspective, although not entirely generalizable to petanque. Gmamdya et al. (2023) studied the combination of motor imagery, action observation, and coach feedback on the accuracy of young archery athletes. Rahman and Islam (2021) studied the direct effects of imagery training on free-throw accuracy, showing the relevance of mental training in target-oriented skills, but the biomechanical characteristics of movement, training context, and intervention components differ from petanque shooting. Deng et al. (2024), through a systematic review and meta-analysis, found potential benefits of imagery on tennis accuracy and serving techniques, but assessed the certainty of evidence to be low to very low. Reinebo et al. (2024) also synthesized various psychological

interventions in sports and emphasized the need to consider research design heterogeneity, intervention characteristics, and outcome indicators.

Based on the synthesis of previous research, there are three underlying gaps in this study. First, the outcome-specific gap, which is the difference between the assessment of total shooting scores and performance across various target configurations. The overall score potentially hides variations in skill changes at each station. Second, the instructional-context gap, which is the limited application of findings from other petanque clubs, beginner athlete groups, or different sports branches to athletes participating in structured training camps at Pelatda KLU. Third, methodological gap, which tends to interpret performance improvement after intervention because of exclusive treatment, even though the study did not use a comparison group, did not measure psychological mechanisms, and did not control for the effects of regular physical training and familiarity with testing procedures. These three gaps indicate the limitations of evidence in this research context, not that imagery training or petanque shooting skills have never been studied before.

The novelty of this research lies in the evaluation of changes in petanque shooting accuracy through the implementation of a structured imagery training program based on the PETTLEP principle on experienced athletes within the regional training center (Pelatda) environment of North Lombok Regency. Unlike the research by Rony et al. (2021) who examined mental imagery on the accuracy of petanque shooting, Wijaya et al. (2024) who compared internal imagery and external imagery, and Perdana et al. (2022) who developed a ccombination ofimagery and self-talk training, this study provides empirical contributions through three specific characteristics. First**,** the study was conducted on experienced athletes participating in the KLU Pelatda program in preparation for Porprov NTB 2026. Second, performance evaluation was conducted not only using total shooting scores but also analyzed skill changes at five stations with variations in target configuration and throwing distances of 6, 7, 8, and 9 meters, so that differences in performance development patterns between tasks could be identified. Third**,** the study evaluates performance changes after the structured imagery training program conducted over 16 meetings and integrates movement visualization, direction control and throwing power, and match simulation with shooting technique practice. Thus, the original contribution of this research is the provision of specific empirical evidence regarding overall shooting performance changes and based on station characteristics in the context of regional athlete development through structured imagery programs.

Based on these problems and gaps, this study aims to analyze the differences in petanque shooting accuracy, both based on total scores and scores at each station, between measurements before and after imagery training on KLU Pelatda athletes. The alternative hypothesis (H1) states that there is a significant difference in the average total shooting scores between the pretest and posttest, while the null hypothesis (H0) states that there is no difference in the mean between the two measurements. The study used a quantitative approach with *a* one-group pretest–posttest pre-experimental design to evaluate performance changes within the same group of athletes. Because it did not involve control groups or randomize participants in the treatment, the observed improvements should be interpreted as changes after the training period, not as definitive evidence that imagery training was the sole cause of those changes. This study also did not allow conclusions to be drawn regarding improvements in concentration, self-confidence, anxiety, or emotion regulation without special measurement of these variables.

METHODS

Research Design

This study uses a quantitative approach with a one-group pretest–posttest design. This design involves one group of athletes who underwent shooting accuracy measurements before (pretest) and after (posttest) in imagery training. The study is categorized as pre-experimental because it did not involve the control group nor randomize participants into the treatment group. Thus, the research design was used to identify changes in shooting performance within the same group, not to definitively establish cause-and-effect relationships. The use of measurements before and after training was also found in imaging research on petanque sports, although the strength of inference depends on the design characteristics and procedures applied (Rony et al., 2021; Wijaya et al., 2024). The research design consisted of three stages: initial measurement (O_1), implementation of imaging training (X), and final measurement (O_2). The intervention variable was imaging training, while the outcome variable was shooting accuracy, expressed through the petanque shooting skills test score. The difference in scores between the two measurements was the main indicator of changes in athlete performance during the study period.

Participants and Sampling Technique

The subjects in this study are 11 petanque athletes from the North Lombok Regency (KLU) Regional Training Center (Pelatda) consisting of 6 male athletes (54.55%) and 5 female athletes (45.45%), with an age range of 23–26 years. All athletes have 10 years of training experience and have been declared to have passed the selection to strengthen the North Lombok Regency contingent in facing the West Nusa Tenggara Provincial Sports Week (Porprov) in 2026. Based on competition experience, the athletes have participated in international level petanque tournaments held in Indonesia, including the UNDIKMA International Open Tournament. These characteristics show that the research subjects are experienced athletes who have the basis of technical skills and experience competing at a competitive level. Thus, this group of athletes is relevant to evaluate the application of imagery training in improving the accuracy of petanque shooting, especially in athletes who are undergoing preparation for provincial level competitions. In this context, the study does not aim to generalize broadly to all Petanque athletes, but rather to evaluate the practical effects of image training among athletes in the Pelatda KLU environment. The participants were treated as an experimental group and each athlete served as their own comparison through pre-test and post-test measurements.

Research Instrument

The instrument used in this study was the Petanque shooting precision test, adapted from the shooting precision format described by Souef Gilles (2015). The test was designed to measure athletes' ability to execute shooting accurately across several target situations and distances. In the original manuscript, the test consisted of a line shooting format with five stations and four shooting distances, namely 6 meters, 7 meters, 8 meters, and 9 meters. Each athlete completed shooting attempts across all stations, and the score was recorded based on the result of each shot. The scoring system used values of 0, 1, 3, and 5 points, depending on the quality of the shot. A score of 5 was awarded when the athlete hit the target cleanly according to the station requirement, while lower scores were given when the shot touched or displaced the target less effectively. A score of 0 was given when the athlete failed to hit the target or hit an obstacle in a station where obstacles had to be avoided. This scoring structure reflects the official logic of Petanque shooting performance, where precision, target contact, and target displacement are central criteria for evaluating performance.

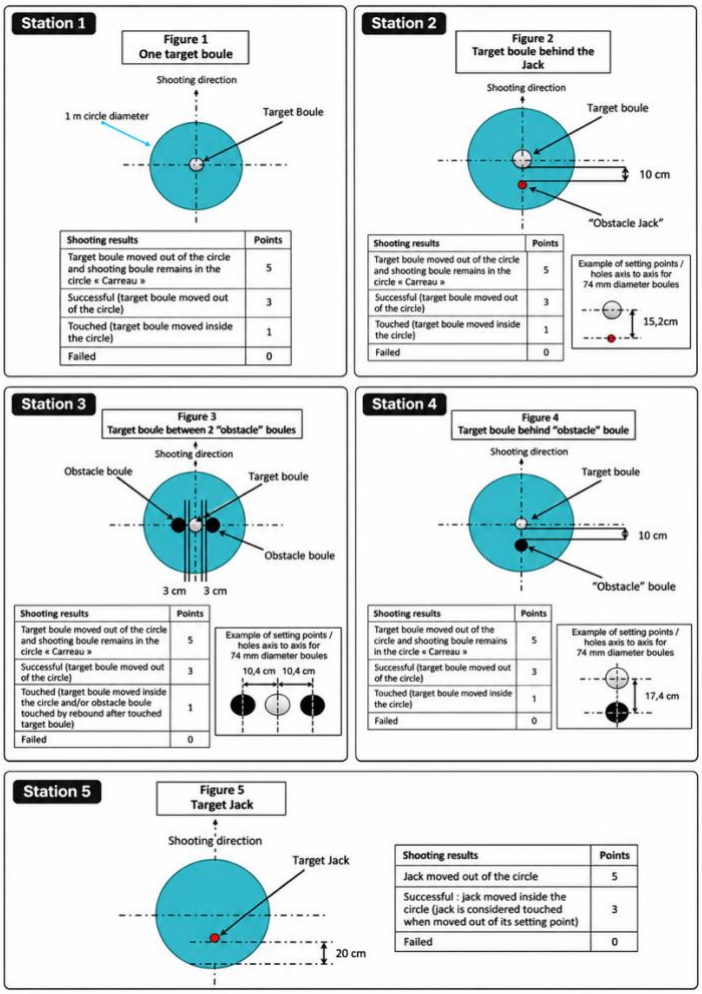


Figure 1. Line Shooting (Gilles, 2015)

The test has strong content relevance because it reflects actual Petanque shooting demands, including different target configurations, varying distances, and station-based scoring. Previous literature indicates that fixed distances and multiple shooting stations support the content validity of Petanque shooting tests because they represent the technical requirements of the sport and its competition structure (Chmiel & Buryta, 2025; Md Rashad Al Hasan Rony dkk., 2021; Rasyono & Yanto, 2024; Selva dkk., 2023; Wijaya dkk., 2024). The test is also responsive to training effects, as several intervention studies have reported significant pretest–posttest changes in shooting accuracy after mental training or sport-specific training interventions (Abdurrahman dkk., 2024; Corrado dkk., 2024; Md Rashad Al Hasan Rony dkk., 2021; Syahwira dkk., 2022). However, because many Petanque studies do not report detailed reliability indicators such as test–retest or inter-rater reliability, this remains a methodological limitation that should be considered when interpreting results.

Imagery Training Procedure

The imagery training program is designed to improve the shooting accuracy of Petanque athletes in North Lombok Regency through the integration of mental training and technical skill practice. The program consists of 16 training sessions with a frequency of three times per week and a duration of 60–75 minutes per session. The training material is developed based on empirical studies on the application of mental imagery in the sport of petanque and the principles of PETTLEP which emphasizes the suitability of visualization with the characteristics of movement and match situations.

The program is arranged in four progressive phases, including the introduction and mastery of imagery, reinforcement of precision and movement control, training of target variation, and integration of imagery in match simulation. Each session includes warm-up, relaxation, mental visualization exercises, shooting practice, and reflection. Visualization is directed at body position, arm swing, power regulation, ball release, throw trajectory, target contact points, and follow-through movements. Skill practice is carried out at distances of 6, 7, 8, and 9 meters using target configurations relevant to five precision shooting petanque test stations. Shooting accuracy measurements are carried out before and after the treatment series using the same instruments to evaluate changes in athlete performance. The program is designed considering the participants' training experiences as well as the technical and psychological demands faced in petanque competitions.

The use of imagery training is supported by previous research on mental training interventions in precision sports. Studies in Petanque and related target-based sports have shown that imagery, self-talk, relaxation, and other cognitive strategies can improve shooting accuracy and performance outcomes (Abdurrahman dkk., 2024; Md Rashad Al Hasan Rony dkk., 2021; Rasyono & Yanto, 2024; Wijaya dkk., 2024). Some studies also indicate that imagery may become more effective when combined with physical practice, action observation, coach feedback, or other mental routines (Henkaryansyah dkk., 2024; Muhammad Naufal Al Fadhil Ramadhan dkk., 2023; Rizal dkk., 2021). In this study, imagery training was therefore treated as a structured mental intervention aimed at improving concentration, technical visualization, confidence, and execution consistency.

Training Phase	Imagery Training Material	Training Procedures	Training Objectives
Phase I: Imagery Adaptation and Acquisition	Introduction to imagery and relaxation	Breathing exercises, relaxation, and visualization of body positioning during shooting.	Develop athletes' mental readiness.
	Internal imagery	Mentally rehearsing arm swing, ball release, and follow-through movements.	Strengthen mental representations of shooting movements.
	External imagery	Observing shooting technique videos and visualizing movements at 6 m.	Improve understanding of shooting techniques.
	Target-focused imagery	Visualizing the target before shooting attempts at 6-7 m.	Enhance concentration on the target.
Phase II: Shooting Accuracy and Motor Control Development	Trajectory imagery	Visualizing ball trajectories and target contact points at 7 m.	Improve directional accuracy.
	Kinesthetic imagery	Mentally experiencing arm swing and ball release sensations at 7-8 m.	Enhance motor control.
	Force-control imagery	Visualizing force regulation during shooting at 8-9 m.	Improve throwing force adjustments.
	Distance-adjustment imagery	Combining visualization and shooting practice at 6, 7, 8, and 9 m.	Improve shooting consistency across distances.
Phase III: Target Variation and Technical Complexity	Target and obstacle imagery	Visualizing shooting tasks at Stations 1 and 2 with different target configurations.	Improve accuracy in obstacle-based situations.
	Precision imagery	Visualizing shooting tasks at Station 3 with two obstacle boules.	Enhance ball trajectory precision.
	Obstacle-control imagery	Visualizing shooting tasks at Station 4 involving an obstacle boule.	Improve directional control during shooting.
	Small-target imagery	Visualizing shooting tasks at Station 5 targeting the jack at 6-9 m.	Improve accuracy when shooting at smaller targets.
Phase IV: Imagery Integration and Competition Simulation	Integrated shooting imagery	Performing mental visualization before shooting practice across five stations.	Integrate imagery with technical execution.
	Pressure-situation imagery	Mentally rehearsing competitive situations involving distractions and scoring pressure.	Improve psychological readiness under pressure.
	Pre-shot imagery routine	Performing brief visualization before each shooting attempt during simulated competition.	Maintain concentration and movement consistency.
	Competition imagery simulation	Conducting simulated competitions involving five stations at 6-9 m.	Consolidate shooting accuracy under competitive conditions.

Figure 2. Imagery Training Program

Data Collection and Data Analysis

Data were analyzed using descriptive and inferential statistics. Descriptive analysis included the number of participants, mean, standard deviation, standard error, and score differences before and after the exercise. Score changes were calculated using the difference between the posttest and pretest results, so a positive value indicates improved performance. Before hypothesis testing, the assumption of the normal distribution was examined. The original manuscript reported the Kolmogorov–Smirnov and Shapiro-Wilk tests on pretest and posttest scores. For the paired-samples t-test analysis, the relevant normality assumption is the distribution of the difference scores for each measurement pair. Therefore, the normality results of the pretest and posttest separately are not sufficient to confirm

these assumptions. Examination of the difference score distribution needs to be conducted based on individual data before the analysis decision is declared final (Arnastauskaitė et al., 2021; Avram & Mărușteri, 2022).

Hypothesis testing used a paired-samples t-test to assess the difference in average shooting scores at both measurement times, with a significance level of $\alpha = 0.05$. The analysis results were reported through t-values, degrees of freedom, p-value, mean difference, and 95% confidence interval. If the normality assumption of difference scores is insufficient, the use of nonparametric alternatives should be considered. The magnitude of standardized changes was reported using Cohen's d for paired data and Hedges' correction according to the available analysis output. The interpretation of effect size must specify the standardization method used. The magnitude of effect size is not interpreted as evidence of intervention superiority compared to groups that did not receive imagery training. Reporting changes in performance and effect size is important to distinguish statistical significance from the magnitude of changes observed in athletes (Harry et al., 2024).

RESULTS

Eleven Petanque athletes from North Lombok Regency (KLU) completed shooting accuracy assessments before and after imagery training. The precision shooting test comprised five stations at distances of 6, 7, 8, and 9 m. The findings are presented in the original order of descriptive statistics, normality testing, paired-samples comparisons, graphical score differences, and standardized effect sizes.

Table 1. Descriftive statistic

Descriptive Statistics

	Valid	Missing	Mean	Std. Deviation	Minimum	Maximum
Station 1 pre-test	11	0	3.818	2.316	1	8
Station 2 pre-test	11	0	2.182	1.537	0	5
Station 3 pre-test	11	0	2.455	1.44	1	5
Station 4 pre-test	11	0	3.273	2.24	0	7
Station 5 pre-test	11	0	1.545	1.864	0	5
Shooting pre-test	11	0	13.273	5.985	6	23
Station 1 post-test	11	0	7.364	2.693	3	12
Station 2 post-test	11	0	4.909	1.578	3	7
Station 3 post-test	11	0	4.909	1.578	3	7
Station 4 post-test	11	0	4.182	1.25	3	6
Station 5 post-test	11	0	2.455	1.809	0	6
Shooting post-test	11	0	23.818	6.493	17	36

Table 1 shows that all 11 athletes provided complete pretest and posttest data, with mean total shooting scores increasing from 13.273 (SD = 5.985) to 23.818 (SD = 6.493), equivalent to a mean gain of 10.545 points; the cumulative total rose from 146 to 262. Every athlete obtained a higher posttest total, with individual gains ranging from 8 to 14 points. The largest station-level mean gains occurred at Station 1 (3.545), Station 2 (2.727), and Station 3 (2.455), whereas Stations 4 and 5 each increased by 0.909 points. This variation indicates that the observed change was not uniform across shooting tasks, a distinction relevant to multistation Petanque assessment as used by Phytanza et al. (2022) and Nurhidayat et al. (2024). Clanet and Maillet (2025) also showed that shooting accuracy can vary with distance and target characteristics, although the present data cannot isolate those factors or establish why the stations differed.

Table 2. Normality Test Results

	Valid	Missing	Shapiro-Wilk	P-value of Shapiro-Wilk
Station 1 pre-test	11	0	0.92	0.322
Station 2 pre-test	11	0	0.901	0.193
Station 3 pre-test	11	0	0.835	0.028
Station 4 pre-test	11	0	0.891	0.142
Station 5 pre-test	11	0	0.752	0.002
Shooting pre-test	**11**	**0**	**0.914**	**0.271**
Station 1 post-test	11	0	0.865	0.066
Station 2 post-test	11	0	0.876	0.092
Station 3 post-test	11	0	0.876	0.092
Station 4 post-test	11	0	0.807	0.012
Station 5 post-test	11	0	0.774	0.004
Shooting post-test	**11**	**0**	**0.892**	**0.146**

Table 2 retains the original Shapiro–Wilk tests for the separate pretest and posttest distributions; significant departures were reported for Station 3 pretest (p = .028), Station 5 pretest (p = .002), Station 4 posttest (p = .012), and Station 5 posttest (p = .004). For a paired-samples t-test, however, normality concerns the within-athlete score differences rather than the two separate distributions (Arnastauskaitė et al., 2021; Avram & Mărușteri, 2022). Reanalysis of the individual differences yielded W = 0.946, p = .590 for the total shooting score, so the normality assumption was not rejected for the primary analysis; corresponding station-level p-values were .341, .518, .790, and .495 for Stations 1–4, but Station 5 departed from normality (W = 0.778, p = .005). Accordingly, the paired t-test is defensible for the total outcome, while a Wilcoxon signed-rank check was additionally performed for Station 5; non-significant normality tests should not be interpreted as proof of a normal distribution.

Table 3. Paired-Samples T-Test Result

Paired Samples T-Test

Measure 1		Measure 2	t	df	p	Mean Difference	SE Difference	95% CI for Mean Difference	
								Lower	Upper
Station 1 pre-test	-	Station 1 post-test	-5.56	10	< .001	-3.545	0.638	-4.966	-2.125
Station 2 pre-test	-	Station 2 post-test	-7.111	10	< .001	-2.727	0.384	-3.582	-1.873
Station 3 pre-test	-	Station 3 post-test	-3.614	10	0.005	-2.455	0.679	-3.968	-0.941
Station 4 pre-test	-	Station 4 post-test	-1.202	10	0.257	-0.909	0.756	-2.594	0.776
Station 5 pre-test	-	Station 5 post-test	-1.715	10	0.117	-0.909	0.53	-2.09	0.272
Shooting pre-test	**-**	**Shooting post-test**	**-17.773**	**10**	**< .001**	**-10.545**	**0.593**	**-11.868**	**-9.223**

Note. Student's t-test.

Table 3 demonstrates a significant pretest–posttest difference in the total shooting score, t(10) = −17.773, p < .001, with a pretest-minus-posttest mean difference of −10.545 points (95% CI [−11.868, −9.223]); expressed as improvement, this is a gain of 10.545 points (95% CI [9.223, 11.868]). Station 1 (p < .001), Station 2 (p < .001), and Station 3 (p = .005) showed significant differences, and these remained significant after Holm adjustment across the five secondary station tests, whereas Station 4 (p = .257) and Station 5 (p = .117) did not. The supplementary two-sided Wilcoxon test for Station 5 was also non-significant (W = 1.0, p = .125). Studies using comparable Petanque station tests (Nurhidayat et al., 2024) and imagery-related precision-sport interventions (Keskin & Van Den Berg, 2025) provide contextual support for evaluating performance changes, but

their distinct interventions and designs cannot establish that imagery alone caused the differences observed here.

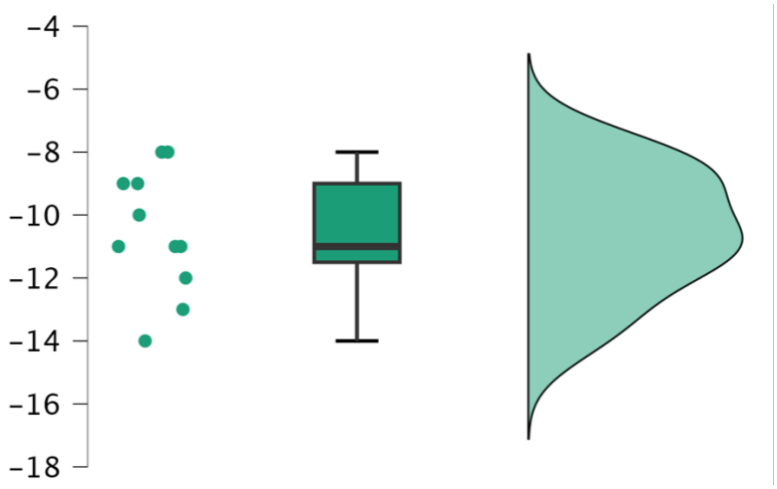


Figure 3. Comparation pre and post test shooting result

Figure 3 displays the 11 paired total-score differences calculated as pretest minus posttest, ranging from -14 to-8 points, all plotted differences are negative because every athlete scored higher at posttest. The distribution therefore illustrates that the total-score increase was observed across the entire participating group, rather than being driven solely by a few positive cases, while still showing variation in individual gains. Because the figure represents only two measurements without an untreated comparison group or follow-up assessment, it cannot distinguish imagery-specific improvement from additional practice, test familiarity, or retention. This restriction is relevant when contrasted with the repeated-measure and retention assessments used to evaluate imagery frequency in the experimental study by Itoh et al. (2022).

Table 4. Paired-Samples Effect Size

Measure 1		Measure 2	Cohen's d	SE Cohen's d	95% CI for Cohen's d	
					Lower	Upper
Station 1 pre-test	-	Station 1 post-test	-1.676	0.39	-2.595	-0.726
Station 2 pre-test	-	Station 2 post-test	-2.144	0.447	-3.227	-1.031
Station 3 pre-test	-	Station 3 post-test	-1.09	0.568	-1.829	-0.318
Station 4 pre-test	-	Station 4 post-test	-0.362	0.429	-0.965	0.257
Station 5 pre-test	-	Station 5 post-test	-0.517	0.307	-1.138	0.126
Shooting pre-test	**-**	**Shooting post-test**	**-5.359**	**0.36**	**-7.737**	**-2.97**

Table 4 reports the standardized within-athlete differences, with a total shooting Cohen's d_z of -5.359 (95% CI [-7.737, -2.970]) for the pretest-minus-posttest contrast; the negative sign therefore denotes higher posttest scores, not performance deterioration. The station-specific estimates were -1.676, -2.144, -1.090, -0.362, and -0.517, respectively, indicating larger standardized changes at Stations 1-3 than at Stations 4-5; the intervals for Stations 4 and 5 include zero. These estimates describe changes relative to the standard deviation of paired differences, rather than a controlled treatment effect (Harry et al., 2024). The small single-group sample also warrants caution when interpreting very large, standardized changes, while Deng et al. (2024) reported low-to-very-low evidence certainty specifically for motor imagery and tennis-serving performance; that finding cannot be directly generalized to Petanque.

Overall, these findings indicate a consistent improvement in the shooting performance of Petanque athletes following a period of imagery training, with all participating athletes achieving

higher scores in the final assessment. However, the magnitude of this improvement varied across different shooting stations. The initial stations showed more pronounced changes-supported by statistical evidence-whereas the later stations showed smaller improvements that did not reach statistical significance. Inferential analysis, standardized effect estimates, and graphical distributions consistently point to positive changes in each athlete's shooting performance. Nevertheless, these findings should be interpreted as improvements observed during the training period, rather than definitive proof of a direct causal effect from the imagery training itself. While this study provides empirical evidence specific to the context of developing shooting performance among regional-level Petanque athletes, it does not yet account for the individual contributions of specific training components or the underlying psychological mechanisms that remain unmeasured.

DISCUSSION

This study shows an overall improvement in petanque shooting performance after regional athletes participate in a structured imagery training program. Although performance improvements are consistently seen in the overall score, these changes do not show a uniform pattern at each station. Some stations show clearer skill development supported by inferential test results, while others show more limited changes and have not provided convincing statistical evidence. These differences in patterns indicate that overall shooting performance development is not always accompanied by equal improvements in each task configuration. These findings provide empirical evidence of performance changes within the same group of athletes during the training period, but do not yet prove that imagery training is the sole factor causing this improvement. Furthermore, concentration, self-confidence, emotion regulation, and imagery ability were not directly measured and should therefore be positioned as possible explanatory mechanisms, not as research results.

Interpretation based on task characteristics is important because petanque shooting skills require coordination of body position, ball release, and regulation of throwing force directed at the target. Al Ardha et al. (2024) documented differences in kinematic characteristics between pointing and shooting techniques, while Helmi et al. (2024) synthesized biomechanical aspects related to the execution of petanque shooting. In another study, Zulbahri et al. (2024) examined the relationship between shooting performance and eye-hand coordination, concentration, and arm length, while Pratama et al. (2024) identified relevant physical characteristics in petanque athletes. Overall, the study indicates that shooting performance is related to the interaction of technical and physical demands, not determined by a single mental process. Differences in development between stations in this study may be related to variations in target configuration demands, but these factors were not manipulated or measured separately. Therefore, non-uniform changes cannot be directly interpreted as ineffectiveness of imagery training at certain distances or configurations without more specific evidence support.

Theoretically, motor imagery training can provide a reasonable explanation of how athletes organize movement preparation before making the throw. The process of imagining actions can help athletes form structured representations of body posture, movement sequences, ball release, and expected contact with the target before physical execution. Lindsay et al. (2023) show that different pedagogical approaches in motor imagery learning can produce individual movement patterns, so the use of one form of mental instruction cannot be assumed to provide the same response to all athletes. Fazel et al. (2022) examine the progressive presentation of imagery material in basketball athletes and emphasize the importance of integrating increasingly challenging performance situations. Su et

al. (2025) described the systematic and supervised implementation of imagery training in a case study of elite Taijiquan athletes, while Song et al. (2025) studied visualization in controlling attack direction and movement distance in fencing. The study supports the rationality of using imagery training developed gradually, even though participant characteristics and motor tasks differ from petanque. However, the research design has not yet identified which components in the combination of imagery training and physical practice contribute the most to performance changes.

Research on other sports that require target accuracy generally shows the potential use of imagery, while also showing differences in the implementation of interventions and measurement of results. Yachsie et al. (2023) studied the combination of imagery and meditation in archery, while Khairunnisa et al. (2024) examined imagery and concentration training in basketball free throw skills. El-Saleh (2023) evaluated mental visualization in basketball shooting skill learning for beginners, while Albaitomi et al. (2025) studied imagery training and concentration on soccer free kick accuracy. Kapre et al. (2025) examined the immediate post-imagery changes in ball passing and ball control skills in soccer. Although the research is relevant to skills that require accuracy, none directly isolated the mechanisms at work in petanque athletes in this study. Interventions that combine imagery with meditation, mindfulness training, or other psychological components also cannot be used as evidence of the contribution of imagery training alone. Thus, the relevance of previous research mainly lies in the importance of matching task characteristics, instructional content, and outcome indicators when comparing cross-sport findings.

The literature also provides reasons not to assume that every form of mental training is always superior to others. Wattimena et al. (2025) compared imagery and relaxation methods in beginner archery athletes, showing that various psychological strategies can have practical usefulness depending on their application conditions. Welis et al. (2024) found that the benefits of internal imagery and external imagery in futsal athletes can differ based on participants' confidence levels, whereas these characteristics were not measured in this study. Budnik-Przybylska et al. (2024) studied imagery in young soccer players and reported progress in several performance indicators without equal changes across all imagery ability indicators. Meanwhile, Eka Wahyudhi et al. (2025) found no clear differences between several petanque shooting technique training approaches in their comparative study. These findings do not necessarily contradict the improvement patterns in this study due to differences in tasks, participant characteristics, and research design. However, the evidence warns that post-exercise improvement cannot be treated as proof that one psychological technique or strategy is inherently superior to another.

Alternative explanations related to physical and technical training also need to be considered. Latar et al. (2024) examined the relationship between the upper extremity strength training approach and petanque shooting accuracy. Rasyono et al. (2026) evaluated core muscle stability training through research involving intervention and comparison groups, while Santosa et al. (2024) studied conditioning approaches to petanque shooting skills using a design with control groups. The study showed that changes in shooting performance can also occur through interventions that do not focus on imagery, while the use of comparison groups allowed for stronger evaluation of various alternative explanations. In this study, imagery was integrated with shooting technique training, while repeated exposure to test procedures also had the potential to increase athletes' familiarity with measurement tasks. Because there is no comparison group with equivalent practice doses nor imagery training conditions without physical practice, the relative contributions of mental training, technique practice, coach feedback, and test repetition cannot be empirically separated.

Interpreting attention and self-confidence also requires caution. Pelana et al. (2021) studied self-confidence along with physical characteristics in relation to petanque shooting performance, while Ihsan et al. (2026) developed a specific assessment of spatial cognitive skills for elite petanque athletes. Jin et al. (2023) identified visual search characteristics based on the skill level of basketball players. However, the study discussed processes related to attention in different sports branches, not attention changes after imagery training in petanque athletes. Kumenap et al. (2025) evaluated the validity and reliability of visualization and relaxation training programs in fast climbing, emphasizing the importance of operationalization and monitoring of psychological training implementation. Additionally, Li et al. (2026) measured cognitive outcomes through randomized studies on imagery training in college athletes, thus providing an example of the need for additional instruments to support claims related to cognitive function. Current research only measures shooting performance. Thus, the possibility of increased focus, self-confidence, or emotion regulation remains a theoretical hypothesis that needs to be tested in further research.

The contextual contribution of this study lies in providing evidence regarding changes in the performance of experienced athletes participating in regional training camp programs after undergoing structured mental and technical preparation periods. Analysis based on station configuration provides a more detailed picture compared to assessments that only use overall scores, while also showing that skill changes do not always occur uniformly across every task. However, the pre-experimental design without a control group, limited sample size from one training group, unavailability of evaluator blinding information, and absence of follow-up measurements limit generality and the strength of causal inference. The available documentation also does not fully explain the consistency of imagery script implementation, individual compliance with the program, the number of additional technique practices, or the reliability of assessment at each station. These limitations are important because familiarity with testing and consistency of assessment procedures can also affect measurement results. Subsequent research needs to verify scores using the original assessment form, document the prospective implementation of interventions, and distinguish the main outcomes in the form of overall scores from the exploratory analysis of each station.

In coaching practice, the results of this study provide an initial basis to consider imagery as a companion to petanque shooting technique training, not as a substitute for physical practice that has been proven experimentally superior. Coaches can develop task-specific imagery scripts, including movement preparation, visual target identification, arm swings, ball release, and follow-through movements, then increase the complexity of the training towards match-like situations. Fazel et al. (2022) provide examples of progressive imagery material preparation, while Su et al. (2025) emphasize the importance of determining perspective, tempo, environment, and distractions in the implementation of mental training. However, this study has not yet determined the most optimal type of script, visualization perspective, or training dose. Further research needs to compare the combination of imagery and physical practice with equivalent doses of physical training, measure imagery ability and psychological variables separately, and include evaluation of retention and skill transfer to match situations. Overall, this study provides specific empirical evidence regarding the development of shooting performance after training periods in regional athletes, but the causal contribution of imagery training and the sustainability of these changes still require testing through a stronger research design.

CONCLUSION

This study shows an overall improvement in petanque shooting accuracy after Pelatda North Lombok Regency athletes participated in a structured imagery training program. Positive changes were found in all athletes based on overall shooting scores, although performance development did not occur uniformly at each station. More clear improvements, supported by statistical testing, were found at the initial station, while other stations showed descriptive changes that were not yet significant. These findings highlight the importance of evaluating shooting skills based on overall scores and task characteristics at each station to obtain a more comprehensive picture of performance development. The contribution of this study lies in providing empirical evidence regarding changes in shooting performance of experienced athletes in the context of regional sports development through the application of imagery programs integrated with technical training. However, the use of a single-group design without comparison limits causal conclusions because the effects of physical training, test repetition, and other factors cannot yet be separated. Therefore, imagery can be considered as a complementary approach in petanque shooting training, while specific effectiveness, sustainability of results, and psychological mechanisms still require controlled experimental research with more comprehensive measurements.

RECOMMENDATION

Petanque coaches are advised to consider integrating structured imagery training as a companion to shooting technique training, especially in regional athlete development programs. Imagery implementation can be directed towards visualizing targets, body positions, arm swings, power regulation, ball release, and advanced movements before shooting practice. Training programs should be implemented progressively by considering the characteristics of each station and individual athlete abilities. Given that performance development is not uniform, coaches need to pay special attention to stations that have not shown significant changes through technique evaluation, training adjustments, and individual feedback. Regular performance monitoring is necessary to ensure that shooting skill development can be objectively evaluated. Further research is recommended to use a controlled experimental design with a comparison group receiving equivalent physical training doses to identify the specific contribution of imagery to shooting accuracy. The study needs to involve a larger sample from several athlete development centers and apply assessment instruments with documented validity and reliability. Standardization of imagery scripts, training duration, participant compliance, and intervention implementation are also necessary to improve research repeatability. Additional measurements of concentration, self-confidence, imagery ability, and anxiety can be used to test psychological mechanisms that have not been measured in this study. Additionally, retention tests and skill transfer tests to match situations need to be conducted to evaluate the sustainability of performance changes. Future research also needs to analyze the characteristics of each station so that factors related to differences in shooting accuracy development can be explained more deeply.

REFERENCES

Abdurrahman, E., Nasuka, Sulaiman, Raharjo, H. P., & Setyawati, H. (2024). Analysing the mental imagery training to improve the ability of petanque sport shooting game: Literature review. Physical Education Theory and Methodology, 24(3), 474–479. https://doi.org/10.17309/tmfv.2024.3.17

Al Ardha, M. A., Ristanto, K. O., Yang, C. B., Wijayanto, A., Pradana, S. W. K. C., Putra, N. S. R. P., Firmansyah, A., Bikalawan, S. S., Rizki, A. Z., & Utomo, R. S. (2024). Kinematic

movement differences between petanque pointing and shooting technique in children. Retos, 52, 52–61. https://doi.org/10.47197/RETOS.V52.97143

Albaitomi, M. A., Subagio, I., Sabillah, M. I., & Arifin, M. (2025). Improved free kick accuracy: Through imagery training and concentration of soccer players. Sportske Nauke i Zdravlje, 15(2), 184–192. https://doi.org/10.7251/SSH2502184A

Arnastauskaitė, J., Ruzgas, T., & Bražėnas, M. (2021). An exhaustive power comparison of normality tests. Mathematics, 9(7), Article 788. https://doi.org/10.3390/math9070788

Avram, C., & Mărușteri, M. (2022). Normality assessment, few paradigms and use cases. Revista Română de Medicină de Laborator, 30(3), 251–260. https://doi.org/10.2478/rrlm-2022-0030

Budnik-Przybylska, D., Makurat, F., Przybylski, J., & Morris, T. (2024). Effect of imagery training on football players. Baltic Journal of Health and Physical Activity, 16(4), Article 3. https://doi.org/10.29359/BJHPA.16.4.03

Chmiel, J., & Buryta, R. (2025). The effect of transcranial direct current stimulation on basketball performance. A scoping review. Journal of Clinical Medicine, 14(10), Article 3354. https://doi.org/10.3390/jcm14103354

Clanet, C., & Maillet, G. (2025). A D-2 distance–accuracy law of human throwing: Theory and experiments in pétanque shooting. European Physical Journal Plus, 140(11), 1100. https://doi.org/10.1140/epjp/s13360-025-07035-z

Corrado, S., Tosti, B., Mancone, S., Di Libero, T., Rodio, A., Andrade, A., & Diotaiuti, P. (2024). Improving mental skills in precision sports by using neurofeedback training: A narrative review. Sports, 12(3), Article 70. https://doi.org/10.3390/sports12030070

Deng, N., Soh, K. G., Abdullah, B. B., & Huang, D. (2024). Does motor imagery training improve service performance in tennis players? A systematic review and meta-analysis. Behavioral Sciences, 14(3), 207. https://doi.org/10.3390/bs14030207

Eka Wahyudhi, A. S. B. S., Nasrulloh, A., & Nugroho, S. (2025). Influence of different shooting techniques on accuracy and arm muscle stamina among beginner petanque athletes. International Journal of Human Movement and Sports Sciences, 13(4), 841–852. https://doi.org/10.13189/saj.2025.130420

El-Saleh, M. S. (2023). The effect of an educational program for mental visualization to teaching some shooting skills for basketball beginners. Annals of Applied Sport Science, 11(2), e1129. https://doi.org/10.52547/aassjournal.1129

Fazel, F., Morris, T., Watt, A. P., & Maher, R. (2022). A real-world examination of progressive imagery delivery in competitive basketball. Asian Journal of Sport and Exercise Psychology, 2(2), 106–113. https://doi.org/10.1016/j.ajsep.2022.09.002

Gmamdya, H., Souissi, M. A., Bougrine, H., Baaziz, M., Guelmami, N., Majdi, B., Robin, N., & Bali, N. (2023). The positive impact of combining motor imagery, action observation and coach's feedback on archery accuracy of young athletes. Perceptual and Motor Skills, 130(5), 2226–2248. https://doi.org/10.1177/00315125231193218

Harry, J. R., Hurwitz, J., Agnew, C., & Bishop, C. (2024). Statistical tests for sports science practitioners: Identifying performance gains in individual athletes. Journal of Strength and Conditioning Research, 38(5), e264–e272. https://doi.org/10.1519/JSC.0000000000004727

Helmi, B., Hidayah, T., Pramono, H., Hartono, M., & Iskandar, T. (2024). Using a biomechanical analysis approach to the accuracy of shooting throws in petanque sport: Literature review. Physical Education Theory and Methodology, 24(1), 130–135. https://doi.org/10.17309/tmfv.2024.1.16

Henkaryansyah, G., Permadi, A. A., Sonjaya, A. R., & Kosasih, A. H. (2024). Efforts to improve shooting accuracy through the target situations game approach in petanque sports. Indonesian Journal of Physical Education and Sport Science, 4(4), 466–474. https://doi.org/10.52188/ijpess.v4i4.855

Ihsan, N., Syafrianto, D., Akbar, A., & Effendi, R. (2026). Evaluating spatial cognitive skills in elite

pétanque athletes using a sport-specific motor-perceptual instrument. Journal of Coaching and Sports Science, 5(2), 61–75. https://doi.org/10.58524/jcss.v5i2.1250

Itoh, S., Morris, T., & Spittle, M. (2022). Examining the frequency variable in the imagery dose-response relationship. Asian Journal of Sport and Exercise Psychology, 2(2), 122–130. https://doi.org/10.1016/j.ajsep.2022.06.003

Jin, P., Ge, Z., & Fan, T. (2023). Research on visual search behaviors of basketball players at different levels of sports expertise. Scientific Reports, 13(1), 1406. https://doi.org/10.1038/s41598-023-28754-2

Kapre, T. M. S., & Alexander, J. O. R. (2025). Immediate effect of mental imagery in improving soccer passing and control skill among male collegiate-level players: A pilot study. Medical Journal of Dr. D.Y. Patil Vidyapeeth, 18(5), 789–794. https://doi.org/10.4103/mjdrdypu.mjdrdypu_987_24

Keskin, C., & Van Den Berg, A. N. T. (2025). Effects of breathing and imagery exercises on postural sway and shooting performance in Olympic archers: A pilot study. Sport Mont, 23(3), 75–80. https://doi.org/10.26773/smj.251011

Khairunnisa, A., Dinata, W. W., Rifki, M. S., Komaini, A., Igoresky, A., Asman, A., & Nazri, S. B. M. (2024). Enhancing free throw basketball shooting ability in female basketball players through imagery and concentration exercises. Journal of Physical Education and Sport, 24(6), 1426–1433. https://doi.org/10.7752/jpes.2024.06161

Kumenap, E. E., Makadada, F. A., Perdana, G. S., & Geantă, V. A. (2025). Validation and reliability of a visualization and relaxation exercise program for enhancing speed climbing performance. Retos, 63, 1045–1053. https://doi.org/10.47197/retos.v63.111162

Kurniawan, R., Junaidi, S., & Hidayah, T. (2022). The effect of flexibility exercises, static balance, eye-hand coordination on petanque shooting results. JUARA: Jurnal Olahraga, 7(2), 442–454. https://doi.org/10.33222/juara.v7i2.2015

Latar, I. M., Ahmadi, D., Baan, A. B., Cahyono, D., Vai, A., & Gusdernawati, A. (2024). Pentanque shooting accuracy through exercise bicep arm workout, Zottman curl and dumbbell clean. Fizjoterapia Polska, 2024(3), 30–34. https://doi.org/10.56984/8ZG020ANR7

Li, Y., Anuar, N., & Cooper, S. B. (2026). Effects of imagery training on cognitive function among collegiate athletes: A randomized controlled trial. Frontiers in Cognition, 5, 1826442. https://doi.org/10.3389/fcogn.2026.1826442

Lindsay, R. S. (2023). Different pedagogical approaches to motor imagery both demonstrate individualized movement patterns to achieve improved performance outcomes when learning a complex motor skill. PLOS One, 18(11), e0282647. https://doi.org/10.1371/journal.pone.0282647

Mao, X., Huang, S., Ouyang, M., Xie, Y., & Tan, X. (2022). Effect of skill proficiency on motor imagery ability between amateur dancers and non-dancers. Frontiers in Psychology, 13, Article 899724. https://doi.org/10.3389/fpsyg.2022.899724

Nurhidayat, N., Jariono, G., & Kustiawan, A. A. (2024). The effectiveness of target practice on the accuracy of shooting petanque 7 metres distance. Fizjoterapia Polska, 24(3), 384–387. https://doi.org/10.56984/8ZG020AB6Q

Pelana, R., Setiakarnawijaya, Y., Dwiyana, F., Sari, L. P., & Antoni, R. (2021). The effect of arm length, arm endurance and self-confidence on petanque shooting. Journal of Physical Education and Sport, 21, 2381–2388. https://doi.org/10.7752/jpes.2021.s4319

Perdana, S. W., Rahayuni, K., Taufik, T., & Supriyatna, S. (2022). Development of imagery and self-talk exercises to improve the shooting game ability of Nusantara Petanque Club athletes. SPORTIF: Jurnal Penelitian Pembelajaran, 8(3), 86–99. https://doi.org/10.29407/js_unpgri.v8i3.18810

Phytanza, D. T. P., Burhaein, E., Indriawan, S., Lourenço, C. C. V., Demirci, N., Widodo, P., Widiyono, I. P., Irawan, Y. F., Sutopo, W. G., Parmadi, M., Azizah, A. R., Saleh, M.,

Hadiatmo, A., & Susanto, A. (2022). Accuracy training program: Can improve shooting results of petanque athletes aged 15–20 years? International Journal of Human Movement and Sports Sciences, 10(1), 121–130. https://doi.org/10.13189/saj.2022.100117

Pratama, R. S., Hafidz, A., Santosa, T., Ashadi, K., Utami, T. S., Muharram, N. A., Maesaroh, S., Handayani, H. Y., & Purwoto, S. P. (2024). Analysis of the main physical condition factors in petanque. Retos, 60, 103–109. https://doi.org/10.47197/retos.v60.102677

Rahman, M. H., & Islam, M. S. (2021). Immediate effect of mental imagery training on accuracy of basketball free throws in Bangladesh. Journal of Advances in Sports and Physical Education, 4(4), 68–72. https://doi.org/10.36348/jaspe.2021.v04i04.004

Ramadhan, M. N., Sukarmin, Y., Arovah, N. I., Anwar, N. I. A., & Aksir, M. I. (2024). The effect of imagery training on the accuracy of free throws in basketball players in terms of concentration. Retos, 51, 603–609. https://doi.org/10.47197/retos.v51.100554

Rasyono, & Yanto, A. H. (2024). The accuracy of shooting petanque iron balls: Effectiveness of resistance band training. Journal Sport Area, 9(2), 186–194. https://doi.org/10.25299/sportarea.2024.vol9(2).14733

Rasyono, R., Ihsan, F., Orhan, B. E., Bayu, W. I., & Yusfi, H. (2026). The effect of core stability training on shooting accuracy and balance in petanque athletes. International Journal of Sport Studies for Health, 9(1). https://doi.org/10.61838/kman.intjssh.4403

Reinebo, G., Alfonsson, S., Jansson-Fröjmark, M., Rozental, A., & Lundgren, T. (2024). Effects of psychological interventions to enhance athletic performance: A systematic review and meta-analysis. Sports Medicine, 54(2), 347–373. https://doi.org/10.1007/s40279-023-01931-z

Rizal, R. M., Asmawi, M., & Lubis, J. (2021). Effect of self-talk on pentanque shooting accuracy. International Journal of Human Movement and Sports Sciences, 9(4), 807–813. https://doi.org/10.13189/saj.2021.090427

Rony, M. R., Asmawi, M., & Lubis, J. (2021). Petanque: Mental imagery and shooting accuracy. In Proceedings of the 4th International Conference on Sports Sciences and Health (ICSSH 2020) (pp. 16–18). Atlantis Press. https://doi.org/10.2991/ahsr.k.210707.005

Santosa, I. G. N. P. E., Adiatmika, I. P. G., Wulanyani, N. M. S., & Sundari, L. P. R. (2024). Sidhakarya state conditioning in improving shooting accuracy of petanque athletes in Bali. Retos, 59, 1071–1080. https://doi.org/10.47197/retos.v59.105523

Selva, Y., Sundar, V., & Arifudeen, A. (2023). Quiet eye duration and performance outcome in petanque. Malaysian Journal of Sport Science and Recreation, 19(2), 364–372. https://doi.org/10.24191/mjssr.v19i2.24012

Solihin, S., Setyawati, H., & Hidayah, T. (2022). The effect of balance and concentration exercises on the shooting results of petanque Riau athletes. JUARA: Jurnal Olahraga, 7(3), 692–704. https://doi.org/10.33222/juara.v7i3.2219

Song, T. T., Liu, A., & Liu, K. (2025). Mental imagery in fencing: Improving point control and lunge distance through visualization. Brain Sciences, 15(12), 1338. https://doi.org/10.3390/brainsci15121338

Souef, G. (2015). The winning trajectory: Pétanque-Training and technique (R. Ager, Trans.). Gilles Souef.

Su, N., Si, G., & Liang, W. (2025). Systematic imagery training for Taijiquan competitive routines: A case study. Asian Journal of Sport and Exercise Psychology, 5(1), 18–27. https://doi.org/10.1016/j.ajsep.2024.08.002

Syahwira, I., Junaidi, S., Hidayah, T., Sumartiningsih, S., & Rahayiu, S. (2022). Exercises for wrist flexibility, arm power, concentration and shooting results on petanque. JUARA: Jurnal Olahraga, 7(3), 706–715. https://doi.org/10.33222/juara.v7i3.2410

Wattimena, F. Y., Alim, A., Basyiruddin, B., & Ockta, Y. (2025). Mental imagery and relaxation methods of novice archers: A comparative analysis. International Journal of Human Movement and Sports Sciences, 13(4), 865–872. https://doi.org/10.13189/saj.2025.130422

Welis, W., Febrinaldo, A., Ihsan, N., Mario, D. T., Komaini, A., Rifki, M. S., Ayubi, N., Sepdanius, E., Orhan, B. E., Karacam, A., & Németh, Z. (2024). The influence of imagery training and self-confidence on shooting skills in futsal: A two-way ANOVA design. Journal of Physical Education and Sport, 24(7), 1767–1777. https://doi.org/10.7752/jpes.2024.07197

Wijaya, A., Solihin, A. O., & Syamsudar, B. (2024). Pengaruh latihan eksternal imagery dan latihan internal imagery terhadap hasil shooting pada atlet petanque Kabupaten Bekasi. JIIP: Jurnal Ilmiah Ilmu Pendidikan, 7(6), 5303–5311. https://doi.org/10.54371/jiip.v7i6.4566

Yachsie, B. T. P. W. B., Graha, A. S., Prasetyo, Y., Nasrulloh, A., & Suhasto, S. (2023). Mental training to improve the 40-meter-distance archery accuracy with imagery and meditation methods. International Journal of Human Movement and Sports Sciences, 11(2), 450–456. https://doi.org/10.13189/saj.2023.110223

Zulbahri, Effendi, R., Ihsan, N., Okilanda, A., Putra, A. N., & Syafrianto, D. (2024). Petanque athletes' shooting skills: Hand eye coordination, concentration and arm length. Journal of Physical Education and Sport, 24(8), 2049–2056. https://doi.org/10.7752/jpes.2024.08227