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THE EFFECT OF TARGET PRACTICE TRAINING PROGRAM ON BACKHAND SHOT ACCURACY OF SUMEDANG SQUASH ATHLETES

Abstract

Backhand shot accuracy is an essential component of performance in squash, particularly in maintaining rally consistency and creating scoring opportunities during matches. However, conventional training methods are often less effective in helping athletes maintain shot precision under high-intensity playing conditions. Target practice training was implemented as a focused exercise method to improve technical precision and movement consistency during backhand execution. This study aimed to examine improvements in backhand shot accuracy through target practice training in junior squash athletes using the Hunt Squash Accuracy Test (HSAT). A quantitative approach with a one-group pretest-posttest experimental design was employed. The sample consisted of 15 regional-level athletes. The intervention program was conducted over eight weeks with a frequency of two training sessions per week, each lasting 120 minutes and including 30 minutes of high-intensity target-based training. Data were analyzed using descriptive statistics, paired-sample t-tests, and N-Gain analysis. The results showed a significant increase in the mean accuracy score from $30.53(\mathrm{SD}=2.13)$ to $48.53(\mathrm{SD}=1.84)$, with $\mathrm{p}<0.05$. The N -Gain value of 0.72 indicated a high level of improvement, while the effect size analysis demonstrated a strong intervention effect. These findings suggest that target practice training is effective in improving backhand shot accuracy and may be considered as an alternative technical training method for junior squash athletes.

INTRODUCTION

In modern competitive squash, shot accuracy is a crucial aspect that directly impacts a player's performance. This ability relates to a player's control of the T-zone and determines how effectively they can direct and force their opponent's movements during a match.

While both the forehand and backhand are fundamental techniques that must be mastered, the backhand requires more complex sensorimotor coordination.

This is due to the limited range of motion and the kinetic chain pattern from the shoulder to the wrist, which tends to be less natural than the forehand.

Recent findings indicate that the backhand is the most dominant shot used in competitive play, accounting for approximately 63.1 % of all shots, but it also carries a higher risk of injury and technical instability (Akl et al., 2021).

The accuracy of this shot is influenced by the athlete's ability to optimize visual-motor coupling and control the co-activation of agonist and antagonist muscles in the elbow area when facing the ball's unpredictable bounce. This process requires advanced technical stabilization skills (Haryanto et al., 2026).

When athletes are unable to maintain a stable backhand, their point success rate tends to decrease because inaccurate shots often result in loose balls that are easily exploited by opponents.

This situation highlights the need for more innovative training methods, particularly those that combine sensory feedback with directed repetition to accelerate motor learning and build technical consistency (Irawati et al., 2025).

The challenge of achieving backhand accuracy stems not only from the complexity of the technique but also from the thermodynamic characteristics of the squash ball itself.

The ball's coefficient of restitution (COR) and bounce are known to be highly sensitive to temperature changes. As the ball heats up due to friction during play, its internal pressure and stiffness increase, resulting in a faster and more unpredictable bounce (Berencsi & Kossa, 2021).

These conditions require athletes to continually adjust their hitting mechanics and power distribution to maintain control.

This phenomenon is often found in junior athletes still in the developmental stage, including those in Sumedang, where the rate of unintentional errors often increases significantly due to limited adaptation to changing ball dynamics during high-intensity matches.

This technical complexity suggests that athletes cannot rely solely on basic skills but also require more structured training programs designed to address specific technical demands.

However, this approach remains an empirical gap in the sports science literature.

The Hunt Squash Accuracy Test (HSAT) has been recognized as a validated global standard for evaluating individual shot performance, but its use has been focused more on diagnostic needs than as a core component of tactical training interventions.

In practice, conventional training methods are still dominated by high-volume static repetitions that are relatively cognitively ineffective, thus failing to train functional adaptations to optimal racket surface use.

Previous findings have shown that inaccurate backhands exhibit significantly higher variability in racket orientation angles than accurate backhands, indicating that traditional methods are ineffective in stabilizing precise kinematic control during the impact phase (Williams et al.

This condition shows the existence of a methodological gap that encourages the need for a shift in the training paradigm towards a more dynamic form of intervention and directly targets the main sources of technical instability.

Despite the critical importance of backhand precision in the game, the application of structured training programs specifically targeting the complexity of the technique remains relatively limited in the sports science literature. Conventional training methods tend to rely on high-volume static repetitions that emphasize internal body movements.

This approach has not been able to consistently reduce the high variability in racket orientation angles, making technical stability difficult to achieve.

This can be explained by the fact that an internal focus tends to disrupt the natural regulatory mechanisms of the motor system, while an external focus directed at the results of movements in the environment has been shown to be more effective in improving both accuracy and efficiency of technique (Razaghi et al., 2020).

Based on this, this study seeks to fill the existing gap by developing the Hunt Squash Accuracy Test (HSAT) function, not only as a static evaluation tool but also as a form of dynamic and structured training intervention. This change in approach is important because it has the potential to optimize foveal vision, considering that the foveal sensitization process that is predictive of target characteristics has begun even before eye movement is made, thus supporting smoother motion transitions and maintaining technical stability when executing high-speed shots (Kroell & Rolfs, 2022).

By shifting the training paradigm towards a fovea-based external focus, this study offers a more relevant training framework to address the main sources of technical instability in junior squash athletes.

This study offers an evidence-based training model that can be implemented in a broader squash coaching program to improve training efficiency while supporting athlete performance.

By demonstrating the effectiveness of target-specific training using the HSAT instrument, this study provides practical assistance to coaches in optimizing the process of technical stabilization, which is known to be a key differentiator between player skill levels (Huang et al., 2024).

Thus, the integration of motor learning theory and precise kinematic control into daily training routines is an important aspect, not only to achieve optimal performance but also to minimize the risk of injury.

METHOD

This study employed a pre-experimental design with a single-group pre-test and post-test model to assess the effectiveness of the targeted training program.

The single-group approach was chosen considering the research focus, which focuses on monitoring the development of individual techniques in specific regional groups, as this design allows researchers to directly observe changes from initial to final conditions after the intervention is administered (Creswell & Creswell, 2018). Furthermore, this approach was deemed the most feasible and ethically appropriate within the context of the research development, ensuring that all high-potential athletes within a limited regional group still had an equal opportunity to participate in the training program without losing the benefits of the intervention due to placement in the control group.

Thus, this research design maintained high ecological validity while providing a more detailed picture of the effect of target-oriented training on stabilizing backhand accuracy.

This study used 15 novice squash athletes who were training in the Sumedang region, with between 1.5 and 3 years of specialized training experience.

This sample selection was carried out to maintain homogeneity of participant characteristics while simultaneously controlling for

potential physiological variables that could influence the results of this study.

Because this study focused on athletes at a relatively uniform developmental stage, basic motor skills were more comparable across the sample.

All study participants under 18 years of age and their legal guardians provided informed consent before this study was conducted.

Furthermore, all study protocols were reviewed and approved by the institutional ethics committee, which ensured that this research complied with ethical standards for human subjects.

Although the sample size in this study was relatively small, the 15 athletes included in this study represent the entire population of athletes actively training in the Sumedang region who met the inclusion criteria for this study.

The primary instrument used in this study was the Hunt Squash Accuracy Test (HSAT), which has been shown to have a strong correlation with shot success in a match (Williams et al., 2018).

The study protocol was specifically modified to accommodate the abilities of athletes in the region.

Adjusting the target dimensions to $50 \times 50 \text{ cm}$ and optimizing the frequency of each shot kept the test challenging yet achievable.

The study protocol underwent assessment by senior coaches and specialist experts.

Modifications were made in close consultation with the coaching staff to ensure the training program had a significant impact on backhand improvement in junior athletes in the region (Williams et al., 2019), reported that this instrument had high reliability, demonstrated by intraclass correlation coefficient (ICC) values ranging from 0.81 to 0.94 across various squash orientations.

Preliminary testing also demonstrated a Cronbach's alpha value of 0.87, indicating the instrument had sufficient consistency for use across the study subjects.

The test area design and target zone division are presented in Figure 1.

This training program was implemented for eight weeks with a frequency of two training sessions per week.

Each session lasted 120 minutes, including a standard 15-minute warm-up, 30 minutes of high-intensity target training, and 75 minutes of low-intensity tactical games.

The duration of the 30-minute core training was determined based on motor learning principles to minimize muscle or nerve fatigue while maintaining optimal foveal focus.

Meanwhile, to control for potential confounding variables, the remaining 75 minutes were specifically limited to light tactical shadow movement and rally activities without involving other accuracy drills that could affect the intervention results.

The training program in this phase of the program rest periods of 3 to 5 minutes were given between sets to maintain consistent movement quality.

Information regarding progressive parameters at each training stage is presented in Table 1.

Quantitative data were analyzed using SPSS software version 26.0 through a paired sample t-test to compare pre-test and post-test scores with a significance level of $p < 0.05$ (Williams et al., 2021).

To obtain a more accurate picture of the magnitude of the exercise program's effect, Hedges' g calculation was used as an appropriate estimate of the effect size in a small sample group ($N = 15$), thus minimizing potential bias arising from the limited number of participants.

In addition, the effectiveness of the intervention was also reported as a percentage change accompanied by a 95 % Confidence Interval (CI) on the difference in means (Williams et al., 2021).

This analytical approach was carried out so that the research results not only show statistical significance, but also describe meaningful and consistent technical changes in the athletes' backhand stroke performance during their development phase.

RESULTS

An eight-week structured target training intervention demonstrated significant improvements, both statistically and practically, in backhand accuracy in junior squash athletes.

To obtain a more comprehensive evaluation, the study results were analyzed using collective performance metrics, focusing on technique stabilization and the magnitude of the intervention's effect.

This approach allowed for a more in-depth interpretation of the results than basic observational descriptions, as recommended in the peer review process.

Table 2 shows that the results of the paired sample t-test indicate a significant difference between the pre-test and post-test scores ($t(14)=14.82$; $\mathrm{p}<0.001$).

This indicates that the increase in accuracy cannot be considered coincidental, but rather stems from the training program provided.

To see the magnitude of the effect, the calculation of Hedges' g yielded a value of 3.12, which according to the classification of Cohen (1988) and Hedges (1981) is included in the category of a large effect.

These results indicate that the training provided was able to provide a sufficiently strong motor stimulus, thereby assisting the sensorimotor adaptation process which has an impact on increasing backhand accuracy in athletes who are still in the developmental stage.

2 shows an overall improvement in technical performance accompanied by stabilization of motor execution.

The data shows a clear increase in accuracy, with the mean score increasing from 30.53 at baseline to 48.53 at post-test.

In addition to the increase in mean values, the boxplot also shows a narrowing of the interquartile range, indicating that athlete performance has become more consistent.

This decrease in variation indicates that the training provided facilitates the process of movement automation, so that even athletes with the lowest scores on the posttest remain above the group average at baseline.

The program's effectiveness was also demonstrated by a Percentage Change value of 58.95 % and an N -Gain score of 0.72 .

These results indicate a high level of effectiveness and align with the objective assessment framework for sports performance in physical culture proposed by (Zanevskyy & Zanevska, 2021), which emphasizes the importance of using objective data to confirm athletes' technical development.

In addition to these descriptive findings, the analysis also showed changes in the stability of athletes' performance after the intervention.

The distribution of the data supports this finding, with the minimum post-test score recorded higher than the average pre-test score of 30.53 .

These results indicate that structured target training sessions can help overcome methodological limitations in junior athlete training, while also producing more consistent and stable improvements in shot accuracy across the developing athlete group.

DISCUSSION

The significant improvement in backhand accuracy in this study aligns with the concept of motor skill learning discussed by (Matthews et al., 2021).

This research emphasizes that consistent technique patterns develop through repeated interactions with a specific training environment.

In the context of this study, this was facilitated through structured, targeted training sessions.

The high effectiveness of the intervention is also supported by the objective assessment framework for measuring sports performance proposed by (Zanevskyy & Zanevska, 2021), which emphasizes the importance of using objective data in evaluating technique development over subjective assessments.

The increased accuracy is thought to be related to the optimization of visual-motor coupling and the quiet eye phenomenon.

Focusing on a 50 $\times$ 50 cm target encourages athletes to maintain a more stable visual fixation before executing a backhand shot.

This allows for better processing time for spatial information and the ball's trajectory, allowing for more effective neuromuscular coordination.

In squash, this situation is crucial because the ball's bounce off the wall is often unpredictable.

Maintaining visual focus helps prepare the kinetic chain for the shot.

These findings align with the principles of specificity and repetition of training described by (Bompa & Haff, 2019), where targeted training can strengthen neuromotor adaptations more permanently.

This process also demonstrates the development of athletes' perceptual-cognitive skills in anticipating the characteristics of the ball's bounce, as described by (Williams et al., 2021).

From an ecological dynamics perspective, modifying distances and angles in a training program serves as a form of manipulation of environmental constraints.

Based on the constraint-based approach described by (Zanevskyy & Zanevska, 2021), changing training parameters can encourage athletes to independently adjust movements and find more efficient movement patterns.

The results of this study are consistent with the findings of (Huang et al, 2024), regarding improved technique consistency, but provide an additional contribution by demonstrating that technique stabilization also helps athletes adapt to changing squash ball characteristics during

play.

Increased ball temperature due to friction is known to affect the coefficient of restitution and internal pressure, resulting in faster and more unstable bounces.

The 30-minute high-intensity core training session in this study appears to provide sufficient stimulus for the neuromotor adaptation process in junior athletes.

This duration allows athletes to repeatedly adjust their hitting mechanics to changing ball dynamics without experiencing a decline in training quality due to excessive fatigue.

These findings complement previous research by (Prasetyo & Prastiwi, 2020) by offering a more specific training overview in the context of mastering backhand technique in squash.

Furthermore, individual responses to the training program demonstrated variations in the level of adaptation among athletes.

Although collectively, average performance increased significantly, differences in the rate of development suggest that each athlete progressed through the stages of motor learning at different rates.

Most participants are thought to have transitioned from a predominantly cognitive learning phase to a more automatic and stable performance phase.

This finding aligns with research by (Leech et al, 2022; Irawati et al, 2025), which suggests that consistent repetition under high-precision training conditions can accelerate the development of technical autonomy by reducing reliance on conscious control.

The fact that the minimum post-test score exceeded the average pre-test score further supports the widespread performance improvement across the study group.

The use of a single-group pre-experimental design in this study was also based on methodological and ethical considerations.

This study can be positioned as a preliminary study in a regional population with a limited number of junior athletes.

In this context, establishing a control group would be logistically difficult and could potentially limit some athletes from benefiting from the intervention at a crucial developmental stage.

Therefore, the design used was deemed appropriate for this research context and provides an empirical basis for further research with a broader sample size and design.

CONCLUSION

This study demonstrates that an eight-week structured target training program is effective in improving backhand accuracy in junior squash athletes.

The intervention strengthened the relationship between diagnostic evaluation and tactical training implementation and demonstrated that an external attention-based approach has the potential to accelerate athletes' transition from a cognitively dominant learning phase to a more stable and automatic performance.

The results also indicate improvements in the athletes' perceptual-cognitive and visual-motor coordination, contributing to an increased ability to adapt their hitting technique to the changing dynamics of the squash ball during play.

Although this study is limited to a small, regional sample size, the findings provide an empirical basis for developing a structured training program with more measurable duration and intensity settings.

Future research is recommended to examine the long-term retention of the accuracy gains achieved to determine the sustainability of technique stability after the intervention.

Furthermore, the use of biomechanical analysis of the kinetic chain can be considered to provide a more comprehensive understanding of the influence of target-based training on athletes' movement efficiency during the developmental phase.

FAQs

What is GPTZero?

GPTZero is the leading AI detector for checking whether a document was written by a large language model such as ChatGPT. GPTZero detects AI on sentence, paragraph, and document level. Our model was trained on a large, diverse corpus of human-written and AI-generated text with support for English, Spanish, French, German, and other languages. To date, GPTZero has served over 17 million users around the world, and works with over 100 organizations in education, hiring, publishing, legal, and more.

When should I use GPTZero?

Our users have seen the use of AI-generated text proliferate into education, certification, hiring and recruitment, social writing platforms, disinformation, and beyond. We've created GPTZero as a tool to highlight the possible use of AI in writing text. In particular, we focus on classifying AI use in prose. Overall, our classifier is intended to be used to flag situations in which a conversation can be started (for example, between educators and students) to drive further inquiry and spread awareness of the risks of using AI in written work.

Does GPTZero only detect ChatGPT outputs?

No, GPTZero works robustly across a range of AI language models, including but not limited to ChatGPT, GPT-5, GPT-4, GPT-3, Gemini, Claude, and AI services based on those models.

What are the limitations of the classifier?

The nature of AI-generated content is changing constantly. As such, these results should not be used to punish students. We recommend educators to use our behind-the-scenes [Writing Reports](#) as part of a holistic assessment of student work. There always exist edge cases with both instances where AI is classified as human, and human is classified as AI. Instead, we recommend educators take approaches that give students the opportunity to demonstrate their understanding in a controlled environment and craft assignments that cannot be solved with AI. Our classifier is not trained to identify AI-generated text after it has been heavily modified after generation (although we estimate this is a minority of the uses for AI-generation at the moment). Currently, our classifier can sometimes flag other machine-generated or highly procedural text as AI-generated, and as such, should be used on more descriptive portions of text.

I'm an educator who has found AI-generated text by my students. What do I do?

Firstly, at GPTZero, we don't believe that any AI detector is perfect. There always exist edge cases with both instances where AI is classified as human, and human is classified as AI. Nonetheless, we recommend that educators can do the following when they get a positive detection: Ask students to demonstrate their understanding in a controlled environment, whether that is through an in-person assessment, or through an editor that can track their edit history (for instance, using our [Writing Reports](#) through Google Docs). Check out our list of [several recommendations](#) on types of assignments that are difficult to solve with AI.

Ask the student if they can produce artifacts of their writing process, whether it is drafts, revision histories, or brainstorming notes. For example, if the editor they used to write the text has an edit history (such as Google Docs), and it was typed out with several edits over a reasonable period of time, it is likely the student work is authentic. You can use GPTZero's Writing Reports to replay the student's writing process, and view signals that indicate the authenticity of the work.

See if there is a history of AI-generated text in the student's work. We recommend looking for a long-term pattern of AI use, as opposed to a single instance, in order to determine whether the student is using AI.