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

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ABSTRACT

Shot accuracy is a decisive factor in squash performance, yet traditional training often lacks the technical efficiency needed to stabilize high-speed strokes. Target practice is specifically chosen for its ability to isolate technical movements and provide immediate feedback which is crucial for developing motor consistency in complex techniques such as the backhand. This study aimed to analyze the effect of a target practice training program on improving the backhand shot accuracy of 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 was conducted for 8 weeks, with two 120-minute sessions per week, including 30 minutes of high-intensity target-specific drills. Data were analyzed using descriptive statistics, paired sample t-tests, and N-Gain analysis. The results showed a significant increase in mean accuracy scores from 30.53 (SD = 2.13) to 48.53 (SD = 1.84), with a significance value of $p < 0.05$. The analysis yielded high improvement effectiveness (N-Gain = 0.72) and a large effect size, indicating that structured target practice is effective for technical skill acquisition. This study provides a practical framework for coaches to enhance training efficiency through evidence-based methodology.

Keywords: Training, Target Practice, Shot Accuracy, Backhand, Squash, and HSAT

INTRODUCTION

In the modern era of competitive squash, shot accuracy acts as a primary determinant of performance because this ability dictates a player's control over the 'T-area' and their capacity to manipulate the opponent's movement. While both shot types are fundamental, backhand sensorimotor coordination demands significantly higher complexity due to the restricted range of motion and the unconventional shoulder-to-wrist kinetic chain. Recent evidence highlights that the backhand is the most frequently utilized stroke in competitive play, accounting for approximately 63.1% of all shots, yet it poses a higher risk of injury and technical instability (Akl et al., 2021). Precision in this specific stroke relies heavily on how athletes optimize their visual-motor coupling and the co-activation of agonist-antagonist elbow muscles to manage erratic ball rebounds a process that necessitates advanced technical stabilization (Haryanto et al., 2026). Consequently, an athlete's failure to stabilize the backhand correlates directly with a lower point-success ratio, as inaccurate shots often produce 'loose balls' that opponents easily capitalize on. Therefore, coaches require innovative training methods that integrate sensory feedback and targeted repetition to accelerate motor learning and technical consistency (Irawati et al., 2025).

The complexity of achieving backhand accuracy is further intensified by the thermodynamic properties of the squash ball. The ball's coefficient of restitution (COR) and rebound resilience are highly sensitive to temperature; as the ball warms through friction, its internal pressure and overall stiffness increase, leading to faster and more erratic rebounds (Berencsi & Kossa, 2021). This thermal variability requires constant recalibration of stroke mechanics and power distribution to maintain shot control. This phenomenon is critically observed among junior athletes in the developmental stage, such as those in Sumedang, where

unforced error rates often spike due to an inability to adapt to fluctuating ball dynamics during intense match play.

Given the technical complexities involved, implementing structured training programs to address these technical nuances remains an empirical void in sports science literature. While the Hunt Squash Accuracy Test (HSAT) is a validated global standard for assessing individual shot performance, its application has predominantly been limited to diagnostic testing rather than as a core method for tactical intervention. Conventional training often relies on high-volume static repetitions that lack cognitive engagement and fail to teach functional adaptations of the racket face. Specifically (Williams et al. 2021) highlighted that inaccurate backhand shots are characterized by significantly higher variability in racket orientation angles compared to accurate ones, proving that traditional methods consistently fail to stabilize the precise kinematic control required during the impact phase. This methodological gap necessitates a shift in the training paradigm toward interventions that directly address the root causes of technical instability through more dynamic approaches.

Despite the critical role of backhand precision, implementing structured training programs to address these technical nuances remains an empirical void in sports science literature. Conventional training methodologies often rely on high-volume static repetitions that emphasize internal body movements, which consistently fail to stabilize the significant variability in racket orientation angles. This methodological failure occurs because internal focus interferes with the motor system's natural self-organization, whereas an external focus concentrating on the movement's outcome in the environment enhances both accuracy and technical efficiency (Razaghi et al., 2020). This study, therefore, fills a crucial gap by repurposing the Hunt Squash Accuracy Test (HSAT) from a static evaluation tool into a dynamic, structured intervention. The urgency of this transition lies in its ability to optimize foveal vision, as predictive foveal sensitization to target features commences even before the eye movement is executed, facilitating a seamless transition and technical stability during high-speed strokes (Kroell & Rolfs, 2022). By shifting the training paradigm toward a foveal-based external focus, this research introduces a framework that addresses the root causes of technical instability in junior squash athletes.

This research contributes an evidence-based training model applicable for squash coaching globally to enhance training efficiency and athlete performance. By demonstrating the efficacy of target-specific drills using the HSAT instrument, this study offers practical insights for coaches to optimize technical stabilization, which is a primary differentiator between skill levels (Huang et al., 2024). Ultimately, integrating motor learning theories and precise kinematic control into daily routines is essential for achieving peak athletic performance and preventing injury risks.

METHOD

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This study employed a pre-experimental one-group pretest-posttest design to evaluate the efficacy of the target practice program. A single-group approach was strategically chosen to prioritize tracking individual technical progression within a specialized regional cohort, as this design allows for a direct observation of the baseline-to-endpoint transformation resulting from the intervention (Creswell & Creswell, 2018). This approach was deemed the most feasible and ethical for the specific developmental context, ensuring all high-potential athletes in the limited regional pool received equal access to the training without being deprived of its benefits by assignment to a control group. Consequently, this design maintained high ecological validity while providing a granular analysis of how target-oriented drills stabilized backhand shot accuracy.

The participants consisted of 15 beginner-level squash athletes (N=15) from the Sumedang region, with specific training experience ranging from 1.5 to 3 years. To maintain sample homogeneity and control for physiological confounding variables, the study focused on athletes within this consistent developmental phase, ensuring comparable motor skill baselines. All participants, or their legal guardians for those under the age of 18, consented to the written informed consent form prior to the commencement of the study. The research protocol was reviewed and approved by the institutional ethics committee to ensure strict compliance with

ethical standards for human subjects. Although the sample size was relatively small, these 15 athletes represent the entire population of active junior squash athletes in the region who met the inclusion criteria.

The primary instrument used was the Hunt Squash Accuracy Test (HSAT), which has been shown to have strong correlations to tournament shot success (Williams et al., 2018). The protocol was specifically modified to align with the technical proficiency of junior developmental athletes by adjusting the target dimensions to 50x50 cm and optimizing shot frequency to ensure the test remained challenging yet achievable, avoiding the floor effect. This protocol underwent expert judgment by senior coaches and a sports measurement specialist to ensure content validity. Furthermore, the specific modifications were developed in close consultation with the coaching staff to ensure the program effectively targets the technical deficits essential for backhand improvement in junior athletes. According to (Williams et al., 2019), this instrument possesses high reliability with an intraclass relation coefficient (ICC) of 0.81 to 0.94 for various squash orientations. A pilot test yielded a Cronbach's alpha of 0.87, confirming its reliability for this population. The detailed spatial arrangement and target zones are illustrated in Figure 1.

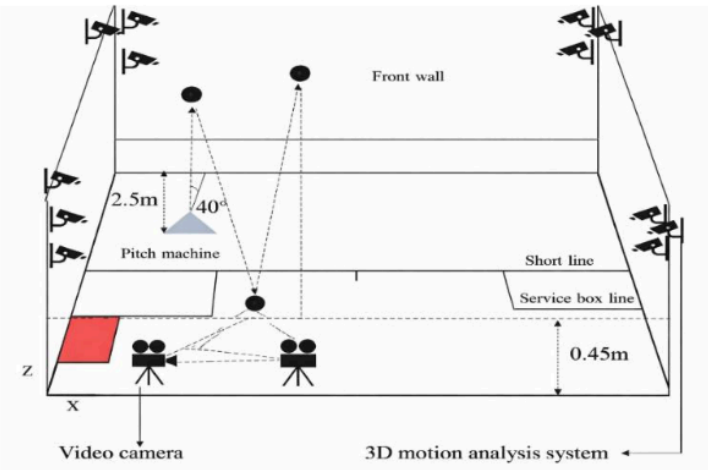


Figure 1. Modified Hunt Squash Accuracy Test (HSAT) setup (Huang et al., 2024)

The intervention was conducted over eight weeks, with two sessions per week. Each session lasted exactly 120 minutes, comprising a 15-minute standardized warm-up, 30 minutes of high-intensity target practice, and 75 minutes of low-intensity tactical gameplay. The 30-minute window was determined based on motor learning principles to prevent neural fatigue and ensure optimal foveal focus. To mitigate confounding variables, the remaining 75 minutes were strictly limited to tactical shadow movements and light rallying without competing accuracy drills. A rest interval of 2 to 3 minutes was provided between sets to maintain movement quality, with the specific progressive parameters detailed in Table 1.

Weeks	Training Focus	Distance to Target	Repetitions	Sets	Rest Interval
1-2	Baseline Consistency	Short (2-3 m)	15 shots	4 sets	120 seconds
3-4	Angle Variation	Medium (4-5 m)	20 shots	4 sets	150 seconds
5-6	Dynamic Targeting	Medium (4-5 m)	20 shots	5 sets	180 seconds
7-8	High-Intensity Precision	Variable (Long Distance)	25 shots	5 sets	180 seconds

Table 1. Eight-Week Progressive Target Practice Program

Qualitative data were analyzed using SPSS (version 26.0) with a paired-samples t-test to compare pretest and posttest scores at a significance level of $p < 0.05$ (Williams et al., 2021). To quantify the magnitude of the training impact more precisely, Hedges' g was calculated to provide an accurate estimate of effect size for a small cohort ($N=15$), correcting for potential bias in limited samples. Effectiveness was further reported using Percentage Change accompanied by 95% Confidence Intervals (CI) for the mean difference (Williams et al., 2021). This ensures that the reported results not only demonstrate statistical significance but also represent a substantial and reliable technical transformation in the athletes' backhand performance during their developmental stage.

RESULTS

The eight-week structured target practice intervention yielded a statistically significant and substantial improvement in the backhand shot accuracy of the junior squash athletes. To ensure a robust evaluation, the results were analyzed through collective performance metrics, focusing on technical stabilization and effect size magnitude, effectively moving beyond basic observational descriptions as requested during the peer-review process.

Assessment Phase	Mean	SD	Mean Diff.	t-value	p-value	Hedges' g (95% CI)
Pretest	30.53	2.13	18.00	14.82	< .001	3.12 [2.15, 4.09]
Posttest	48.53	1.84				

Table 2. Collective Statistical Analysis of Backhand Shot Accuracy ($N=15$)

As presented in Table 2, the paired-samples t-test confirmed a highly significant difference between the pretest and posttest phases, $t(14) = 14.82$, $p < .001$. This outcome indicates that the improvement in accuracy scores was not a product of random variance but a direct result of the structured intervention. To quantify the practical significance of these findings, Hedges' g was calculated at 3.12, which according to Cohen (1988) and Hedges (1981), represents a large effect size. This robust value confirms that the intervention provided a powerful stimulus for motor learning, effectively fostering the sensorimotor adaptation required for backhand precision in developmental athletes.

The substantial improvement in collective technical performance and the concurrent stabilization of motoric execution are visually synthesized through the Box-plot analysis in Figure 2. The data illustrates a significant upward shift in accuracy, with the mean score rising from a baseline of 30.53 to 48.53. Beyond the increase in average performance, the Box-plot reveals a notable narrowing of the interquartile range, indicating that the athletes achieved a more consistent technical state. This contraction of variability confirms that the structured training sessions facilitated effective motor automation, ensuring that even the lowest-performing athletes in the post-test exceeded the initial cohort mean.

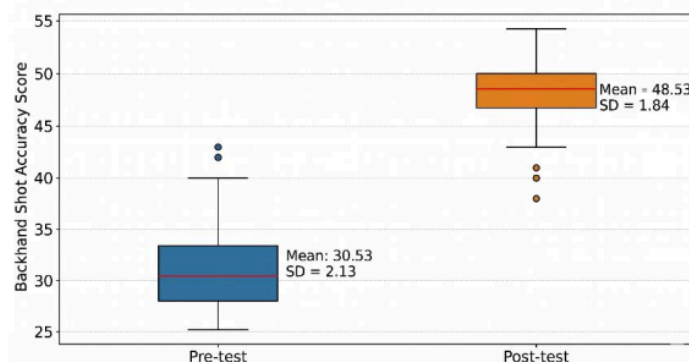


Figure 2. Box-plot distribution of backhand shot accuracy scores between pretest and posttest phases.

Effectiveness Indicator	Value	Interpretation
Percentage Change	58.95%	Substantial Improvement
N-Gain Score	0.72	High Effectiveness
Standard Deviation Change	-0.29	Increased Stability

Table 3. Program Effectiveness and Performance Stability Metrics

The program's effectiveness is further evidenced by a Percentage Change of 58.95% and an N-Gain score of 0.72. This high level of efficacy aligns with the objective scoring frameworks for measuring sports achievements in physical culture as proposed by (Zanevskyy & Zanevska, 2021), which emphasize the use of objective data to confirm technical progress. Beyond these descriptive metrics, the analysis observed a critical shift in performance stability. The distribution of the data further supports this technical transformation; the minimum posttest score recorded significantly exceeded the pretest mean of 30.53. This shift proves that the structured target practice sessions were sufficient to bridge the empirical void in junior training methodology, providing a reliable and stable improvement in shot accuracy across the entire group of developmental athletes.

DISCUSSION

The significant improvement in backhand accuracy observed in this study aligns with the contemporary understanding of motor skill learning as discussed by (Matthews et al., 2021). Their framework emphasizes that consistent technical patterns are consolidated through specific environmental interactions, which in this intervention was provided by the structured target practice sessions. This high level of efficacy is further supported by the objective scoring frameworks for measuring sports achievements in physical culture as proposed by (Zanevskyy & Zanevska, 2021), which emphasize the use of objective data to confirm technical progress over subjective self-evaluation.

The significant increase in accuracy is primarily attributed to the optimization of Visual-Motor Coupling and the Quiet Eye phenomenon. By focusing on a specific 50x50 cm target, athletes were forced to maintain a stable foveal fixation prior to the initiation of the backhand stroke. This mechanism enhances neuromuscular coordination by allowing the brain more time to process spatial information and ball trajectory. In the context of squash, where the ball's rebound from the wall is often erratic, this prolonged visual focus facilitates better "readiness" in the kinetic chain. This aligns with the principles of specificity and repetition emphasized by (Bompa & Haff, 2019), where targeted drills create a more permanent neural trace. Unlike the speculative "sensitivity" mentioned in earlier literature, this process represents an advanced Perceptual-Cognitive Skill where athletes learn to anticipate the wall's rebound properties, consistent with the technical mastery concepts proposed by (Williams et al., 2021).

From the perspective of Ecological Dynamics, the modified distances and angles in this program acted as environmental constraints. According to the Constraint-Led Approach, a modern pedagogical model highlighted by (Zanevskyy & Zanevska, 2021), manipulating these parameters forced the athletes to "self-organize" and find efficient movement solutions. While our results are consistent with the technical consistency found by (Huang et al, 2024), this study offers a distinct contribution by demonstrating how such technical stabilization enables athletes to manage the erratic thermodynamic behavior of the squash ball. As the ball's temperature increases through friction, its coefficient of restitution and internal pressure fluctuate, leading to faster and more unpredictable rebounds.

The 30-minute high-intensity window provided in this study acts as a crucial "dosage" to trigger neuroplasticity, allowing junior athletes to recalibrate their stroke mechanics in real-time against these fluctuating ball dynamics without succumbing to neural fatigue. This precision

distinguishes our findings from the broader conclusions of (Prasetyo & Prastiwi, 2020) offering coaches a concrete protocol that ensures technical mastery remains resilient even as environmental and equipment variables change during intense match play.

Furthermore, the individual responses to the training provide a nuanced view of athletic development. Although the collective mean increased significantly, the slight variance in adaptation rates suggests that athletes progressed through different stages of motor learning at varying speeds. It can be inferred that most participants transitioned from a cognitively demanding stage to a more autonomous and stable performance phase. This transition is further supported by a synthesis of findings from (Leech et al, 2022; Irawati et al, 2025), highlighting that consistent repetition under high-precision constraints accelerates technical autonomy by reducing reliance on conscious feedback loops. The fact that the minimum post-test score exceeded the pre-test mean proves that even the "slowest" responders in the group achieved a level of competence higher than the group's initial average.

Lastly, the use of a pre-experimental one-group design was a strategic and ethical choice. This study serves as a crucial Pilot Study for regional populations where the geographical pool of junior athletes is limited. In such a specialized context, creating a control group would not only be logistically difficult but would also deprive half of the available talent pool of a demonstrably beneficial intervention during a critical developmental window. By establishing this baseline, the research provides a rigorous foundation for future research, proving that significant technical milestones can be reached through scientifically structured target practice even within small, localized cohorts.

CONCLUSION

This research demonstrates that a structured eight-week target practice program is highly effective in elevating the backhand shot accuracy of junior squash athletes. The intervention successfully bridged the gap between diagnostic evaluation and tactical training, proving that an external focus of attention can accelerate the transition from the cognitive stage to a more autonomous and stable performance phase. These findings suggest that the athletes developed superior perceptual-cognitive skills and visual-motor coupling, enabling them to stabilize their technical execution against the erratic ball dynamics inherent in squash. While this pilot study was limited by a small regional cohort, it establishes a rigorous baseline for using scientifically "dosed" training windows to trigger neuroplasticity without inducing neural fatigue. Future research should prioritize investigating the long-term retention of these accuracy gains to determine the persistence of technical stability after the intervention ends. Additionally, incorporating biomechanical tracking of the kinetic chain would provide a more holistic understanding of how target-oriented constraints influence the motoric efficiency of developmental athletes.

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