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Effects of structed drill practice on the precision of overhead clears: a quasi-experiential research study in collegiate badminton players

Fariz Maulana Syawshindra, Eval Edmizal[*)], Donie Donie, Juanda Putra
Universitas Negeri Padang

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ABSTRACT

This study investigated the effect of structured drill training on the accuracy of overhead clear shots among badminton athletes at the UNP Badminton Academy, Padang, Indonesia. The research was motivated by the athletes' inconsistent overhead clear performance, which contributed to the academy's inability to reach the top eight in the 2024 UNP Rector Cup despite serving as the tournament host. A quantitative quasi-experimental approach with a one-group pretest–posttest design was employed. Twelve athletes were selected through purposive sampling from a population of 24 registered academy athletes. Overhead clear accuracy was assessed using the French Test, a standardized instrument with documented validity (0.60) and high reliability (0.98), administered before and after 16 sessions of structured drill training. Data were analyzed using descriptive statistics, the Shapiro–Wilk normality test, and a paired-sample *t*-test at a significance level of $\alpha = .05$. The results showed a substantial improvement in overhead clear accuracy following the intervention. The mean score increased from 59.33 (SD = 16.12) at the pretest to 84.33 (SD = 6.95) at the posttest. Both datasets met the normality assumption, and the paired-sample *t*-test revealed a statistically significant difference between pretest and posttest scores (*t*(10) = −6.240, *p* < .001). These findings suggest that structured, repetition-based drill training is effective in enhancing overhead clear shot accuracy among competitive badminton athletes. However, because the study employed a single-group design without a control group, alternative explanations such as maturation, testing, or history effects cannot be entirely ruled out. Nevertheless, the findings provide preliminary empirical evidence supporting the use of structured drill training as an effective approach for improving technical performance in badminton and offer practical implications for coaches in designing skill development programs.

Corresponding Author:

Eval Edmizal
Universitas Negeri Padang
Email: evaledmizal@fik.unp.ac.id

Introduction

Badminton is one of the most widely practiced racket sports globally and it attracts both male and female players across a wide range of abilities in the amateur and competitive worlds. With its typical combination of forceful, speed-oriented shots and quick, multidirectional changes of direction, the sport demands quite a lot from the players in terms of accuracy, physical fitness, and decision-making. In particular, for athletes in the highest and sub-elite levels of competition, usually it is a marginal technical difference that may decide the outcome between a victory and a defeat.

Badminton as a sport holds a special cultural significance and official institutional place in Indonesia as it is one through which the country's international sporting successes have been largely achieved. The presence of training facilities at the universities level like the UNP Badminton Academy provides a significant developmental channel, through which grassroots activities are linked up and down the competitive pathways at the regional and national levels. Along this competitive track, athletes are expected to already have good fundamentals in basic strokes, as well as to keep improving these through a variety of methods so that when they reach the senior level they have the best chances of being successful. This is because it has been seen that technical issues or mistakes which athletes develop during their college years if left uncorrected tend to become ingrained and therefore limit their progress as competitors later on. So, coming up with a set of training techniques that are both consistent and effective in solving these problems is a very important factor from the standpoint of sport science but at the same time it has practical relevance also to institutions which may have to cope with only few coaches, limited hours of practice, and training facilities that are inferior compared to those at the national level centers.

In addition to overhead strokes, the clear (also described in coaching literature as the *lob*) stands out among other strokes for being very basic yet indispensable. The technique behind this shot is rather simple to grasp: the player hits the shuttlecock with a swing from above the head, then continues the movement with a forward-upward stroke, a fast arm extension with which the wrist is quickly snatched to drive the shuttlecock well into the opponent's back court. The clear can be considered as the best defensive and tempo-control shot in the game (Aji & Komari, 2018). A clear shot performed without errors gives a player the chance to change the momentum of the rally, take the opponent out of position to relieve the pressure on oneself, and control the tempo of exchange. On the other hand, a poorly executed clear can expose the court in areas where the opponent can make a strong move by being out of reach or hitting a cross-court or smash. Therefore the effectiveness of the clear as a good shot can be evaluated not only by the power involved in hitting but also by the accuracy in directions and how far the shot goes. This requires working out the combination or coordination of the forces applied by the arm and forearm in a way that leads to a very fast wrist-snap movement, and also figuring out at what point the acceleration of the racket-head is best applied in the hitting zone (Ibrohim, Setiawan, & Agustin, 2022; Mangngassai, Abdul, Syaiful, & Marsuki, 2020).

Lots of biomechanically-oriented research has recently highlighted the physical factors that determine accurate overhead stroke in badminton. Forearm and grip strength support racket-head and direction control of the shuttlecock (), whereas wrist-flexion velocity contributes to the final part of the swing by adding speed and changing the swing trajectory of the racket (). In line with these determinants, recent work has expanded this model to areas beyond the upper limbs. Edmizal et al. (2023) observed a study of hand muscular power, hip flexibility, and lob-shot proficiency among competitive badminton players where they reported that trunk and hip mobility combine with hand-arm power to affect stroke consistency together: it means that clear-stroke accuracy is better viewed as the property of a coordinated kinetic chain rather than a one-muscle-group isolated output. Besides that, biomechanical investigations of an overhead smash a stroke which has similar preparatory kinematic sequencing with the clear also underscore the importance of segmental sequencing and racket-arm coordination in shot outcome determination ( )

While there is already an evidence-based understanding of the physical, physical therapy aspects and biomechanical characteristics of quality movements, little has been explored regarding training techniques that effectively convert these aspects into visible improvements in movement accuracy for less-developed athletes and in particular areas other than Western top-sports training settings. This issue is not just an academic one. The coaching staff and researchers at the UNP Badminton Academy, Padang, Indonesia, observed that certain players could not regularly deliver the shuttlecock to the far end of their opponents' court after the clear. In addition to not reaching the baseline, the shuttle often went into the sidelines. The result of this technical limitation was obvious when the final eight competitors at the 2024 Rektor Cup UNP tournament were decided, and yet neither of the academy players reached that phase. The university was actually one of the hosts at the tournament, and that fact only intensified the embarrassment, especially because the academy is a center for athletic development. In this context, the problem clearly reflects the need to look deeper into the methods of training that are best suited to the identification and remediation of particular technical flaws, such as the inaccurate clear-stroke.

One of the techniques that coaches have most appreciated for handling technical inconsistency is drilling: a method of teaching that relies on repeat work where athletes do the same stroke or body-movement over and over again in order to master the movement and reach perfection. Athletes train in controlled surroundings with low changeability conditions. A motor-learning approach sees drill training as a form of practice where the

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learners master a skill by practicing it a lot without changing the context much. For decades the debate has been about whether it is better to use a low-contextual-interference, i.e. blocked, practice (practice a skill repeatedly without changing the task context) vs. high-contextual-interference (random) practice schedules. A large systematic review and meta-analysis by Ammar et al.(2023) pointed out that there wasn't enough evidence to prove the commonly accepted idea that high-contextual-interference (i.e., "disrupted") practice reliably produces significantly better retention/transference outcomes than blocked practice in sports. This finding was disputed by Czyż, Wójcik & Solarská (2024) which pointed out that high-interference practice gives better retention under certain methodological circumstances. These conflicting views between high-contextual-interference versus low-contextual-interference (or so-called "disrupted" vs "repeated") practice in motor skills learning have led to stronger rather than weaker arguments for conducting a study in which a controlled/deliberate/drilling-based intervention is pitted directly against stroke accuracy as a target goal within an authentic athlete's population. The applied evidence base for either position is still contested and setting-dependent.

Sports drills have been proven very useful and effective by various studies in improving a range of skills in badminton over the years; however, the research on clear-stroke accuracy still stands out as a comparatively unexplored area. Ashari, Hazar, Damayanti, and Khanina (2025) found out that an organized drilling schedule of six weeks considerably increased the accuracy of dropshot and smash among adolescent athletes. The accuracy of both stroke types significantly improved from pretest to posttest, and the improvements were substantial enough to show statistical significance. Similarly, a combination of drill interventions and upper arm workouts have shown to be effective on smash accuracy and skill execution with good results in badminton players (Yudiani et al., 2024), whereas drills and a supplementary throwing training have led to notable results in the increase of forehand overhead lob accuracy for extracurricular athletes (Putra & Anwar, 2022). Technical correction using drills is not only effective in badminton; for instance, in cricket bowling accuracy has been found to significantly improve through a mix of strength training and variation drills (Amal & Yanto, 2023). This supports the notion that repetition training works as an underlying system for refining directional accuracy in sporting activities that involve a lot of precision and control.

However, elite-level badminton research indicates that relying solely on drill sessions to improve technique at all times may lead to incorrect generalization. Edel, Weis, Ferrauti and Wiewelhove (2023) carried out a study involving top world-ranked badminton players running intense multiple-feed drills, in which they noticed that the different lengths of the time between feeds impacted players' internal physiological stress (workload) and their physical running exertion demand but stroke accuracy was not statistically significantly affected. It shows how at such a high level, the parameters of drill training mostly condition the athlete, but the technical aspects are already mastered and only minimal technical improvement is possible. This conclusion is also supported by a close analysis of factors and findings of this paper, where the developmental (collegiate academy) nature of participants was a major determining factor. It can be reasoned that technical ceiling of elite performances limits any further gains in accuracy through technical drills. However, sub-elites and developmental players, such as those of the UNP Badminton Academy who were mainly categorized in 'fair' or 'poor' initial clear-stroke accuracy levels, have a much higher potential for improving performance technically by means of drills.

From the motor-learning viewpoint, it would be expected that the mechanism through which drill practice enhances accuracy is one of increasing automatization: namely, the reduction of attentional and cognitive resources required to make a technically correct movement gradually due to the repetition of actions. The study by Porter, Makaruk, and Starzak (2016) showed that movement automatization transfers the athlete's attentional focus primarily from the mechanical aspects of the action to the result, a transition that leads, on the one hand, to better precision when it comes to aiming and, on the other, to increased performance overall. In a systematic review on practice, instruction, and motor-skill acquisition in soccer, Pacheco, de Oliveira, dos Santos, Godoi Filho, and Drews (2023) also came to the same conclusion: structured, repetition-based practice settings reliably support the earlier and intermediate developmental steps of skill acquisition, at which the main concern of the athlete moves away from cognitively demanding trial and error towards a consistent, self-controlled execution of the skill. When relating the model to the overhead clear skill, we can deduce that those athletes who receive the same kind of extensive, repetitive drill trainings are expected to have not only higher accuracy on average but also lower variability of both the trial and athlete levels, as the individual errors of a technical nature will gradually be eliminated by repetition. Such a forecasting can be readily checked by comparing the pretest and posttest score distributions from the present research paper.

In addition, the published works provide an explanation for the technical and tactical significance as well as the physiological and biomechanical factors influencing the precision of the stroke. Moreover, the accumulated evidence indicates that targeted exercises lead to a considerable increase in the dropshot, smash, and lob strokes' accuracy. However, there still exist two contradictory theories explaining whether a consistent practice of blocked shots is better than practicing the same set of moves repeatedly. Through a controlled, outcome-based field research study, a clear answer could be obtained. One of the gaps present in the literature is the absence of a research work that focuses on the overhead clear exclusively, uses a verified field assessment for accuracy purposes, and is carried out by a university-affiliated Indonesian badminton academy motivated by the documented competitive shortcoming. In this particular study, a major goal was to look into a possible change that a16- session structured drill training would have on the accuracy when an overhead clear-stroke is performed by the athletes of UNP Badminton Academy. Such a validated measure of field-based accuracy was used both prior to and shortly after the intervention. This study attempts to answer the question by testing the effectiveness of a drill training session that consists of 16 sessions in producing a significant level of improvement of clear-stroke accuracy for badminton players from the UNP Badminton Academy. In line with what was suggested earlier by theoretical as well as empirical literature, the researchers expected that drilling the players would result in an improvement of their clear-stroke accuracy before and after the testing session.

The conceptual frame that was taken by this paper basically connects three components one after the other: a drill stimulus based on repetition of movements (a self-variable), a proposed automatization mechanism that is acting on the arm-wrist-racket kinetic chain (the theoretical mediating process, supported by research from Edmizal et al., 2023; Ibrohim et al., 2022; Mangngassai et al., 2020; Porter et al., 2016), and an objectively measured increase in overhead clear-stroke accuracy (a dependent variable), which was done by a validated field test that participants took before and after the training program. With regard to this conceptual model, a hypothesis is proposed stating that a properly designed multi-week drill training program is capable of causing a statistically significant rise in clear-strokes accuracy scores of the participants of the UNP Badminton Academy.

Method

Research Design

This study used a quasi-experimental single-group pretest-posttest quantitative design (Sugiyono, 2021). The subjects were evaluated for their stroke accuracy at the beginning of the study (pretest) after which a specific set of drills was implemented (intervention) and finally at the end of the study (posttest). As stated in the limitation section below this particular design makes it impossible to identify if the difference between the pre- and post-measurements are truly attributable to the intervention. Therefore other threats to internal validity such as history, maturation, regression, instrumentation and the pretest sensitisation phenomenon which cannot be controlled in this design would result in misleading conclusions (Moore & Adam, 2025). This research was a good example of coaching research where it is not possible to set off the comparison group due to the constraints of training academies having a small-sized pool of athletes (which was in this case a single training academy).

Setting

The research was carried out in the badminton venue of the PPSP Pembangunan facility at Universitas Negeri Padang (UNP) or in other words the training center of UNP Badminton Academy in the city of Padang, the capital of West Sumatra, Indonesia.

Population and Sample

The group under study included all 24 young athletes enrolled at the UNP Badminton Club. The subjects were distributed over several age and gender categories with male athletes ≤12, 13-15, and 16-18 years old, and female athletes <12 as well as 12-14 years old, making the club a mix of boys and girls at different developmental stages. A purposeful sampling method (Susanti, 2005) was employed to pick 12 of the athletes who fulfilled the three selection criteria: (a) They were identified as having reached a sufficiently high training level within the club; (b) They had already demonstrated good knowledge of the basic badminton shots, i.e. serves & drives; (c) They were consistently competing, which gave them motivation to train hard. Choosing such motivated athletes as our research subjects allowed us to focus on their stroke accuracy while they were at an intermediate level rather than when beginners were struggling with the first strokes. Practically speaking, requirement (a) was interpreted as a player who has been through one year's training with the academy, and has been assigned to the club's middle/upper team based on technical level; requirement (b) meant coaches must have seen and verified the basic serve and drive strokes as proficient; while requirement (c) meant that participation in either inter-club or regional competitions during the last season should have been active. Owing to the relatively small and same venue population (N = 24) from which the sample was taken, no pretest power analysis was carried out. Instead, a sample of 12 was selected according to the number of athletes who have met all three criteria. This limitation is mentioned in the Limitations part.

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Variables
The research focused on one independent factor, drill training (X). And also one dependent variable, clear-stroke accuracy (Y). Drill training was defined as a method in which trained and repeated movements are a main point, and athletes perform the overhead clear stroke repeatedly in practice conditions, getting ready to hit shuttlecocks at the target from the far end. Clear-stroke accuracy in this regard, meant by the skill of the player to guide the shuttlecock, hitting an overhead clear, into the area that's been scored in the opponent's back court.

Procedure and Intervention
Data collection took place in three parts. During the first phase, all 12 selected athletes did the clear-stroke accuracy instrument (below) to get baseline performance. Athletes continued and carried out a structured drill training regime for the overhead clear stroke which was spread over 16 training sessions within four weeks. After the intervention, athletes did the same accuracy instrument as a posttest, this time under the same conditions as in the baseline.

All athletes and, when necessary, their parents or guardians were made aware of the nature of the study and procedures of the study before they decided to join, and all who participated did so freely; none of the athletes stopped their involvement during the program. The pretest and posttest testing sessions were carried out at the same hour of the day, on the same ground, and performed by the same trio of test personnel. This was to ensure that the two times the measures were taken differed in procedures only when necessary and that instrumentation-related bias was kept to a minimum.

Instrument
The accuracy of clear-strokes was evaluated with the French Test, an outdoor badminton lob/clear precision assessment (Komari, 2017). According to the primary references, through the half-competition criterion ranking method, French Test was found to have a validity coefficient of.60 and through odd-even split-half method a reliability coefficient of.98. To carry out the test, one needed a badminton court, net, racket, shuttlecocks, measuring tape, marking cord, score materials, and was done by a three-member testing team including a feeder, a scorer, and a caller. Each player did 20 trials of clear-stroke (5 from each side of the court), under a standardized procedure that fed the shuttlecock to the backcourt as a caller loft was done. Then, the player made an overhead clear and aimed at a graduated target area that was divided into 5 zones (1 to 5 points) where the scores increased as the points were deeper and closer the back-borders of the court target. A shuttlecock was marked if it was left unplayed after a feeder's service that passed the criteria of acceptability and therefore, the score would be zero; the possibility for players to say no and then reattempt a wrongly delivered feed was given. A cumulative point score of both the tests made the clear-stroke accuracy pre or post testing score.

Data Analysis
Afterwards, the data were analyzed at three phases with(SPSS) Version 29. Initially, summary statistics (mean, standard deviation, minimum, and maximum values) and frequency distributions were generated individually for pretest and posttest scores. Afterwards, checking the normality of pretest and posttest score distributions through Shapiro-Wilk test because of the small sample size, this test was selected, and together with the Kolmogorov-Smirnov (Lilliefors-corrected) test used as second check. Then, comparing pretest and posttest scores the treatment's effect was tested through a paired-sample t-test, keeping p =.05 as statistical significance. If one-tailed significance value was below.05, we were going to reject the null hypothesis (pretest and posttest clear-stroke precision are the same).

Results and Discussions

Descriptive Statistics
Pretest scores among the 12 athletes sampled varied from a low of 38 to a high of 85 with an average of 59.33 and a standard deviation of 16.12. Immediately after their 16-session drill intervention, posttest scores also varied with the lowest at 74 and the highest at 93 and a calculated average of 84.33 at a deviation rate of 6.95. The fact that the deviation rate dropped from pretest to posttest meant that apart from the raise in average accuracy, the variability in scores across athletes also decreased. The reduced variability is interpreted here as a decrease in diversification or homogeneity and the authors are showing how an overall competence is increased. Further arguments in the Discussion section support that interpretation.

Table 1. Frequency Distribution of Pretest and Posttest Clear-Stroke Accuracy Scores

Score Category	Category	Pretest f (%)	Posttest f (%)
≥ 84	Excellent	1 (8.33%)	5 (41.67%)
68–83	Good	3 (25.00%)	7 (58.33%)
52–67	Fair	4 (33.33%)	0 (0.00%)

Score Category	Category	Pretest f (%)	Posttest f (%)
36–51	Poor	4 (33.33%)	0 (0.00%)
≤ 35	Very Poor	0 (0.00%)	0 (0.00%)
Total		12 (100%)	12 (100%)

Before the test, most athletes were still in Fair and Poor categories with the same distribution (33.33% for each category) and only one athlete (8.33%) achieved an Excellent result. After the intervention, all members of the sample were placed either into Good or Excellent categories with 58.33% of the athletes being in the Good category and 41.67% in the Excellent ones. So, no athletes were left in Fair, Poor, and Very Poor categories. The banding criteria in Table 1 refer to the English language proficiency test standard French Test scoring system, which was adopted by Komari (2017), to calculate a person's overall English language proficiency grade directly based on an individual's performance (in terms of cumulative points) of a certain level; given that each individual trial is judged objectively based on where the badminton shuttle lands rather than being evaluated subjectively by raters, differences among raters were considered irrelevant in this case.

Normality Test

The p values for the pretest, p =.372, and the post test, p =.137, from the Shapiro-Wilk test were both greater than the level of α =.05. Therefore, these results imply that both the pre- and the post-distribution samples came from normal populations and did not differ significantly from the normal distribution curves. This met one of the conditions necessary to run the following parametric, related samples t-test.

Table 2. Normality Test (Kolmogorov-Smirnov and Shapiro-Wilk)

	K-S Statistic	df	K-S Sig.	S-W Statistic	df	S-W Sig.
Pretest	0.164	11	.200*	0.926	11	0.372
Posttest	0.204	11	.200*	0.890	11	0.137

Hypothesis Testing

A paired sample t-test was conducted. The results of the t-test showed that the mean difference between clear-stroke accuracy scores of pretest and posttest is -25.455 (standard deviation = 13.530, standard error = 4.080, 95% confidence interval [-34.544, -16.365]) t(10)= -6.240, p=.000. As the significance value (which is 0.000) that we got from our study was smaller than α= 0.05, therefore, we rejected the null hypothesis (H0).

Table 3. Paired-Sample t-Test (Pretest vs. Posttest)

Pair	Mean Diff.	SD	SE Mean	95% CI	t	df / Sig.
Pretest − Posttest	-25.455	13.530	4.080	[-34.544, -16.365]	-6.240	df=10 p<.001

This result suggests that 16 sessions of structured drill intervention can improve clear-stroke accuracy of badminton players significantly as per UNP Badminton Academy in such a way that the average within-athlete benefit was about 25.5 accuracy points. The reported mean difference and the differences standard deviation were used to compute the standardized within-subject effect size (Cohen's 's dz' = mean difference / SD of differences). Thus, 25.455 / 13.530 ≈ 1.88 was our result for the 'standardized mean difference'. Based on conventional references (Cohen, 1988), this magnitude was considered as a "very large effect size" i.e., indicating the effect of training was substantial in practice not just being statistically detectable.

The most important finding reported in this article was the significantly larger overhead clear-stroke accuracy in a single training sample after the structured 16 sessions of drilling, t(10) = -6.240, p <.001. The lack of a control group means that this study serves as supportive field evidence, not as definitive, empirical validation, of the theoretical claim that repetition-based blocked-practice is a means for automaticity gain and for improving the motor performance of a specified stroke; moreover, the single-site, twelve-athlete sample limits the extent to which we can generalize these results beyond the UNP Badminton Academy context. These findings are also congruent with, and provide support for, a series of stroke-specific experiments that have already established that drilling is an effective teaching method in badminton. For example, Ashari et al. found a similarly large improvement in dropshot and smash accuracy after a six-week drilling among teenagers, whereas drill-based interventions combined with arm-power conditioning have similarly been seen to elevate smash accuracy (Yudiani et al., 2024), and drill training along with ball-throwing exercises has improved forehand lob accuracy (Putra & Anwar, 2022). Beyond the high probability with which the effect of our study will be observed the same across any replicate, that study gave a big standardized effect size (dz ≈ 1.88; Cohen, 1988) such that the level of improvement is a large one rather than a mere change of minor importance. The fact that such effects have been consistently noticed in different strokes such as drop, smash, and lob and most recently, overhead clear in this investigation indicates that not only is drill training accuracy-improvement stroke-dependent mechanism effective but it is mainly a feature of repetitive practice refining the technical aspects of a racket-sport action carried out overhead to such a degree that it results in a more or less permanent motor ability. Having such similar and reliable outcomes from multiple studies in different areas not only supports that the results are genuine but also the fact that single-stroke, single-site work has the potential of becoming credible after converging with a broader, independently verified trend of drill effectiveness will make this paper more readable.

The scale of improvement identified in our work a mean increase of 25.455 points, lifting the modal performance level of group players from 'Fair/Poor' to 'Good/Excellent' is relatively much bigger than the one mentioned in the work of Edel et al. (2023) where they observed how a different method (high-intensity multifeed drills) for internationally ranked players, changed player's physiological load but did not result in a visible change in stroke precision (if you will). Combined, these two outcomes lead to a conclusion that is, more or less, a very important limiting factor for the kind of training via drills that aims at the acquisition of new skills. When we have elite players, who have already reached a very high level but cannot go too far (for example, they cannot make a shot even better than they are doing it right now), then the drill training is not a very effective technical tool anymore, it can only contribute on a physical level. If on the other hand, we are talking about less developed players or even those not at very high level yet, e.g. players of the UNP Badminton Academy which had a majority of Fair and Poor level players as their starting point, there is still space enough for considerable technical development and one could see the benefits of the repetitive training through drills in terms of increasing the consistency of direction and depth of ball shots. This difference between two athlete groups indicates something quite theoretical. Basically, the skill that a person develops through training via drills can be seen also as a skill-dependent variable (i.e. the ability of the person can act like a moderating factor). So, the less skill you have, the better you can develop skill by training and as you become a better player, your development by training becomes slower.

Moreover, these results have wider ramifications in the ongoing controversy about the efficacy of blocking versus random (high-contextual-interference) practice styles in motor learning. In a detailed systematic review and meta-analysis of Ammar et al. (2023), high-contextual-interference practice was not found to yield better performance results than blocked learning in applied sport settings. On the contrary, Czyż et al. (2024) in their meta-analysis challenged that conclusion since their results showed advantages of the high-interference schedule for retention if certain conditions were fulfilled. In the present paper, the drill method used is, on purpose, a low-contextual-interference, blocked-practice: athletes did only one stroke over several sessions under the same conditions (approximately) sixteen times. The fact that this simple learning method led to very large improvement in a real competitive setting is an example of how the blocking of practice can still be considered a worthwhile, if not better, method for training technically underdeveloped athletes to correct specific technical faults, at a minimum, even though many issues regarding whether it is better or has the edge over long-term retention and transfer are still open and merit further, controlled, investigations.

The results at the mechanistic level are in line with the physical and biomechanical determining model used in previous badminton studies. Ibrohim et al. (2022) and Mangngassai et al. (2020) identified arm strength, forearm flexibility, and wrist joint movement velocity as the principal determinants of stroke accuracy, while Edmizal et al. (2023) showed that hand muscle power interacts with hip flexibility to jointly shape lob-shot proficiency. Since the current study did not measure the mentioned physical variables directly, the repetition of the drill protocol's overhead swing presumably trained these very muscle groups together with the kinetic chain so that one could master the exact timing and consistency of the arm-wrist-racket action responsible for the ball going into the target. The narrowing of the range of scores in the pretest (SD=16.12) after the posttest (SD=6.95) supports this explanation: as the players' movement patterns were more automatized due to repetition, execution quality differences among players got less noticeable at the same time as the mean accuracy increased, this being exactly the situation seen in motor-skill consolidation.

What is particularly remarkable about the paper is not only what the researchers found but also why they did these experiments in the first place. For example, the lack of success of the host, the UNP Badminton Academy, at this event where only a minimum level of technical skills is required, has partially revealed a problem in their preparation method. In pretest, the technical skill assessments showed that 66% of the athletes were at Fair or Poor levels of accuracy categories. The removal of these lower-performing athletes after the drill intervention almost entirely suggests that with a relatively brief, low-cost, and logistically simple training adjustment a structured 16-session drilling block a developing academy's athletes' technical gap from the standard needed to compete at the advanced levels can be significantly narrowed without resorting to specialized equipment that a standard training facility already possesses.

However, it is important to understand that this outcome should be considered with the limitations of the study design. It would not be reasonable to credit the drill intervention with the improvement in a very simple, single group study that relies solely on pre-test and post-test measures. There is still the possibility, to varying degrees depending on the nature and speed of maturation, that concurrent maturation, incidental practice, or testing- familiarity effects have also made a contribution. Moore & Adam (2025) note that this is a limitation characteristic of many within-subjects studies as well, and they elaborate on this issue a bit later.

Table 4. Summary of Recent Drill-Training Studies in Racket and Related Sports (2022-2025)

Study	Sport / Stroke	Design / Sample	Key Finding
Putra & Anwar (2022)	Badminton - forehand overhead lob	Quasi-experimental, pre-post, n = 20	Significant improvement in forehand lob overhead accuracy following combined drill and ball-throwing training.
Amal & Yanto (2023)	Cricket - bowling	Experimental, factorial design	Drill variation combined with strength training significantly improved bowling accuracy.
Edel et al. (2023)	Badminton - multifeed drills, elite players	Repeated-measures, n = 19 elite players	Longer feed intervals increased physiological load without significantly changing stroke precision.
Ashari et al. (2025)	Badminton - dropshot and smash	Quasi-experimental, pre-post, n = 30 adolescents	Six-week structured drilling produced large, significant gains in dropshot and smash accuracy.
Yudiani et al. (2024)	Badminton - smash	Experimental, drill + arm-power conditioning	Combined drill and arm-power training significantly improved smash accuracy and skill.
Present study (2026)	Badminton - overhead clear	One-group pretest-posttest, n = 12 collegiate athletes	16-session structured drill produced a large, significant improvement in clear-stroke accuracy (25.46-point mean gain).

Table 4 demonstrates that the present results are consistent with a growing and coherent body of empirical evidence: in studies of drop-shots, smash, and forehand loom, structured drill training had repeatedly led to significant accuracy increases in development and adolescence players, the one elite-level study that was available (Edel et al., 2023) did not find any additional precision benefit from drill-parameter manipulation, which is in line with a ceiling effect interpretation. This pattern gives us more assurance regarding the present study's mechanism: repetition-driven automatization that is generalizable rather than a unique finding to the UNP Badminton Academy sample, and on the other hand, it makes clear that the effect reaches its peak among athletes, such as those in this study, whose technical level has not yet reached a ceiling.

Novelty and Theoretical Contribution

The research has, in theory, two major contributions. Firstly, the present research adds to the growing body of evidence on the effectiveness of drill training that is particular to a stroke by confirming, for the first time in a quasi-controlled exercise-drill study, the effectiveness of a drill specifically targeting the overhead clear, a particular stroke that, to the best of the authors' belief, had not been the only variable of interest and the outcome of the study before. The study thus reaffirms the theory explaining the effectiveness of drills by developing automaticity according to Porter et al. (2016), and Pacheco, V., Leclercq P., & Van der Steen J. (2023): that significant reduction of variation from first to last measurement (SD = 16.12 vs. SD = 6.95) is the pattern we would expect from an automatization process according to which repetition reduces random, performer-related errors rather than bringing about uniform improvement of the same amount in all the athletes. Secondly, the research sheds light on the unresolved problem of contextual interference (Ammar et al., 2023; Czyż et al., 2022) through providing practical and real-life data showing that with minimal interference in drill structure it is possible for a group of developmental athletes to achieve a substantial increase in accuracy and also to have statistically strong results in a real competitive setting where very few of the current meta-analyses, mostly based on lab environments or very short paradigma, had been tested.

We argue that the novelty element of the paper is that it is grounded in a real-life problem. Instead of taking the idea of training drills as a separate pedagogical issue, the researchers wanted to know why the UNP Badminton Academy didn't even have an athlete from it in the top eight in the2024 Rektor Cup UNP although the tournament was being held locally. Very few papers on badminton drill training talk about such clear-cut examples of a specific competitive performance being used to design and test training intervention. As such, this context enhances the applicability of the results to coaches and sport administrators who would like to have research findings to justify training allocations that prioritize technical skills remediation instead of pure conditioning and/or tactical work solely.

Nonetheless, we should probably temper our expectations when interpreting directly quantitative findings based on studies in Table 4 since they vary on several grounds: the length of interventions (four to six weeks), age and performance level of samples (young athletes of extracurricular activities versus elite athletes in academies at different levels of education versus internationally ranked adults), and the nature of instruments used to measure accuracy. These methodological variations imply that consistency of direction (drill training increases accuracy) is better supported by findings of recent series of these papers than a specific magnitude effect, which is to be expected to vary with baseline skill level, dose of intervention, and measurement method. Hence the work of the authors on the topic of the paper is a confirmation, as it adds, through a stroke- and context-specific description overhead clears, an Indonesian university badminton training program to be precise which had not previously been documented, of the directional, cross-stroke research on drill training effectiveness.

Supplementary Evidence from the Broader Scopus-Indexed Badminton Training Literature

Moreover and also in conjunction with all these very specific stroke drilling investigations, other works in the field of scopus-indexed badminton intervention training programs confirm the hypothesis that well-planned training sessions bring consistent physical performance results. For the case of physical conditioning, some well-done and thorough reviews together with some powerful meta-analyses have confirmed, that structured training interventions are quite effective. As a matter of fact: core strength training improved badminton players' front-court and back-court skills and also movement stability (Ma et al., 2024), the next one a more comprehensive summary of regular physical training showed that badminton players' VO2max, agility, and balance were enhanced significantly by such training in comparison to routine training (Ma et al., 2025), and last but not least, plyometric training is the one that particularly helps skill-related physical fitness components among badminton players (Deng, Soh, Abdullah, & Huang, 2024) and also contributes to broader physical fitness measures across racket-sport athletes at large (Deng, Soh, Abdullah, & Huang, 2023) and even more so among tennis players (Deng et al., 2022). Very similar studies were conducted to test this hypothesis. These researches indeed found that a brief but intensive plyometric training program has led to substantial improvements in male college level badminton players' agility, speed, and power after three weeks (Chandra, Sharma, Malhotra, Rizvi, & Kumari, 2023). This period was similar to the duration of the current study's drill block i.e., Four Weeks.

Apart from studies on how conditioning affects sports performance, some studies which have been indexed on Scopus have dealt with effects of training on more technically and perceptually based aspects of badminton performance that coincide with the present study's focus of stroke accuracy. According to Malwanage, Senadheera, & Dassanayake (2022), structured balance-training intervention significantly enhanced footwork performance in badminton players, showing that targeted, repetition-based training block of the same length as in the present paper can bring technical gains in addition to the conditioning effects through a training intervention alone.

Likewise, Kuo, Liao, & Kao (2022) have come to know that a systematic visual- reaction training significantly enhanced special ability performance of badminton players. This is a further confirmation of the general idea that properly designed, sport-specific training methods that might involve physical, perceptual, and technical aspects can result in the players' performance gains relatively shortly during the phase of intervention. In addition, through their descriptive study, Ayuningtyas, Susanto, & Suroto (2021) show the interdependence of the physical and somattype variables of the players at a higher level of badminton competition. Specifically, they found a relationship between players's physique and their levels of physical fitness at a competitive Indonesian badminton club. This highlights the importance of individual physical traits (i.e. morphological ones & physical) of future, larger-scale, similar replication design of this study as a confounding variable. Finally, at the instrument level, Hidayat, Yudiana, Hambali, & Nugraha (2022) confirmed the reliability and factorial structure of an outcome- and process-based badminton basic- skills assessment battery that includes the clear/lob stroke (i.e., explicitly). They thus provided a reference method and methodological justification for the measurement of badminton performance through standardized, validated field-based accuracy instruments that include the French Test used in our study.

Together, these additional sources of Scopus-indexed evidence place the current research findings in a much broader international context one encompassing various and different methodologies of literature where the results support a number of short, structured and sport-specific training interventions be they targeted at strength, power from plyometrics, balance, visual reaction, or, in the case of ours, technical drilling with repetition being quite good at producing statistically significant and practically meaningful improvements to badminton performance across intervention periods (three to ten weeks) of a similar duration as the 16-week session block we looked at.

Practical Implications

Coaching practice will benefit from this research by using structured progressive drill blocks focusing on a overhead clear can be effectively incorporated into normal academy workout schedules as an inexpensive way to fix deficiencies in specific skills, especially to athletes who have a level of skill performance within the Fair-to-Poor. Coach at UNP Badminton Academy and also at Indonesian collegiate academies with similar resources may want to implement a similar 16-session four-week drill block into preseason periodization or midseason periodization, preferably combined with strength conditioning for arm and forearm strength, wrist-snap speed, and hip flexibility, considering the known roles of such physiological characteristics in executing proficient overhead strokes (Edmizal et.al., 2023; Ibrohim et.al., 2022; Mangngassai et.al., 2020). At this organizational level, that almost entirely the category of Fair/Poor performance being done away after the training could be a major factor behind the academy's poor performance at the 2024 Rektor Cup UNP tournament which will be solved, to the very least, with such kinds of technical correction programmes that were evaluated rather than just through conditioning or tactical changes. It is also a low-cost monitoring tool that allows period-wise tracking of the proficiency in a player's clear technique and selecting candidates for drill-based specific interventions. This field instrument, which one employs through this paper, provides such possibilities for the practitioners on the ground in an inexpensive and standardized way before such lack of performance in matches could manifest.

From the perspective of periodization, the four-week, 16-session block employed here aligns nicely with the pre-competition mesocycle and may be programmed anywhere from three to four times a week. Since it does not disturb the core content of training, it can still be considered an auxiliary activity and hence, the primary training load can continue unaffected. Moreover, by examining the reduced variation in scores at the team level after a certain amount of training, the coaches might want to think about utilizing the early-cycle pretesting scores to separate the athletes into high- and low-accuracy subcategories which would make it possible to tailor drill frequency and target-zone difficulty accordingly instead of using one-size-fits-all approach, so that the high-achievers will get to more varied or match-realistic conditions to practice while the lower-end players will stick with a type of training which brings them technical improvement through concentrated, blocked repetition.

Limitations

A number of limitations are inherent to the ways these results can be considered. To begin with, the absence of a control group a feature of the one-group prepost-test design means the design is open to internal validity threats as a result of history, maturation, testing, and instrumentation effects, which cannot be ruled out for sure Moore & Adam (2025). One needs a randomized controlled or a comparison group experiment if one is to confidently say that the observed improvement in drilling skills is only due to drilling training, excluding other elements like general training or becoming more acquainted with the test protocol. A small sample (n = 12) was used, and it was selected with a purpose from only one sports training club, this restricts the ability of the analysis to detect statistically significant effects as well as limits the extent to which the results can be generalized to other groups of athletes, different ability levels, or even different contexts of training. The time the athletes were allowed in the training program was a short one 16 sessions in one week. The study did not contain a retesting measurement. Therefore, one cannot know whether the accuracy improvements were temporary after the posttest or not and the extent of their transfer to real match situations also remains a question. It was difficult to hold a number of factors on a field level constant throughout the data gathering as athletes might have varied in their commitment or motivation to the test, and they could have had their own out of program training or been affected by weather, for instance, to the point of missing the sessions from time to time. The main study focused on stroke accuracy in isolation and it did not measure directly the physical factors which are believed to be the mediators of the training effect namely, arm strength, forearm strength, wrist-flexion velocity, hip flexibility, or hand- eye coordination. That way, the exact physiological basis of the improvement was only inferred rather than directly established. In terms of equipment the study made use of French Test a field test that is quite frequently used among Indonesian coaches, that is, reliable (α =.95 via odd-even split-half method), yet is characterized by a fairly low validity coefficient (.60). That degree of measurement imprecision should be taken into account when judging the exact effect size the study has revealed. It is possible that future research will adopt the French Test as a benchmark to cross-check with video or motion sensor measurements of the shuttlecock landing position, for example, for shuttlecock landing position measurements, such as a shuttlecock landing position.

Conclusions

This research looked at how overhead clear-stroke accuracy was affected by a structured, 16-session drill training program on 12 subjects recruited purposefully from UNP Badminton Academy. There was a big change from pretest (M = 59.33, SD = 16.12) to posttest (M = 84.33, SD = 6.95) that indicated a significant improvement of the clear-stroke accuracy after the training. The paired-sample t-test indicated that this increase was statistically significant, t(10) = -6.240, p <.001, and the average increase for one athlete was 25.455 points in accuracy. The above outcomes point out that there was a statistically significant increase in clear-stroke accuracy in the participants as a result of participating in the structured drill training program. In fact, since maturation, practice effects and regression to the mean cannot be ruled out as factors which accounted for part of or all of this improvement because of the fact that a one-group pre/post design was used, it is clear that there is a need to conduct further more controlled studies. The researchers, however, have made a point of saying that participants really did significantly get better at clear-strokes after attending to training programme. Give field evidence that aligns and supports the literature on the usefulness of drills in learning badminton strokes which is across the strokes by different researchers (Ashari et al., 2025; Putra & Anwar, 2022; Yudiani et al., 2024), while also showing that the overhead clear as one of the areas is covered and further, in an Indonesian collegiate academy context that is motivated by a documented competitive shortfall. Future studies that would like to expand and replicate these findings should aim at using larger and multi-site samples, employ the use of randomized controlled or comparison-group designs, and the physical determinants of stroke accuracy should be directly measured; they should also make follow-ups at a longer-term and measure retention, whereas they could compare the results from the drill training with the other ones that can be done through the multishuttle feeding method or game-based training. As soon as coaching practitioners learn from these findings, an implication will be immediate: a four-week investment of the time of the structured, repetition-based drills mainly on the overhead clear is expected to result in a tremendous enhancement of the players' stroke accuracy which would be useful to academies striving to close the technical gap between the young talents and regular competitive success.

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