

Effect Of Shuttlecock Launcher-Based Training Drills On Smash Speed In Novice Badminton Players

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ABSTRACT

This study investigates the effects of different badminton training drills on smash speed among novice players, with particular emphasis on three variables: training frequency, duration, and intensity. An innovative multiple shuttlecock launcher was employed to replicate the unpredictability of real-match conditions. Adopting a controlled experimental design, the research measured performance through pre- and post-tests. Participants, mainly 12 to 13-year-olds with minimal playing experience were assigned to groups following distinct training regimens, while a control group continued with conventional practice methods. Systematic data collection involved performance logs and comprehensive statistical analyses, including paired-samples t-tests and one-way ANOVA, to ensure a rigorous evaluation of training effects. Results revealed that both increased training frequency and prolonged session duration produced significant improvements in smash speed, with mean gains of approximately 22–23 km/h. Conversely, variations in training intensity did not result in statistically significant enhancements compared with the control group. These findings suggest that, while high-intensity efforts have their value, the repetition and extended practice time associated with frequency and duration-based training play a more decisive role in developing explosive power and facilitating motor learning. The superior impact of frequent training sessions is likely attributable to enhanced neuromuscular adaptations and the consolidation of technique achieved through consistent practice opportunities. The findings further support the adoption of advanced training technologies, such as the multiple shuttlecock launcher, to more accurately replicate competitive conditions. Overall, this research offers valuable guidance for coaches and sports institutions, emphasizing that optimizing training frequency and duration is critical for achieving maximum performance gains in novice badminton players.

Key Words: Multiple Shuttlecock Launcher, Frequency-based Training, Duration-based Training, Intensity-based Training, Smash Speed, Novice Badminton Players.

INTRODUCTION

Badminton has been an integral part of the Olympic Games since 1992. Renowned for its dynamic pace and rapid exchanges, the sport is characterized by exceptionally high physical demands on athletes, particularly in terms of agility and coordination (Phomsoupha & Laffaye, 2014). Competing at the highest level requires a unique combination of speed, power, and strategic acumen, making badminton one of the most physically and mentally demanding racket sports.

Coaches employ a variety of training regimens, including multi-shuttlecock drills, which play a pivotal role in enhancing players' reaction time, as well as the accuracy and power of their strokes. By closely replicating match conditions, these drills effectively prepare athletes for the intensity and rapid pace of competitive play (Li & Xian, 2021).

The smash in badminton is one of the most dynamic and decisive shots, requiring a precise combination of raw power, rapid execution, and controlled accuracy to dominate the court. Mastery of this technique is essential for competitive players, as it can decisively influence the pace and momentum of a match. Distinguished by its force, steep angle, and high velocity, the smash makes it challenging for opponents to mount an effective defense. Putra et al. (2023) demonstrated that an optimal cycloid trajectory enables players to execute a smash in the shortest possible time, underscoring the critical role of trajectory in maximizing smash effectiveness.

A crucial element in executing a powerful badminton smash is the effective generation of force, which relies on the coordinated movement of the legs, torso, and arms to produce the power needed to propel the shuttlecock at high velocities. Putra et al. (2023) emphasize that optimizing the smash trajectory not only minimizes shot time but also enhances both the force and speed of the shuttlecock.

Shuttlecock speed is a critical determinant of smash effectiveness in badminton. Elite players can generate velocities exceeding 300 km/h, making the smash one of the most powerful and challenging strokes in competitive racket sports (Ramasamy et al., 2021). The badminton smash is a key point-winning skill, with its velocity playing a decisive role in match outcomes. However, the existing evidence guiding coaches on how to structure training frequency, session duration, and intensity to improve smash speed in novice players remains limited and outdated. While contemporary biomechanics has established that racket head speed, approach mechanics, and kinetic sequencing are fundamental to smash performance, these biomechanical insights alone do not provide clear, actionable recommendations on the optimal frequency, duration, and intensity of training needed to accelerate smash speed development in beginners (King, Towler, Dillon, & McErlain-Naylor, 2020).

Training frequency is one of the most direct variables influencing skill consolidation; however, evidence specific to badminton remains inconsistent and is often derived from studies on adult or elite populations. Research on session design indicates that increased training frequency can enhance technical repetition and learning opportunities, but the effectiveness of these exposures depends heavily on how sessions are structured and progressed within a microcycle (Kinnerk, Kearney, Harvey, & Lyons, 2021).

Session duration adds another layer of complexity, as longer practices increase the total number of smash repetitions but also elevate fatigue, which can alter mechanics and diminish impact quality. Evidence shows that acute fatigue significantly affects forehand smash biomechanics, suggesting that excessively long sessions may compromise the technical accuracy that novices need to establish in the early stages of skill acquisition (Zhang, 2020).

Training intensity is the third variable that must be balanced with frequency and duration to ensure safe and efficient improvement in novices. High velocity striking places considerable stress on the shoulder and trunk, and excessive intensity at early stages can trigger compensatory movement patterns or increase injury risk before stable coordination is established (Bullock et al., 2023).

These gaps highlight the need for a targeted investigation that isolates the effects of training frequency, session duration, and intensity on smash speed within a practice framework capable of delivering precise and repeatable feeds. Multiple-shuttle launcher drills provide a controlled method to standardize the number of smashes, inter-repetition intervals, and target trajectories, enabling experimental manipulation of these three key variables for novice development while minimizing confounding factors such as inconsistent feeding and rally constraints (Li & Hongsaenyatham, 2023).

This study aims to investigate the effects of training frequency, session duration, and training intensity on the enhancement of smash speed by comparing pre-test and post-test results, as well as by analyzing differences in smash speed between the experimental groups and the control group.

METHODS

Participants

A purposive sampling approach was used to ensure that all participants met the study's eligibility criteria. This study recruited 120 middle school students from Luoyang, China, all actively participating in their school badminton teams. Participants were selected through purposive sampling to ensure both novice status and a uniform level of prior exposure to the sport. Pre-test results served as baseline data for allocating intact classes into experimental and control groups, ensuring balanced representation of abilities across groups. After the 12-week intervention, post-test data were collected under identical conditions to enable accurate comparisons.

Instruments

a.) Shuttle Cock Launcher - Programmable Shuttle Launcher in Badminton Training

i.) Precision Control for Training Frequency - These machines allow users to set the exact launch interval (e.g., every 1.2–6 seconds), enabling highly consistent and repeatable smash practice. This precision supports frequently disciplined repetitions that are essential for skill consolidation in novices.

ii.) Flexibility to Modify Session Duration - With capacities to hold up to 180–200 shuttlecocks and battery runtimes of 3–6 hours, launchers support both short, focused drills and longer endurance-based sessions. They enable coaches to carefully structure session length—maximizing practice volume while allowing for built-in rest to manage fatigue and ensure technique integrity.

iii.) Adjustable Intensity Levels - Speed settings typically span 20–140 km/h, enabling tailored progression from low-intensity feeds to high-velocity smashes. This feature helps introduce intensity gradually, reducing injury risk while safely building power and coordination in novices.

iv.) Programmable Trajectory & Variation - Multi-directional launch modes fixed points, two- or three-line patterns, oscillation, and random feeds create dynamic, match-like conditions. Such programmable drills challenge players' reaction time, adaptability, and decision-making, which are critical for real-game transfer.

v.) Standardization to Eliminate Manual Variability - By replacing manual feeding, these launchers ensure all players experience identical trajectory, speed, and intervals. This removes a major source of variability and enables reliable comparisons in experimental or training studies (Karamuz, Olejnik, & Awrejcewicz, 2014).

b.) Smash Speed Measurement

Smash speed was assessed using a calibrated radar-based measurement system, like the i-Court Smash X, positioned in a fixed location directly behind the shuttle's flight path. This placement enabled unobstructed tracking of shuttle velocity immediately after racket contact. During each testing session, participants executed three valid smash attempts, and the mean velocity (km/h) was calculated and recorded. This procedure follows established badminton performance assessment protocols, in which shuttle speed is recognized as a reliable indicator of technical execution and power output (Phomsoupha & Laffaye, 2014; Ryew & Kim, 2003).

Intervention Period

Programme variables are staged to respect technical learning while progressing frequency (3×/week fixed), duration (60 minutes), and intensity via feed rate and 90 target zones. Intensity progression is supported by HR and RPE monitoring to maintain quality of movement.

Twelve-Week Multiple-Shuttle Cock Training Programme (EG)

Weeks	Sessions/ week	Session duration	Target Intensity	Feed Rate	Smashes/Sessi on	Technical Focus
1-2	3	60 Min	RPE 5-6; HR ~65- 75% max	18-22 shuttles/min	180-220	Contact point, arm swing sequencing, safe landing
3-4	3	60 Min	RPE 6; HR ~70-78%	23-24	200-240	Approach footwork into jump smash, trunk rotation timing

5-6	3	60 Min	RPE 6-7; HR ~75- 82%	25-26	220-260	Jump-smash rhythm. proximal-to- distal sequencing
7-8	3	60 Min	RPE 7; HR ~78-85%	27-28	240-280	Speed at impact. repeatability under moderate fatigue
9-10	3	60 Min	RPE 7-8; HR ~80- 88%	29-30	260-300	Power consolidation .
11-12	3	60 Min	RPE 8; HR ~85-90%	31-32	280-320	angle control Peak velocity; stability of mechanics

Statistical Analysis

All participants underwent a pre-test to establish baseline smash speed, measured using a radar-based device with high accuracy in capturing shuttlecock velocity (Ryew & Kim, 2003). These baseline values served as the reference for post-intervention assessments conducted after the 12-week training program. Identical testing protocols and environmental conditions were maintained across both assessments to minimize measurement bias and ensure the reliability of comparisons.

For within-group analysis, a dependent samples t-test was conducted to evaluate changes in smash speed between pre- and post-test scores. This statistical approach is appropriate for determining whether a statistically significant difference exists in the mean scores of the same group measured at two time points (Cohen, 1988). Applying this test to each training group allowed for an assessment of the improvement attributable to the specific training variable under investigation.

Between-group differences in performance gains were analyzed using a one-way Analysis of Variance (ANOVA), a method recognized for its robustness in detecting statistically significant differences among three or more group means (Field, 2013). In this study, ANOVA was applied to compare post-test scores across the frequency, duration, intensity, and control groups. The significance level was set ($p < 0.05$) in accordance with conventional standards in sports science research to minimize the risk of Type I errors while ensuring that any detected differences represented meaningful effects (Cohen, 1988).

RESULTS

Descriptive Statistics

Demographic Information

Demographic	Experimental Groups		Control Group	
	Frequency	(%)	Frequency	%
Gender				
Male	41	45.6	14	46.7
Female	49	54.4	16	53.3
Age				
12 years old	47	52.2	19	63.3

13 years old	43	47.8	11	36.7
Duration of Playing Badminton				
Less than 1 year	36	40.0	12	40.0
1-2 years	33	36.7	12	40.0
3-4 years	15	16.7	6	20.0
More than 4 years	6	6.7	0	0.0
Skill Level				
Beginner	38	42.2	22	73.3
Elementary	37	41.1	7	23.3
Competent	15	16.7	1	3.3

Inferential Statistics

A paired samples t-test was conducted to compare scores of pre-tests and post-test for the Frequency Intervention Group on Smash Speed. On average, participants scored higher after the intervention ($M = 106.75$, $SD = 2.14$) than before ($M = 84.31$, $SD = 2.86$). This difference was statistically significant, $t(29) = -28.48$, $p < .001$. The mean difference was -22.44 with a 95% confidence interval of $[-24.06, -20.82]$, indicating that the intervention had a statistically significant positive effect on scores.

To compare smash speed scores between the pre-test and post-test within the Duration Group, a paired samples t-test was performed. On average, participants achieved higher scores following the intervention ($M = 107.85$, $SD = 0.40$) than before ($M = 84.45$, $SD = 0.40$). This difference was statistically significant, $t(29) = -47.66$, $p < .001$. The mean difference was -23.40 with a 95% confidence interval of $[-24.40, -22.40]$. This indicates that the intervention produced a statistically significant improvement in scores.

To compare pre-test and post-test smash speed in the Intensity Group, a paired samples t-test was conducted. Participants recorded higher post-intervention scores ($M = 107.23$, $SD = 1.27$) compared to pre-intervention scores ($M = 83.36$, $SD = 2.38$). This difference was statistically significant, $t(29) = -46.74$, $p < .001$, with a mean increase of 23.40 (95% CI: $[-24.92, -22.83]$), indicating that the intervention led to a substantial and statistically significant improvement in smash speed.

The One-way ANOVA was employed to compare the Smash Speed between groups. Assumption testing for ANOVA includes assessing normality to ensure that the data meets the required conditions for valid statistical comparisons.

Meeting the normality assumption is essential for conducting ANOVA, as it ensures that the F-statistic accurately reflects differences between groups. The results indicate that the three training conditions meet this assumption, enabling valid ANOVA comparisons. Since three groups show normally distributed final smash speeds, parametric testing is appropriate for determining whether varying training intensities lead to significant improvements in badminton smash speed.

A one-way ANOVA was performed to evaluate the effects of three shuttlecock launcher-based training interventions, Frequency, Duration, and Intensity on smash speed. The analysis revealed a statistically significant difference among the groups, $F(3, 117) = 6.86$, $p = .02$. Post-hoc comparisons showed that participants in the Frequency Training Group achieved significantly higher smash speeds compared to those in the Duration, Intensity, and Control groups ($p < .05$).

DISCUSSION & CONCLUSION

The findings for the first research objective highlight training frequency as a key factor in improving smash speed among novice badminton players. Updated results provide strong evidence that more frequent training sessions lead to substantial performance gains. In the Frequency Training Group, the average pre-test smash speed was 84.31 km/h, which increased to 106.75 km/h after the intervention, reflecting a marked improvement in performance.

This improvement represents a mean increase of 22.44 km/h. The paired samples t-test confirmed the statistical robustness of this enhancement, yielding a t-value of -23.26 and a significance level of $p < 0.001$, indicating that the performance gains were directly attributable to the structured training regimen. Furthermore, the one-way ANOVA for the frequency group produced an F-value of 6.857 with a p-value of 0.017, reinforcing that variations in training frequency result in measurable and statistically significant changes in smash speed. These findings emphasize that training frequency serves as a powerful stimulus for developing the explosive power essential for an effective smash. Post-hoc analysis further substantiated this conclusion by comparing the group's frequency performance with other training conditions.

Post-hoc analysis reinforces these findings by comparing the frequency group with the duration, intensity, and control groups. Results revealed significant differences favoring frequency-based training. Specifically, when the frequency group was directly compared with the duration-based, intensity-based, and control groups, the data consistently demonstrated that higher training frequency produced superior improvements. This indicates that regular, repeated exposure to targeted smashing drills enhances neuromuscular adaptations, sharpens motor execution, and ultimately results in a more explosive and efficient smash. The evidence strongly supports the view that increasing the number of weekly training sessions serves as an optimal stimulus for performance enhancement in this specific athletic skill.

These findings are consistent with established theoretical frameworks, particularly the Theory of Deliberate Practice and the Contextual Interference Effect. The Theory of Deliberate Practice asserts that consistent, purposeful, and focused training is essential for skill mastery, as repeated practice enables athletes to refine technique through systematic error detection and correction. In the context of smash speed development, frequent training sessions offer multiple opportunities for immediate feedback, allowing players to fine-tune their striking mechanics. Ericsson and Harwell (2019) highlight that such structured repetition is vital for building the muscle memory needed to perform high-speed, precise movements. This repeated exposure not only reinforces smash mechanics but also enhances coordination among muscle groups, improving both timing and force production.

Extensive research in sports training consistently underscores the importance of practice frequency. For example, Walklate et al. (2009) found that higher practice frequencies are linked to improved technical proficiency and enhanced overall performance across various sports. Such evidence suggests that increased practice opportunities not only refine athletes' movement patterns but also cultivate sharper timing and spatial awareness both essential for executing a powerful smash. Additionally, findings from sports periodization research highlight the need to balance training stimulus with recovery. Insufficient practice fails to provide the necessary stimulus for adaptation, whereas excessive, poorly managed practice can result in fatigue and overtraining. The present study identified an optimal frequency of three to four training sessions per week, which appears to achieve the ideal balance delivering enough stimulus for skill and strength gains while ensuring adequate recovery to maximize performance.

Increased training frequency also appears to enhance consistency in performance. The reduced variability observed in post-test measurements indicates that players who participated in more frequent practice sessions experienced a narrowing of the performance gap, suggesting that repeated practice fosters more uniform and reliable smash execution. This outcome is particularly important for novice players in the early stages of skill development. When a high volume of repetitions is accumulated over the week, the cumulative effect is an improvement in both the technical and physical components of the smash. Enhanced coordination strengthened muscle memory, and refined techniques collectively contribute to greater reliability and explosive power during performance. This suggests that frequent practice not only narrows performance differences among players but also promotes more reliable skill execution, particularly in novice athletes (Walklate et al., 2009).

The benefits associated with increased training frequency carry significant practical implications for coaching and athlete development. Coaches and trainers can apply these findings by designing practice schedules that maximize the frequency of targeted drills. Implementing more frequent training sessions is likely to accelerate performance

improvements, particularly in specific metrics such as smash speed. The clear, statistically significant gains observed in the frequency training group demonstrate that simply increasing weekly practice sessions can produce measurable performance enhancements. This approach is especially valuable for novice players, who require consistent, repeated practice to build a strong technical foundation before advancing to more complex training methods.

Furthermore, incorporating structured, frequent training sessions align well with established pedagogical principles in sports training. As highlighted by Ericsson and Harwell (2019), combining deliberate, focused practice with immediate corrective feedback not only enhances specific performance metrics such as smash speed but also accelerates the development of broader athletic skills. Supporting this view, Li and Xian (2021) found that higher training frequency is strongly associated with improved motor control, faster reaction times, and more effective execution of sport-specific skills. In badminton, where delivering a powerful smash depends on both technical precision and physical conditioning, these findings emphasize that increasing training frequency serves as a critical driver of performance enhancement.

The study's findings provide robust evidence regarding the influence of training variables such as frequency, duration, and intensity on enhancing smash speed among novice badminton players. Based on the latest updated results, it is clear that

Each variable contributes to performance improvement, yet their impacts differ in magnitude and practical application. The data indicates that while all three factors promote neuromuscular adaptation and technical improvements, one variable stands out as the most effective in consistently boosting smash

AUTHOR CONTRIBUTIONS

All authors contributed equally to this study.

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ETHICAL APPROVAL

SEGi Research Ethics Committee Approval Number: SEGiEC/SR/FOELPM/446/2024-2025

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