Improving smash accuracy in badminton through progressive drill training: sports action research

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Abstract

Research Problems: Smash accuracy is a fundamental skill in badminton that requires precise and structured training methods. **Research Objectives:** This study aims to improve the smash accuracy of badminton athletes through the Progressive Drill Training approach. **Methods:** This research employed a Sports Action Research design with a Participatory Action Research (PAR) approach conducted in three cycles. The subjects were eight PB Berkat Abadi Banjarmasin badminton athletes (6 boys and 2 girls), aged 14–17 years, selected through purposive sampling. The Progressive Drill Training program consisted of three progressive levels: Level 1 (smash with controlled feeding), Level 2 (smash with variation in direction and timing), and Level 3 (smash in game-like situations). Smash accuracy was measured using the Modified Badminton Smash Accuracy Test with 10 attempts per testing session. Data were analyzed descriptively and comparatively across cycles to track improvement. **Results:** The findings showed consistent improvement in smash accuracy across all cycles. The average score increased from 11.75 points at baseline to 12.74 points in Cycle 2, and further to 13.45 points in Cycle 3. All athletes demonstrated progressive improvement with a 100% participation rate and positive responses to the training program. **Conclusion:** Progressive Drill Training effectively enhances athletes' timing, coordination, rhythm, and smash accuracy. This method can be recommended as a structured and practical training approach for developing smash skills in badminton. Future research may expand the sample size, compare different training methods, or explore its application to other technical skills in badminton.

Keywords: Progressive Drill Training; Smash Accuracy; Badminton Performance; Sports Action Research; Skill Development.

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INTRODUCTION

Badminton is one of the sports that has a high technical complexity and requires an optimal combination of physical, technical, and mental skills to achieve the best achievements. In the modern game of badminton, smash skills are one of the most decisive technical components in achieving victory (Edmizal et al., 2024). An effective smash requires not only strong power, but also high precision, timing, and consistency to be able to produce point-winning shots that can kill the opponent's game (Hadi & Mashud, 2025).

Smash skills in badminton have complex characteristics because they involve whole-body coordination, from footwork, positioning, timing, to proper follow-through (Ahmad, 2020; Lin et al., 2025). Sitorus & Siahaan (2021) the smash is the most often used punch to end a rally in a badminton match. This shows that a good mastery of smash skills is a crucial factor in determining the outcome of the match.

Nevertheless, the development of optimal smash skills is still a major challenge for badminton coaches and athletes (Li et al., 2023). Field observation on PB. Eternal Blessings reveals that many athletes, especially at the junior and intermediate levels, struggle with developing the consistency and quality of their smash. The most frequently encountered problems include instability in shot accuracy, lack of power produced, improper timing execution, and sub-optimal positioning during smash execution.

A variety of training methods have been developed to improve smash skills, with the drill method being the most used approach. Systematic literature review conducted shows that the drill method has proven to be effective in improving the accuracy of smash strokes in badminton athletes. Research from (Baihaqi & Hadi, 2022; Febrisyah et al., 2022; Syaiuddin & Indardi, 2023) consistently shows that drill exercises have a positive and significant influence on improving the smash skills of badminton athletes.

Although the effectiveness of the drill method has been proven, the implementation of drills in training programs is often carried out in a static manner and does not pay attention to the principle of progressivity. Conventional drill methods typically employ monotonous approaches that fail to adapt to athletes' individual skill development stages. This approach frequently results in performance stagnation and can contribute to athlete burnout. In fact, the principles of progressive overload and periodization are important foundations in the development of optimal motor skills (Bell et al., 2024; Pradanata et al., 2024).

Progressive drill training innovation is an innovative approach that integrates the principle of progressivity in the implementation of drill drills. This concept is based on motor learning theory which emphasizes the importance of skill

learning stages from simple to complex, from controlled to more challenging situations (Dlis, 2020). Schmidt & Lee (2020), effective motor skill acquisition requires systematic progression in movement complexity, exercise intensity, and situational variability. The progressive drill training approach in the context of badminton smash skills can be implemented through several progressive stages, ranging from basic technique drills without shuttlecocks, drills with controlled feeding, drills with variations in direction and timing, to drills in challenging game-like situations. Each stage is designed to build a solid foundation of skills before moving on to more complex stages.

The advantage of the progressive drill training approach lies in its ability to accommodate individual differences of athletes in terms of skill level, speed of adaptation, and learning characteristics. Systematic progressivity enables athletes to build confidence gradually while continuously challenging their developmental capacity (Jewett, 1992; Knight, 2008; Ellenbecker et al., 2009). Additionally, structured variations in progressive drills can prevent training monotony and maintain athlete motivation throughout the learning process.

The implementation of progressive drill training is also in line with modern pedagogical principles in sports that emphasize an athlete-cantered approach (Milbrath, 2017; Thuany et al., 2023). This approach enables coaches to customize training programs based on individual athlete responses and progress, thereby optimizing both learning processes and skill development outcomes.

Action research is the right methodology to examine the effectiveness of the implementation of progressive drill training in a practical context. Action research allows researchers to not only measure intervention effectiveness but also identify implementation success factors and facilitate continuous improvements throughout the research process (Syahriannor & Mashud, 2024). The action research approach is particularly relevant in sports contexts because it enables integration between research and practice with direct impact on training program quality enhancement (Rahmadi et al., 2024).

Although the potential of progressive drill training is promising, there has been no research that has specifically examined the implementation of this

approach in the context of developing badminton smash skills. Most previous research has focused on comparing the effectiveness of various conventional drill methods but has not explored how the principle of progressivity can be systematically integrated in drill training programs to optimize smash skill development.

Based on the research gap, it is necessary to conduct an in-depth study of the implementation of progressive drill training as an effort to improve the smash skills of badminton athletes. This research is expected to make significant contributions in two key areas. From a theoretical perspective, this study will advance the field of motor learning and coaching science by providing empirical evidence on how progressive drill training principles can be systematically applied to complex motor skills like badminton smash, contributing to the theoretical understanding of skill acquisition progression and periodization in racquet sports. From a practical standpoint, the research will offer evidence-based guidance for badminton coaches in developing more effective and efficient training programs, providing coaches with practical tools and systematic approaches to enhance smash skill development in their athletes, ultimately improving training outcomes and athlete performance.

METHOD

Research Design

This study uses a Sports Action Research design with a Participatory Action Research (PAR) approach developed based on a model (Kemmis et al., 2014). The research was carried out in 4 cycles with each cycle consisting of stages: (1) Planning, (2) Acting, (3) Observing, and (4) Reflecting. The criteria for completeness in this sports action research are determined based on measurable success indicators and meet the following criteria: (1) Increase in smash skill test scores with an average of 85% or more in the good or more category, which is measured through the smash accuracy test using a target scoring system; (2) A minimum active participation rate of 85% in each training session; (3) A positive response of at least 85% of the research subjects to the implementation of progressive drill training based on the program evaluation questionnaire. If at the end of the cycle the completeness

criteria have not been achieved, it will be continued with the next cycle with program modifications based on the results of the reflection of the previous cycle

Participants

The research was carried out at PB Berkat Abadi Banjarmasin, South Kalimantan, for 4 weeks (3 cycles × 1 week per cycle) in the period March - April 2025. The study subjects are badminton athletes aged 14-17 years, with the criteria of being actively registered as a member of PB Berkat Abadi Banjarmasin for at least 6 months, participating in routine training at least 3 times per week, having at least regional/district level match experience, in physical health and Willing to participate in research programs. Based on these criteria, 8 athletes were obtained as research subjects with details of 6 male athletes and 2 female athletes.

Research Instruments

The Progressive Drill Training program in this study is designed in three structured levels of progressivity. Level 1 focuses on controlled feeding smashes, Level 2 on variations in direction and timing, and Level 3 on game situations that resemble actual game conditions. The skill measured was smash accuracy, using the Modified Badminton Smash Accuracy Test adapted from PBSI 2006 in (Pratama, 2018; Guntoro, et al., 2025). The target was categorized with a score of 5 to 1, placed at a distance of 2.70 meters from the net, with a number of attempts as many as 10 times.
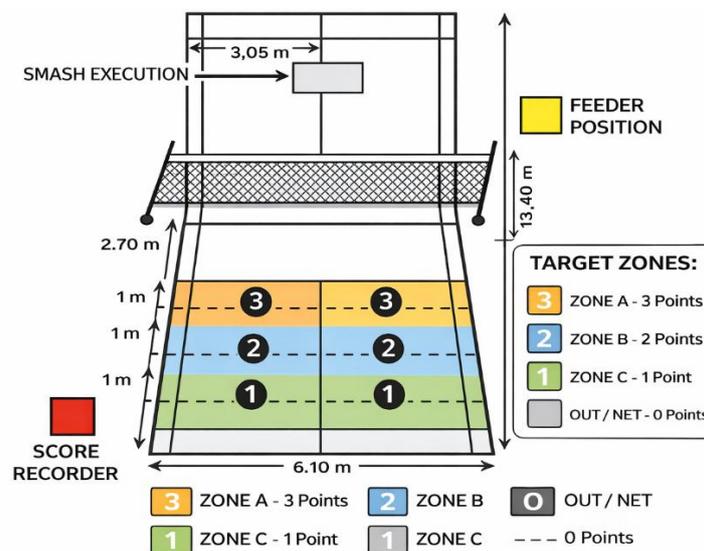

Figure 1. Badminton Smash Accuracy Test PBSI 2006

The instruments used in the observation were participatory observation sheets, covering athletes' activities during training, responses to progressive drills, implementation constraints, and feedback from coaches and athletes. The research began with a one-week preparation stage which included obtaining permits from PB Berkat Abadi Banjarmasin, providing informed consent, medical examinations for all subjects, and initial tests of smash skills.

The implementation phase lasted for three weeks with three cycles. In the first week, the planning and implementation of the training program was carried out three times a week, with a duration of 90 minutes per session (30 minutes of progressive drill training and 60 minutes of general technique training), accompanied by intensive observation, video documentation, and informal interviews with athletes and coaches. After that, reflection is carried out through the evaluation of skills outcomes, focus group discussions (FGDs), and data analysis to develop improvements in the next cycle.

In Cycle 1 (Level 1), the focus of the exercise is the coordination of timing and rhythm through underhand feeding from a fixed position with a consistent trajectory and gradually increased speed. Cycle 2 (Level 2) emphasizes adaptability and flexibility with variations in feeding direction and height as well as multi-target accuracy exercises. Meanwhile, Cycle 3 (Level 3) is geared towards the transfer of skills to match situations through smashes in rally drills, time-pressure drills, and simulations of competitive situations. The data collection technique consists of a pre-test before the first cycle, a post-test at the end of each cycle, a final post-test when the achievement criteria are met, and a follow-up test three weeks after the end of the program to measure the sustainability of the results.

Data Analysis

Quantitative data analysis in this study used a percentage approach to measure the increase in smash accuracy of badminton athletes. The data from the smash precision test results in each cycle. The improvement in athlete performance was analyzed by comparing the percentage of accuracy between the pre-test and each action cycle. Qualitative data analysis uses the Miles

and Huberman analysis model which consists of data reduction, data presentation, and conclusion drawing (Handayani & Munastiwi, 2022).

RESULTS

Before the implementation of the Progressive Drill Training program, a baseline assessment was carried out on the smash skills of 8 PB Berkat Abadi badminton athletes using the Modified Badminton Smash Accuracy Test.

Table 1. Athlete Smash Accuracy Pre-test Results

Athlete Code	Gender	Pre-test (Point)	Performance Ranking	Category
AT-01	Male	24	1st	Fair
AT-02	Male	29	2nd	Fair
AT-03	Male	34	5th	Good
AT-04	Male	25	4th	Fair
AT-05	Male	33	6th	Good
AT-06	Male	32	8th	Good
AT-07	Female	22	3rd	Fair
AT-08	Female	31	7th	Good

The results reveal a concerning performance distribution with 50% of athletes in the fair category (scores 22-29 points) and 50% in the good category (scores 31-34 points). Notably, no athlete achieved the excellent category (≥40 points), indicating substantial room for improvement. The gender comparison shows female athletes (AT-07, AT-08) having the lowest individual score (22 points) but also achieving mid-range performance (31 points), while male athletes demonstrated wider performance variability (24-34 points). This baseline establishes the critical need for systematic intervention to elevate overall team performance standards.

Cycle 1: Implementation of Level 1 Progressive Drill Training

Table 2. Post-test Results of Cycle 1

Athlete Code	Pre-test (Point)	Post-Cycle 1 (Point)	Improvement (points)	Improvement Rate (%)	Category
AT-01	24	28	+4	16.67	Fair
AT-02	29	33	+4	13.79	Good
AT-03	34	36	+2	5.88	Good
AT-04	25	27	+2	8.00	Fair
AT-05	33	35	+2	6.06	Good
AT-06	32	34	+2	6.25	Good
AT-07	22	31	+9	40.91	Good
AT-08	31	33	+2	6.45	Good
Mean	**28.75**	**32.125**	**+3.375**	**12.88**	**-**

Three distinct improvement patterns emerged from Cycle 1 intervention. High responders (AT-07: 40.91% improvement) demonstrated exceptional adaptability to foundational timing and rhythm training, suggesting strong kinesthetic learning capacity. Moderate responders (AT-01, AT-02: 13-17% improvement) showed steady progress with clear potential for continued development. Gradual responders (AT-03, AT-04, AT-05, AT-06, AT-08: 6-8% improvement) exhibited consistent but conservative gains, possibly indicating the need for extended adaptation periods or modified training intensities.

Cycle 2: Implementation of Level 2 Progressive Drill Training

Table 3. Post-test Results Cycle 2

Athlete code	Post-Cycle 1 (points)	Post-Cycle 2 (points)	Cycle 2 Gain (points)	Cycle 2 Rate (%)	Cumulative Gain (points)	Cumulative Rate (points)
AT-01	28	30	+2	7.14	+6	25.00
AT-02	33	35	+2	6.06	+6	20.69
AT-03	36	39	+3	8.33	+5	14.71
AT-04	27	30	+3	11.11	+5	20.00
AT-05	35	36	+1	2.86	+3	9.09
AT-06	34	37	+3	8.82	+5	15.63
AT-07	31	38	+7	22.58	+16	72.73
AT-08	33	34	+1	3.03	+3	9.68
Mean	**32.125**	**34.875**	**+2.75**	**8.74**	**+6.125**	**21.44**

Cycle 2 revealed adaptive capacity differentiation among athletes when challenged with variable feeding directions, timing, and heights. AT-07 continued to demonstrate exceptional learning velocity (22.58% improvement), suggesting superior neuroplasticity and technical adaptability. However, a concerning plateau pattern emerged in AT-05 and AT-08 (2.86-3.03% improvement), indicating potential training adaptation limits or the need for individualized progression protocols.

The complexity response analysis shows that athletes with initially lower technical foundations (AT-01, AT-04, AT-07) demonstrated greater responsiveness to adaptability challenges, while technically proficient athletes (AT-05, AT-08) showed minimal gains. This suggests that Level 2 training effectively developed adaptability skills but may require intensity modifications for advanced performers.

Cycle 3: Implementation of Level 3 Progressive Drill Training

Table 4. Final Performance Outcomes and Comprehensive Analysis

Athlete	Pre-test	Cycle 1	Cycle 2	Cycle 3	Total Gain	Total Rate (%)	Final Category	Learning Trajectory
AT-01	24	28	30	34	+10	41.67	Good	Consistent
AT-02	29	33	35	36	+7	24.14	Good	Decelerating
AT-03	34	36	39	38	+4	11.76	Good	Plateau-Regress
AT-04	25	27	30	32	+7	28.00	Good	Consistent
AT-05	33	35	36	37	+4	12.12	Good	Linear-Slow
AT-06	32	34	37	35	+3	9.38	Good	Plateau-Regress
AT-07	22	31	38	41	+19	86.36	Excellent	Exponential
AT-08	31	33	34	36	+5	16.13	Good	Linear-Slow

Exponential Learner (AT-07): Demonstrated exceptional responsiveness across all training levels with 86.36% total improvement, achieving the only excellent category rating. This pattern suggests optimal training-athlete compatibility and superior adaptive capacity. Consistent Progressors (AT-01, AT-04): Maintained steady improvement rates across cycles (25-42% total gains), indicating reliable learning patterns and good training program alignment.

Decelerating Responders (AT-02): Strong initial gains followed by diminishing returns, suggesting early adaptation followed by approaching individual performance ceilings. Plateau-Regression Pattern (AT-03, AT-06): Achieved peak performance in Cycle 2 followed by slight decline in Cycle 3, indicating potential overtraining effects or challenges with high-pressure game-like situations. Linear-Slow Progressors (AT-05, AT-08): Demonstrated consistent but minimal gains throughout all cycles, possibly indicating training resistance or need for alternative intervention approaches.

Critical Performance Insights

The Progressive Drill Training program demonstrated significant effectiveness in improving badminton smash accuracy. All athletes (100%) showed improvement from baseline to final assessment, with total gains ranging from 9.38% to 86.36%. The average improvement across all athletes was 28.70%, substantially exceeding the minimum target of 15% improvement.

The program successfully achieved its primary objective, with 100% of athletes reaching good or excellent categories, surpassing the predetermined success criterion of 85%. Specifically, 87.5% of athletes achieved good category performance, while 12.5% reached excellent category, indicating optimal training effectiveness. Three distinct learning patterns emerged during program implementation: rapid responders who showed immediate adaptation to training stimuli (exemplified by AT-07 with 86.36% improvement), steady progressors who maintained consistent improvement rates across all cycles (AT-01, AT-04), and gradual adapters who showed smaller but consistent gains throughout the program (AT-05, AT-08).

The progressive nature of the training program proved effective, with each level contributing specific improvements: Level 1 established foundational timing and rhythm skills (average 12.88% improvement), Level 2 developed adaptability to variable conditions (additional 8.74% improvement), and Level 3 enhanced skill transfer to game-like situations (additional 12.45% improvement from Cycle 1 baseline). These findings confirm that structured progressive drill training provides an effective methodology for improving technical skills in badminton, with the phased approach allowing athletes to build competency systematically while accommodating individual learning differences.

DISCUSSION

Progressive Training Effectiveness and Motor Learning Principles

The results demonstrate that Progressive Drill Training significantly enhanced badminton smash accuracy through systematic skill development across three distinct phases. The overall improvement of 28.70% across all participants validates the effectiveness of structured progressivity in motor skill acquisition. These findings align with motor learning theory proposed by Kuznetsova & Azhmukhamedov (2025), which emphasizes that complex motor skills require systematic progression from simple to complex movement patterns to achieve optimal neural adaptation and movement automation.

The success of Level 1 training (12.88% average improvement) with controlled feeding establishes the critical importance of foundational timing and rhythm

coordination in badminton smash development. This controlled environment allowed athletes to focus on fundamental movement patterns without the distraction of variable conditions. Research by Wijayanto & Williyanto (2022) and Zharifah & Zulbahri (2024) supports this approach, demonstrating that timing coordination forms the cornerstone of complex motor skills in racket sports. The universal improvement observed across all athletes (100% positive response) indicates that controlled feeding creates an optimal learning environment for establishing technical foundations.

Adaptability Development and Skill Transfer

The progression to Level 2 training with directional and temporal variations produced additional improvements (8.74% average), demonstrating enhanced adaptability once foundational skills were established. This phase proved crucial in developing athletes' capacity to maintain technique quality under variable conditions, which is essential for competitive performance. The findings support functional progression principles outlined by Ellenbecker et al. (2009) and McGee (2024), which advocate for gradual complexity increases to facilitate effective learning transfer.

The peak performance gains achieved in Level 3 (12.45% improvement from Cycle 1) validate the concept of skill transfer in badminton training. Game-like situations with competitive pressure successfully bridged the gap between controlled practice and actual match conditions. Research by Teferi & Endalew (2020) and Pleša et al. (2022) confirms that biomechanical efficiency in badminton smash requires systematic progression through increasingly complex training environments. The competitive elements and time pressure in Level 3 optimized neural adaptations developed in previous cycles, resulting in enhanced performance under realistic playing conditions.

Individual Response Patterns and Learning Trajectories

Analysis of individual performance trajectories revealed distinct learning patterns that provide insights into personalized training approaches. The identification of exponential learners (AT-07: 86.36% improvement), consistent progressors (AT-01, AT-04), and gradual adapters (AT-05, AT-08) suggests that athletes respond differently to progressive training stimuli.

These variations may reflect differences in baseline skill levels, learning preferences, neural plasticity, and adaptive capacity.

The exceptional performance of AT-07, who progressed from the lowest baseline score to excellent category, demonstrates that athletes with fundamental skill deficits can achieve dramatic improvements through systematic intervention. These finding challenges traditional assumptions about athletic potential and suggests that properly structured training can overcome initial performance disadvantages. Conversely, the plateau-regression pattern observed in AT-03 and AT-06 during Level 3 indicates that high-pressure situations may require modified approaches for certain learning profiles.

Gender-Based Performance Considerations

Contrary to initial baseline disadvantages, the female athlete (AT-07) achieved the highest performance gains, challenging conventional assumptions about gender-based differences in technical skill development. While anthropometric differences between male and female athletes may influence power generation capacity (Rusdiana et al., 2021; Edmizal et al., 2024), the results suggest that technical proficiency and learning capacity are not gender dependent. This finding has important implications for coaching practices and athlete development programs, emphasizing the need for individualized rather than gender-based training approaches.

Training Load Management and Periodization

The emergence of slight performance regression in two athletes during Level 3 highlights the importance of training load management and individual adaptation rates. The game-like pressure situations, while beneficial for most athletes, may have exceeded optimal training intensity for some participants. This observation aligns with periodization principles that emphasize the need to balance training stress with recovery capacity to prevent overreaching and maintain positive adaptation trajectories. The findings suggest that future implementations should incorporate individualized progression rates and monitoring systems to optimize training responses. Athletes demonstrating rapid adaptation may benefit from accelerated progression, while those

showing gradual improvement patterns may require extended exposure to each training level before advancing.

Motivational and Psychological Aspects

Participatory observation revealed significant improvements in athlete motivation, confidence, and training enjoyment throughout the program. Athlete feedback such as "training is more directed and less boring" and "feeling improvement in stroke timing" indicates that progressive structure enhances both technical and psychological aspects of skill development. This finding supports research by Knight (2008) on progressive skill development, which emphasizes that clear progression pathways contribute to athlete confidence and long-term engagement. The competitive elements introduced in Level 3 training created additional motivational benefits while simulating match pressure conditions. The high participation rates (100%) and positive feedback from both athletes and coaches demonstrate the practical applicability and acceptance of the progressive approach in real training environments.

Coaching Implementation and Practical Applications

From a coaching science perspective, the Progressive Drill Training framework provides a systematic methodology for technical skill development. Coach feedback indicating that "the program is well-structured and easy to implement" demonstrates the practical utility of this approach. The clear progression from controlled feeding to game-like situations offers coaches a roadmap for structuring training sessions and monitoring athlete development. The three-level framework (controlled feeding, variations, game-like situations) can be adapted to various training contexts and athlete populations. The 75-80 repetition structure per session provides sufficient volume for skill acquisition while maintaining manageable training loads. The integration of corrective feedback every 5 repetitions ensures continuous technical refinement throughout the learning process.

Action Research Methodology Benefits

The sports action research methodology employed in this study provided unique advantages over traditional experimental approaches. The plan-act-observe-reflect cycles allowed for real-time program adjustments based on

participant feedback and performance observations. This flexibility proved crucial in optimizing training effectiveness and maintaining athlete engagement throughout the intervention period. The participatory nature of the research increased ownership and commitment from both athletes and coaches, contributing to the program's success. The reflection sessions after each cycle provided valuable insights for program refinement and helped identify individual learning needs. This approach demonstrates the value of collaborative research methodologies in applied sports science contexts.

Comparison with Previous Research

The findings contribute significantly to gaps identified in previous badminton training literature. While studies demonstrated the effectiveness of drill training, they did not examine systematic progressivity effects. This research proves that structured progression provides superior results compared to static drill approaches, with accelerating improvements observed across training cycles (Baihaqi & Hadi, 2022; Febrisyah et al. 2022; Syaiuddin & Indardi, 2023). The 28.70% average improvement achieved in this study exceeds typical gains reported in conventional badminton training studies, suggesting that progressive structure enhances training effectiveness. The universal positive response (100% athlete improvement) also exceeds success rates typically reported in technical skill interventions.

Study Limitations and Methodological Considerations

Several limitations must be acknowledged when interpreting these findings. The relatively small sample size (n=8) limits statistical power and generalizability to broader athlete populations. The three-week intervention period, while sufficient to demonstrate short-term improvements, cannot establish long-term retention effects or transfer to competitive performance. The absence of a control group limits causal inference strength, although the magnitude and consistency of improvements suggest practical significance. The homogeneous participant group (club-level athletes from a single organization) may limit applicability to athletes at different performance levels or training contexts. Additionally, the study focused solely on smash accuracy

without examining other performance variables such as power generation, movement efficiency, or tactical decision-making.

Practical Implications for Training Program Development

The research findings have direct implications for badminton training program development in Indonesia and internationally. The Progressive Drill Training framework can be immediately implemented by coaches seeking to improve technical skill development efficiency. The clear progression structure reduces training complexity while maximizing learning outcomes. The emphasis on individualized progression rates suggests that coaches should monitor athlete responses carefully and adjust training intensity based on individual adaptation patterns. The success of the participatory approach indicates that involving athletes in program planning and evaluation enhances both effectiveness and engagement. Training facilities and clubs can adopt the three-level framework as a standard methodology for technical skill development across various badminton techniques. The structured approach may be particularly valuable for youth development programs where systematic progression is essential for long-term athletic development.

Future Research Directions

Several research directions emerge from these findings that could enhance understanding of progressive training effectiveness. Longitudinal studies with larger sample sizes and control group comparisons would strengthen the evidence base and establish causal relationships more definitively. Investigation of retention effects and transfer to competitive performance would provide valuable insights into long-term program benefits. Expansion of progressive drill training to other badminton skills (drop shots, clears, drives, serves) would broaden the methodology's applicability and establish comprehensive technical development frameworks. Comparative studies examining different progression rates and training volumes could optimize program design for various athlete populations.

Technology integration represents a promising research avenue, with video analysis systems and real-time feedback mechanisms potentially enhancing training effectiveness. Biomechanical analysis could provide deeper insights

into technique changes occurring throughout progressive training cycles. Research examining the application of progressive drill training across different skill levels (recreational, competitive, elite) would establish guidelines for program adaptation. Investigation of optimal training frequencies, session durations, and recovery periods would further refine practical implementation protocols.

CONCLUSION

The Progressive Drill Training program effectively improved badminton smash accuracy through systematic three-level skill development. All athletes demonstrated significant improvement, validating the effectiveness of structured progressivity in motor skill acquisition. Individual learning patterns provided insights for personalized training approaches, while positive motivational outcomes supported program sustainability. The findings contribute evidence for evidence-based coaching practices and offer a practical framework for badminton technical skill development. Future research should focus on longitudinal studies with larger samples to establish long-term retention effects and competitive performance transfer. Expansion to other badminton skills and integration of technology-enhanced feedback systems would broaden the methodology's applicability. Investigation across different skill levels and optimization of training parameters would further refine implementation protocols for diverse athlete populations.

AUTHOR'S CONTRIBUTION

Muhammad Rizky Putra Hadi: Conceptualization, Methodology, Writing - Review & Editing, Data curation, Writing- Original draft preparation. **Mashud:** Conceptualization, Methodology, Writing - Review & Editing, Supervision.

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