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Development of Multiball Feeding Training Program to Improve Selected Physical Fitness and Skills in Novice Badminton Students

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Abstract

Background and Aims: This study aimed to address the limitations of traditional badminton training methods in effectively enhancing both physical fitness and skill development in novice players. Many beginners struggle with footwork, reaction time, endurance, and stroke accuracy due to insufficient training intensity and limited shuttle repetition. To address these issues, this research developed a multiball feeding training program to enhance selected physical fitness components and badminton skills in novice badminton students.

Materials and Methods: A quasi-experimental research design with a two-group pretest-posttest approach was employed. The sample consisted of 46 students from Hangzhou Senior High School in Hangzhou City, who were systematically assigned into two groups based on their Wall Volley Test scores. The experimental group underwent an eight-week multiball feeding training program developed by the researcher, with a validity score of 0.97 (range: 0.80-1.00). Training sessions were conducted after school, twice a week, for two hours per session. The control group followed a traditional badminton training program. Research instruments included the multiball feeding training program, selected physical fitness tests (zig-zag run, hand release push-up, standing long jump, reaction time, and 1500-meter run), and badminton skill assessments (footwork test, wall volley test, short serve test, clear test, smash test, and accuracy stroke test). Data were collected before and after the experiment and analyzed using an independent t-test for between-group comparisons and a paired t-test for within-group comparisons, with a significance level of $p<.05$.

Results: The findings indicated that (1) Both the multiball training and traditional training groups demonstrated improvements in physical fitness and badminton skills; (2) Participants in the multiball training program showed significantly greater improvements in all five physical fitness components and five out of six badminton skill assessments compared to the traditional training group, except the short serve test, where no significant difference was observed.

Conclusion: The multiball feeding training program was more effective in enhancing both physical fitness and badminton skills compared to the traditional training approach. Future research should explore its long-term effects and applicability in different training populations.

Keywords: Multiball Feeding, Badminton Training, Physical Fitness, Skill Development

Introduction

Badminton has surged in popularity due to its accessibility and the comprehensive benefits it offers. It enhances physical agility, requiring players to react quickly to the shuttlecock's high-speed movements. This necessity for swift reflexes improves balance and flexibility, as players frequently engage in reaching and lunging motions. The social aspect of badminton is also significant, fostering a strong community that contributes to increased longevity. Moreover, its popularity has been amplified by social media, and younger generations are drawn to its dynamic nature and active lifestyle.

The physical benefits of badminton are extensive, including cardiovascular fitness, muscle toning, and core stability development, making it not only an engaging sport but also a holistic workout. With over 300 million active players worldwide, badminton appeals across ages and skill levels, making it a globally influential sport. The fundamental skills in badminton are categorized into five groups: (1) footwork or movement (left and right, forward and backward, diagonal movement, and combinations); (2) front-court shots (net drop, jab, and defensive lob); (3) mid-court shots (short serve, long serve, drive, side shot, and smash return); (4) backcourt shots (clear or lob, smash, and drop shot) (Badminton World Federation [BWF], 2012; Sport Authority of Thailand, 2011; Tasnaina et al., 2016; Hongchareon, 1996).

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In badminton training, footwork and movement are typically emphasized in the initial stages of lessons or training programs for novices. These skills are crucial, as many coaches and teachers assert that "you cannot execute a perfect hit if you are not in the right position" (Tasnaina et al., 2016; Chiu, Tsai, Sung, & Tsai, 2020). Modern badminton has evolved into a fast-paced game requiring agility, strategic movement, and balance. The shuttlecock's speed can be exceptionally high, with recorded smashes exceeding 400 km/h in professional play (Guinness World Records, 2017; Phomsoupha & Laffaye, 2015). Studies have demonstrated that visual anticipation is crucial for expert performance in striking sports (Morris-Binelli & Müller, 2017; Müller & Abernethy, 2012; Williams & Jackson, 2019).

A badminton player runs an average of around 3–4 miles per match, nearly double the distance covered by the average tennis player. One of the longest-recorded badminton matches lasted well over two hours (Badminton HQ, 2021). Efficient footwork is essential for improved gameplay, allowing for better court coverage and faster reactions. Techniques such as the split-step, running, chasse, and recovery steps enhance mobility and positioning. Drills like the six-corner drill simulate match scenarios, improving agility and endurance. Incorporating SAQ (Speed, Agility, and Quickness) training, including ladder agility exercises, agility jumps, sprints, and jump rope drills, can further enhance these attributes (Chandrakumar & Ramesh, 2015; Marom et al., 2023).

In addition to agility, strength, and endurance play a crucial role in badminton performance. The sport requires rapid transitions between offensive and defensive stances (Lees, 2003). Endurance is essential for sustaining performance throughout matches, particularly given badminton's high-intensity, intermittent nature (Zhang et al., 2017; Bishop et al., 2011). Aerobic endurance enables players to maintain their performance over extended durations, with matches sometimes lasting over an hour. As rallies progress, lactic acid accumulates, breathing intensifies, and mental fatigue sets in, making endurance a critical factor in maintaining precision and strategic execution (Olympics.com, 2021).

Multiball training is an effective method in badminton for improving skills and overall performance. It involves a coach or partner feeding multiple shuttlecocks in rapid succession, enhancing reaction time, stroke consistency, and endurance (Chen & Hongsaenyatham, 2021). Studies highlight its benefits in refining movement, physical fitness, tactics, and stroke execution (Tasnaina et al., 2016). Badminton-Insight.com (2021) outlines several half-court training drills that improve skill consistency, including smash lay-offs, drives, slice and push drills, defensive pressure exercises, drop shots, mid-court play, and push shots. Training in a confined space can improve precision and movement efficiency, complementing full-court training. Additionally, multiball training allows for increased stroke repetitions, immediate feedback, and optimized technical practice, boosting confidence and motivation (Badmintonandy.com, 2020).

Despite the widespread adoption of traditional badminton training, many novice players struggle to develop essential physical attributes such as agility, reaction time, and endurance, which are critical for skill execution (Phomsoupha & Laffaye, 2015; Zhang et al., 2017). Conventional training often lacks the intensity and structured repetition necessary to reinforce motor learning and movement efficiency, leading to slower progress in technical and tactical development (Morris-Binelli & Müller, 2017; Tsai & Chang, 2018). Additionally, existing training approaches may not adequately simulate real-game conditions, limiting their effectiveness in preparing players for match scenarios (Williams & Jackson, 2019). While multiball feeding training has been shown to improve stroke repetition and consistency in other racket sports, such as table tennis and squash (Tsai & Chang, 2018; Zhu & Chen, 2020), its direct impact on physical fitness and badminton-specific skill development in novice players has not been extensively validated. This study seeks to address this gap by developing and assessing a structured Multiball Feeding Training Program that integrates agility drills, endurance training, and skill-focused repetitions to enhance overall player performance in a school-based training setting.

As a badminton coach and a master's student in physical education, the researcher recognizes the importance of integrating SAQ exercises and other physical fitness training with skill-based multi-ball training. Combining these methodologies is expected to enhance footwork, selected physical fitness attributes, and badminton stroke performance simultaneously. Therefore, this research proposes the

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Development of a Multiball Feeding Training Program to Improve Physical Fitness and Selected Skills in Novice Badminton Students.

Objectives

1. To develop a multiball feeding training program to improve physical fitness and selected badminton skills in novice badminton students.

2. To evaluate the efficiency (validity) and effectiveness of the program in terms of physical fitness improvement, skill enhancement, and participant acceptance.

Literaterature Review

Badminton is a physically demanding sport that requires a combination of agility, endurance, power, and precise skill execution. Traditional training methods often focus on structured drills and controlled practice sessions, but recent research has highlighted the benefits of multiball feeding training as an alternative approach to skill development. Multiball training, widely used in racket sports such as table tennis and tennis, has been adapted to badminton to enhance movement efficiency, stroke accuracy, and decision-making speed. This review explores the significance of physical fitness in badminton, skill acquisition, and the effectiveness of multi-ball training, particularly for novice players.

Badminton performance is heavily dependent on physical fitness, including agility, endurance, strength, and reaction speed. Studies have shown that elite badminton players rely on explosive power to execute smashes and quick movement transitions (Lees, 2003; Phomsoupha & Laffaye, 2015). Footwork efficiency is another critical factor, as players need to move swiftly across the court while maintaining balance and positioning for optimal shot execution (Zhang et al., 2017). Speed, agility, and quickness (SAQ) training has been found to improve a player's ability to change direction rapidly and respond effectively to their opponent's shots (Marom et al., 2023). Furthermore, endurance is a key determinant of success, as matches can last over an hour, requiring sustained energy and stamina. High-intensity interval training (HIIT) has been widely used to improve cardiovascular endurance and overall performance in competitive badminton (Bishop et al., 2011).

In addition to physical fitness, skill acquisition plays a crucial role in badminton training. The development of technical proficiency, tactical intelligence, and decision-making ability is essential for success in the sport. Badminton strokes, including smashes, clears, drops, and net shots, require precise control and consistent execution. Research suggests that structured training programs that incorporate progressive skill development result in greater improvements in shot accuracy and movement efficiency (Williams & Jackson, 2019). Footwork drills, such as ladder exercises and shuttle runs, have been shown to enhance coordination and positioning on the court (Kwan & Fu, 2019). Furthermore, reaction training and visual anticipation exercises have been found to improve decision-making speed, allowing players to respond more effectively to unpredictable game situations (Morris-Binelli & Müller, 2017).

Multiball training has emerged as an effective method for improving both physical fitness and skill acquisition in badminton. Originally popularized in table tennis, this method involves feeding multiple shuttlecocks in rapid succession, forcing players to react quickly and execute strokes under high-pressure conditions (Wang et al., 2020). This approach has been shown to enhance stroke consistency, shot accuracy, and tactical awareness (Liu, 2020). Compared to traditional training methods, which often involve slower-paced, repetitive drills, multiball training accelerates the learning process by increasing the volume of strokes practiced in a single session (Zhu & Chen, 2020).

The effectiveness of multiball training extends beyond skill development, as it also contributes to improved reaction time, endurance, and overall fitness levels. Studies indicate that multiball training increases the intensity of practice, resulting in greater physiological adaptations, such as improved agility and muscular stamina (Li et al., 2023). The randomized nature of multiball drills forces players to make split-second decisions, sharpening their cognitive processing and on-court awareness (Tsai & Chang, 2018). Research comparing traditional badminton training with multiball feeding programs found that players who

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engaged in multiball drills demonstrated superior improvements in movement speed, stroke accuracy, and rally consistency (Chen & Hongsaenyatham, 2021).

Despite its advantages, multiball training has certain limitations. While it enhances agility, reaction time, and stroke execution, it does not significantly improve serving accuracy, as serving requires controlled precision rather than rapid shot repetition (Li et al., 2023). As a result, coaches and trainers may need to supplement multiball training with dedicated serve drills to ensure well-rounded skill development. Additionally, while multiball training is highly effective for novice and intermediate players, elite-level athletes may require more specialized training programs that incorporate match simulations and strategic gameplay analysis.

In conclusion, the literature strongly supports the integration of multiball feeding training into badminton coaching, particularly for novice players. This training method offers significant advantages in terms of stroke repetition, reaction speed, and movement efficiency, making it a valuable addition to conventional training approaches. However, to achieve comprehensive skill development, multiball training should be combined with targeted practice sessions for specific techniques, such as serving and defensive positioning. Future research should further explore the long-term effects of multiball training on competitive performance and its applicability across various skill levels.

Conceptual Framework

The conceptual framework summarizes the theoretical foundation and structural design of the study, demonstrating that multi-serve training enhances badminton skill development and physical fitness in novice players.

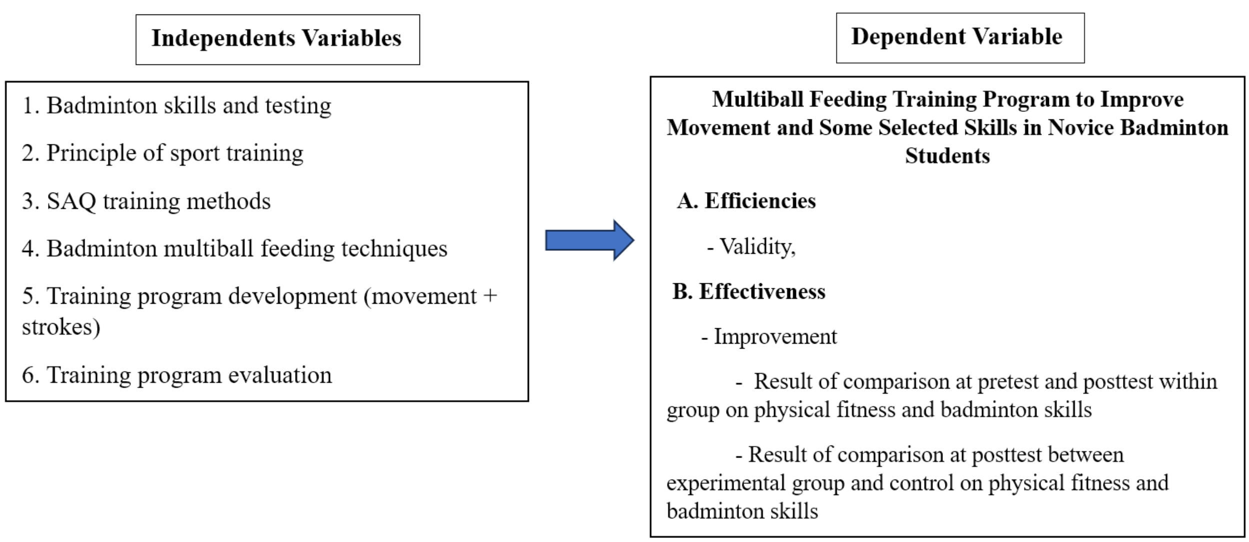

Figure 1 Conceptual Framework

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Methodology

Population

The population of this study consists of high school students in Hangzhou. As this research is quasi-experimental, the researcher purposively selected students from Hangzhou Senior High School who met the following criteria: no history of sports injuries in the past six months, good physical condition, no prior participation in badminton competitions, and willingness to volunteer. A total of 190 students enrolled in general education badminton courses this semester.

Sample Group

This study was conducted after school hours, with volunteers participating from 17:00 to 19:00 between October 2024 and January 2025. A total of 46 students volunteered. The researcher assessed badminton skill levels using the Wall Rally Test and agility via the Zig-Zag Run Test. Participants were ranked by total scores and systematically assigned into two groups of 23 female students each, forming the experimental and control groups.

Inclusion Criteria

Students who enrolled in the second-semester badminton course had no injuries in the past three months, did not have chronic illnesses, and could fully participate in after-school training from October to December 2024.

Exclusion Criteria

Students who missed more than three training sessions became ill or requested withdrawal from the study.

Expert Interviews

Nine experts participated in interviews. First round: High school badminton teachers and club coaches were consulted to develop concepts for enhancing fitness and fundamental skills using multiball feeding drills. Second round: Experts reviewed a draft training program covering objectives, activities, evaluation, and assignments, assessing its practicality and appropriateness.

Research Instrument

1. Interview Form: A semi-structured interview form designed to gather expert opinions and insights on badminton training, physical fitness for badminton, skill priorities for novice players, and multi-birdie feeding drills.

2. Multiball Feeding Training Program: A structured training program developed to enhance movement, physical fitness, and badminton skills.

3. Physical Fitness Tests: A set of standardized tests including the zigzag run, standing long jump, hand-release push-ups, reaction time assessment, and 1500-meter run (see Appendix).

4. Badminton Skills Tests: Performance-based assessments evaluating footwork, wall volley, short serve, clear, smash, and accuracy stroke.

Experiment Design and Process

This study employed a two-group pretest-posttest research design. The research tools included: Multiball Feeding Training Program: Conducted over 8 weeks, twice a week, for 2 hours per session. The first 30 minutes focused on footwork, movement, and physical fitness, followed by specific badminton skills training using multiball techniques. Traditional Badminton Training Program: Routine badminton training is used in standard coaching programs. Measurement of Movement Abilities, Physical Fitness, and Badminton Skills: Evaluations were conducted pre- and post-experiment. Program Evaluation: Conducted at the end of the 9th week.

Data Collection and Analysis

1. Expert Interviews: Nine experts were interviewed in two rounds to gather insights on multiball training. Content analysis was performed.

2. Pretest and Posttest: Movement abilities, physical fitness, and badminton skills were assessed. Paired t-tests were used for within-group analysis, and independent t-tests were used for between-group comparisons.

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3. Program Evaluation: Data were collected via a questionnaire and analyzed using descriptive statistics.

Research Process

Step 1: Gather expert opinions through literature review and interviews.

Step 2: Develop the multiball training program and select appropriate tests.

Step 3: Validate program quality through a try-out with 1, then three students.

Step 4: Experiment: Recruit 46 female students from an elective badminton class. Administer pretests: Wall Volley Test (badminton skills) and Zig-Zag Run (physical fitness). Rank students and systematically assign them to two groups. Implement training for 8 weeks, with specific training days for each group. Conduct posttests at the experiment's conclusion.

Step 5: Analyze results using t-tests.

Step 6: Compile findings and complete the research report.

Results

The researcher prepared the data and then conducted a statistical analysis. The results of the analysis were analyzed and presented in the table as follows:

Table 1 Comparison of Pretest on Physical Fitness Between Experimental and Control Groups

No	Test	Experimental Group (x̄ ± SD)	Control Group (x̄ ± SD)	t	p
1	Zig-Zag Run (seconds)	15.64 ± 0.76	15.67 ± 0.89	-0.14	0.16
2	Push-ups (count)	36.65 ± 4.32	35.47 ± 4.47	0.134	0.93
3	Standing Long Jump (cm)	147.43 ± 8.13	145.73 ± 7.57	0.732	0.6
4	Reaction Time (ms)	21.04 ± 4.59	20.74 ± 4.43	0.037	0.85
5	1500-meter Run (min)	15.22 ± 0.89	15.26 ± 1.14	-0.12	0.17

Table 1 presents the comparison of pretest results for physical fitness between the experimental and control groups before the intervention. The table includes five fitness components: agility (zig-zag run), muscular endurance (push-ups), explosive power (standing long jump), reaction time, and cardiovascular endurance (1500-meter run). The p-values for all tests exceeded 0.05, indicating that there were no statistically significant differences between the two groups before the training began. This suggests that both groups started at a similar baseline in terms of physical fitness, ensuring fair comparisons for post-training assessments.

Table 2 Comparison of Posttest and Pretest on Physical Fitness Within Experimental Group

No	Test	Posttest (x̄ ± SD)	Pretest (x̄ ± SD)	t	p
1	Zig-Zag Run (seconds)	13.25 ± 0.79	15.64 ± 0.76	12.3	0.01*
2	Push-ups (count)	45.56 ± 5.22	35.65 ± 4.32	10.47	0.01*
3	Standing Long Jump (cm)	156.09 ± 10.21	147.43 ± 8.13	6.564	0.01*
4	Reaction Time (ms)	23.30 ± 4.64	21.04 ± 4.64	6.24	0.01*
5	1500-meter Run (min)	13.57 ± 0.81	15.22 ± 0.90	15.35	0.01*

*P<.05

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Table 2 illustrates the improvements in physical fitness within the experimental group, comparing post-test and pre-test results. The data indicate statistically significant improvements across all five physical fitness components, with p-values less than 0.05, demonstrating the effectiveness of the multiball feeding training program. Agility, as measured by the zig-zag run, showed a marked improvement, with posttest times averaging 13.25 seconds, compared to 15.64 seconds in the pretest. Muscular endurance, assessed using push-ups, exhibited a substantial increase from an average of 35.65 repetitions in the pretest to 45.56 repetitions in the posttest. Explosive power, tested through the standing long jump, also improved significantly. Participants demonstrated an average increase from 147.43 cm to 156.09 cm. Reaction time was another critical area of progress. The posttest results indicate a reaction time of 23.30 milliseconds, an improvement from the 21.04 milliseconds recorded in the pretest. Cardiovascular endurance, measured via the 1500-meter run, saw a significant improvement, with completion times dropping from 15.22 minutes in the pretest to 13.57 minutes in the posttest.

Table 3 Comparison of Posttest and Pretest on Badminton Skills Within Experimental Group

No	Test	Posttest ($\bar{x}$ ± SD)	Pretest ($\bar{x}$ ± SD)	t	p
1	Footwork	14.27 ± 1.159	16.58 ± 1.40	10.03	0.01*
2	Wall Volley Test	29.69 ± 4.32	24.69 ± 4.03	14.28	0.01*
3	Short Service Test	23.96 ± 4.80	19.04 ± 4.49	7.488	0.01*
4	Clear Test	37.52 ± 2.08	19.28 ± 7.32	8.711	0.01*
5	Smash Test	36.61 ± 2.80	31.43 ± 2.57	10.4	0.01*
6	Accuracy Test	6.30 ± 1.22	3.43 ± 1.03	11.67	0.01*

*P<.05

Table 3 illustrates the improvements in badminton skills within the experimental group, comparing post-test and pre-test results. The data indicate statistically significant improvements across all six skill components, with p-values less than 0.05, demonstrating the effectiveness of the multiball feeding training program. Footwork, as measured by the footwork test, showed a marked improvement, with posttest times averaging 14.27 seconds, compared to 16.58 seconds in the pretest. The Wall Volley Test, which measures rallying ability and consistency in strokes, showed an increase from 24.69 to 29.69 repetitions. In the Short Serve Test, post-test scores rose from 19.04 to 23.96. The Clear Test, which evaluates a player's ability to hit deep shots, improved significantly from 19.28 to 37.52. The Smash Test demonstrated an increase in power and speed, with scores rising from 31.43 to 36.61. Lastly, the Accuracy Test results improved from 3.43 to 6.30.

Table 4 Comparison of Posttest on Physical Fitness Between Experimental and Control Groups

No	Test	Experimental Group ($\bar{x}$ ± SD)	Control Group ($\bar{x}$ ± SD)	t	p
1	Zig-Zag Run (seconds)	13.52 ± 0.86	14.60 ± 0.90	5.9	0.01*
2	Push-ups (count)	45.56 ± 5.22	43.91 ± 6.08	4.1	0.01*
3	Standing Long Jump (cm)	156.09 ± 10.21	152.83 ± 7.11	3.8	0.01*
4	Reaction Time (ms)	23.30 ± 4.64	22.08 ± 4.43	4	0.01*
5	1500-meter Run (min)	13.57 ± 0.81	14.79 ± 0.856	4.5	0.01*

*P<.05

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Table 4 presents a comparison of post-test physical fitness results between the experimental and control groups. The data indicate statistically significant improvements across all five physical fitness components, with p-values less than 0.05. The zig-zag run, which measures agility, showed an improvement, with posttest times averaging 13.52 seconds for the experimental group compared to 14.60 seconds for the control group. In the push-up test, which evaluates muscular endurance, participants in the experimental group achieved an average of 45.56 repetitions, whereas the control group recorded 43.91 repetitions. The standing long jump, an indicator of lower-body explosive power, also improved significantly. The experimental group achieved an average jump distance of 156.09 cm, compared to 152.83 cm in the control group. Reaction time, measured in milliseconds, was also significantly enhanced. The experimental group demonstrated an average reaction time of 23.30 ms, compared to 22.08 ms in the control group. Cardiovascular endurance, assessed via the 1500-meter run, showed a notable improvement. The experimental group completed the run in an average time of 13.57 minutes, whereas the control group took 14.79 minutes.

Table 5 Comparison of Posttest on Badminton Skills Between Experimental and Control Groups

No	Test	Experimental Group ($\bar{x} \pm SD$)	Control Group ($\bar{x} \pm SD$)	t	p
1	Footwork	15.02 ± 1.40	14.01 ± 1.53	1.2	0.01*
2	Wall Volley Test	29.69 ± 4.32	26.08 ± 3.61	2.5	0.01*
3	Short Service Test	23.96 ± 4.80	22.48 ± 4.65	0.3	0.79
4	Clear Test	37.52 ± 5.73	25.26 ± 7.62	3.6	0.01*
5	Smash Test	36.61 ± 2.80	33.26 ± 2.19	3.8	0.01*
6	Accuracy Test	6.30 ± 1.22	5.08 ± 1.08	3.9	0.01*

*P<.05

Table 8 compares posttest badminton skills results between the experimental and control groups. The data indicate statistically significant improvements in five out of six tested badminton skills. The footwork test, which measures agility and movement efficiency, showed an improvement with post-test scores of 15.02 in the experimental group compared to 14.01 in the control group. The Wall Volley Test, which assesses rallying ability and shot consistency, improved significantly. The experimental group recorded an average of 29.69 repetitions, whereas the control group achieved 26.08. The Short Serve Test showed minor improvement, with scores increasing from 22.48 to 23.96, but this change was not statistically significant (p = 0.790). The Clear Test, which evaluates the ability to hit deep shots, demonstrated significant enhancement in the experimental group, improving from 25.26 to 37.52. The Smash Test, which measures shot power and effectiveness, saw an increase from 33.26 to 36.61. Accuracy Test results showed improvement, with scores rising from 5.08 to 6.30, reflecting better shot placement.

Conclusion

The primary objective of this study was to develop and assess the effectiveness of a multiball feeding training program aimed at improving physical fitness and selected badminton skills in novice badminton students. The results presented in Chapter 4 provide strong evidence supporting the success of this training approach. The key findings can be summarized as follows: Improvement in Physical Fitness: The experimental group exhibited statistically significant enhancements in all five physical fitness components (zig-zag run, push-ups, standing long jump, reaction time, and 1500-meter run). Comparisons between pretest and posttest results within the experimental group revealed notable progress, with all p-values below 0.05. Furthermore, posttest comparisons between the experimental and control groups confirmed that

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participants who underwent multiball feeding training outperformed those in traditional training programs. Enhancement of Badminton Skills: The training program proved highly effective in improving footwork, rally ability, clear strokes, smash power, and shot accuracy. Participants in the experimental group demonstrated superior post-test performance compared to the control group, highlighting the impact of structured multiball training on stroke precision and tactical movement. The only skill that did not show a statistically significant difference was the short-serve test, indicating that additional targeted training might be necessary for this particular skill. Validation of the Training Program: The research incorporated expert interviews and feedback to validate the efficiency and practicality of the developed training regimen. The multiball feeding training program was structured based on scientific principles of skill acquisition, motor learning, and sports conditioning, ensuring its applicability for novice players. Effectiveness of the Program: The posttest comparisons demonstrated that multiball feeding training was significantly more effective than traditional training methods in developing essential badminton skills and improving physical conditioning. These findings suggest that integrating multiball drills into badminton coaching can be a highly efficient approach for developing players at the beginner level.

This methodology effectively illustrates how multiball training enhances various aspects of badminton performance, establishing clear connections between physical fitness development, skill acquisition, expert evaluation, and overall program effectiveness. By integrating high-repetition drills, movement optimization, and real-game simulations, multiball training provides a structured and scientifically grounded approach to player development. This method not only refines technical precision, agility, and endurance but also complements traditional coaching strategies, ensuring a comprehensive training framework. As a result, multiball training has become an essential component of modern badminton coaching, equipping players with the physical and tactical capabilities needed for competitive success.

Discussion

Badminton, at its core, is a dynamic interplay of strategy and reflexes, where milliseconds and precision dictate the momentum of a match (Phomsoupha & Laffaye, 2015). Seamless transitions between court zones highlight an athlete's spatial awareness and proprioceptive acuity, while optimized movement patterns reflect biomechanical efficiency and tactical intelligence (Kwan & Fu, 2019). The fusion of power, speed, and technical precision underpins successful stroke execution, with the smash becoming a tactical weapon rather than merely a forceful stroke (Majumdar & Khanna, 2021). The effectiveness of multiball training lies in its ability to maximize training intensity by eliminating downtime associated with ball retrieval, thereby increasing the number of repetitions and improving stroke execution efficiency (Tsai & Chang, 2018). This method, widely used in table tennis, tennis, and badminton, enhances hand-eye coordination, footwork, shot accuracy, reaction speed, and overall consistency through rapid and continuous shuttlecock feeds. Players exposed to high-volume, high-frequency shuttle drills develop superior technical skills and decision-making capabilities, which are crucial for real-game scenarios (Wang, Fu, & Hao, 2020).

Multiball training has been extensively validated for improving technical skill acquisition and tactical awareness. By continuously engaging in high-repetition stroke drills, athletes refine their motor skills and stroke mechanics (Zhu & Chen, 2020). The repetitive exposure allows players to master correct movement patterns, reducing errors and reinforcing proper technique. Studies indicate that this training accelerates skill development and minimizes training time, making it highly effective for novice and intermediate players (Zhu & Chen, 2020). Furthermore, the ability to adjust body positioning and anticipate shuttlecock trajectories is enhanced through continuous movement adaptation. Athletes using multiball training improve reaction time, agility, and coordination, ensuring they are well-prepared for rapid exchanges and high-intensity rallies (Phomsoupha & Laffaye, 2015). These improvements are particularly relevant in modern badminton, where the game has transitioned from slow-paced rallies to fast, aggressive play styles.

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Beyond skill acquisition, multiball training positively impacts aerobic and anaerobic endurance, muscular strength, and flexibility (Andersen & Aagaard, 2002). Studies on racket-sport athletes highlight the role of high-intensity shuttle drills in improving oxygen utilization and sustaining physical exertion levels (Wang et al., 2020). The physiological benefits extend to enhanced cardiovascular function and respiratory efficiency, which are critical for sustaining long rallies and maintaining optimal performance throughout matches. Additionally, multi-directional movement training has been found to significantly improve footwork speed and on-court movement efficiency (Kwan & Fu, 2019). Badminton demands rapid directional changes, and strengthening multi-directional movement patterns provides athletes with a competitive advantage in match-play scenarios. Research confirms that precise movement execution, coupled with increased physical endurance, enhances overall playing efficiency and stress response control (Cao, 2021).

Multiball training has been extensively utilized in table tennis, tennis, and squash, demonstrating cross-sport applicability. Studies in table tennis have shown that it significantly improves stroke accuracy, shot consistency, and reaction time (Tsai & Chang, 2018). Similarly, badminton research confirms that continuous shuttle feeding enhances tactical execution, motor control, and shot consistency (Phomsoupha & Laffaye, 2015). The findings of this study align with previous research, particularly regarding the role of multiball training in refining technical precision, speed, and endurance. Recent work also demonstrated that structured, high-intensity interventions (e.g., Power, Agility, Speed, and Quickness training) significantly enhance badminton performance, reinforcing the importance of carefully designed training programs (Wang et al., 2020).

Despite its advantages, multiball training demonstrated limited impact on short-serve proficiency. This could be attributed to the insufficient focus on serve variation drills within the program. Unlike footwork, smash execution, and rally consistency, short-serve execution requires precision-based training, which was not the primary focus of this multiball training intervention. Future programs should integrate dedicated short-service drills to ensure well-rounded skill development. Additionally, while multiball training improves physical fitness and technical execution, its effectiveness varies across experience levels. Novice players benefit significantly from high-repetition exposure, but elite players may require more tactical game-play drills to simulate real-match conditions. Future research should investigate how multiball training can be modified for high-performance athletes.

Multiball feeding training remains a powerful tool for skill acquisition, endurance building, and technical mastery in badminton. The results of this study highlight its effectiveness in structured training environments, offering a scientifically backed approach to accelerating athlete development. With future refinements such as enhanced serve training, tactical scenario drills, and real-time performance tracking, multiball training can continue to revolutionize modern badminton coaching and high-performance training methodologies.

Recommendation

Application of the Research.

This study confirmed that Multiball Feeding Training significantly improved agility, endurance, explosive power, reaction time, and most badminton skills, except for the short serve. Based on these findings:

1. As this study was conducted on female subjects, future applications should consider implementing this program among female university students. If adapted for male university students, adjustments should be made according to the FITT principles (Frequency, Intensity, Time, and Type) to ensure optimal results.

2. Universities should incorporate Ba Duan Jin into general physical education programs, as this research and other studies have demonstrated that Ba Duan Jin contributes to improved physical fitness, mental health, and overall well-being in female university students, similar to other Health Qigong practices.

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For Further Research.

1. Future studies should expand the scope by examining the effectiveness of the multiball feeding training program across different demographics, including children, youth, and adults, to preserve national sports traditions and enhance training methodologies.

2. Integration of Multiball Training into Standard Badminton Curricula: Given the improvements observed in agility, endurance, explosive power, reaction time, and cardiovascular fitness, multiball feeding training should be adopted as a core component in school and community badminton training programs.

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