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SELECTION OF EXERCISES FOR DEVELOPING SPEED ENDURANCE IN BADMINTON FOR STUDENTS AT LANG SON COLLEGE

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Abstract. This study aimed to select and develop a system of exercises for improving speed endurance in badminton among students at Lang Son College. Based on an analysis of movement characteristics and sport-specific physical fitness requirements, ten exercises, including both shuttlecock-based and non-shuttlecock-based activities, were selected. A pedagogical experiment was conducted with 72 first-year students using four speed endurance assessment tests administered before and after the intervention. The results indicated significant improvements in speed endurance indicators as well as badminton learning outcomes. The differences were statistically significant, with effect sizes ranging from moderate to large. The findings confirm the effectiveness and practical applicability of the selected exercise system in badminton instruction.

Keywords: *Speed endurance, badminton, physical training exercises, students, physical education.*

1. Introduction

Physical education and school sports have long been recognized as essential components of holistic education, contributing not only to students' physical development but also to the formation of healthy lifestyles, discipline, and lifelong participation in physical activity. In Vietnam, the Government has emphasized the importance of improving the quality of physical education and enhancing students' physical fitness through various national policies and development strategies. Notably, Decision No. 1076/QD-TTg issued by the Prime Minister highlights the objective of strengthening physical education and promoting comprehensive physical development among learners at all educational levels (Prime Minister of Vietnam, 2016).

Among the sports commonly included in school and college physical education programs, badminton is one of the most popular due to its accessibility, relatively simple facility requirements, and suitability for a wide range of learners. In addition to its recreational value, badminton provides substantial benefits for the development of physical fitness, motor coordination, and cardiovascular health. Performance in badminton is determined by the interaction of technical, tactical, psychological, and physical factors. Among these, sport-specific physical fitness plays a decisive role in enabling athletes and learners to execute technical and tactical skills effectively throughout training and competition. In particular, speed endurance is considered a fundamental physical quality because it allows players to maintain high-intensity movements, rapid directional changes, and repeated stroke execution over prolonged periods (Nguyen & Tran, 2012).

Badminton competition is characterized by intermittent bouts of high-intensity activity requiring repeated accelerations, decelerations, jumps, lunges, and stroke actions. As fatigue accumulates, declines in movement speed, reaction ability, and stroke quality may occur, negatively affecting overall performance. Consequently, the development of speed endurance has become an important objective in badminton training programs and physical education curricula (Do, 2014; Ngo, 2014). Previous studies have demonstrated that appropriately selected training exercises can significantly improve sport-specific endurance and contribute to enhanced learning outcomes and competitive performance (Tran, 2020).

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At Lang Son College, badminton is included in the physical education curriculum with a total instructional duration of 30 class periods. Although the course provides students with fundamental technical knowledge and skills, the limited training time and relatively large class sizes restrict opportunities for systematic physical conditioning. As a result, many students acquire basic badminton techniques but do not achieve the level of physical fitness necessary to perform these techniques effectively under conditions of fatigue. This situation highlights the need for supplementary training strategies aimed at improving students' speed endurance and overall physical preparedness.

Therefore, the present study was conducted to select and evaluate a system of exercises specifically designed to develop speed endurance for students participating in badminton classes at Lang Son College. The findings are expected to provide practical evidence for improving badminton instruction and enhancing the effectiveness of physical education programs in higher education institutions.

2. Theoretical Background of Speed Endurance in Badminton

2.1. Concept and Importance of Speed Endurance in Badminton

Speed endurance is considered one of the most important physical capacities in racket sports, particularly badminton, where athletes are required to repeatedly perform explosive movements while maintaining high levels of performance throughout a match. In sports science, speed endurance is generally defined as the ability to resist fatigue while sustaining movements at maximal or near-maximal intensity for a prolonged period (Nguyen & Pham, 2000). This capacity enables athletes to maintain movement efficiency, technical precision, and tactical effectiveness despite the accumulation of physiological fatigue.

In badminton, speed endurance represents the dominant form of sport-specific endurance because the game is characterized by rapid footwork, repeated accelerations and decelerations, jumping actions, and continuous execution of offensive and defensive strokes (Nguyen & Tran, 2012). The ability to sustain these high-intensity actions directly influences match outcomes, particularly during long rallies and extended competitions. Previous studies on badminton training have highlighted that insufficient speed endurance often results in a decline in movement speed, stroke quality, and tactical decision-making during the later stages of competition (Do, 2014; Ngo, 2014). Therefore, developing speed endurance is considered a fundamental objective in badminton training programs across different performance levels.

2.2. Physiological Characteristics of Speed Endurance in Badminton

Badminton is classified as a high-intensity intermittent sport that places substantial demands on both anaerobic and aerobic energy systems. During competition, players frequently perform explosive actions lasting only a few seconds, including lunges, directional changes, jumps, and powerful strokes. These movements rely primarily on anaerobic energy production mechanisms, particularly the phosphagen and anaerobic glycolytic systems (Nguyen & Pham, 2000).

Although anaerobic metabolism provides the majority of energy during high-intensity rallies, aerobic metabolism also plays a critical role in facilitating recovery between rallies and maintaining performance during prolonged matches. A typical badminton match may extend beyond one hour, requiring athletes to repeatedly recover from intense physical exertion while preserving technical accuracy and tactical efficiency (Peng & Hou, 2000). Consequently, speed endurance in badminton should be understood as a multidimensional physical quality that depends on the interaction between anaerobic power, aerobic capacity, neuromuscular coordination, and recovery efficiency.

The physiological demands of badminton further require athletes to maintain a high frequency of movement under conditions of increasing fatigue. As fatigue accumulates, reductions in reaction speed, movement velocity, and stroke effectiveness become more evident, highlighting the importance of well-developed speed endurance for sustained competitive performance (Do, 2014).

2.3. Factors Affecting the Development of Speed Endurance

The development of speed endurance is influenced by several interrelated physiological, psychological, and training factors. According to Nguyen and Pham (2000), the functional efficiency of the cardiovascular,

respiratory, and nervous systems provides the physiological foundation for sustaining high-intensity exercise. Athletes with superior aerobic and anaerobic capacities generally demonstrate greater resistance to fatigue and enhanced recovery abilities.

Psychological factors also contribute significantly to speed endurance performance. Motivation, concentration, perseverance, and competitive determination enable athletes to maintain effort levels despite physical discomfort and fatigue. In addition, technical proficiency influences energy expenditure during movement. Athletes who execute badminton techniques efficiently require less energy to perform the same actions, thereby delaying fatigue onset and improving endurance performance (Nguyen & Tran, 2012).

Training-related factors represent another critical determinant. Systematic and progressive training programs stimulate physiological adaptations that improve both energy production and fatigue resistance. Research conducted on badminton athletes at different competitive levels has demonstrated that appropriately selected training exercises can significantly enhance sport-specific endurance and overall playing performance (Do, 2014; Ngo, 2014; Tran, 2020). Therefore, training design should integrate technical, tactical, and physical conditioning components to maximize improvements in speed endurance.

2.4. Manifestations and Training Requirements of Speed Endurance in Badminton

The manifestation of speed endurance in badminton can be observed through an athlete's ability to sustain movement speed, reaction speed, and stroke execution quality throughout training sessions and competitive matches. Players with well-developed speed endurance are capable of maintaining high-intensity movement patterns, recovering quickly between rallies, and preserving technical consistency during prolonged play (Peng & Hou, 2000).

From a training perspective, the development of speed endurance requires exercises that closely replicate the physiological and biomechanical demands of badminton competition. Such exercises should involve repeated high-intensity movements, multidirectional footwork, stroke combinations, and intermittent work-rest patterns similar to those encountered during actual matches (Tran, 2020). Both shuttlecock-based and non-shuttlecock-based drills may be employed to improve sport-specific endurance while simultaneously enhancing technical execution.

Furthermore, contemporary approaches to physical education and sports development emphasize the importance of systematically improving students' physical fitness capacities, including speed endurance, as part of comprehensive athletic development programs (Prime Minister of Vietnam, 2016). Within badminton instruction, speed endurance training not only contributes to improved physical performance but also supports the acquisition and effective application of technical and tactical skills during competition.

3. Selection of Exercises for Developing Speed Endurance in Badminton

The effectiveness of speed endurance development largely depends on the appropriate selection of training exercises that correspond to the physiological and technical demands of badminton. Physical exercises are purposeful movement activities designed to improve physical fitness, motor performance, and overall functional capacity through systematic training processes (Ngo, 2014). In badminton, exercises aimed at enhancing speed endurance should not only improve the body's resistance to fatigue but also enable players to maintain movement speed and technical performance during prolonged periods of high-intensity activity.

The selection of exercises in the present study was based on the specific movement characteristics of badminton, the major muscle groups involved in technical execution, and the dominant energy systems activated during training and competition. Following recommendations from previous badminton training studies (Do, 2014; Ngo, 2014; Tran, 2020), the exercise selection process consisted of three stages. First, the primary muscle groups involved in badminton-specific movements were identified. Second, exercises demonstrating biomechanical similarities to badminton techniques in terms of movement direction, range of motion, and muscular contraction patterns were selected. Finally, the selected exercises were reviewed and tested to determine their suitability and practical effectiveness for college students.

To ensure scientific validity and practical applicability, all exercises were designed according to several principles. The exercises had to be appropriate for students' physical fitness levels, compatible with the

available facilities and instructional time, and capable of maintaining students' motivation and engagement during training. In addition, each exercise included clearly defined parameters regarding exercise intensity, training volume, work duration, and recovery intervals. Such training prescriptions are essential for maintaining neuromuscular stimulation and maximizing adaptations related to both speed and endurance capacities.

Based on these criteria, a training system consisting of ten supplementary exercises was developed. The exercise system was designed to achieve three primary objectives: (1) improving badminton-specific movement speed endurance; (2) enhancing the ability to maintain movement speed and technical quality under fatigue; and (3) simulating movement patterns commonly encountered during badminton training and competition. Consistent with previous studies on badminton-specific conditioning (Do, 2014; Ngo, 2014; Tran, 2020), the exercise system was divided into two categories: three exercises without shuttlecock involvement and seven shuttlecock-based exercises.

3.1. Non-Shuttlecock Exercises

The first category comprised exercises designed to improve general speed endurance and movement efficiency without requiring direct shuttlecock interaction. These exercises primarily targeted lower-limb muscular endurance, agility, and multidirectional movement capabilities.

Exercise 1: High-Speed Rope Skipping. This exercise was intended to develop lower-body speed endurance and improve whole-body coordination. Students performed rapid rope-skipping movements continuously while maintaining a stable rhythm and proper posture. Training volume consisted of three sets of two minutes with three to five minutes of recovery between sets.

Exercise 2: Four-Corner Court Movement Drill. The objective of this exercise was to improve badminton-specific movement endurance through repeated accelerations and directional changes. Students started from the center of the court and moved rapidly to the four corners of the playing area, performing shuttle placement or retrieval tasks before returning to the center position. The exercise emphasized maximal movement speed, proper footwork technique, and efficient changes of direction.

Exercise 3: Six-Point Court Movement Drill. This drill aimed to enhance whole-court movement endurance and multidirectional agility. Participants moved from the center position to six predetermined locations on the court, including front-court, side-court, and rear-court positions. At each location, a shuttle retrieval or placement action was performed before returning to the center. The exercise required continuous high-speed movement and effective balance control during rapid directional transitions.

3.2. Shuttlecock-Based Exercises

The second category included exercises that integrated technical badminton skills with speed endurance development. These drills were designed to closely replicate the physiological and technical demands encountered during competitive play.

Exercise 4: Net Shot and Jump Smash Combination Drill. Students moved from the center position to perform a net shot before retreating rapidly and executing a jump smash. This sequence was repeated continuously for one minute. The exercise focused on maintaining technical quality while performing repeated high-intensity movement transitions.

Exercise 5: Continuous Jump Smash Against Suspended Shuttlecock. This drill was designed to develop anaerobic speed endurance and explosive power endurance. Participants repeatedly performed jump smashes against a suspended shuttlecock for one minute while maintaining consistent movement speed and technical execution.

Exercise 6: Lateral Rear-Court Movement with Jump Stroke Execution. Students performed repeated lateral movements along the rear court before executing jump strokes directed toward target areas. The exercise emphasized movement endurance, jumping ability, and stroke accuracy under conditions of accumulated fatigue.

Exercise 7: Two-Step Net Interception Drill. This exercise focused on improving short-distance movement endurance and technical consistency during net interceptions. Students repeatedly moved from

the center position to the forecourt corners to perform net kills before returning to the ready position.

Exercise 8: Multi-Shuttle Drill with Single Technical Actions. Participants performed repetitive sequences of specific badminton skills, including net shots, jump smashes, and backhand returns, using a multi-shuttle feeding system. The high exercise density increased both aerobic and anaerobic demands while reinforcing technical consistency.

Exercise 9: Multi-Shuttle Drill with Combined Technical Actions. This exercise simulated competition-like conditions by requiring players to perform a variety of strokes, including clears, drops, smashes, drives, and defensive returns, in response to randomly fed shuttlecocks. The drill emphasized rapid technical transitions and sustained movement intensity.

Exercise 10: Match-Play Training. Competitive match play was incorporated as the most sport-specific method of developing speed endurance. Students participated in singles or doubles matches under various tactical conditions. The objective was to maintain movement speed, technical performance, and tactical execution throughout the duration of play despite increasing fatigue.

3.3. Supplementary Extracurricular Training

For students demonstrating higher levels of physical fitness, additional conditioning activities were recommended to further enhance speed endurance development. These activities included 1,500-meter running, two-minute box-jump drills, repeated three-step movement patterns combined with deep clears, continuous jump-smash exercises, and repeated net-to-rear-court movement sequences. These supplementary exercises were intended to increase overall training volume and reinforce the physiological adaptations necessary for sustained badminton performance.

The final exercise system provided a balanced combination of general physical conditioning and badminton-specific training. By integrating movement endurance, technical repetition, and competition-like activities, the program was expected to improve students' ability to maintain high-intensity performance and technical effectiveness during badminton practice and competition.

3.4. Implementation of Speed Endurance Training Exercises in Badminton

Speed endurance in badminton represents the integration of speed and endurance capacities, requiring athletes to sustain high-intensity movements while maintaining technical efficiency throughout prolonged periods of activity. Consequently, the development of speed endurance cannot be achieved through isolated training methods but instead requires the systematic integration of strength, speed, and endurance training components. Effective training programs should simultaneously stimulate both aerobic and anaerobic energy systems through repeated high-intensity exercise bouts interspersed with appropriately structured recovery intervals. The scientific manipulation of exercise intensity, duration, training density, and rest periods is therefore essential for maximizing physiological adaptations and improving speed endurance performance.

In the present study, the selected exercises were implemented through a structured training process consisting of several stages. Initially, a comprehensive exercise system was developed based on the physiological and technical demands of badminton. The exercises were subsequently introduced through trial training sessions to evaluate their suitability for students' physical fitness levels and learning conditions. Based on the observed responses, training loads were adjusted to ensure an appropriate balance between exercise intensity and recovery. Continuous monitoring of both physical fitness indicators and technical performance was conducted throughout the training period to ensure that the exercises contributed effectively to the development of badminton-specific speed endurance. Following this evaluation process, the exercise system was integrated into regular badminton instruction and extracurricular training activities.

The implementation strategy emphasized the progressive development of students' physical capacities while maintaining the technical characteristics of badminton performance. Non-shuttlecock exercises were primarily used to establish a foundation of movement endurance and lower-limb conditioning, whereas shuttlecock-based exercises were employed to enhance sport-specific endurance through repeated execution of technical skills under conditions of fatigue. This combination allowed students to improve their ability to sustain movement speed, maintain stroke quality, and perform tactical actions effectively throughout

training sessions.

To evaluate the practical applicability of the proposed exercise system, consultations and professional interviews were conducted with eight badminton instructors and physical education lecturers. The results indicated unanimous agreement regarding the suitability and effectiveness of the selected exercises. All participants considered the exercise system appropriate for the physical characteristics and training conditions of college students and affirmed its potential for broader implementation within badminton teaching programs. According to the instructors, the exercises not only contributed to improvements in speed endurance but also enhanced students' overall physical fitness, learning outcomes, motivation to participate in training activities, and long-term engagement in physical exercise.

These findings suggest that the proposed exercise system provides a feasible and scientifically grounded approach for improving badminton-specific speed endurance among college students. The integration of the selected exercises into badminton instruction may therefore contribute to enhancing both educational effectiveness and students' physical development while promoting lifelong participation in sports and physical activity.

4. Pedagogical Experiment

Purpose of the Experiment

The pedagogical experiment was conducted to evaluate the effectiveness of the selected exercise system in developing speed endurance among students enrolled in badminton courses at Lang Son College. Specifically, the study aimed to determine whether the proposed training program could improve badminton-specific speed endurance and contribute to better learning outcomes in badminton instruction.

Participants and Experimental Content

The experiment involved 72 first-year students majoring in Chinese Language Studies at Lang Son College, including 39 students from Class K21TV1 and 33 students from Class K21TV2. The intervention was implemented during the 2024–2025 academic year through both formal badminton instruction and extracurricular practice activities. Students participated in a total of 30 instructional periods, with four periods per week allocated to badminton classes.

The experimental content consisted of implementing the selected speed-endurance exercises within the regular teaching process. The exercise system was designed to be flexible and practical, allowing instructors to integrate different exercises at appropriate stages of each lesson. In addition to requiring minimal equipment, the exercises were closely associated with fundamental badminton techniques and tactical skills, including footwork, stroke execution, smashing, serving, and court movement patterns. As a result, the training program simultaneously targeted the development of physical fitness and technical proficiency.

The speed-endurance training program was implemented over an eight-week period. To ensure progressive overload and continuous adaptation, the exercises were organized systematically throughout the intervention. During the first week, Exercises 1, 2, 3, and 4 were introduced to establish a foundation of movement endurance and familiarize students with the training procedures. In the second week, Exercises 1, 2, 4, and 5 were employed to further develop lower-limb endurance and badminton-specific movement patterns.

During the third week, Exercises 2, 3, 4, 5, and 6 were incorporated to increase training intensity and enhance students' ability to sustain repeated high-speed movements. In the fourth week, Exercises 1, 3, 4, 6, and 8 were implemented, emphasizing the integration of movement endurance with technical execution under conditions of increasing fatigue. During the fifth week, Exercises 1, 4, 5, 7, and 8 were utilized to further improve speed endurance through a combination of movement drills and shuttlecock-based technical exercises.

The sixth week focused on Exercises 5, 6, 7, and 9, which placed greater demands on badminton-specific endurance and technical consistency. During the seventh week, Exercises 2, 6, 7, 9, and 10 were introduced to simulate competitive situations and develop students' ability to maintain performance during prolonged high-intensity activity. Finally, during the eighth week, all ten exercises were incorporated into the training

program, providing a comprehensive stimulus for the development of speed endurance and the consolidation of badminton-specific physical and technical abilities.

Experimental Procedure

A one-group pretest–posttest experimental design was employed. Students' speed endurance performance was assessed before and after the intervention using four badminton-specific performance tests:

1. Forward–backward movement test performed 15 times (s);
2. Forward–backward movement combined with shuttle throwing over the net performed 10 times (s);
3. Three-step diagonal movement to the right and left sides combined with smashing actions performed 15 times (s);
4. Four-corner court movement test performed 10 times (s).

Baseline measurements were collected before the students commenced the badminton course. Following the pretest assessment, the selected speed-endurance exercises were implemented according to the eight-week training schedule. Upon completion of the intervention, all participants performed the same set of tests under identical conditions. In addition, students' badminton learning outcomes were evaluated to examine the relationship between improvements in speed endurance and academic performance in badminton instruction.

The comparison of pretest and posttest results provided the basis for determining the effectiveness of the proposed exercise system in enhancing badminton-specific speed endurance and improving learning outcomes among college students.

Experimental Results

- Changes in Speed Endurance Performance

The effectiveness of the proposed exercise system was evaluated through comparisons of pre-test and post-test results obtained from the four speed-endurance assessments.

Zigzag Shuttle Retrieval Test (Five Repetitions Across Six Court Positions)

The results demonstrated substantial improvements in students' performance following the intervention. Mean completion time decreased from 72.66 s before training to 68.92 s after training, representing an improvement of 3.74 s. Similarly, reductions were observed in frequency and median values, indicating enhanced movement efficiency and lower-limb speed endurance.

Statistical analysis revealed a highly significant difference between pre-test and post-test scores ($p = 3.74 \times 10^{-9} < .05$). The correlation coefficient ($r = .83$) indicated a very strong relationship between the two measurements according to Hopkins' classification. Furthermore, the effect size reached ES = 0.94, which represents a large practical effect according to Cohen's criteria. The growth rate of 6.19% further confirms the effectiveness of the training program in improving badminton-specific speed endurance.

Forward–Backward Movement and Shuttle Throw Test

The second test also showed significant improvement following the intervention. Average performance time decreased from 59.59 s to 57.97 s, while the median score improved by 4.45 s. These results indicate enhanced speed endurance during repeated forward–backward movements and improved muscular endurance of the upper body.

The paired-samples t-test revealed a statistically significant difference ($p = .02 < .05$). The correlation coefficient was very high ($r = .89$), indicating strong consistency between measurements. Although the effect size (ES = 0.35) was classified as small, the positive growth rate of 1.83% suggests that the exercise system contributed meaningfully to improvements in this performance component.

Lateral Court Movement Test

The third assessment examined speed endurance during repeated lateral court movements combined with badminton-specific actions. Following the intervention, the mean score improved from 67.35 s to 64.70 s, corresponding to a reduction of 2.65 s.

The difference between pre-test and post-test results was statistically significant ($p < .05$). The correlation coefficient reached $r = .83$, indicating a very strong relationship between measurements. The calculated effect size was ES = 0.77, representing a moderate-to-large training effect. The observed growth rate of 2.66% demonstrates that the exercise program effectively enhanced students' ability to sustain repeated high-speed lateral movements.

Four-Corner Court Movement Test

Improvements were also observed in the four-corner movement assessment. Mean performance time decreased from 103.02 s to 101.96 s after training. Although the magnitude of improvement was smaller than that observed in the previous tests, statistical analysis still indicated a significant difference between measurements ($p = .02 < .05$).

The correlation coefficient ($r = .47$) suggested a moderate relationship between pre-test and post-test performances. The effect size was ES = 0.37, representing a small but meaningful practical effect. The growth rate of 0.69% indicates that the intervention contributed positively to students' badminton-specific movement endurance.

Overall, the findings from the four performance tests consistently demonstrated statistically significant improvements following the implementation of the proposed exercise system. The largest effect was observed in the zigzag shuttle retrieval test, suggesting that the training program was particularly effective in enhancing multidirectional movement endurance and agility, which are critical components of badminton performance.

- Effects on Badminton Learning Outcomes

In addition to physical fitness improvements, the study examined changes in students' badminton learning outcomes before and after the intervention. The distribution of achievement levels revealed a decline in the proportion of students classified as average or below-average and a corresponding increase in the number of students achieving good and excellent performance levels.

The mean academic score increased by 0.37 points, while the median score improved by 1.0 point. These findings indicate that the enhancement of speed endurance was accompanied by improved technical execution and overall badminton performance. Although the standard deviation increased from 0.8 to 1.1, suggesting greater variation among students, this pattern also reflects substantial progress among previously lower-performing participants.

The paired-samples t-test confirmed that the observed improvement in learning outcomes was statistically significant ($p = .01 < .05$). The correlation coefficient ($r = .33$) indicated a moderate association between pre-test and post-test academic performance, while the effect size (ES = 0.58) represented a moderate practical effect according to Cohen's classification.

Taken together, the results suggest that improvements in speed endurance are positively associated with better badminton learning outcomes. The selected exercise system not only enhanced students' physical fitness but also contributed to more effective skill acquisition, improved academic achievement, and greater participation in extracurricular sports activities. These findings support the integration of structured speed-endurance training into badminton instruction as an effective strategy for improving both physical and educational outcomes among college students.

5. Conclusion

The development of physical fitness, particularly speed endurance, is a long-term process that requires systematic, continuous, and scientifically designed training. Within badminton instruction, the improvement of speed endurance depends on the coordinated efforts of both instructors and students, combining appropriate training methodologies with consistent practice. As speed endurance represents a fundamental physical quality underpinning technical and tactical performance, its development should be considered a key objective of badminton teaching and training programs.

The findings of the present study demonstrate that the selected exercise system effectively improved badminton-specific speed endurance among college students. Significant improvements were observed across all four performance tests following the intervention period, with statistically significant differences

between pre-test and post-test results. These improvements indicate that the observed changes were attributable to the training program rather than random variation. The magnitude of the training effects varied across the assessed performance components, with the greatest improvements observed in lower-limb speed endurance and multidirectional court movement abilities, particularly in tasks involving rapid diagonal and court-wide movements that closely resemble competitive badminton situations.

In addition to enhancing physical fitness, the implementation of the exercise program contributed positively to students' badminton learning outcomes. Improvements in academic performance suggest that enhanced speed endurance enabled students to maintain technical quality, movement efficiency, and tactical execution more effectively during practice and assessment activities. These findings support previous research indicating a close relationship between sport-specific physical fitness and skill acquisition in badminton training.

The proposed exercise system was found to be appropriate for the physiological characteristics of college students and compatible with the practical teaching conditions at Lang Son College. The exercises required relatively simple equipment, could be integrated easily into regular physical education classes, and provided sufficient flexibility for use in both formal instruction and extracurricular training activities. Consequently, the training program offers a practical and feasible approach for improving badminton-specific fitness in higher education settings.

To achieve sustainable long-term benefits, however, speed endurance development should extend beyond formal class hours. Students should be encouraged to engage actively in independent practice and extracurricular training, while instructors should continue to integrate structured conditioning exercises into badminton instruction. Furthermore, educational institutions should promote regular sports activities, recreational competitions, and campus-based badminton events to create additional opportunities for physical development and skill application. Through the combined efforts of students, instructors, and educational institutions, the long-term enhancement of speed endurance and badminton performance can be effectively achieved.

REFERENCES

[1] Tran Anh Dung. (2020). Selection of exercises to improve sport-specific endurance for male badminton athletes aged 14–15 in the Tuyen Quang Provincial Talent Training Program. *Journal of Science, Hanoi National University of Education*.

[2] Nguyen Van Hong, & Tran Viet Dung. (2012). *Badminton curriculum*. Ho Chi Minh City University of Education.

[3] Peng, M., & Hou, Z. (1997). *Badminton* (L. D. Chuong, Trans.). Sports Publishing House. (Original work published 1997; Vietnamese translation published 2000).

[4] Ngo Thu Ngoc. (2014). *Research on the selection of exercises for developing sport-specific endurance in male badminton athletes of the University of Transport Technology badminton team* (Master's thesis). Bac Ninh Sport University.

[5] Prime Minister of the Government of Vietnam. (2016). *Decision No. 1076/QD-TTg dated June 17, 2016, approving the Master Plan for the Development of Physical Education and School Sports for the Period 2016–2020, with Orientation to 2025*.

[6] Nguyen Toan, & Pham Danh Ton. (2000). *Theory and methodology of physical education and sports* (pp. 282–291). Sports Publishing House.

[7] Do Tuan Viet. (2014). *Research on the selection of exercises for developing speed endurance in male badminton athletes aged 14–15 in Thai Nguyen City* (Master's thesis). Sport University I, Tu Son, Bac Ninh.