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Original Article

Assessment of the Impact of an Experimental Program Incorporating Badminton Techniques on the Motor Skills of Middle School Students

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Abstract

The evaluation of students' motor skills is a fundamental aspect of the physical education process, significantly contributing to the development of motor and psychomotor qualities. This study examines the impact of an experimental program utilizing badminton-specific means on the motor skills of middle school students. Hypothesis: It is hypothesized that the use of badminton-specific methods will positively influence students' motor performance. Objectives of the study were: to assess the initial level of students' motor skills, implement an experimental program based on badminton for the experimental group, and compare the motor results of the experimental group with those of the control group. Students in the experimental group demonstrated significant improvements in strength, speed, coordination, and endurance, as evidenced by enhanced performance in all four motor tests evaluated. The implementation of badminton-specific means proved effective not only in developing motor skills but also in increasing students' motivation towards physical activities.

1. Introduction

Sport plays an essential role in education, health, and the development of motor skills, and research conducted by specialists has led to the proposal of modern solutions to optimize the instructional process. Traditional methods have been supplemented and enhanced through the use of innovative technologies, high-performance equipment, and specialized facilities, significantly contributing to the efficiency of the educational process in the field of sports. These technological advancements have facilitated the implementation of teaching techniques tailored to the diverse needs of students and have improved the quality of activities carried out

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during physical education and sports classes (Bosînceanu &Vizitiu, 2023; Milici, Rață, & Milici, 2007). From a psychopedagogical perspective, the professional mindset of the teacher plays a fundamental role in the instructional-educational process. This mindset is influenced by the teacher's personality, perception of students, and self-assessment of their competencies. Physical education and sports teachers bear the responsibility of fostering effective collaborative relationships with students and communicating in a manner that encourages harmonious development and student performance (Agache & Vizitiu, 2022 a; Agache &Vizitiu 2022 b; Petrea & Rață, 2015). Badminton is a dynamic sport practiced by two or four players, requiring the use of lightweight rackets and a shuttlecock—a cork-based ball equipped with stabilizing feathers. Considered the fastest racket sport, badminton demands quick reactions and abrupt movements, requiring players to possess advanced levels of muscular strength, agility, flexibility, and athletic abilities to achieve remarkable performances. Recent research highlights the importance of these physical abilities for success in badminton, as the sport is characterized by the execution of complex and high-intensity techniques, especially at a competitive level (Petrea & Rață, 2015). The traditional method of teaching badminton, which lacks technological support, has been widely used. However, in the absence of technology, instructors face difficulties in improving students' motor skills due to the speed and complexity of movements inherent in this sport (Lin, Lee, Chien, Chiang, & Chen, 2020). Therefore, it is imperative to develop an innovative and efficient training module that addresses the diversity of students' skill levels in middle school, aiming to support their progress in badminton through modern methods, such as the STAD cooperative learning model (Metzler & Colquitt, 2021). Engaging students in sports activities such as badminton can have a significant impact on their health, contributing to reducing risks associated with non-communicable diseases. The beneficial effects of these sports interventions have been observed in various studies, which highlighted significant improvements in physical health, particularly among participants with cardiovascular and neuromuscular conditions (Hazari, Jalgoum, & Kumar Kandakurti, 2023). However, the intensity of physical education lessons, particularly in badminton classes, does not always meet the recommended levels for cardiovascular training. Motor skills developed during football lessons have led to higher values of maximum heart rate and moderate-to-vigorous physical activity compared to badminton and aerobics lessons (Hellin, Garcia-Jimenez, & Garcia-Pellicer, 2019). This suggests the need to rethink the structure of physical education lessons to maximize cardiovascular benefits and support students' weight management.

In this context, proper execution techniques in badminton, even from the early stages of learning, are essential. Correctly developed motor skills contribute to improved performance and the prevention of injuries (Tzetzis & Votsis, 2006). Regarding teacher training, professional development programs should focus on enhancing knowledge of the specific content of sports disciplines, emphasizing effective teaching methods and constructive feedback to improve the learning process for students (Kim, 2011). Numerous studies highlight the critical importance of developing a system of knowledge and motivation among students, aimed at

fostering the formation of competencies necessary for consistent physical exercise throughout their lives (Avram & Vizitiu, 2020).

2. Materials and Methods

The aim of this research is to analyze the impact of an experimental program based on badminton-specific methods on the development of motor skills in middle school students.

Hypothesis: It is hypothesized that the use of badminton-specific means will positively influence the motor performance of students.

The applied *research methods* in the field of physical education and sports included: analysis of specialized literature, systematic observation, experimental methodology, mathematical and statistical analysis (X - mean, α - standard deviation, CV% - coefficient of variability, and D - difference between initial and final testing), motor skill assessment (25m sprint, 5x5m shuttle run, standing long jump, static balance coordination test, and 800m endurance run), and graphical analysis. Objectives of the study were: to assess the initial level of students' motor skills, to implement an experimental program based on badminton for the experimental group, to compare the motor results of the experimental group with those of the control group. tudents in the experimental group demonstrated significant improvements in strength, speed, coordination, and endurance, as evidenced by enhanced performance in all four motor tests evaluated. The implementation of badminton-specific means proved effective not only in developing motor skills but also in increasing students' motivation toward physical activities The research was conducted at the "Alexandru Ioan Cuza" School in Fălticeni, where 40 students were selected to participate in an experiment conducted during physical education classes. The students were evenly divided into two groups: 20 students were assigned to the control group, while the remaining 20 were included in the experimental group. The experiment was carried out over a 7-week module, with each week including two physical education lessons.

In the case of the experimental group, a program based on the use of badminton-specific means was implemented, while the control group followed the standard plan proposed by another physical education teacher. Initial testing was conducted during the first week of the experiment, and final testing took place in the last week to evaluate the progress of students in both groups.

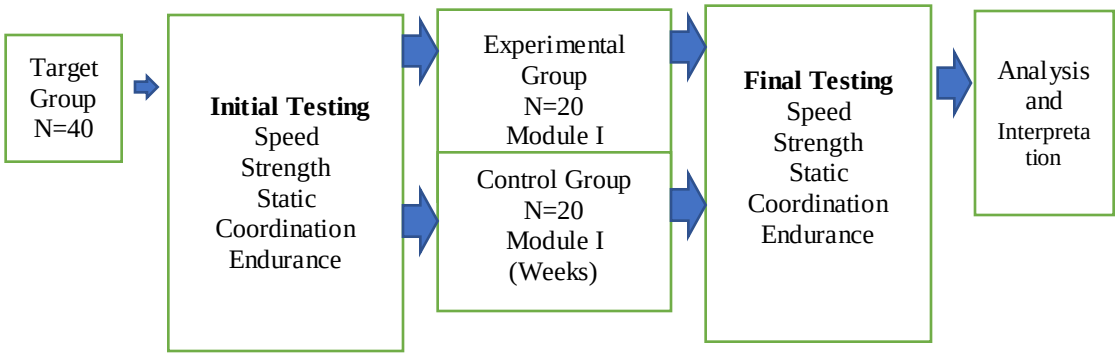

Figure 1. *Quasi-Experimental Design with Pretest and Posttest*

Participation in the experiment was carried out based on well-defined criteria: age, inclusion of both boys and girls, absence of medical exemptions, voluntary consent to participate in the research, and mandatory attendance at all physical education classes.

Experimental Program Based on the Use of Badminton Means for Middle School Students Teaching Methods: Applied games, demonstrative exercises, participation in pairs and teams, initial and final evaluation. Necessary Resources: Badminton rackets and shuttlecocks, court markings, stopwatch, and observation sheets for evaluations. *Program Objective:* Improving general motor skills, developing coordination and reflexes, as well as promoting engaging and varied physical activity during physical education classes.

Table 1. *Experimental Program Using Badminton Means for Enhancing Motor Skills in Middle School Students*

Duration: 7 weeks, with two lessons per week (14 lessons). Lesson Structure: Warm-up: 10–15 minutes. Main part: 25–30 minutes. Cool-down: 5–10 minutes.	
Specific Objectives	Developing Hand-Eye Coordination. Improving Reaction Speed and Agility. Enhancing Physical Endurance Through Dynamic Exercises. Promoting Teamwork and Fair Play Through Badminton-Specific Games.
Proposed Content:	
Week 1	Familiarization with Equipment and Basic Rules of Badminton. Warm-up exercises focused on joint mobility and coordination. Basic drills to develop racket control and shuttlecock handling, such as stationary light strokes.
Week 2	Exercises for Lateral and Forward-Backward Movement to Enhance Positioning Basic strokes: short and long serve. Pair games to develop shot accuracy.
Week 3	Combined Exercises of Strokes and Movement. Introduction of the Smash as a Power Element. Mini-Matches to Apply the Concepts Learned.
Week 4	Tactical Exercises: Placing the Shuttlecock in Hard-to-Reach Areas for the Opponent. Team game strategies. Team-Based Point Games to Foster Competitive Spirit.
Week 5	Tactical exercises: positioning the shuttlecock in hard-to-reach areas for the opponent. Team play strategies. Point-based team games to foster a competitive spirit.
Week 6	Reinforcing learned techniques through applied exercises. Simulating full matches. Intermediate Evaluation of Progress: Observations on Speed, Coordination, and Endurance.
Week 7	Recreational Activities and Tournament-Style Games to Promote Healthy Competition. Final Assessments to Evaluate the Program's Impact on Motor Skills. Student Feedback and Final Conclusions.

Week 4 (Model): Exercises for Coordination and Quick Reaction

Objectives: Improving reaction speed; Developing hand-eye coordination. Examples of activities: Warm-up: The game "Shuttle Hunt" – students catch shuttlecocks thrown by the teacher using only their rackets. Main part: Competitive game: "Rapid Duel" – quick exchanges of shots in pairs, without letting the shuttlecock fall. Cool-down: Recreational games, such as "Switch the Racket" – exchanges between peers after each shot. Duration: Rapid Duel: 12–15 minutes (3-minute series with 1-minute breaks). Reaction speed: 10 minutes, alternating students.

The means included in the program were selected based on specialized literature and the specific curricular objectives for middle school. These aimed at developing general motor skills such as speed, coordination, balance, and endurance, as well as familiarizing students with basic badminton techniques. The exercises and games were progressively structured, taking into account the students' age and skill level. This approach ensured active and effective participation of all students, regardless of their initial skill levels.

3. Results and Discussions

The data analysis suggests that the badminton-specific training methods implemented within the experimental program had a positive impact on students' motor development, as evidenced by the progress observed in their performance across various motor skill tests.

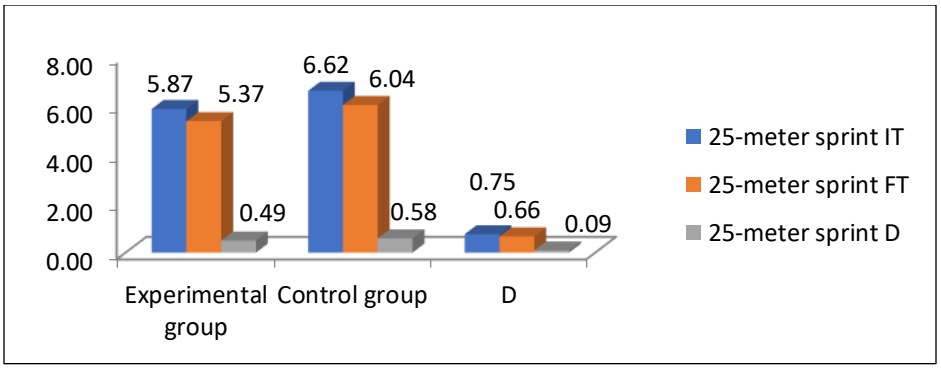

Figure 2. *Comparative Analysis of Initial and Final Results in the 25m Sprint Test*

The results obtained in the 25-meter sprint test highlight significant differences between the experimental and control groups, both in the initial tests and the final tests. The average times in the experimental group decreased from 5.87 seconds in the initial test (I.T.) to 5.37 seconds in the final test (F.T.), indicating an improvement of 0.49 seconds. This significant reduction can be attributed to the implementation of the badminton-based program, which contributed to the development of speed and coordination.

In the control group, the average times decreased from 6.62 seconds in I.F. to 6.04 seconds in F.T., showing a difference of 0.58 seconds. Although the

improvement is greater in absolute value than in the experimental group, the final time remains higher compared to the experimental group, suggesting that the standard physical education program was less effective in optimizing short-term speed.

The progress difference between the two groups is 0.09 seconds (0.58 - 0.49), indicating that, although both groups showed improvements, the specific program applied to the experimental group demonstrated greater efficiency, as reflected in the lower final time.

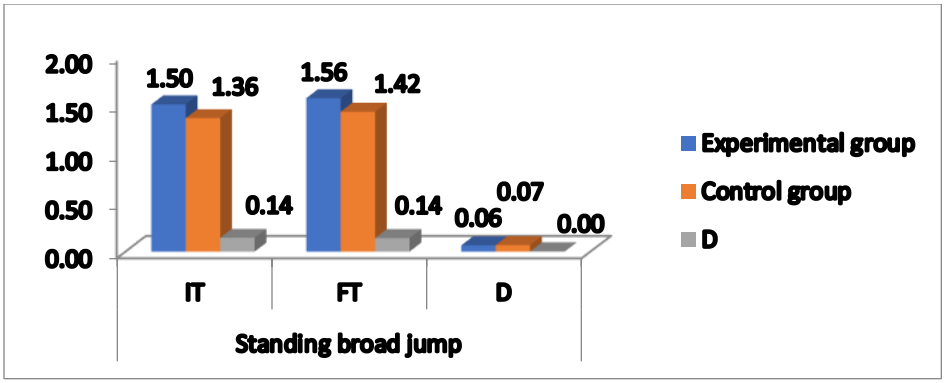

Figure 3. *Comparative Analysis of Initial and Final Results in the Standing Broad Jump Test*

In Figure 3, the results of the experimental group can be observed. In the initial test (I.T.), the average jump distance was 1.50 m, which increased to 1.56 m in the final test (F.T.), marking an improvement of 0.06 m. The progress of the experimental group can be associated with the use of a training program based on specific badminton exercises, which contributed to the development of explosive strength and lower limb coordination. For the control group, the average jump distance in I.T. was 1.36 m, increasing to 1.42 m in F.T., indicating an improvement of 0.07 m.

Although the control group showed similar progress to the experimental group in terms of absolute difference (0.07 m vs. 0.06 m), the lower initial level and lack of a specific program limited the overall performance.

The average progress of the experimental group was close to that of the control group. However, the initial difference between the groups (1.50 m in I.T. for the experimental group vs. 1.36 m for the control group) suggests a baseline superiority for the experimental group. Interestingly, the relative improvement was equal in both groups (D = 0.14 m between I.T. and F.T.), indicating that the specific intervention for the experimental group had a similar impact to the general program of the control group in this particular dimension.

In Figure 4, the initial average time for the experimental group was 13.99 seconds, which decreased to 13.39 seconds in the final test, indicating an improvement in performance. The difference between the initial and final times was 0.60 seconds.

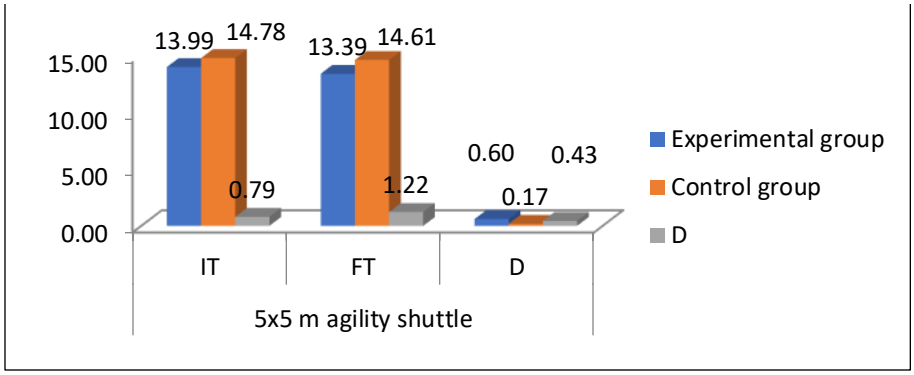

Figure 4. *Comparative Analysis of Initial and Final Results in the 5x5 m Shuttle Run Test*

This slight improvement in agility may result from the specific program implemented in the experimental group, which included exercises designed to develop agility. For the control group, the initial average time was 14.78 seconds, decreasing to 14.61 seconds in the final test, with a difference of 0.17 seconds. Although there were improvements, they were less significant compared to the experimental group, suggesting that the standard physical education program did not have as strong an impact on agility as the specific program applied to the experimental group. The average difference between the two groups at the start was 0.79 seconds, which increased to 1.22 seconds by the end, resulting in a final difference of 0.43 seconds. This indicates that the experimental group achieved greater improvement in agility performance compared to the control group.

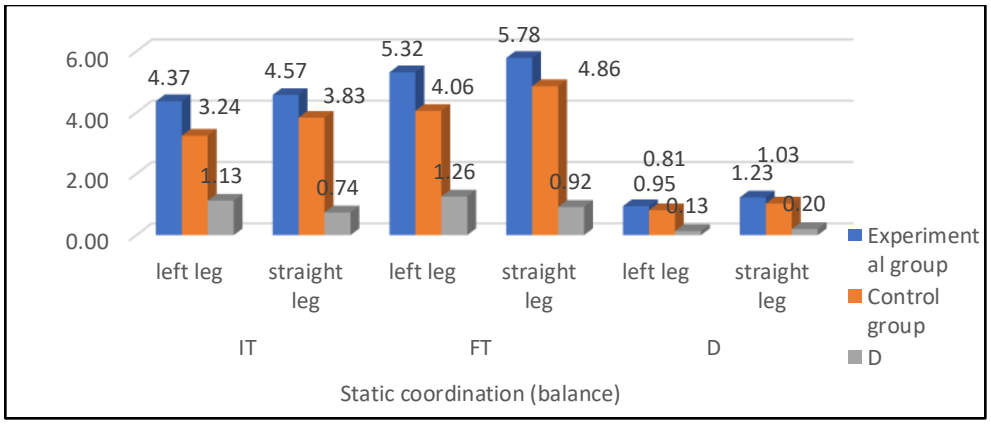

Figure 5. *Comparative Analysis of Initial and Final Results in the Static Balance Coordination Test*

The data presented in Figure 5 reflect students' performances in the balance test on the left and right foot, evaluating static coordination at two moments: the

beginning (I.T.) and the end (F.T.) of the test, as well as the respective differences in time. For the experimental group, the average time at the beginning of the test for the left foot was 4.37 seconds, which increased to 5.32 seconds at the end, showing a difference of 0.95 seconds. For the right foot, the average was 4.57 seconds at the start and 5.78 seconds at the end, with a difference of 1.23 seconds. These improvements suggest that students in the experimental group made progress in maintaining balance on both feet. The significant differences between I.T. and F.T. indicate a positive adaptation in static coordination ability on both feet, suggesting that the specific program implemented in the experimental group had a significant impact on developing balance skills. In the control group, the average initial time for the left foot was 3.24 seconds, which increased to 4.06 seconds at the end, showing a difference of 0.81 seconds. For the right foot, the average was 3.83 seconds at the start and increased to 4.86 seconds at the end, with a difference of 1.03 seconds. In the case of the control group, progress in balance was also observed, but the differences between I.T. and F.T. were smaller compared to the experimental group.

The differences between the two groups are more evident at the end of the test, for both the left and right foot.

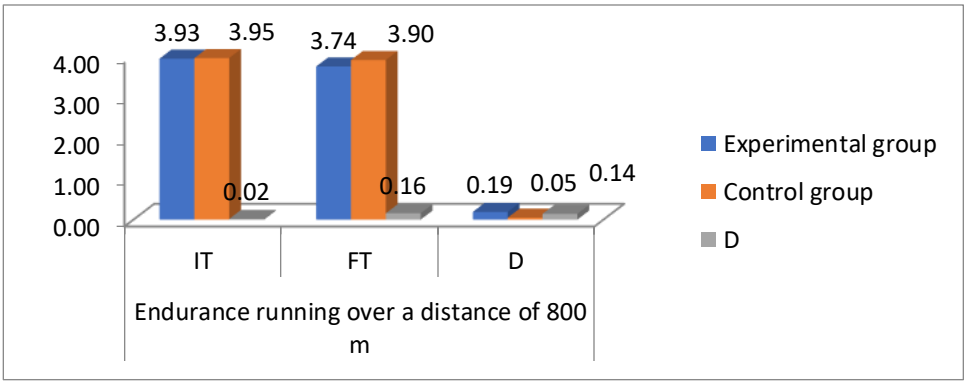

Figure 6. *Comparative Analysis of Initial and Final Results in the Endurance Running over 800 m*

As shown in Figure 6, the average time for the 800 m endurance run in the experimental group was 3.93 minutes. At the end of the test, the average time for the same distance decreased to 3.74 minutes. The difference between the initial test (I.T.) and the final test (F.T.) was 0.19 minutes (approximately 11.4 seconds), indicating a significant improvement in performance. For the control group, the average time for the 800 m run was 3.95 minutes. At the end, the average time decreased to 3.90 minutes, with a difference of 0.05 minutes (approximately 3 seconds). This shows a much smaller improvement compared to the experimental group. In the control group, the observed improvements were significantly smaller, suggesting that the standard physical education program did not have the same impact on endurance performance as the program implemented in the experimental group. The performance difference between the two groups is evident. While the experimental

group showed a considerable improvement of 0.19 minutes, the control group achieved only a minor improvement of 0.05 minutes.

Discussions

The results of various studies analyzed reveal complementary perspectives regarding the efficiency of modern interventions in badminton lessons and teaching, each highlighting specific factors that contribute to the development of students' motor and technical skills.The study conducted by (Erol, 2022) demonstrated that a basic badminton training program applied to children aged 11 to 12 years had a significant impact on agility, balance, strength, and vertical jump performance. This indicates that structured interventions can positively influence children's physical development, especially during the critical period of growth and motor development. However, the study did not explore the program's effects on other age groups, providing opportunities for future research.

In a complementary direction, (Nguang, Sye, & Hutkemri, 2020) investigated the impact of cooperative learning methods, such as STAD and Jigsaw, on backhand low service skills in badminton. Unlike the general training program studied by Erol, this study addressed a specific technical aspect of the game and compared modern methods with traditional ones. The results showed that cooperative learning methods are significantly more effective, suggesting that active student involvement in the learning process can have a superior impact on the development of technical skills. The study by (Syed & Nguang, 2023) analyzed the effectiveness of a structured badminton training module conducted over six weeks, focusing on improving serving skills and lob shots. Similar to the conclusions of (Nguang, Syed, & Hutkemri, 2020), this study demonstrated that structured and well-planned approaches have a clear advantage over traditional methods, supporting the idea that adapting pedagogical methods to students' needs significantly contributes to athletic performance. Comparing these studies, it is evident that, although all address the improvement of students' performance through modern interventions, they have different perspectives and directions. The study by (Erol, 2022) focuses on the development of general motor skills, while (Nguang, Syed, & Hutkemri, 2020)) and (Syed & Nguang, 2023) analyze the development of specific technical skills through innovative learning methods. The study by (Nguang, Syed, & Hutkemri, 2020) introduces an additional element—cooperative learning—which is not addressed in the other research, emphasizing the importance of social and collaborative involvement in the instructional process. The development of badminton at the school level or within education and training programs generally begins between the ages of 6 and 14. This interval represents a critical stage in the development process, playing a vital role in sustaining and perpetuating sports progress. These initiatives not only support the growth of individual performance but also represent essential strategies for optimizing results and establishing a strong foundation for practicing this sport. (Hidayat, 2011).

5. Conclusions

1. Analyzing statistical indicators (mean, standard deviation, and coefficient of

variability), it is evident that the experimental group recorded significant improvements, particularly in the average performance of physical tests (e.g., endurance running and standing long jump), with a greater reduction in performance time compared to the control group. The coefficient of variability in the experimental group is higher, suggesting a wider distribution of performances, indicating more significant progress for some students, while others showed more modest results.

2. The control group displayed smaller progress and lower variability in performances, suggesting that the standard physical education program had a more uniform effect on students. The relatively low standard deviation and coefficient of variability show that students' performances were more consistently distributed, and improvements were limited compared to the experimental group. This indicates that the control program did not stimulate physical performance as effectively as the badminton-based program.

3. Students who participated in the experimental program demonstrated a greater ability to transfer developed motor skills (such as agility and hand-eye coordination).

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