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Article

Application of core strength training based on learning control robot technology in Badminton

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Abstract: The implementation of core strength training in badminton has received increasing attention as the game and training theories have matured. A single typical strength training session is not the same as core strength training. Strengthening the trunk's core muscles can help athletes become more adaptable and physically strong, which will have a significant influence on badminton's future growth. At present, core strength training has been tried to be applied to the routine training of athletes. However, its application has not been scientifically guided and its role cannot be fully exerted, which has adversely affected the improvement of athletes' skill levels. Consequently, a thorough analysis of badminton's features was done in this research. The use of core strength training in badminton was thoroughly investigated based on an exploration of the application value of this technique in conjunction with learning and control robot technology. This article examined three levels of special abilities, physical fitness and balancing ability, and compared it with the standard core strength training technology to demonstrate the application impact of the learning control robot's core strength training in badminton. According to the experimental findings, learning control robot technology may be achieved through core strength training, the average scores of students' badminton speed quality and strength quality were about 8.10 and 8.45. There was a clear difference between the scores of 6.69 and 7.54 of the traditional training methods, which proved its feasibility.

Keywords: core strength training; learning controlled robotics; Badminton training; special sports qualities

1. Introduction

With the continuous development of strength training in competitive sports, core strength training has eventually started to be employed extensively in various competitive sports. Badminton, as an intense confrontational running event, requires players to maintain control over their bodies according to the changes of the event. Core strength training can not only effectively improve the balance and stability of badminton players, but also optimize energy efficiency and movements' flexibility even further. Despite being a valuable tool for daily training, strength training for the core primarily targets the superficial muscles because of individual differences in athletes' physical condition and athleticism as well as a lack of thorough knowledge about the practice. As a result, the usefulness of core strength training has not been thoroughly examined, which may influence badminton's future growth. Learning-controlled robotics is the product of the combination of deep learning, iterative learning control algorithms and robotics. It is used in many professional fields due to its high precision and high intelligence. For example, it has exerted its application value in professional fields such as automobile manufacturing, smart furniture and

medicine [1]. It can effectively optimize the utilization of core strength training. Through the intelligent analysis of sports characteristics, the connection between the athlete's nerve and muscle system can be strengthened and it has important reference value for promoting the improvement of badminton players' special sports skills.

Using core strength training to improve badminton skills has always been the research direction of many scholars. The authors examined the effect of core strength conditioning on clear overhead shots in 12-year-old badminton players through an 8-week course intervention [2]. The study combined the changes in an athlete's heart rate and other functions to discuss the application of core strength conditioning in badminton [3]. The author used the latest computer visualization technology to make the core strength conditioning effect of badminton closer to actual combat [4]. The study analyzed the core strength conditioning strategy of badminton based on computer-intelligent control to improve the training quality [5]. The authors collected and preprocessed badminton technical action data and used the Apriori algorithm to study the application of core strength conditioning in badminton [6]. The application of core strength training in badminton is very common. Previous studies have only analyzed it at the theoretical level. With the frequent development of competitions, the practicality of core strength conditioning needs to be better explored and learning control robot technology would become a more suitable choice.

Learning-controlled robotics has been extensively studied in recent years. The researchers believed that learning-controlled robotics could be used to control various energy systems and reviewed its application in smart grid demand response [7]. The study proposed a new policy iteration algorithm based on learning-controlled robotics to solve the multi-person system cooperation problem under control constraints [8]. To shorten the response time to spacecraft modifications, The researchers improved the telemetry monitoring application under learning-controlled robotics [9]. The researchers studied the development and application trend of learning control robot technology through the centrality index [10]. The study believed that in the cleaning process of the filling line, the installation of a static nozzle system based on learning-controlled robotics was beneficial to the subsequent development of the brewing industry [11]. The authors analyzed the self-generated acoustic pulse reflection effect of animal active echolocation in the external environment through learning-controlled robotics [12]. Overall, learning-controlled robotics is widely used, but studies that combine it with physical training are rare. To promote the improvement of badminton training level, the use of core strengthening exercises based on learning control robot technology in badminton is very important. In this paper, the application of core strengthening exercises in badminton was studied in depth by utilizing the technique of learning control robots. According to the application's practicing data, those in the experimental group using the core conditioning technique of learning control robots scored 8.71, 8.03, 8.77, 8.92, 8.05 and 8.14 for each of the six categories of special abilities in the exam. The average speed quality score in the physical fitness test was around 8.10 and the average strength quality score was approximately 8.45; the two balancing ability test results in the balance ability stage 1 test were 7.01 and 7.57, respectively. After the fourth stage, the test results improved to 8.14 and 8.34. From these experimental data, it seems that the learning-based core strength training control robot technology had high application value in badminton. It had an obvious effect on

the improvement of participants' overall skill level in badminton and can effectively promote the in-depth development of badminton sports.

2. Application of exercise for core strength in Badminton

Overview of exercise for core strength applications

A relatively recent physical training technique is core strength training. It was more frequently employed in the medical field for rehabilitation purposes in the early 20th century. Some academics introduced core strength training into the training regimen for competitive sports in the 1990s [13]. However, the competitive sports training world did not gradually adopt and value core strength training until the twenty-first century. These days, a lot of national teams in competitive sports use core strength training methods to increase body stability and athletic ability, as well as to develop the strength of core muscle groups in a comprehensive and balanced manner. It is also an effective means for athletes to prevent injuries.

Figure 1 represents a schematic diagram that illustrates the key elements and connections in executing stable badminton hitting techniques. It identifies the body's "kinematic chain" and the numbered circles that correspond to vital points like joints or muscle groups. The lines connecting these circles represent the flow of force or movement within the kinetic chain, illustrating energy transmission during a hitting action. The shaded areas can indicate areas for core strength training, emphasizing the importance of developing stability and control in these areas for improved badminton performance. The figure serves as a visual representation of the interconnectedness and coordination required for effective badminton techniques. Therefore, the development of muscle strength coordination in various parts of the body is very important. In competitive competitions with high sports intensity, only when the batting technique is in a stable state, the athletes can better execute the game tactics. The speed and strength of badminton players in the game require strong upper-body strength and the ability to move quickly underfoot requires strong lower-body strength. Core muscle group training allows athletes to adapt quickly to complex dynamics. It can reduce the energy consumption of the body while maintaining the stability of the body, thereby reducing the probability of sports injuries [14]. All kinds of batting skills and movement footwork in badminton must be connected and the "action chain" is a process of communication and integration that occurs through the core parts of the body.

According to the characteristics of badminton, it can be seen that in this sport, in addition to the higher physical requirements, the level of special skills, physical fitness and balance are also the key factors for whether to achieve excellent results in the competition. A large part of the reason for the formation and improvement of these three aspects depends on whether the core strength is strong. Using core strength training to improve badminton skills is explained by focusing on special technology, physical fitness and balance ability.

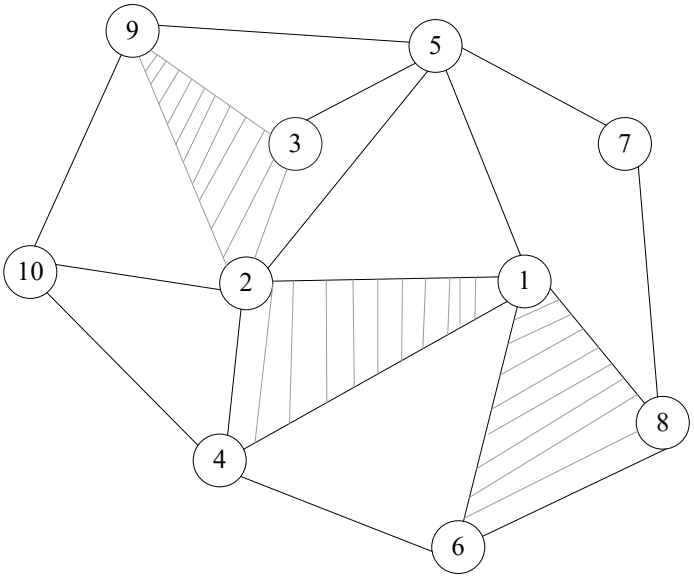

Figure 1. Illustration of a kinematic chain.

Special technology: In the batting process of badminton, when the speed of the incoming ball is fast and surpasses the body, it is difficult to turn around to save the ball, so it is necessary to adjust the body posture to hit the ball [15]. At this time, if the muscle strength in the core area is at a certain level, the body can be controlled to maintain a stable state to avoid losing balance due to sudden changes in body movements. In the jumping smash, the technical application of the opponent's hand is very demanding, especially during the whipping action of the badminton hitting technique. At this time, whether the hand badminton technique can play normally depends on whether the muscle training in the core area can play a role in stabilizing and transmitting force, as well as the ability in the core area determines the strength of the smash. In the process of foot movement in badminton, a large number of emergency stops and multi-directional running require the stability of the core area of the body to keep the body's center of gravity in a dynamic and stable state [16]. In essence, core strength is highly correlated with spine and pelvic stability in badminton players. Through the special training of muscle strength in the core area, the stability and balance of the muscle strength in the core area can be improved according to the characteristics of badminton and the coordination of the upper and lower limbs of the badminton players can be ensured.

Physical fitness: The change of the ball path in badminton is difficult to predict and it can only be dealt with instantaneously according to the change of the ball path of each ball. This type of coping requires a lot of physical fitness. The evaluation of badminton hitting skills is mainly to mobilize opponents through the speed of hitting and the placement of the ball. Through the change of speed and landing point, it is difficult for the opponent to keep up with this rapid change, to win the game. This ability is based on specific physical fitness. Fast running is taken as an example, when performing a quick-start sprint, the transversus abdominis in the core area is used first and the transversus abdominis itself is the starting point of speed. The 30-meter sprint embodies the quality of speed. The characteristics of badminton are short and fast movements. When hitting the ball, it is necessary to judge the landing point and then

quickly move to the landing point to quickly hit back, as shown in **Figure 2**. This determines the high requirements for fast movement in badminton. The excellent speed quality can make up for the deficiencies of badminton special skills to a certain extent, to gain an advantage in badminton offense and defense. The pillar stabilization training in the core area can ensure the transmission of force and better exert the strength of the upper body, thus enabling the athlete to maintain stability in the air. It enables the athlete to adapt to the rapid change of the center of gravity in the dynamic, so that the trunk maintains good stability, to ensure the moving efficiency in the non-unidirectional motion state.

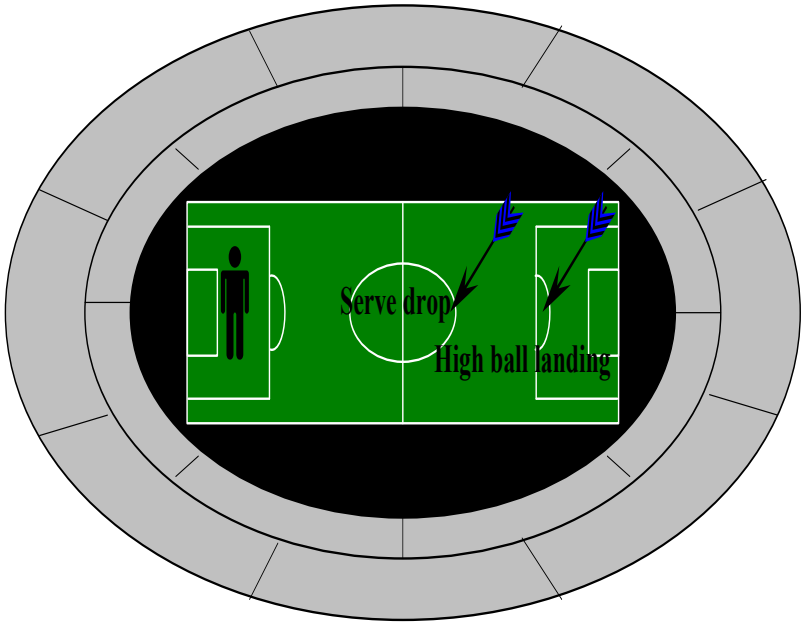

Figure 2. Schematic diagram of the hitting point.

Balance ability: Balance ability refers to a stable state of various portions of human beings without exceeding the support range of the support point. In badminton, because the core area of the body in badminton is always in an unstable state, each swing is a quick and instantaneous action. That is to say, the core stability of badminton is a relatively dynamic stable state and it is always in a random equilibrium state. The uncertainty of badminton's landing point would inevitably lead to a passive and unstable state of the body at all times and it is necessary to adjust the unstable state in time to hit the ball back and forth. In the process of badminton, once badminton players cannot adjust their body balance, they would lose points due to wrong movements. In badminton, the stability of the core strength plays a decisive role in quickly adjusting the imbalance in the body movement. Badminton requires good flexion-extension stability and rotational stability. The balance ability of the human body mainly depends on the function of proprioceptors and vestibule, as well as the training of core strength is multi-plane dynamic training. Not only does it improve the stability of the body in various situations, but it also improves the body's sensitivity to balance.

3. Learning controlled robotics

It can be seen from these aspects that core strength training has usefulness for the enhancement of the development level of badminton. Consequently, the main emphasis of badminton training should be on core strength training. However, when formulating strategies for athletes to strengthen their core, most coaches did not link the training methods with the characteristics of badminton and did not fully consider the consistency of the training movements used in the program with the actual training needs of athletes. Moreover, it is necessary to formulate a differentiated plan based on the athlete's function before training. At present, there are yet some difficulties in achieving these aspects simultaneously. Therefore, it is proposed to enhance the usefulness of core strengthening exercises for badminton under the learning control robot technology.

Learning-controlled robotics is one of the components of intelligent technology [17]. Its purpose is to gradually reduce the tracking error of the system and finally achieve complete tracking of the desired trajectory through repeated operations. The basic idea of this method is: that through the existing control experience, the actual output data obtained and the preset track deviation are measured. Finally, the algorithm is used for correction, so that the trajectory of the target object is gradually idealized [18]. The process is shown in **Figure 3**.

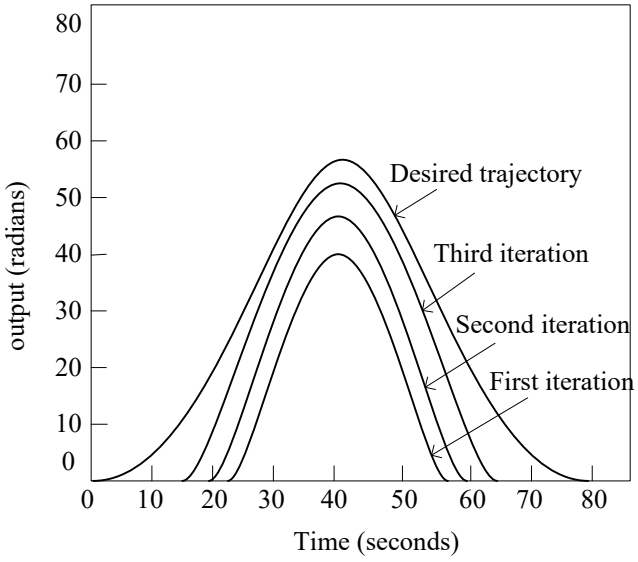

Figure 3. Learning controlled robotics control process.

Learning control robot technology mainly uses the method of repeated learning and training to control and analyze. The technical framework includes storage modules and correction modules, that is, it can effectively control the target object. When the output track deviates from the specified track, the storage module would automatically recall the experience record and correct the unsatisfactory control signal to generate a new control signal. This can facilitate subsequent analysis of the target object [19]. The principle is shown in **Figure 4**.

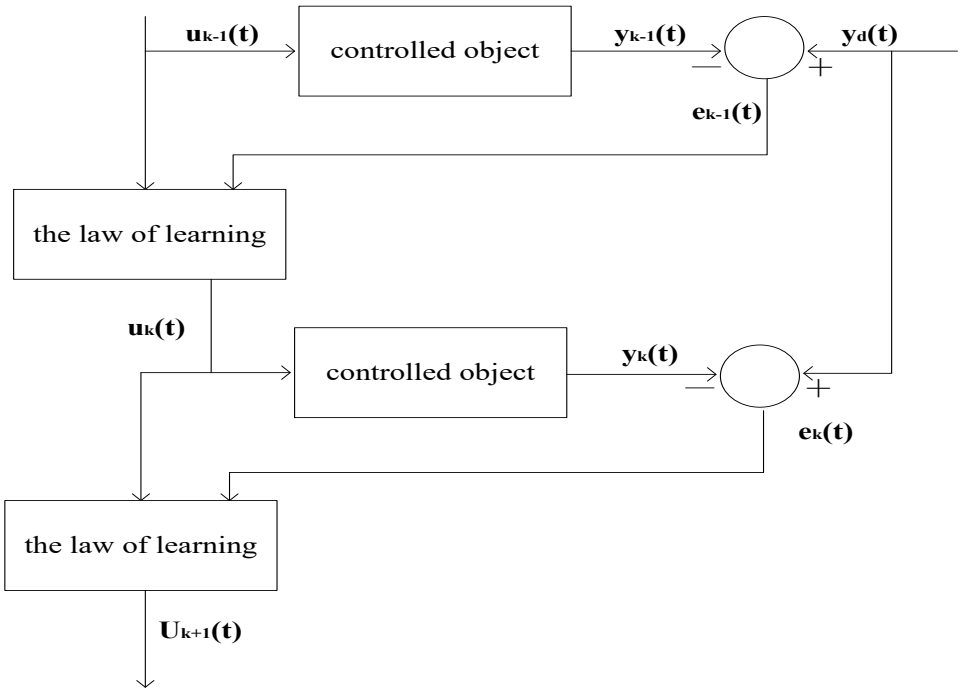

Figure 4. Learn the principles of controlled robotics.

This control technique can handle dynamic systems with a fairly high degree of uncertainty in a very simple way and with less empirical knowledge [20]. It has the following salient features:

1) It is suitable for movements with repeated variable speed and direction change characteristics;
2) It can achieve full tracking, which is different from progressive tracking;
3) It can analyze its characteristics in the state of an unknown control object;
4) The calculation amount is small and the convergence is strong;
5) It has strong intelligence and can record different control tasks. It can schedule records in the same type of control tasks, thus saving time and cost [21].

Action characteristics with uncertainty and disturbances considered in badminton:

$$\dot{x_k}(t) = Ax_k(t) + Bu_k(t) + w_k \quad (1)$$

$$y_k(t) = Cx_k(t) + v_k(t) \quad (2)$$

Among them, k represents the k-th repeated operation of the system. The definitions of parameters$x_k(t) \in R^n$, $y_k(t) \in R^m$, $u_k(t) \in R^r$, and $t \in [0, T]$ are shown in **Table 1**.

Table 1. Interpretation of each parameter.

Sequence	Parameter	Meaning
1	$x_k(t)$	State vector
2	$y_k(t)$	Output vector
3	$u_k(t)$	Input vector
4	$w_k(t)$	Uncertainty
5	$v_k(t)$	Disturbance
6	A, B, C	Bounded matrix with appropriate dimensions

The core strength training application is derived from the learning law in learning controlled robotics:

$$u_{k+1}(t) = u_k(t) + K_p e_t(t) + K_I \int_0^t e_k(\tau)d\tau + K_D \dot{e}_k(t) \tag{3}$$

It is assumed that the uncertainty of the athlete's motion state and the disturbance factors in it are bounded and satisfied:

$$\|w_k(t)\| \le b_w, \|v_k(t)\| \le b_v, \|\dot{v}_k(t)\| \le b_{dv} \ (\forall k = 0,1,\cdots, \forall t \in [0,T]) \tag{4}$$

To deeply analyze the application value of core strength training, the relevant norm definitions are given.

For n-dimensional vectors:

$$W = (w_1, w_2, \cdots, w_n)^T \tag{5}$$

its norm is defined as:

$$\|W\| = \sqrt{\sum_{i=1}^{n} w_i^2} \tag{6}$$

and the norm of the corresponding $n \times n$ matrix A is:

$$\|W\| = \sqrt{\lambda_{max}(A^T A)} \tag{7}$$

Among them,λ_{max} represents the largest eigenvalue.

The λ-norm of function $f{:}[0,T] \to R^n$ is:

$$\|f\|_\lambda = \sup_{0 \le t \le T} \{\|f(t)\| e^{-\lambda t}\} \tag{8}$$

At a given time $[0,T]$, the desired trajectory $y_d(t)$, the arbitrary force initial control $u_0(t)$, and the motion initial state $x_k(t) = x_d(t)$ utilize the learning law. If there is $\|I - K_D CB\| \le \rho < 1$ for $\forall(t) \in [0,T]$, then when $k \to \infty$, $e_k(t)$ is uniformly bounded on $[0,T]$. When $w_k(t)$ and $v_k(t)$ do not exist, the core strength output converges to the desired trajectory, that is:

$$y_k(t) \to y_d(t) k \to \infty \tag{9}$$

In this state, the core strength of the athlete can achieve the best output.

Training Details: Core strength training is crucial in badminton for improving performance and reducing injury risk. Focusing on exercises targeting core muscles like obliques, lower back muscles and abdominals, such as planks, Russian twists, stability ball exercises and weighted core exercises, gradually increase the intensity to keep athletes challenged without overdoing it.

Rest Time: Rest periods are crucial for optimizing recovery and performance during core strength training. Between sets of core exercises, athletes should take a 30- to 60-second pause to allow for partial recovery while maintaining training intensity. To ensure ideal technique and attention, athletes are also suggested to take longer rest intervals, ranging from one to two minutes, between different core workouts.

Apparatus: Exercises involving core strength training can be made more interesting and efficient by using a variety of equipment. This can include medicine balls for dynamic core workouts like medicine ball throws or slams, resistance bands to add resistance to core motions, and stability balls for exercises like crunches or planks. Russian twists with dumbbells are one type of weighted exercise that could be used to gradually stress the core muscles.

Scoring Method: Badminton players undergoing core strength training need to monitor advancement and performance indicators using various measures like stability, resistance exercises and plank positions. Real-time feedback mechanisms, either from coaches or technology, can provide valuable information on form, technique and areas needing improvement.

Combining Badminton Instruction: The badminton training program should be integrated with core strength training, creating workout routines that mimic rapid badminton motions. Core workouts should enhance badminton techniques like smashes and lunging. Periodizing core training phases based on the athlete's seasonal objectives, emphasizing maintenance during the competitive season and building on basic strength in the off-season.

4. Core strength training application practice

To verify the application effect of core strength training under this method in badminton, an 8-week core strength training practice was carried out. Twelve students were selected from the 2021 badminton elective class of the College of physical education of a university, with six female students comprising the control group and six male students forming the participant group. The experimental group underwent training for core strength with the assistance of learning-controlled robotics, while the control group underwent traditional training for core strength. Aiming at the methods and means of training for core strength, the main contents of the training test were divided into special skills, physical fitness and balance ability. Before the experiment began, the fundamental data for the two student groups was gathered and the *T*-test results were analyzed to verify the efficacy of the training effect of the two groups are shown in **Table 2**.

Table 2. *T*-test for basic information of experimental subjects.

Index	Group	Mean	Standard deviation	*T* value	*P* value
Age	Experimental group	20.71	±0.82	1.021	0.761
	Control group	20.69	±1.01		
Height	Experimental group	173.64	±4.11	−2.174	0.102
	Control group	173.72	±4.47		
Weight	Experimental group	63.42	±5.24	−6.337	0.316
	Control group	63.77	±5.01		

From **Table 2**, it can be seen that the *P* values of the two groups of students in terms of age, height and weight were all greater than 0.05, which means because the two student groups' basic information did not significantly differ from one another, so the influence of these three aspects on the experimental results of this paper can be excluded.

Special skills: The special skill training test is mainly for badminton hitting skills.The special skill training test needs to send 20 balls to the subject's field sequence continuously and the serving line is not fixed. It can be served evenly between the left and right court areas, or it can be repeatedly served in the same court area.The subject was tested on their ability to hit the ball using specific technology,

including pulling, lobbing, smashing, pushing, releasing and swiping, based on the incoming ball's line and placement. Subjects were scored by the judges according to the technical criteria, with 10 points for each item. **Figure 5** displays the test results for the two student groups.

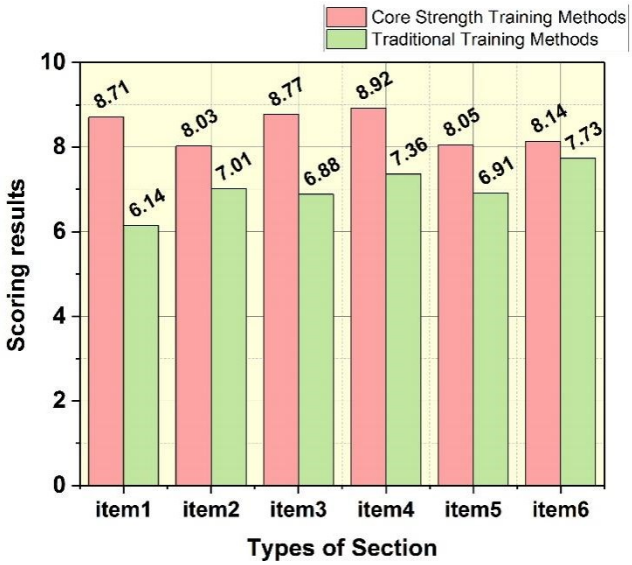

Figure 5. Special skills training results.

The results of the approaches' traditional training and core conditioning are shown in **Figure 5**. In badminton, the power of a player's shot is largely determined by the basics of the power of the body. In the process of hitting the ball, the power of the upper body hitting the ball needs to be pushed on the ground with the help of the lower body and then the force is superimposed and transmitted through the torso part. Therefore, athletes with strong trunk core strength can hit the ball more powerfully. **Figure 5** illustrates how the training outcomes for the two student groups using various approaches also revealed various degrees. The application effect of learning control robot technology-based core strength training in badminton was generally more evident. In the six items, the individual scores of the students in the experimental group were 8.71, 8.03, 8.77, 8.92, 8.05 and 8.14; the scores of each item were above 8 and the overall average score of the six items was about 8.44, which was related to the strong control ability of the learning control robot technology. Therefore, it is necessary to choose a core strength training method with a high degree of matching according to the structural differences of each student's body and trunk, so that it can exert its highest level of special skills. In contrast, the traditional core strength training method showed a poor overall training effect; the scores of the six items were 6.14, 7.01, 6.88, 7.36, 6.91 and 7.73, respectively and the overall average score was about 7.01, which was 1.43 points away from the training results under our method. In actual badminton competitions, this difference in results was quite significant.

Physical fitness: For physical fitness training, this paper referred to the national student physical fitness test standards and combined the age characteristics, strength characteristics and badminton characteristics of the test subjects. The test content was divided into speed quality training and strength quality training. The significant items are shown in **Table 3**.

Table 3. Physical fitness training-specific content.

Test items	Sequence	Training content
Speed quality training	1	30-meter fast run
	2	10-meter × 4 round-trip run
	3	Low center of gravity square run
	4	30-second fast swing
Strength quality training	1	Standing long jump
	2	60-second push-up
	3	Shot Putting
	4	Push barbell

The test method adopted a scoring system. The subjects were scored according to the results of each training content, with a full score of 10. The scoring results of the two groups of students are shown in **Figure 6a,b**.

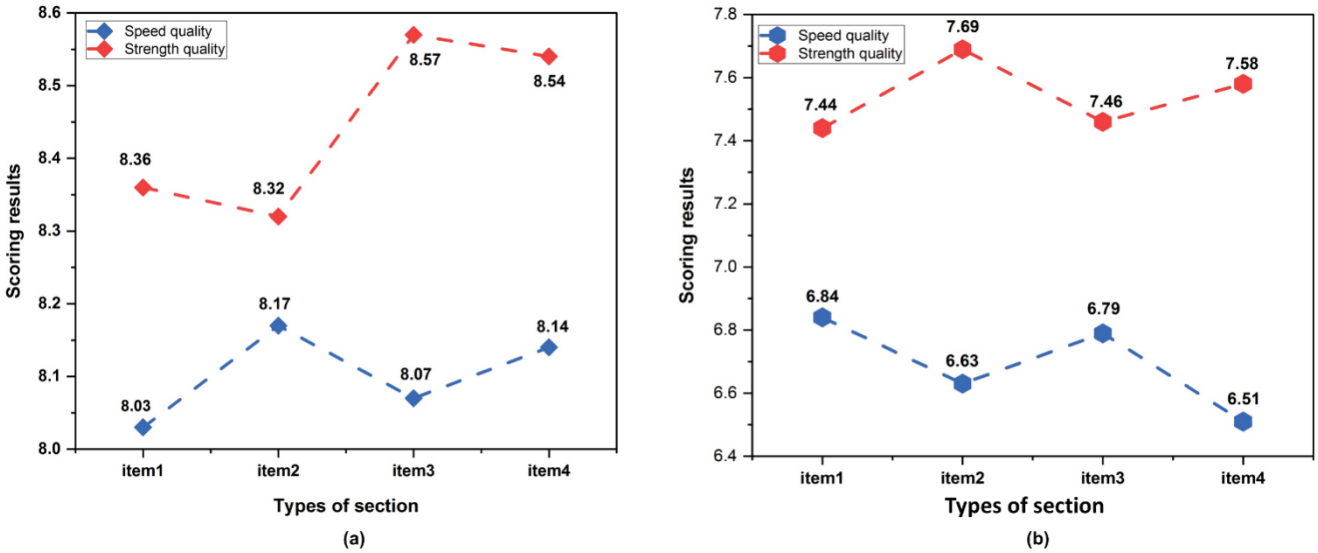

Figure 6. Physical fitness training results: **(a)** core strength training method; **(b)** traditional training method.

In **Figure 6**, the benefits of strengthening one's core the speed quality and strength quality of badminton players varied. Overall, the training test results of strength quality were better than the speed test, which could be related to the fact that practice for core stability focuses on the development of athletes' physical strength. Under the practice for core stability based on the learning control robot technology in **Figure 6a**, the average score of the speed quality of the students in the experimental group was about 8.10 and the average score of the strength quality was about 8.45; under the traditional method in **Figure 6b**, the average of the pupils' grade in the control group was about 6.69 in the degree quality and the average score in the strength quality was about 7.54. From these two sets of data, it can be seen that the core strength training based on the learning-controlled robot technology had a greater advantage in badminton and its speed quality and strength quality were higher than the training test results of the control group students. Traditional practice for core stability generally focuses on the development of superficial functions in athletes. It applies traditional

training programs to each athlete's daily training but ignores the improvement of their deep muscle strength and function, which leads to unsatisfactory test results. The learning-controlling robot can effectively formulate intelligent training programs according to the characteristics of badminton and effectively improve the speed and strength of athletes.

Balance ability: For the balance ability test, two items of rotational stability and flexion-extension stability were selected to test the balance ability according to relevant research standards. The flexion and extension stability test mainly reflects the balance and stability of the trunk in the horizontal plane when the body is doing the same movement of the upper and lower limbs on the opposite side. The rotational stability test mainly reflects the balance and stability of the trunk when the body is doing complex abdominal exercises. To observe the training effect in-depth, this test was carried out after every two weeks of training and it was divided into four stages. The test method was still based on a scoring system, with a full score of 10. The result is shown in **Figure 7a,b**.

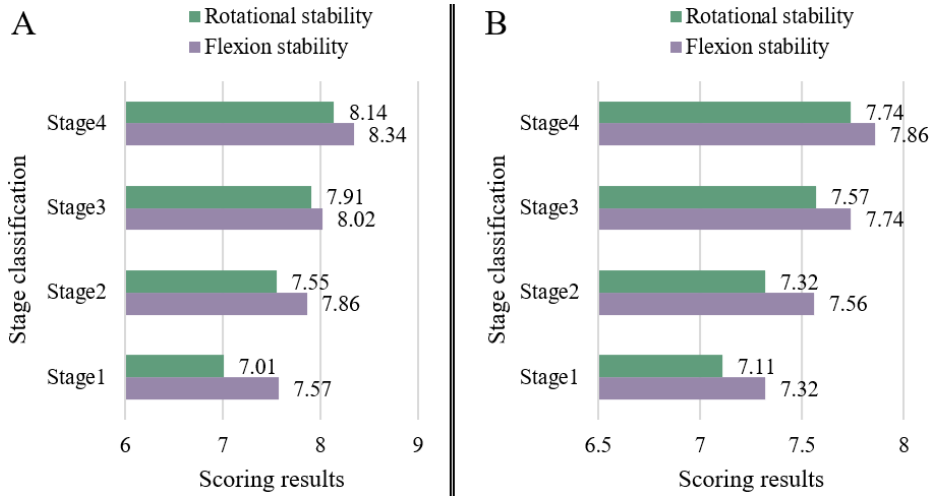

Figure 7. Balance ability test results.

Figure 7a is the training result of the method in this paper and **Figure 7b** is the training result of the traditional method.

In badminton, both the frontcourt and the backcourt need to use balance. The balance ability of badminton players can be reliably improved with the assistance of learning control robot technology. It can be seen from **Figure 7** that there was little difference in the realization of the two groups of students in the early stage. However, through 8 weeks of core strength training, rotational stability, flexion and extension stability had been improved at different levels. In **Figure 7a**, the improvement effect of core strength training based on learning control robot technology was more obvious; in stage 1, the results of the two balance ability tests were 7.01 and 7.57 respectively; after stage 4, the test results increased to 8.14 and 8.34. However, under the traditional training method in **Figure 7b**, the results of the two balance ability tests were 7.11 and 7.32, respectively; after stage 4, the test results only improved to 7.74 and 7.86. It can be seen that the core strength training carried out by the control group can have a certain positive impact on the balance and stability of badminton players. This was mainly because the core strength training performed by the control group trained a

single muscle or muscle group, thereby strengthening the stability of some muscles and joints. However, this kind of stability presented a local and single form, which cannot deeply and effectively improve the balance ability of athletes. However, with the assistance of learning-controlled robotic technology, the purpose of daily training was stronger and the effect was more obvious, which also had a reliable effect on the improvement of the overall ability of badminton players.

5. Conclusion

In the changing times, the development of modern sports is becoming more and more mature and the application level of practice for core stability in badminton has attracted more and more attention. To promote the scientific and intelligent development of badminton sports, this paper combined the learning and control robot technology to make an in-depth exploration of the practical benefits of its practice core stability. With the support of learning-controlled robot technology, the special skills of badminton players have been significantly improved and their physical fitness and balance have also been greatly improved. The speed and strength indicators before and after training were improved to varying degrees. It had changed the single form of traditional core strength training, thus making badminton more specialized. Nonetheless, given the intricate features of badminton, there are indeed several aspects of the research for this work that require improvement. The application practice of core strength training needs to be further improved from the perspective of experimental samples and experimental scope. The limitations of the sample and scope lead to limitations in the generalizability of the conclusions of this paper. The application of core strength training based on learning and control robot technology in badminton is yet in the early stage of exploration, and its practicality needs to be continuously improved. In future research, existing technology will be used to continuously improve the problems in this paper and enhance the application value of practice for core stability in badminton.

Author contributions: Conceptualization, LW and XF; methodology, LW and XF; software, LW and XF; validation, LW and XF; formal analysis, LW and XF; investigation, LW and XF; resources, LW and XF; data curation, LW and XF; writing—original draft preparation, LW and XF; writing—review and editing, LW and XF; visualization, LW and XF; supervision, LW and XF; project administration, LW and XF; funding acquisition, LW and XF. All authors have read and agreed to the published version of the manuscript.

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Data availability: The data pertaining to the present study are accessible upon request, allowing interested parties to obtain the relevant information for further examination.

Ethical approval: Not Applicable.

Conflict of interest: The authors declare no conflict of interest.

References

1. Amjad MK, Butt SI, Anjum N, et al. A layered genetic algorithm with iterative diversification for optimization of flexible job shop scheduling problems. Advances in Production Engineering & Management. 2020; 15(4): 377–389. doi: 10.14743/apem2020.4.372
2. Chai J, Liu P, Wang Q. Research and Analysis of Badminton Training Strategy Based on Computer Intelligent Control. Revista de la Facultad de Ingenieria. 2017; 32(9): 30–37.
3. Chin NS, Ting KY. Effect of Eight-week Plyometric and Resistance Band Training on Badminton Overhead Clear Stroke in 12 Years Old Players. Pertanika Journal of Social Science and Humanities. 2019; 27(S3): 183–192.
4. Darzabi T, Taheri HR, Saberi Kakhki AR. The Variation of Acquisition, Consolidation Memory and Coordination Pattern of Elbow Joint in Short Service Badminton before and after Aerobic Training. Annals of Applied Sport Science. 2018; 6(1): 37–46. doi: 10.29252/aassjournal.6.1.37
5. Fatih YÜKSEL M. Examination of Reaction Times of Elite Physically Disabled Badminton Players. International journal of Science Culture and Sport. 2017; 5(25): 319–327. doi: 10.14486/intjscs695
6. Frank S. Cleaning Filling Lines and Tanks with Robot Technology. Brauwelt international. 2017; 35(2): 137–139.
7. Huang Q, Shi Y. Analysis and research on training mode optimization of badminton players based on data mining technology. Revista de la Facultad de Ingenieria. 2017; 32(16): 294–300.
8. Huanpin L. Research and application of Outward Bound Training in badminton sports. Agro Food Industry Hi Tech. 2017; 28(1): 1548–1552.
9. Javaid M, Haleem A, Singh RP, et al. Substantial capabilities of robotics in enhancing industry 4.0 implementation. Cognitive Robotics. 2021; 1: 58–75. doi: 10.1016/j.cogr.2021.06.001
10. Jiang H, Zhang H, Xie X, et al. Neural-network-based learning algorithms for cooperative games of discrete-time multi-player systems with control constraints via adaptive dynamic programming. Neurocomputing. 2019; 344: 13–19. doi: 10.1016/j.neucom.2018.02.107
11. Kumari R, Jeong JY, Lee BH, et al. Topic modelling and social network analysis of publications and patents in humanoid robot technology. Journal of Information Science. 2019; 47(5): 658–676. doi: 10.1177/0165551519887878
12. Liu Y, Han J, Xiao L. Analysis of badminton training strategy based on computer intelligent control. BoletinTecnico/Technical Bulletin. 2017; 55(20): 289–295
13. Nassar B, Hussein W, Medhat M. Supervised learning algorithms for spacecraft attitude determination and control system health monitoring. IEEE Aerospace and Electronic Systems Magazine. 2017; 32(4): 26–39. doi: 10.1109/maes.2017.150049
14. Nirendan J, Murugavel DrK. Effect of shadow training on motor fitness components of badminton players. International Journal of Physiology, Sports and Physical Education. 2019; 1(2): 04–06. doi: 10.33545/26647710.2019.v1.i2a.8
15. Nugroho S, Nasrulloh A, Karyono TH. Effect of intensity and interval levels of trapping circuit training on the physical condition of badminton players. Journal of Physical Education and Sport. 2021; 21(3): 1981–1987.
16. Ren JF, Ye CM, Li Y. A new solution to distributed permutation flow shop scheduling problem based on NASH Q-Learning. Advances in Production Engineering & Management. 2021; 16(3): 269–284. doi: 10.14743/apem2021.3.399
17. Tsumaki Y, Mori K. Robot Technology Challenging the Mysteries of Animals. Journal of the Robotics Society of Japan. 2017; 35(6): 463–466. doi: 10.7210/jrsj.35.463
18. Van Riet TCT, Chin Jen Sem KTH, Ho JPTF, et al. Robot technology in dentistry, part one of a systematic review: literature characteristics. Dental Materials. 2021; 37(8): 1217–1226. doi: 10.1016/j.dental.2021.06.001
19. Vázquez-Canteli JR, Nagy Z. Reinforcement learning for demand response: A review of algorithms and modeling techniques. Applied Energy. 2019; 235: 1072–1089. doi: 10.1016/j.apenergy.2018.11.002
20. Wei X. An analysis of the training mode of badminton players using data mining technology. Agro Food Industry Hi Tech.2017; 28(1): 3486–3489.
21. Xu X. Research on Teaching Reform of Robot Technology under the Background of New Engineering. Open Access Library Journal. 2020; 07(12): 1–7. doi: 10.4236/oalib.1107005.