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Impact of Technical Characteristics Statistics and Pace Training of Badminton in Colleges and Universities under the 5G Environment

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Keywords: Wireless Network, College Badminton, Technical Characteristics Statistics, Pace Training

Abstract: Badminton is a confrontational sport that hits the ball against each other across the net. It has the characteristics of high speed, strong strength, strong endurance, high sensitivity and good flexibility. With the continuous development of science and technology, 5G networks have also been applied to all walks of life. The statistics of technical characteristics and pace training of badminton in colleges and universities in the 5G environment have become the current research hotspot. It has theoretical basis and feasibility. Through the investigation and research method, this paper has found that pace training has an impact on badminton skills, and through effective pace training, the level of competition can be improved. The survey results have shown that the badminton competition level of boys in the experimental group based on pace training is on the rise, and the level of competition has increased by 7.4 on average. The pace training in the 5G environment has a significant impact on badminton technology.

1. Introduction

With the development of badminton, people have higher requirements for sports career and competitive level, and it has quickly become an indispensable part of college students' fitness boom, lifelong sports habits and social life. The technical characteristics of college badminton include upper body training and pace training. These two affect the basic technology of badminton, and the two affect each other and are indispensable. Therefore, in the 5G environment, it is very important to analyze the impact of technical characteristics statistics and pace training of badminton in colleges and universities. Therefore, it is imperative to study the statistics of badminton technical characteristics and the impact analysis of pace training in colleges and universities.

In order to more accurately study the impact of badminton technical characteristics statistics and pace training in colleges and universities, many researchers have invested in the study. Xie R has considered badminton to be a high-drag sport whose aerodynamics are significantly different from

other ball, racket or projectile sports [1]. Fang L has considered badminton to be a very popular sport in Asia, suitable for players of all genders and all ages. It is loved by the public for its simplicity and fun [2]. Yu K has thought that badminton has become a sport with high technical and physical requirements [3]. Mc K's research has found that how to maximize one's ability under limited time and physical strength has become an important topic in badminton [4]. Ying L has studied how to introduce some basic skills and tactics of badminton court for beginners, and cooperate with multimedia technology to exert the maximum effect with minimum consumption [5]. Wang Y has considered that the practice of basic badminton skills such as badminton posture practice has become essential [6]. Yu L has tried to activate the dynamic program of some basic skills of badminton by exercising the non-dominant arm, and has used this phenomenon to transfer the learning effect to the dominant arm, thus producing the desired response to badminton for students [7]. But from the current point of view, there are still some problems in the basic training of badminton, not only facing the problem of training methods, but also facing the problem of badminton players' cognition.

With the progress of the times, many researchers are committed to the study of 5G. Duong T's research has found that the increasing data traffic and the popularization of smart terminals have caused the fourth generation mobile communication network (4G) to be unable to meet the demand in terms of capacity, speed, spectrum, etc. [8]. On the basis of reviewing the development of mobile communication in recent years, Zhang Y has summed up a class of 5G network architecture with large capacity, high speed and low latency from the network deployment scenarios, access network and core network [9]. Zhang J has disclosed a system and method for providing position location in wireless networks using techniques suitable for providing reliable position determination in complex topological environments [10]. Sun Z has implemented location-location techniques that utilize multiple antenna patterns, such as using phased array antennas to provide location-location without requiring changes to the remote station [11]. Research by Dh C has uncovered various techniques for determining location, including channel model-independent methods, channel model-based methods, or a combination thereof [12]. Swarna R N has investigated channel model independent methods to provide position location, which can compare received signal strength differences with antenna gain differences to determine the angle of azimuth where the remote station is located [13]. Zhou R has considered a mobile network as a collection of mobile nodes, enabling the interconnection between nodes to change continuously [14]. This paper has introduced the application of wireless backhaul optimization in the statistics of technical characteristics of badminton in colleges and universities in the 5G environment, providing a feasibility analysis for the article.

This paper has found through the investigation and research method that pace training has an impact on badminton skills. Through effective pace training, the level of competition, reaction speed, body coordination and balance ability and the frequency of foot movement can be improved.

2. Statistics of Technical Characteristics of College Badminton under 5G Environment

(1) System architecture of 5G environment

In addition to empowering the Industrial Internet, the emergence of 5G has brought communication technology into the entire social production field for the first time. It not only promotes social change, and develops various lifestyles in the direction of computing and intelligence, but also promotes more intelligent and efficient social governance and urban management [15]. The reason why 5G has such great potential is that the core network architecture in the 5G era has moved from closed to open. Through the comprehensive cloudification of the network, a new industrial ecology has been born, as shown in Figure 1.

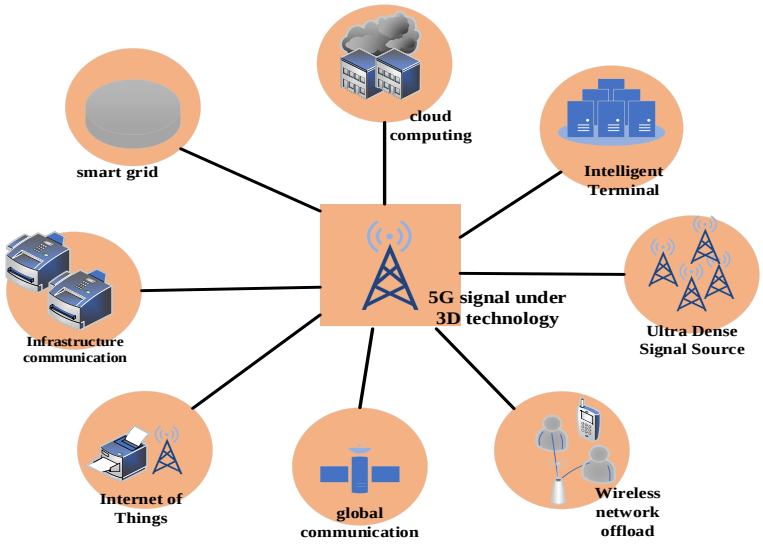


Figure 1. System architecture for 5G environment

In the current 5G network architecture, technologies such as software-defined networking (SDN) and network function virtualization (NFV) are used to transform and upgrade broadband fixed networks. The hardware problems in complex systems and traditional communication networks brought about by software integration are solved [16]. However, when designing a 5G network, to support different scenarios at the same time, flexible and demanding IT service-based network services are also required. Therefore, it is expected that 5G would naturally adopt technologies such as SDN and NFV.

High-level innovations in networks, terminals, and hardware have spawned two waves of technology, the Internet and the mobile Internet. The 5G era, the cloud era, and the cloud-network integration era are coming one after another.

(2) 5G two-layer heterogeneous network system model

The emergence of two-layer heterogeneous networks can solve the problem of 1000 times increase in 5G wireless data rate, thereby improving space spectrum utilization and system capacity, as well as the flexibility of services between various access technologies and coverage levels [17]. The emergence of 5G network technology can connect global networks through optical fibers, thereby bringing a new platform to communication operations, as shown in Figure 2.

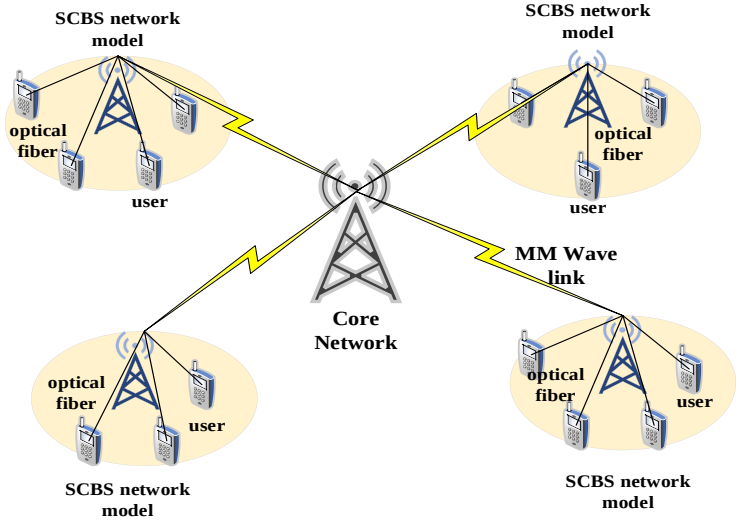


Figure 2. 5G two-layer heterogeneous network system model

(3) Basic introduction of badminton

Badminton technology refers to a reasonable method for human beings to give full play to their physical strength and effectively complete actions within the scope allowed by the rules of the game during the learning process. It is a general term for a specific action in badminton. In badminton, a player's intelligence, skills, qualities, temperament, etc. are all expressed through badminton techniques. Each technique requires ball line, speed, position, consistency and "cheating". Badminton tactics refer to the tactics and actions taken by players to show their superb level of competition and to defeat the opponent in the game. In order to control the opponent in the game, try to take the initiative to play your own advantages, so as to overcome the opponent's weakness and suppress the opponent, the goal of any strategy is to give better play to one's own technical expertise, so as to limit the performance of the opponent's expertise, to control the initiative of the game, and to win the game.

Badminton training not only needs to practice the basic skills of badminton, but also needs to exercise to improve the basic skills of badminton. Therefore, the same goes for pace training in badminton. In addition to specific specialized training, some auxiliary training is also required to improve the muscle strength of the lower body.

1) Endurance training: Badminton is a long-term and physically consuming sport. If the lower limbs are not strong enough, it is impossible to persist. Beginners can run long distances several times a week to build endurance. To improve performance and physical fitness, long distance running exercises must be persisted for a long time.

2) Speed training: Badminton is not only a sport that requires endurance, but also a sport that requires speed. Therefore, the role of explosive force is also important for speed. There are many training methods for exercising explosive power. In addition to sprint running training, reentry running, variable speed running training, etc. can also be carried out. These can not only improve the explosive power of the lower body, but also exercise the movement speed of the footsteps and improve the agility of the badminton rhythm.

3) Strength training: half squat jump, squat against the wall, half jump, step walk, etc. For badminton beginners who have not yet fully mastered the speed, these exercises can lay the foundation for their badminton speed in the future.

There are two main types of serving techniques: one is for the front serve, and the other is for the back serve. These two serving methods need to be decided according to the actual situation of the game and the tactics of the game. For example, when serving, the athlete's racket needs to be under the hand, and the position of the hitting point is below the waist. Once the racket is swung, it needs to ensure a certain hit and cannot use fake action. Because of the above regulations, serving is less of a threat to your opponents, but using the right serving technique can also help gain the upper hand in the game. If the player controls the net quickly and counterattacks in time to take advantage of the opponent's low-quality serve, he can gain the initiative in the game. Once an athlete makes a mistake in serving or has a low serving level, it is very easy to become a passive side in the whole game, resulting in an unsatisfactory final game result.

Hitting technique refers to the posture that a player needs to be fully prepared while hitting the ball. At the same time, considering the opponent's shot, the next direction, which direction the body is moving, etc., this situation should be avoided as much as possible: wait for the ball to fly before judging the direction. This process requires the athletes to work hard on their own. It can be seen from the above analysis that in actual competitions, athletes need to choose badminton skills reasonably to avoid mistakes in judgment. It is specifically shown in Figure 3.

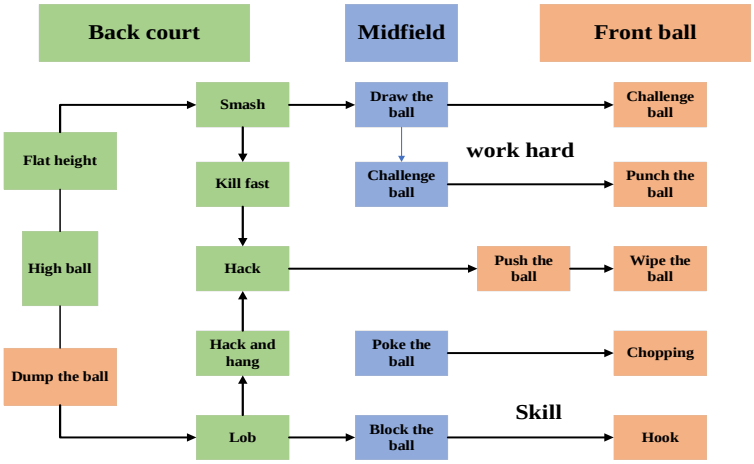


Figure 3. Basic introduction to badminton

3. Application of Wireless Backhaul Optimization in Statistics of Technical Characteristics of College Badminton under 5G Environment

In the future, 5G networks would meet the explosive growth demands of storage areas and high-speed data traffic. Network density increases access to wireless network access points, thereby increasing the demand for backbone networks [18]. Also, backlinks are about to become a traffic bottleneck for the entire network. The cost of wireless backhaul is lower than that of wired backhaul, and it is easy to transmit and deploy.

(1) Analysis of delay indicators

In the wireless communication environment, link delay includes propagation delay and line delay. Among them, the delayed propagation depends on the signal transmission, the distance and the propagation speed of the electric wave, which is the speed of light. In the 5G communication scenario, the signal transmission distance is very short, so the transmission delay is very small and almost negligible. The transmission delay can be defined as the delay that occurs during data transmission. For ease of expression, it is assumed that the transmit power of all users is equal, and the transmit power of all base stations is equal, then the distances are b_{im}^1, b_{im}^2, and b_i^3 respectively. Then the average received power is:

$$\theta_{im}^1 = Q_{OU}\left(b_{im}^1\right)^{-c} \tag{1}$$

$$\theta_{im}^2 = Q_{OU}\left(b_{im}^2\right)^{-c} \tag{2}$$

$$\theta_{im}^3 = Q_{CS}\left(b_i^3\right)^{-c} \tag{3}$$

c is the free space fading index, generally $c = 1 \sim 4$.

Assuming that all link channels obey small-scale fading, the receiving success rate obeys the exponential distribution formula:

$$k\left(q_{im}^i\right) = \frac{1}{\theta_{im}^i} o^{u_{im}}, q_{im}^i > 0 \tag{4}$$

$$k\left(q_{im}^i\right) = 0, q_{im}^i = 0 \tag{5}$$

Because the connected links cannot be repeatedly allocated the same channel, and there is no interference in all links, it can be considered that there is no interference between BANs. At the same time, since the BAN adopts millimeter wave intervention, the signal-to-noise ratio (SINR) can be expressed as [19]:

$$SINR_{im}^{l} = \frac{q_{im}^{1}}{m_0^{BAN}.a_{im}\nabla_{BAN}} \tag{6}$$

q_{im}^{1} represents the power received by the receiver. m_0^{BAN} represents the noise power spectral density. ∇_{BAN} represents the bandwidth of a single channel, and can also be expressed as:

$$SINR_{im}^{3} = \frac{q_{im}^{3}}{m_0^{BAN}.a_{im}\nabla_{BAN}} \tag{7}$$

q_{im}^{3} represents the user power received at the BAN end.

Since some links do not allocate the same channel, the links interfere with each other, so the formula is expressed as:

$$SINR_{im}^{2} = \frac{q_{im}^{2}}{m_0^{CS}\nabla_{CS} + \sum_{im}^{i} y_{im,m}(fm)} \tag{8}$$

The received power obeys an exponential distribution and can be expressed as:

$$k\left(q_{im}^{4}\right)(fm) = \frac{1}{\theta_{im}^{4}(fm)_u}, q_{im}^{4}(fm) > 0 \tag{9}$$

$$k\left(q_{im}^{4}\right)(fm) = 0, q_{im}^{4}(fm) = 0 \tag{10}$$

Among them, $k\left(q_{im}^{4}\right)$ represents the distance between links.

(2) Analysis of packet loss rate

In order to calculate the packet loss rate, it is first necessary to analyze the probability of successful transmission within the link. If $SINR \geq SINR_{ig}$, the probability of successful transmission within the link can be calculated [20]. Therefore, the three types of probability calculation power formulas are:

$$SINRS_{im}^{1}(g) = 2^{\frac{G}{a_{im}\nabla BAN}} - 1 \tag{11}$$

$$SINR_{im}^{2}(g) = 2^{\frac{G}{\nabla BAN}} - 1 \tag{12}$$

$$SINR_{im}^{3}(g) = SINR_{im}^{i}(g) \tag{13}$$

Among them, G is the sending rate. According to the assumption, the transmission rates of the three types of links are equal, so the probability of successful transmission to the BAN is first obtained as:

$$Q_{BAN} = \exp\left\{-\frac{m_0^{BAN}.a\nabla_{BAN}.SINR_{im}^1(fm)}{\theta_{im}^i}\right\} \tag{14}$$

Similarly, the probability of successful transmission in the small base station link can be calculated as:

$$Q_{CS-BAN} = \exp\left\{\frac{m_0^{BAN}.a\nabla_{BAN}.\left(2^{\frac{G}{a\nabla BAN}}-1\right)}{\theta_{im}^3}\right\} \tag{15}$$

The probability of successful transmission within the link is derived as:

$$Q_{OU-CS_i} = Q\left\{q_{im}^2.m_0^2(fm)\right\}.SINR_{im}^2(fm) \tag{16}$$

Theoretically speaking, the allocated channel size should be continuous, so as to best meet the essence of optimization and find the real optimal solution of the wireless network.

(3) Improve the model

The network load is used to describe the resource utilization of the network under certain conditions, and is usually measured by how many user resources it can carry. The configuration of the above model is discussed from the perspective of network transmission capacity.

When the load exceeds the network carrying capacity model, the probability function is expressed as:

$$M = \sum_{F=1}^{F} M_f > M_2 \tag{17}$$

The improved model is established as:

$$\arg\max M_2 = \left\{O + \alpha_1\left(M_2 - \sum_{\nabla m}^{i} a_i\right)\right\} \tag{18}$$

On the basis of the above delay analysis, the optimization objective can be expressed as:

$$\arg\min\left\{\sum_f \sum_m (1-b_{im})\right\} = \left[\max b_{im} + \alpha_{im}\right] \tag{19}$$

$$\sum_{m=1}^{M_i} y_{im} = 1 \forall f, m \tag{20}$$

Under the 5G dynamic architecture, in order to prevent the unbalanced optimization of individual target delays and the special situation that the number of users exceeds the network load, a corresponding improved model is proposed. Then, according to the proposed optimization model, and the characteristics of 5G, the optimization problem is solved by using a hierarchical algorithm. Finally, the improved and optimized 5G model is effective.

4. Influence of Statistics of Badminton Technical Characteristics and Pace Training in Colleges and Universities

Sport is essentially a "functional" technology, which can be understood as a technology that manipulates one's own or others' movement process. Therefore, its basic meaning is: a sports action method that can effectively exert the physical strength of the athlete. The movement elements of sports technology include: movement body posture, movement speed, movement speed, movement trajectory, movement time, movement power and movement speed. The adversarial category group can be summarized as: high, full, active, variable, ruthless, accurate, stable and fast characteristics, which are summarized as shown in Table 1.

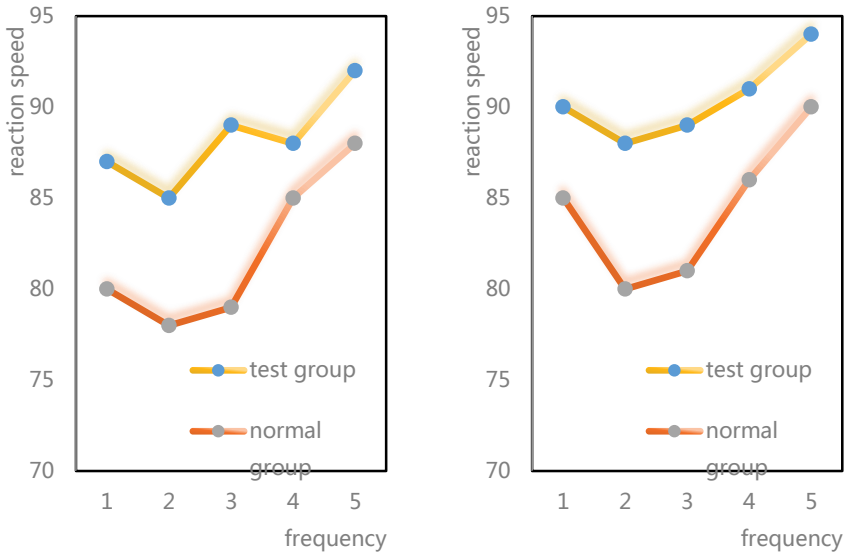
Table 1. Summary of badminton adversarial item groups

Feature	Generalize
Stable	Refers to the stability of the batting technical action structure,especially the variation combination structure
Allow	It is required to hit the ball landing point and achieve accurate effect
Quick	Requires movement on the field and fast hitting speed
Ruthless	It requires a fierce style of play
Change	It is required that the batting technique used and the speed, strength, and placement of the bat should be varied.
Live	Refers to the flexibility of tactical form and application
Complete	Refers to the comprehensive technical and tactical aspects of badminton hitting
High	Is a requirement Athletes with high physical fitness in all aspects

Badminton technology is an intelligent training method, which conforms to the scientific principles of human movement, including the operation of the upper and lower limbs in the execution process. The upper body technique and the lower body technique are two independent parts, and constitute a complete system. Based on this, the pace training was introduced into the technical characteristics of school badminton to strengthen students' badminton exercise, and the pace training made statistical investigations from the training of movement speed, coordination, foot balance and foot speed. In order to make the experimental data more reliable, 20 students from a university were randomly selected as the research objects and divided into two groups, the experimental group and the ordinary group. The experimental group consisted of 5 boys and 5 girls, which were pace-training students. There are 5 boys and 5 girls in the general group, which are students of ordinary training.

(1) Comparison of reaction speed in badminton pace training

In college badminton technology, pace training is the most important part, as important as the foundation. The movement speed of badminton is very fast, so in the pace training, the training of reaction speed is also essential. In order to test whether the pace training can improve the reaction speed, the five experimental results of the experimental group and the ordinary group are now recorded, as shown in Figure 4.



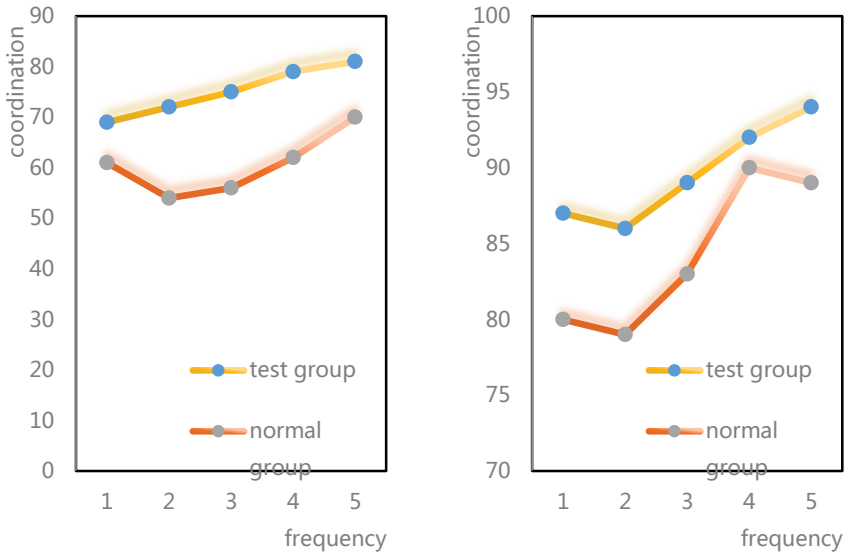
A: Comparison of reaction speed of male group *B: Comparison of reaction speed of girls group*

Figure 4. Comparison of reaction speed in badminton pace training

It can be clearly seen from Figure 4 that in the badminton technical pace training, the reaction speed of the experimental group is significantly higher than that of the ordinary group. Figure 4A is the comparison of the reaction speed of the two groups of boys, and Figure 4B is the comparison of the reaction speed of the two groups of girls. It can be seen from the experimental graph that the reaction speed of the boys in the experimental group is the highest at 92 and the lowest at 85. The girls in the experimental group had the highest reaction speed of 94 and the lowest of 88. The boys in the normal group had the highest reaction speed of 88 and the lowest of 78. The girls in the normal group had the highest reaction speed of 90 and the lowest of 80. The average reaction speed of boys in the experimental group was 88.2, and the average reaction speed of girls was 90.4. The average reaction speed of boys in the general group was 82, and the average reaction speed of girls was 84.4. This shows that in badminton technique, pace training can improve the reaction speed.

(2) Comparison of coordination and balance ability in badminton pace training

Badminton is fast and flexible. Students should not only have fast movements and reaction speeds, but also have high requirements for coordination and balance. In order to test whether pace training can improve coordination and balance ability, the five experimental results of the experimental group and the ordinary group are now recorded, as shown in Figure 5.



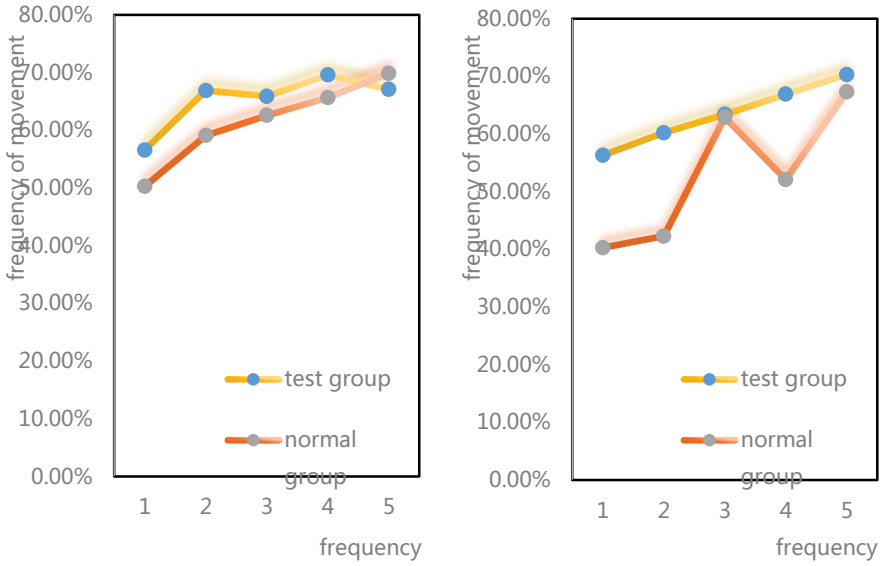
A: Badminton coordination comparison *B: Badminton balance ability comparison*

Figure 5. Comparison of coordination and balance in badminton pace training

It can be clearly seen from Figure 5 that in the badminton technical pace training, the coordination and balance ability of the experimental group were significantly higher than those of the ordinary group. Figure 5A is the comparison of the coordination of the two groups of students, and Figure 5B is the comparison of the balance ability of the two groups of students. It can be seen from the experimental diagram that the coordination of the experimental group is the highest at 81, with an average of 75.5, and the coordination of the common group is the highest of 70, with an average of 60.6. The balance ability of the experimental group was the highest at 94, with an average of 89.9, and the balance of the normal group was the highest at 90, with an average of 84.2. In terms of coordination and balance, the performance of the students who participated in the pace training was higher than that of the ordinary group, which indicated that in badminton, the pace training could improve the coordination and balance.

(3) Comparison of moving frequency in badminton pace training

In badminton, the frequency of footwork movement is the most critical. If a good footwork movement frequency is possessed, it is possible to quickly and accurately respond to the opponent's shot in a competitive game. In this way, in the process of confrontation, more physical energy can be saved, so as to gain more room for play. In order to test whether pace training can improve the frequency of movement, the five experimental results of the experimental group and the ordinary group are now recorded, as shown in Figure 6.



A: Comparison of the movement frequency of the two groups of boys

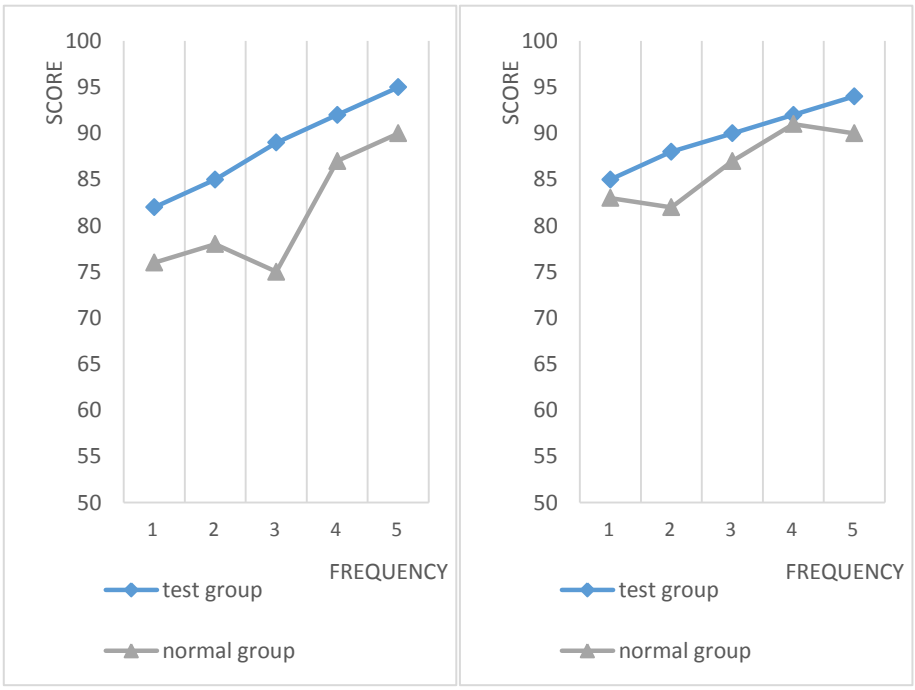
B: Comparison of the movement frequency of the two groups of girls

Figure 6. Comparison of moving frequency in badminton pace training

It can be seen from Figure 6 that in the badminton technical pace training, the movement frequency of the experimental group is basically higher than that of the ordinary group. Figure 6A is the comparison of the movement frequency of the two groups of boys, and Figure B is the comparison of the movement frequency of the two groups of girls. As can be seen from the figure, the highest movement frequency of boys in the experimental group was 69.6%, and the lowest was 56.6%. The highest movement frequency of boys in the general group was 69.9%, and the lowest was 50.3%. However, in the fifth test, the normal group moved more frequently than the experimental group, indicating that pace training requires persistence. As can be seen from Figure 6B, the highest movement frequency of girls in the experimental group was 70.3% and the lowest was 60.2%. The highest movement rate of girls in the ordinary group was 67.3% and the lowest was 40.3%. In the third test, the frequency of movement of the two groups was similar, which shows that the pace training still needs to be persisted in order to be fruitful.

(4) Comparison of competitive levels under badminton pace training

Badminton is a competitive sport. The most important thing about competitive sports is that it cannot be separated from the competitive competition, and the purpose of the competition is to achieve better results, so it is particularly important to improve the technical level of badminton. The pace training of badminton is the basis for improving the technical level of badminton. In order to test whether the pace training can improve the level of competition, the five test results of the experimental group and the ordinary group are now recorded, as shown in Figure 7.



A: Comparing the athletic levels of the two groups of boys

B: Comparing the athletic levels of the two groups of girls

Figure 7. Comparison of competitive levels under badminton pace training

It can be clearly seen from Figure 7 that the competitive level of the experimental group is higher and shows a steady upward trend. Figure 7A is the comparison of the athletic levels of the two groups of boys, and Figure 7B is the comparison of the athletic levels of the two groups of girls. As can be seen from the figure, the highest athletic level of boys in the experimental group is 95, with an average of 88.6, and it is on the rise. The highest level of boys in the general group is 90, with an average of 81.2, and the average level of boys in the boys group has increased by 7.4. The female competition level in the experimental group was the highest at 94, with an average of 89.8, and it showed an upward trend. The average competition level of girls in the general group was 91, and the average was 86.6. The average level of girls' competition was increased by 3.2, which showed that it is feasible to use the pace training method in badminton skills.

5. Conclusion

Badminton is a very difficult sport to learn thoroughly. Although it is relatively quick to get started, it is not easy to play badminton well and improve your skills. It still requires many aspects of practice and effort, especially footwork training. It is not only necessary to improve the technique of the hand, but also to practice the reasonable movement of the steps diligently. Pace and technique complement each other. If there is no fast and proper pace, then no matter how strong the technique is, it would not help. Therefore, adding pace training in badminton is conducive to the improvement of badminton skills. Studies have found that pace training is conducive to the improvement of badminton competition level, the improvement of reaction speed, the improvement of physical coordination and balance ability and the improvement of moving frequency, and the pace training is conducive to the improvement of badminton skills in colleges and universities.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1] Xie R. Indoor air quality investigation of a badminton hall in humid season through objective and subjective approaches. Science of the Total Environment. (2021) 7(71): 145-390. https://doi.org/10.1016/j.scitotenv.2021.145390

[2] Fang L. Motion recognition technology of badminton players in sports video images. Future Generation Computer Systems. (2021) 14(9): 123-156. https://doi.org/10.1016/j.future.2021.05.036

[3] Yu K. Research on the Techniques and Tactics of the World's Top Badminton Men's Double Combinations Based on Computer Coding Technology. Journal of Physics Conference Series. (2021) 17(3): 032-248.

[4] Mc K. Training and injuries among world elite junior badminton players Identifying the problems. Asia-Pacific Journal of Sports Medicine. (2021) 26(2): 21-26. https://doi.org/10.1016/j.asmart.2021.07.003

[5] Ying L. Stochastic energy saving strategies using machine learning for badminton robots. Aggression and Violent Behavior. (2021) 12(6):101-615. https://doi.org/10.1016/j.avb.2021.101615

[6] Wang Y. Simulation of badminton sports injury prediction based on the internet of things and wireless sensors. Microprocessors and Microsystems. (2021) 81(1): 103-176. https://doi.org/10.1016/j.micpro.2020.103676

[7] Yu L. Analysis and Research on Badminton Spot Tactics Based on Computer Association Rules Mining. Journal of Physics Conference Series. (2020) 14(8): 032-065.

[8] Duong T. Load balancing routing under constraints of quality of transmission in mesh wireless network based on software defined networking. Journal of Communications and Networks. (2021) 23(1): 12-22. https://doi.org/10.23919/JCN.2021.000004

[9] Zhang Y. Salient object detection on hyperspectral images in wireless network using CNN and saliency optimization. Ad Hoc Networks. (2021) 112(8): 102-369. https://doi.org/10.1016/j.adhoc.2020.102369

[10] Zhang J. Research on Grid High Voltage Harmonic Detection Based on Ubiquitous Power Wireless Network. Journal of Physics: Conference Series. (2021) 18(2): 022-028.

[11] Sun Z. Performance Analysis of Wireless Network Aided by Discrete-Phase-Shifter IRS. arXiv e-prints. (2022) 15(2): 125-156.

[12] Dh C. Physical layer secrecy performance analysis of relay selection in a cooperative wireless network. Physical Communication. (2021) 5(52): 45-56.

[13] Swarna R N. 5G and Next Generation Wireless Network in Bangladesh: Trends, Opportunities, and Challenges. International Journal of Science and Business. (2022) 9(12): 132-156.

[14] Zhou R. A smarter algorithm in wireless network to optimize frequency allocation. Journal of Physics: Conference Series. (2021) 19(1): 012-034.

[15] Megala V. Solid state switching using wireless network in home automation. Materials Today: Proceedings, (2021) 3(45): 023-056.

[16] Zhang R. Beamforming Optimization for Wireless Network Aided by Intelligent Reflecting Surface With Discrete Phase Shifts. Transactions on Communications. (2020) 68(3): 1838-1851. https://doi.org/10.1109/TCOMM.2019.2958916

[17] Srinivasan B. Secrecy capacity against adaptive eavesdroppers in a random wireless network using friendly jammers and protected zone. Journal of Network and Computer Applications. (2020) 1(65): 102-698.

[18] Wiewiorski P. Energy Harvester Based on Magne to mechanical Effect as a Power Source for Multi-node Wireless Network. Chapters. (2020) 4(23): 45-86.

[19] Frb A. A survey and taxonomy of congestion control mechanisms in wireless network on chip - ScienceDirect. Journal of Systems Architecture. (2020) 6(12): 178-201.

[20] Qi L. A Novel Wireless Network Intrusion Detection Method Based on Adaptive Synthetic Sampling and an Improved Convolutional Neural Network. IEEE Access. (2020) 8(4): 191-195. https://doi.org/10.1109/ACCESS.2020.3034015