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RESEARCH ARTICLE

THE APPLICATION OF COMBINED MULTI-BALL EXERCISES IN TENNIS TEACHING IN A UNIVERSITY IN CHINA

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ABSTRACT

This paper aimed to explore an experimental analysis and research on the practices and application effect of the conventional multi-ball exercise method and the combined multi-ball exercise method in the college tennis special teaching in Huaibei Normal University during the second semester of school year 2022–2023. Forty boys under the tennis special classes were selected as the respondents of the study, with 20 each for the control and experimental groups. The special training program ran for eight weeks at 90 minutes per session twice a week. the researcher gathered the data through video recording, observations and note-taking. In terms of physical fitness, both combination technique multi-ball training and traditional single technique multi-ball training can improve students' physical fitness, but the combination technique multi-ball training has a more significant effect on improving students' physical fitness. In terms of technology, combination technique multi-ball training can effectively improve the forehand, backhand, and volley skills of tennis majors. The results indicate that using combination techniques and multi-ball training in college tennis elective teaching can improve students' individual skill levels. In terms of the standardization of technical movements, both traditional multi-ball training and combination technique multi-ball training can effectively improve the standardization of individual technical movements in tennis, but the combination technique multi-ball training has a more significant effect on improving the standardization of individual technical movements.

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INTRODUCTION

With the progress of the times and the innovation of science and technology, the application of various tennis techniques and tactics in tennis events has become more and more mature. In tennis matches, combination technology is the main scoring method. Almost 80% of the scores are from the tactics based on combination technology.Therefore, combination technology plays a very important role in tennis matches. Literature suggests that current research on combination technology is mainly concentrated in martial arts, football, basketball, badminton and table tennis, while research on combination technology in tennis israre and the application of combination technology multi-ball training in college tennis special teaching is even rarer. At present, college tennis special teaching mainly focuses on traditional single technology multi-ball training. This is not conducive to the flexible use of individual techniques and the improvement of the individual technical level of tennis special students. At the same time, due to the relatively simple traditional multi-ball practice method, the single movement structure, and the lack of flexibility, this puts forward new requirements and challenges to the tennis special teaching incolleges and universities.

Background of the study: In recent years, China has gradually attached importance to and strengthened the reform and innovation in the field of education, and the innovations and reforms of school education are numerous.

Tennis teaching, as one of the parts of the college physical education teaching plan, has also been developed to a certain extent. Among them, the multi-ball training method was first seen in Japanese women's volleyball training and has made great progress. Through the positive transfer of sports training, many professionals gradually introduced this method into other sports, which was generally supported and approved by many coaches and teachers. In the multi-ball exercise method, the conventional multi-ball exercise pays attention to the single technical exercise and the mastery of technical movements. Although it is beneficial to the beginners to lay down solid technical movements and the details of the players' technical movements, there are still some limitations in the teaching and practice, such as monotonous practice, long time of single movement practice, etc. However, during the long period of periodic exercise, the exercisers are prone to fatigue and lack of interest, resulting in the practice cannot achieve the expected results. The combined multi-ball practice method requires students to have flexible steps, agile movement speed and quick connection between technical actions. It is closer to and in line with the requirements of changing, fast rhythm and sharp angles in tennis matches, and thus makes up for the limitations of the traditional conventional multi-ball practice, which is single and periodic repetition. At present, there is no unified overview of the research on the combined multi-ball exercise in the multi-ball exercise method. Although most teachers and coaches actively use the combined multi-ball exercise method in training, there is little few theoretical research and scientific research on the effect of the

combined multi-ball exercise method in teaching application. Therefore, how to further improve the overall tennis skills of athletes and enrich the multi-ball training methods for teachers to carry out tennis special teaching, explore the application effect of combined multi-ball training method in tennis special teaching, and explore the advanced teaching methods different from the traditional tennis special teaching methods have become the top priority.

Statement of the problem

This study mainly expounded the following problems:

- What is the level of performance of the experimental and controlled group in the multi-ball exercise method pretest and posttest?
- What improvements can be made in light of the results?

Significance of the study

The results of this study will be of great significance to the following personnel or departments.

Tennis students: This paper makes a reasonable combination of tennis single technology according to the development law of tennis sports technology. It can help improvethe basic skills of tennis special class students, strengthens the flexible use of tennis single technology combination of tennis special students, and provide some effective training means for future tennis learning.

Tennis teachers: This paper can provide certain ideas and theoretical basis for future teachers to study the tennis special teaching methods and improve and innovate tennis teaching methods.

Tennis coaches: This paper compares the advantages of combined multi-ball training and conventional multi-ball training in tennis training through experiments, which can guidetennis coaches to reform the training methods and means to improve the performance of athletes.

Future researchers: The results of this study can be used as future reference or basis for new studies.

Scope and delimitation: This paper aimed to explore an experimental analysis and research on the practices and application effect of the conventional multi-ball exercise method and the combined multi-ball exercise method in the college tennis special teaching in Huaibei Normal University during the second semester of school year 2022–2023. Forty boys under the tennis special classes were selected as the respondents of the study, with 20 placed in the experimental group and 20 in the control group. The special training program ran for eight weeks at 90 minutes per session twice a week.

In selecting influencing factors, the researcher mainly focused on four aspects: physical fitness, interest, completeness and standardization of technical movements, and stability of technical movements. Due to the limitations of the number of tennis majors and course arrangements, the research sample size is small and there is no gender difference.

Theoretical framework: People's cognition of things follows certain objective laws, which are based on scientific principles. In physical education, only by observing objective laws can we succeed in teaching. Therefore, the following principles should be followed in the combination of multiple balls:

***Systematic training principle*:** Systematic training principle refers to the training principle of organizing the sports training process continuously and gradually.

***Principle of suitable load*:** The principle of suitable load refers to the corresponding measured load in training according to the actual possibility of athletes and the adaptive law of individual functions, as well as the need to improve the competitive ability of athletes.

***Principle of differentiated treatment*:** The principle of differentiated treatment refers to the training principle that different disciplines, different athletes, and different training conditions should be organized and arranged differently.

***Principle of skill teaching*:** When teaching skills, teachers should pay attention to such factors as venue, number of people, time, exercise density, and exercise load.

METHODOLOGY

This chapter describes the research design, research locale, sampling methods, research instruments, data collection procedures, ethical considerations, and statistical processing to be used after data collection.

Research locale: The research locale is Huaibei Normal University in Anhui Province, China. Huaibei Normal University is located in Huaibei City, Anhui Province, a national civilized city and national garden city. It is a comprehensive provincial key university.The school has a building area of 750,000 square meters housing more than 33,000 teaching and scientific research instruments and equipment, and several intelligent classrooms.

Sample and sampling technique: In this study, a random sampling method was used to randomly select 40 boys from the students of tennis major in physical education in grade 2020 or junior grade level and divide them into an experimental group and controlled group, with 20 in each group. In this way, a certain number of samples are randomly selected from all tennis majors. Each sample has the same chance to be selected, so selection bias can be avoided.

Data gathering procedure: In this paper, two groups of different multi-ball exercise methods were used for experimental comparison. The combined multi-ball exercise method and the conventional multi-ball exercise method was employed for the two months of teaching experiments on the two groups of respondents. The data was collected and sorted before and after the experiment, and various indicators were noted using different evaluation criteria.

Statistical analysis

The social science statistical software package or SPSS software was used, with a 0.05 significance level:

Frequency Count and Percentage: This was used to analyze the age and playing years of student respondents.

***Weighted Mean*:** This was used to analyze the data results of respondents under two different training methods, and then conduct statistical tests on relevant variables to determine their differences.

t-test: This was usedto determine whether there are significant differences in the responses of the two groups of respondents

RESULTS

This chapter presents the results of the study and their corresponding analyses. The data of the physical fitness indicators of the experimental group before and after the experiment passed the T-test, and the p-values were all less than 0.05, indicating a significant difference. This indicates that the physical fitness indicators of the experimental group improved after the experiment, especially in the in the 50-meter run, which increased from 6.87 ± 0.09 to 6.75 ± 0.04. During the experiment, the respondentswere required to hit the ball at a certain depth, which required the experimental subjects to improve their explosive hitting power, especially the instantaneous kicking and

Table 1. Comparison and analysis of physical fitness test data of the experimental group before and after the experiment

Test items	Before the experiment	After the experiment	T	P
50-meter run	6.87±0.09	6.75±0.04	2.412	＜0.05
Mizi Run	29.56±0.32	28.44±0.41	3.745	＜0.05
Jumping rope within one minute	159.3±1.60	166.6±1.30	-2.634	＜0.05
standing long jump	2.53±0.42	28.44±0.41	-2.869	＜0.05
sit-and-reach	22.46±0.28	25.62±0.38	-4.442	＜0.05

Table 2 Comparison of physical fitness test data of the control group before and after the experiment

Test items	Before the experiment	After the experiment	T	P
50-meter run	6.85±0.12	6.83±0.14	0.141	＞0.05
Mizi Run	29.76±0.28	29.38±0.31	4.814	＞0.05
Jumping rope within one minute	158.7±1.20	162.4±0.20	-0.943	＜0.05
standing long jump	2.53±0.32	2.57±0.25	- 3.223	＜0.05
sit-and-reach	22.86±0.33	25.61±0.36	6.867	＜0.05

Table 3. Comparison of physical fitness test data between the experimental group and the control group after the experiment

Test items	Experimental group	Control group	T	P
50-meter run	6.75±0.04	6.83±0.14	5.223	＜0.05
Mizi Run	28.44±0.41	29.38±0.31	-3.521	＜0.05
Jumping rope within one minute	166.6±1.30	162.4±0.20	4.842	＜0.05
standing long jump	2.58±0.36	2.57±0.25	0.345	＞0.05
sit-and-reach	25.62±0.38	25.61±0.33	-0.636	＞0.05

Table 4. Comparison table of single technical data testing in the control group before and after the experiment

Types of Tennis Techniques	Before the experiment	After the experiment	T	P
Forehand stroke	31±0.65	33±0.72	2.452	＜0.05
backhanded stroke	29±0.82	32±0.69	-3.124	＜0.05
volley	27.5±0.74	31±0.81	4.781	＜0.05
High-pressure	20±0.69	24±0.76	-3.983	＜0.05

Table 5. Comparison and analysis of single technical data testing in the experimental group before and after the experiment

Types of Tennis Techniques	Before the experiment	After the experiment	T	P
Forehand stroke	30±0.68	36±0.75	2.652	＜0.05
backhanded stroke	28.5±0.56	35±0.63	-3.478	＜0.05
volley	27±0.71	35±0.82	3.689	＜0.05
High-pressure	22±0.66	23±0.78	0.322	＞0.05

Table 6. Comparison of single technical data testing between the experimental group and the control group after the experiment

Types of Tennis Techniques	Experimental group	Control group	T	P
Forehand stroke	36±0.75	33±0.72	3.632	＜0.05
backhanded stroke	35±0.63	32±0.69	-5.665	＜0.05
volley	35±0.82	31±0.81	2.334	＜0.05
High-pressure	23±0.78	24±0.76	2.334	＜0.05

Table 7. Comparative analysis of technical action standardization scores between the experimental group and the control group after the experiment

Types of Tennis Techniques	Experimental group	Control group	T	P
Forehand stroke	7.94±0.38	7.78±0.33	3.524	＜0.05
backhanded stroke	7.86±0.25	7.25±0.32	3.684	＜0.05
volley	7.43±0.24	6.92±0.26	3.684	＜0.05
High-pressure	7.36±0.31	6.78±0.29	3.842	＜0.05

hip rotation of the ball and the explosive force released by the racket. Under such training requirements, the experimental subjects' kicking power was strengthened and their leg strength was strengthened, resulting in a certain improvement in explosive power and a certain improvement in standing long jump performance(Zhu Tingting, 2019). Tennis also has certainrequirements for flexibility, which refers to the amplitude of various joints in the human body and the stretchability of soft tissues such as muscles, tendons, and ligaments. The hitting movements of tennis are all based on various joints as the axis, and bone lever movements are performed through the stretching and pulling of soft tissues such as muscles. The greater the amplitude of bone lever movements, the better the hitting quality. Therefore, during the training process of the experimental group, the flexibility of the experimental subjects is improved to a certain extent. The energy supply of tennis is a hybrid system, but the tennis hitting process is mainly powered by the phosphate energy supply system. The experimental group's combination technique training requires a large amount of fast- and short-distance running. Under these training conditions, the trainer's phosphate energy supply system developed well(Liu Panhua,2021). The main energy supply system for the 50-meter run is phosphate energy, so the experimental group's 50-meter run performance was improved to some extent.

Table 2 shows that there was no significant difference in the performance of these two items before and after the experiment, and the improvement in performance was not significant. The performance data of the three groups of one-minute rope skipping, standing long jump, and sitting forward bending were tested by t-test, and the p-values were all less than 0.05, indicating a significant difference in the performance of the control group before and after the experiment, with a significant improvement in performance. The control group moved less during the training process compared to the experimental group, and the movement mode was mainly horizontal movement. The 50-meter run mainly tested the speed and quality of vertical short-distance fast running, while the meter run mainly tested the ability to move in multiple directions. Therefore, there was no significant improvement in the performance of the control group in the 50-meter run and meter run after the experiment. The control group also achieved significant improvements in the three events of one-minute rope skipping, standing long jump, and sitting forward bending, mainly because the control group had the same requirements for hitting quality during the training process as the experimental group.

Table 3 indicates no significant difference in performance. To improve the hitting quality, practitioners must improve their explosive power of pushing the ground and turning the hip when hitting the ball. Therefore, in the process of hitting training, both groups have to some extent strengthened their explosive training, so the growth rate of the standing long jump performance between the two groups is not significant. For the posttest results of sitting forward flexion, neither group of training had a specific training method for improving flexibility, but both groups of experimental content had certain requirements for hitting quality. Many technical movements in tennis require muscles to perform super isometric contractions, and the greater the degree of elongation and relaxation of super isometric contractions, the better the hitting quality. So, during the training process of stretching joints to perform super isometric contractions, the flexibility of both groups was improved (Ji Chunmei,2020). Therefore, the training of the experimental group places higher demands on their coordination skills, so the experimental group performs better in one-minute rope skipping. From the training content of the experimental group and the control group, it can be seen that the experimental group has higher running intensity and movement distance than the control group. The most obvious thing is that the training of the four technical combinations in the experimental group requires a larger range of movement before, after, left, and right. Therefore, the training of the experimental group had a stronger stimulation on the cardiovascular function and phosphate energy supply system of the trainees, so the performance of the 50-meter run in the experimental group improved significantly compared to the control group.

Generally speaking, the basic techniques of tennis are diverse, with relatively delicate techniques that require good physical fitness. For example, in the process of hitting a ball from a wide angle, the practitioner needs to have strong mobility and high requirements for footwork ability (Wang Baixiang,2021); In front of the net interception, the technical movements of the practitioner are required to be concise and delicate, with advance judgment and fear of the ball, which requires a high level of psychological quality for the practitioner. In cutting and shortening techniques, practitioners need to have good hand feel, ball feel, and strong concealment, and have high requirements for technical movements (He Pingjing, 2020). Table 4 shows that the control group passed the T-test for various technical data before and after the experiment, and the p-values were all less than 0.05—indicating a significant difference before and after the experiment.

From the results of the individual technical tests before the experiment in Table 3, it can be seen that the training level of the two groups of experimental subjects' volleying and high-pressure ball techniques is relatively low, with more room for improvement, and the improvement of technical level is relatively easier. Therefore, the improvement of the volleying and high-pressure ball techniques is greater than the improvement of the forward and backhand pumping techniques. During the experimental process, the control group practiced the techniques of intercepting the ball and high-pressure ball through repeated training, which is beneficial for improving the stability of technical movements(Tong Yanhua, Zhang Xiaoqiu,2019). Therefore, the standardization and proficiency of high-pressure ball techniques in intercepting the ball have been strengthened, which can effectively reduce errors. However, due to the greater difficulty of intercepting the ball and high-pressure ball techniques compared to forehand and backhand movements, these two techniques require more practice. Time and even practical combat are used to enhance hand feel, thus forming a dynamic stereotype of technical movements. Therefore, it is difficult for these two techniques to reach a high level. Therefore, although the performance of volleying and high-pressure techniques has increased significantly, their scores in the test are not high, and the difference in scores between these two techniques after the experiment is not significant. Table 5 shows that the individual technical test data of the experimental group passed the T-test before and after the experiment, and the p-values were all less than 0.05, indicating a significant difference.

In the training of the experimental group's intercepting ball technique, the main focus was on intercepting while moving. This not only makes the trainer more proficient in technical movements, but also requires more accurate judgment of the hitting point of the intercepting ball during movement(Jiang Mingfei,2022). Therefore, the experimental group's grasp of the hitting point of the intercepting ball is more accurate after training. Therefore, the experimental group can not only reduce errors but also obtain higher scores in the testing of intercepting ball technique. The training of high-pressure ball techniques in the experimental group is mainly conducted in combination balls. However, due to the technical characteristics of difficulty in mastering high-pressure balls, errors are easily made during the training process, and even several consecutive sets of errors may occur.This makes it difficult for the experimental group's experimental subjects to fully understand the high-pressure ball techniques and receive sufficient and correct stimulation for high-pressure ball technique training. Therefore, the improvement of high-pressure balls in the experimental group is not significant. The experimental group adopts the combination multi-ball practice method. After mastering the rhythm of the combination multi-ball practice, the practitioners can actively mobilize their learning potential, improve the enthusiasm of the practice, and transform the learning state from passive acceptance and repetitive actions to the subjective initiative of active thinking and changing actions. Zhang Xin(2021) proposed that the combination of multiple ball training methods has greatly improved the shaping of movements and the success rate of hitting the ball. In terms of teaching organization, coaches should pay attention to the stability and rhythm of feeding the ball.

Ball sports have high requirements for rhythm, so coaches are required to provide targeted teaching in daily training, cultivate students' sense of hitting rhythm, and pay attention to the intensity and density of training during the training process. Table 6 shows that the individual technical test data of the experimental group and the control group after the experiment passed the T-test, and the p-values were both less than 0.05, indicating a significant difference. Through literature review, it was found that the training of the experimental group is similar to the content change training method in sports training. In one group of training, there will be different combinations of forehand and backhand, volleys, high pressure, and changes in their different circuits. For different technical movements and hitting requirements, the body needs to make corresponding changes, which is equivalent to each shot being a new stimulus. This not only improves the interest of the practitioner, but it will also keep the trainer's body in a relatively excited state throughout a group of training, thus improving the quality of training throughout the entire training process(Zhang Binhao,2019). At the same time, the interest of experimental subjects can be increased by changing different training content, improving their focus, and ensuring the quality of hitting and the accuracy of controlling the ball(You Shidong,2019).
The reason why the experimental group had a slightly higher head and backhand lift than the control group is likely due to the differences in the two training methods. Although both were mobile hitting training, the experimental group had a higher overall focus on head and backhand hitting than the control group, resulting in better training outcomes.

Through literature review, it was found that the improvement of the experimental group's interception technique was significantly better than that of the control group. This may be because the training content of the experimental group's interception technique was more in line with the technical characteristics of interception(Xu linan,2018). The training of the experimental group's interception technique mostly moved from the back to the front to hit the ball, relying more on the forward transfer of the center of gravity and physical strength to hit the ball, which is more in line with the power of the interception technique. From the experimental data, it can be seen that combination multi-ball practice and conventional multi-ball practice have significantly improved the player's hitting speed, hitting strength, hitting depth, hitting angle, hitting movements, and hitting stability. The combined multi-ball practice method is superior to the conventional multi-ball practice method in terms of the overall improvement of tennis skills. From the data analysis, it can be seen that the conventional multi-ball practice method adopts a single technique of multi-ball practice, which enables students to quickly master a certain tennis technical action by repeating it(Fan Fei,2020). However, conventional multi-ball practice is relatively monotonous in the teaching process, and the teaching content is boring, making it difficult to arouse students' interest. After the students have initially mastered the technique, if there are no new stimuli to attract their attention, their interest in the practice will gradually fade until it disappears completely (Peng Jin,2018). At this point, conducting regular multi-ball exercises for a long time may not have a significant effect and may backfire. On the contrary, the teaching content of the combined multi-ball practice method is relatively rich. By combining several tennis techniques with multiple balls, students can use different techniques during the hitting process to constantly attract their attention and ensure efficient teaching quality. The combination multi-ball practice method is to practice according to the designed practice format. It can strengthen the organic integration of various parts of the body(Yang Xirang,2021). At the same time, its practice form is closer to practical combat and has a certain degree of difficulty in practice to enhance their own control of the ball. Table 7 shows that the technical action standardization scores of the experimental and control groups before and after the experiment were T-tested, and the p-values were both less than 0.05. After the experiment, there were significant differences in the technical action standardization scores, indicating that the technical action scores of the experimental and control groups were improved after the experiment.

Therefore, there is not much difference in the completeness of technical movements between the two groups. For the fluency of movements, both the experimental group and the control group practiced and consolidated various technical movements. However, the practice of the control group focused more on repetitive training of technical movements, which was more conducive to the finalization of technical movements. So, the training content of the control group improved the fluency of technical movements more, so the control group was also better than the experimental group in terms of fluency of technical movements. Both the experimental group and the control group have certain requirements for the depth of hitting, which means that during the training process, the two groups of experimental subjects must exert force to hit the ball. Tennis hitting mainly relies on the forward force of the body, and much of the training content of the experimental group is completed during the forward movement process (Jiang Xiaohong,2022).

Therefore, the experimental group could better experience the forward force of the body, although the fluency of the force in the experimental group and the control group improved to some extent after the experiment, However, the fluency of the experimental group's subjects was better than that of the control group. The training content of the experimental group has a greater impact on the improvement of mobile hitting ability, which can ensure the stability of the experimental subjects during the mobile hitting process and ensure the standardization of technical actions. The training content of the control group did not significantly improve the ability to hit the ball while moving. The formation of motor skills involves three stages: generalization, differentiation, and automation, each with its unique characteristics. People in the generalization stage may experience a diffusion of the excitation and inhibition processes of their motor central nervous system towards other excitation centers. Entering a generalizedstate results in a brief unstable state in the connection between the conditioned reflex and it(Xie Zheng,2021). In tennis practice, the specific manifestations are stiff movements, inadequate foot movements, excessive or incorrect movements, and disorderly hitting rhythm. People in the differentiation stage gradually gather the excitation and inhibition processes of their motor central nervous system. Through repeated practice of movements, the shortcomings of motor skills gradually improve. At this time, generalization enters differentiation, and the movements are more flexible, with faster speed with redundant and incorrect movements reduced. The most important thing is to have their own insights into the internal laws of motor skills, strengthen correct movements, and correct incorrect movements. People in the automation stage have highly concentrated excitatory processes in their motor centers, and their internal inhibition is quite stable. At this time, their motor skills can form a solid dynamic stereotype, and are able to easily complete various technical movements with ease and ease in movement.

Both the experimental group and the control group of students have played for one and a half years. Through practice, they are already in the differentiation stage. Practitioners are prone to interference from external stimuli during the practice process, resulting in repeated technical movements and mistakes, which leads to emotional fluctuations, lack of interest, and inability to extend to the automation stage(Li Jie,2021). Therefore, in teaching, it is necessary to pay attention to the specific analysis of specific problems, and the combination multi-ball practice method adopted by the experimental group is precisely flexible in its feeding method, pace movement, technical application, and hitting rhythm. Therefore, the conventional multi-ball practice method is not as effective in improving technical movements as the combined multi-ball practice method(Long Yang2018). In terms of improving the four tennis techniques, the experimental group showed significantly better improvement than the control group. In summary, compared to the conventional multi-ball practice method, the combined multi-ball practice method can see more comprehensive problems in teaching and is more in line with the needs of modern tennis development. In terms of technical evaluation, it is significantly better than the conventional multi-ball practice method.

From the analysis of the formation process of tennis technical movements, it can be seen that both multi-ball practice methods comply with teaching laws and have a certain positive effect on the improvement and improvement of basic tennis technical movements. However, compared to the two methods, the combined multi-ball practice method has played a significant role in mastering and shaping basic tennis technical movements in various aspects. The combination multi-ball practice method and the conventional multi-ball practice method have their respective strengths in improving the basic skills of tennis. The difference lies in the different emphasis of the two multi-balltraining methods, with the conventional multi-ball training method focusing on local improvement and relatively insufficient control over the entire field.

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