The Development of a Table Tennis Outstanding Program of International Competition for Mixed Doubles

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Abstract

Background and Aims: Table tennis mixed doubles is an emerging event in the Olympic Games. my country's academic community has only begun to study table tennis mixed doubles techniques and tactics in recent years. Research on statistical methods for mixed doubles techniques and tactics is still in the preliminary exploration stage. Based on this, this article aims to explore and use more scientific and effective statistical methods to analyze the techniques and tactics of my country's main opponents in the table tennis mixed doubles event of the Paris Olympic Games, to find technical and tactical statistical methods suitable for the mixed doubles event, and to explore the mixed doubles The characteristics and winning rules of the game provide certain theoretical reference for preparing for the table tennis mixed doubles competition of the 2024 Paris Olympic Games. The objective of this research is to develop a table tennis program for international competitions for mixed doubles.

Methodology: This article mainly uses the four-stage and four-round evaluation method of table tennis mixed doubles technical and tactical statistical methods as the research object, and analyzes the international mixed doubles competition held between November 2021 and August 2023 by four athletes from different countries ranked top two in the world. Analysis and in-depth study of major mixed doubles matches. First, we review previous literature on table tennis doubles technical and tactical statistical methods. Secondly, we searched the literature from authoritative academic platforms at home and abroad in the past 10 years and selected and formulated technical and tactical research methods related to this article. Then, refer to Simi Scout technical and tactical video-related analysis software to study the technical and tactical use, points gained and lost, and competitive ability of the world's outstanding mixed doubles athletes in the game, at the same time. Combining the gender characteristics of table tennis doubles and mixed doubles events, a four-round model of serving and receiving for men and women was established, and a four-stage and four-round evaluation method of technical and tactical statistical methods for table tennis mixed doubles events was established. Finally, the study is summarized and recommendations are made.

Results: The statistical method of "Four Stages and Four Rounds Evaluation Method" used in this article is a new technical and tactical statistical method for table tennis mixed doubles projects based on previous research on table tennis doubles. It is based on both theory and practice. Perspective, it improves the existing technical and tactical statistical indicator system, provides a theoretical reference for winning the gold medal in the table tennis mixed doubles event of the 2024 Paris Olympic Games and the future training and competition of my country's table tennis mixed doubles event, and enhances the overall strength of China's table tennis mixed doubles event., contributing to the continuous development of the world table tennis mixed doubles project

Conclusion: The main conclusions of this article are as follows: 1. The four-stage and four-round evaluation method of mixed doubles technical and tactical statistical methods is feasible and effective. 2. The eight-round three-stage index evaluation method can specifically analyze the performance of athletes' techniques and tactics in a certain round, but it cannot reflect the use of techniques and tactics by mixed doubles athletes when facing different opponents. 3. The dual-system four-round evaluation method can analyze the advantages and disadvantages of rounds based on the gender differences between men and women, but it does not fundamentally solve the problem of inconsistency in the statistical data of each section. 4. The four-stage and four-round evaluation method can not only analyze the advantages and disadvantages of mixed doubles players according to gender characteristics but also summarize the techniques and tactics used by mixed doubles players when facing different opponents.

Keywords: Table Tennis; Mixed Doubles; Left and Right-Handed Pairing; Advantage

Introduction

In the finals of the 2020 Tokyo Olympics, the Japanese pair Mima Ito/Shun Mizutani defeated my country's world-ranked mixed doubles pair Xu Xin/Liu Shiwen and won the first mixed doubles championship in the history of Olympic table tennis. This was the first defeat since the 2008 Beijing Olympics, which also gave other countries hope of competing in the mixed doubles event. After the

Tokyo Olympics, in addition to China and Japan, countries and regions around the world such as South Korea, France, Hong Kong, and Taipei have also further strengthened research on table tennis mixed doubles projects.

Most previous research on the statistical methods of table tennis doubles techniques and tactics were based on the "three-stage index evaluation method", which has been gradually improved and developed after more than 30 years. However, statistical methods for table tennis doubles techniques and tactics mostly use the traditional three-stage method as the standard and do not substantively distinguish the differences between singles and doubles.

According to the new requirements for table tennis projects in the new era, if the technical and tactical statistical methods of mixed doubles can be innovated and reconstructed, it can well fill the gap in technical and tactical statistical methods of mixed doubles projects. Therefore, this article will propose new statistical methods and conduct special research on the techniques and tactics of the world's outstanding table tennis players in the mixed doubles event, to provide a comprehensive, objective, and scientific reference basis for the practical training of the mixed doubles event. (Ma, et al, 2016)

Niu Zhisheng's "Discussion on the Rules of Table Tennis Doubles Competition" (Niu, 1996) believes that in doubles competitions, to have a better offensive position in the game and make up for each other's shortcomings in footwork, technical and tactical During the training, single-ball and multi-ball running training can be strengthened, and front and rear running training can be strengthened at the same time.

In 2014, Yang Qing improved based on the three-stage method, and proposed the "four-stage index evaluation method", which solved the problem that the data of each stage of the two athletes did not correspond to each other in the three-stage method, and formulated the male and female respectively. Evaluation criteria (Yang, et al., 2014).

In 2015, Jiang Jinjun proposed the evaluation system of "Dual System Five Stage Analysis". A game is macroscopically divided into a serving system and a receiving system, and it is proposed to divide the game into five stages: the serving stage, the fifth rebound, the receiving stage, the sixth rebound, and the stalemate stage. At the same time, the evaluation criteria were formulated according to the gender differences between men and women, and the concept of "individual evaluation criteria" was proposed (Jiang & Yao, 2015).

In 2018, Xiao Dandan and others proposed the "double three-stage statistical method"(Xiao, et al., 2018) of table tennis techniques and tactics, and together with Zhang Xiaodong and others, proposed the "dynamic three-stage method of table tennis techniques and tactics" based on the technical type of receiving and serving.

The statistical method of table tennis skills and tactics is based on the "three-stage index evaluation method". After more than 30 years of research by predecessors, it has been gradually improved and developed. However, statistical methods for table tennis doubles techniques and tactics mostly use the traditional three-stage method as the standard and do not substantively distinguish the differences between singles and doubles. At the same time, although the "eight rounds and three stages method" conducts a comprehensive analysis from the perspective of different rounds, it ignores the gender differences between men and women in mixed doubles events.

To sum up, according to the new requirements for table tennis projects in the new era, if we can innovate and reconstruct the characteristics of mixed doubles projects and doubles technical and tactical statistical methods, we can better make up for the technical and tactical statistics of mixed doubles projects. The method is blank. Therefore, based on drawing lessons from predecessor's research on statistical methods of table tennis doubles techniques and tactics, this paper proposes new statistical methods and conducts special research on the techniques and tactics of the world's outstanding table tennis mixed doubles players, to provide a basis for the technical and tactical research of mixed doubles. and practical training to provide a comprehensive, objective, and scientific reference basis.

Objectives

Main objective
To develop the Table Tennis outstanding program of international competitions for mixed doubles.

Subsidiary objectives
1. To test the feasibility and effectiveness of the four-stage and four-round evaluation method of technical and tactical statistical methods for table tennis mixed doubles events.
2. To analyze the actual application performance of the world's outstanding table tennis players in mixed doubles competitions.
3. To provide more effective suggestions for the training and competition of mixed doubles events for outstanding table tennis players in China and the world.

Literature Review

Development of a Table Tennis Outstanding Program

The development of an outstanding table tennis program involves a comprehensive approach that encompasses player development, coaching strategies, infrastructure, and organizational support. Table tennis, an Olympic sport, requires a systematic and well-structured program to nurture talent and enhance performance. The success of such a program is contingent upon addressing various facets, including talent identification, skill development, and competition preparation. This paper aims to explore the key components and considerations involved in the development of a table tennis program.

Talent Identification and Recruitment: Effective talent identification is a critical component in the development of a successful table tennis program. Identifying young players with potential involves assessing their technical, tactical, physical, and psychological attributes. The process may involve collaboration with schools, clubs, and regional associations. Utilizing established talent identification frameworks can aid in selecting individuals with the highest likelihood of excelling in the sport (Smith et al., 2019).

Coaching Strategies: The coaching component of a table tennis program is paramount in honing players' skills and maximizing their potential. Incorporating evidence-based coaching strategies, such as periodization and individualized training programs, contributes to player development (Lees, 2003). Additionally, fostering a positive and motivational coaching environment enhances player engagement and long-term commitment to the sport (Gould et al., 2002).

Infrastructure and Facilities: A well-equipped training environment is essential for the development of table tennis players. State-of-the-art facilities, including specialized training halls, fitness centers, and sports science support, contribute to optimal training conditions (Hughes, 2019). Investing in infrastructure not only facilitates skill development but also promotes a professional atmosphere conducive to athlete growth and performance.

Competition and Exposure: Participation in competitive events is crucial for the development of table tennis players. Incorporating a structured competition calendar that includes local, national, and international tournaments provides players with exposure to different playing styles and levels of competition (Hill et al., 2018). Exposure to diverse competition experiences contributes to the holistic development of players and prepares them for elite-level challenges.

Organizational Support and Governance: The success of a table tennis program is contingent upon strong organizational support and effective governance. This involves clear communication channels, transparent decision-making processes, and financial backing for program sustainability (Hums & MacLean, 2008). Collaboration with national and international federations ensures adherence to established guidelines and standards, fostering a positive and growth-oriented sports ecosystem.

The development of a table tennis program is a multifaceted process that requires a holistic approach. Addressing talent identification, coaching strategies, infrastructure, competition exposure, and organizational support is essential for nurturing skilled and competitive players. Implementing evidence-based practices, collaborating with stakeholders, and maintaining a commitment to athlete

development are key principles that contribute to the success of such programs in the dynamic and competitive world of table tennis.

Conceptual Framework

The research entitled "The Development of A table Tennis Outstanding Program of International Competition for Mixed Doubles" designed the conceptual framework as follows
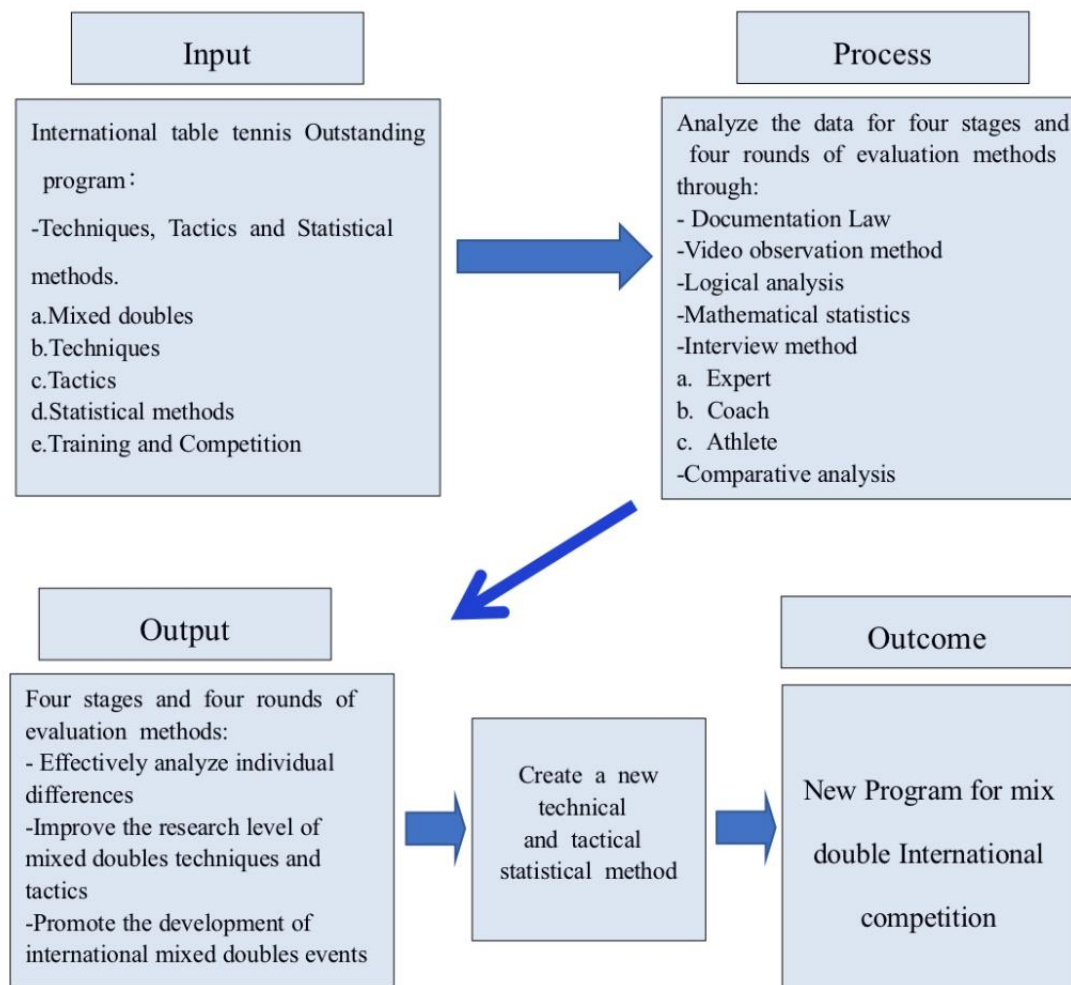
Figure 1 Conceptual Framework

Methodology

The research is carried out through research methods such as documentary data method, video observation method, logical analysis method, mathematical statistics method, and interview methods (experts, athletes, and coaches).

Population and sample

This article mainly takes the table tennis mixed doubles technical and tactical statistical method as the research object. The official information shall prevail, Table 1) Analysis and in-depth study of major international mixed doubles competitions held between November 2021 and August 2023.

Table 1: 2023 ITTF Table Tennis Mixed Doubles World Ranking Statistics

Name	National (Regional)	World ranking
Wang Chuqin / Sun Yingsha	China	1
Tomokazu HARIMOTO/Hina HAYATA	Japan	2

Research instrument

Referring to the Simi Scout technical and tactical video analysis software, combined with the gender characteristics of the table tennis mixed doubles event, a model of four rounds of men's and women's serving and receiving serves was established (Qian, 2017) and Excel software was used for research.

Through interviews with 5 experts in table tennis theory, technical and tactical research, 5 national team and local professional team coaches, and 10 high-level athletes, this article provides a practical basis and research conditions (Table 2).

Table 2 Types, categories, and quantity statistics of interviewers

Type	Title (category)	Quantity (person)
Expert	Professor	2
	Associate Professor	1
	National team scientific researchers	1
	National team fitness coach	1
Professional	Coach National Team Coach	2
	Provincial and city coaches	3
High-level athletes	National team athletes	2
	Retired National Team Athletes	2
	Provincial and municipal professional athletes	6
	Total	**20**

Data collection in each stage

Watch the game videos by searching the Internet, Migu Video, WeChat official account Table Tennis World, etc., and collect original data, mainly focusing on the World Table Tennis Championships, On the collection and arrangement of video recordings of recent major mixed doubles competitions such as the WTT series.

Use the four-stage and four-round evaluation method for formula calculation and SPSS statistical software analysis and induction.

Refer to Yan Sen. According to the Simi Scout technical and tactical video analysis software imported from Germany by the Institute of Sports Science of the General Administration of Sport of China, combined with the gender characteristics of table tennis doubles and mixed doubles, a model of 4 rounds of serving and receiving for men and women was established.

Use Excel software to research the use of techniques and tactics, points scored and lost, and competitive ability of the world's outstanding mixed doubles athletes.

Data Analysis

statistics：Descriptive Statistics, SUM. software applications will be used: SPSS，Excel，Word, CAJ Viewer, Simi Scout Technical, and tactical video analysis software

Statistics used in data analysis

By searching authoritative academic platforms at home and abroad in the past 10 years, more than 70 journal documents and master's and doctoral theses related to this article were selected, which provided an accurate scientific theoretical basis for the research of this paper (Tang, et al, 2010).

Watch the video data of a total of 17 games of the top two combinations Wang Chuqin/Sun Yingsha and Tomokazu HARIMOTO/Hina HAYATA in the world mixed doubles rankings for statistics and analysis. All calculations are completed with SPSS statistical software.

Results
    4.1 To test the feasibility and effectiveness of the four-stage and four-round evaluation method of table tennis mixed doubles technical and tactical statistical methods
    This study will simultaneously analyze the same game between the four-stage four-round evaluation method the eight-round three-stage evaluation method and the dual-system four-round evaluation method studied by previous studies, and compare the overall conclusions drawn by the three methods. are consistent. The following analysis takes the mixed doubles final of the 2023 Durban World Table Tennis Championships as an example.
    4.1.1 **Eight rounds of the three-stage method**

Table 3 Wang Chuqin/Sun Yingsha 2023 Durban World Table Tennis Championships Mixed Doubles Finals Eight Round Analysis Statistics Table

	Score	lost	Subtotal	Score rate	Usage rate
Wang Serve HARIMOTO Receive	3	0	3	100%	6%
Wang Serve HAYATA Receive	6	2	8	75%	17%
Sun Serve HARIMOTO Receive	5	3	8	63%	17%
Sun Serve HAYATA Receive	4	0	4	100%	8%
HARIMOTO Serve Wang Receive	4	4	8	50%	17%
HARIMOTO Serve Sun Receive	1	1	2	50%	4%
HAYATA Serve Wang Receive	3	1	4	75%	8%
HAYATA Serve Sun Receive	7	4	11	64%	23%
Subtotal	33	15	48	69%	100%

    Through the analysis of Table 4.1, it can be seen that the overall scoring rate of Wang Chuqin and Sun Yingsha in the eight rounds has a clear advantage compared to Tomokazu HARIMOTO and Hina HAYATA. The scoring rate in two of the rounds was 100%, indicating that both Wang Chuqin and Sun Yingsha had the upper hand in serving. The scoring rate in the lower two rounds among the eight rounds was 50%, which shows that Wang Chuqin and Sun Yingsha did not have a clear advantage in receiving the serve. In particular, Wang Chuqin made many mistakes when receiving the serve from Tomokazu HARIMOTO and was in a passive situation.
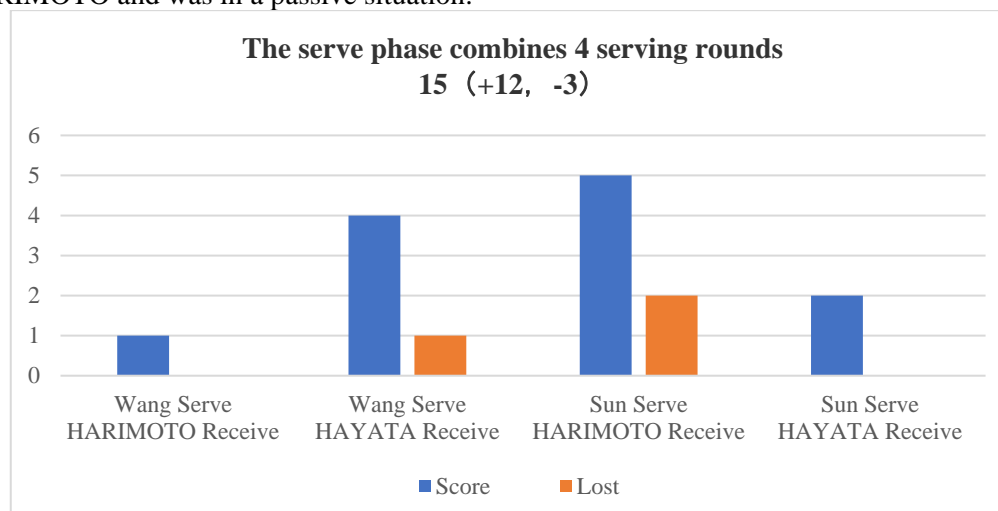

Chart 1 Wang Chuqin/Sun Yingsha's serve phase combined with statistics of four serving rounds

    It can be seen from Figure 1 that the scoring rate in the four rounds is higher than the usage rate. Among them, the highest score was Sun Yingsha's serve and Tomokazu HARIMOTO's return round, which scored 5 points; followed by Wang Chuqin's serve and Hina HAYATA's return round, which

scored 4 points, which shows that Wang Chuqin and Sun Yingsha have a greater advantage in the serve and attack section of this game, and they have done a better job in connecting the serve and the attack on the third board.

The receiving phase combines 4 receiving and servings rounds
15（+9，-6）
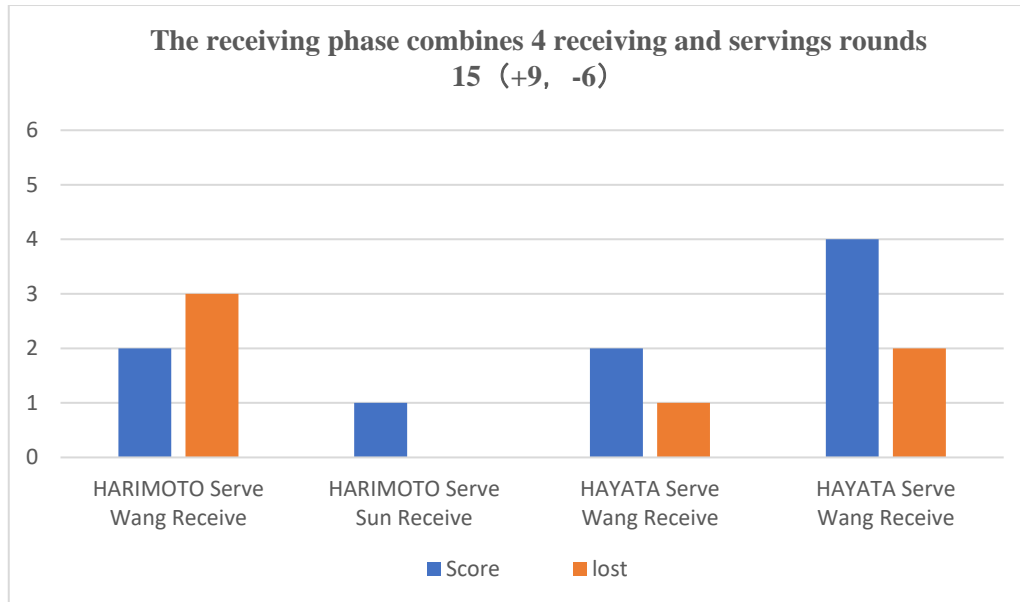
Chart 2 Wang Chuqin/Sun Yingsha's receiving and grabbing section combined with statistics of four receiving and serving rounds

It can be seen from Figure 2 that although there are three rounds where the scoring rate is higher than the usage rate, there are more points lost in the three rounds, which are half of the points scored. Especially in the round where Tomokazu HARIMOTO and serve Wang Chuqin performed the worst among the four rounds, they lost more points than they scored. This shows that the receiving section of this game made more mistakes in this round, and their skills were poor. The tactical application effect is not ideal.

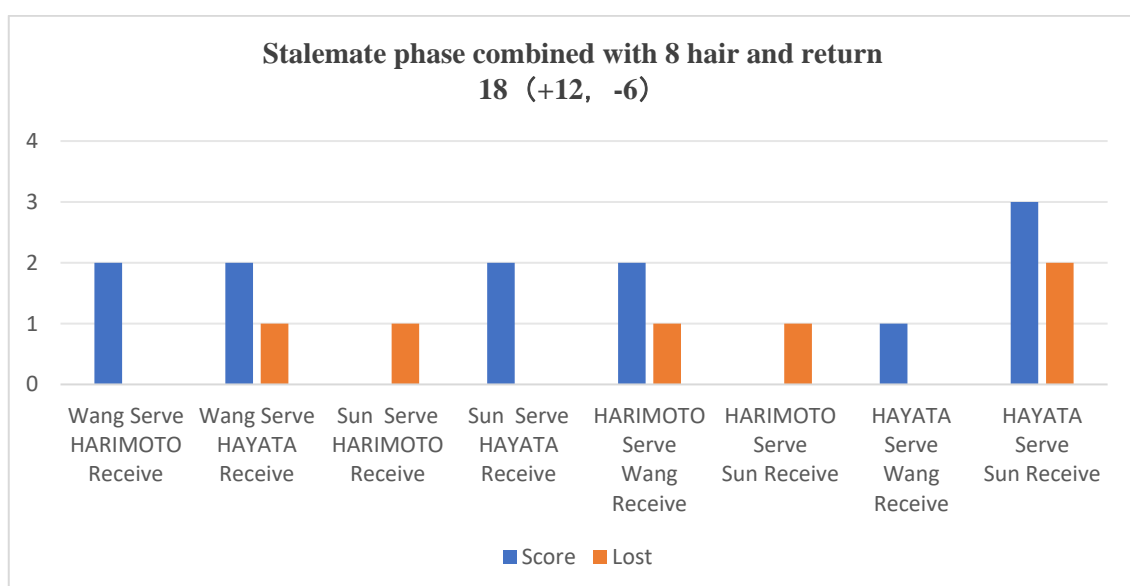**Stalemate phase combined with 8 hair and return**
18（+12，-6）

Chart 3 Statistics of the Wang Chuqin/Sun Yingsha stalemate combined with 8 serving and receiving rounds

It can be seen from Figure 3 that in the stalemate section combined with 8 rounds of serve and return, 6 rounds scored higher than the points lost, and the other 2 rounds did not score and both lost 1 point. This shows that the stalemate section of this game has Sun Yingsha and Tomokazu HARIMOTO relatively passive in the serving and receiving rounds and did not gain an advantage.

4.1.2 Dual-system four-round evaluation method

Table 4 Wang Chuqin/Sun Yingsha 2023 Durban World Table Tennis Championships Mixed Doubles Final Serving System Statistics

Serving System	Serve phase (Boards 1 and 3)		Connect after serving and attacking（Board 5）		Stalemate phase		Total Score	Round scoring rate(%)	Round usage rate (%)
	Score	lost	Score	lost	Score	lost			
Wang Serve Man Receive	1	0	1	0	1	0	3	100%	6%
Wang Serve Woman Receive	4	1	2	0	0	1	8	75%	17%
Sun Serve Man Receive	5	2	0	1	0	0	8	63%	17%
Sun Serve Woman Receive	2	0	1	0	1	0	4	100%	8%
Total Score	12	3	4	1	2	1	23	78%	48%
Segment score rate(%)	80%		80%		67%				
Segment usage (%)	31%		10%		6%				

According to Table 4, Wang Chuqin/Sun Yingsha's highest scoring rate and usage rate in the serving system of this game are both in the serve and grab segment, with a scoring rate of 80% and a usage rate of 31%. This shows that in this game Wang Chuqin/Sun Yingsha's serve and grab segment is the link in the serving system that generates the most points and is also the segment with the best performance in the serving system.

Table 5 Wang Chuqin/Sun Yingsha 2023 Durban World Table Tennis Championships Mixed Doubles Finals Statistics

Serving System	Board 1		Board 3		Total Score	Round scoring rate(%)	Round usage rate (%)
	Score	Lost	Score	Lost			
Wang Serve Man Receive	1	0	0	0	1	100%	7%
Wang Serve Woman Receive	0	0	4	1	5	80%	33%
Sun Serve Man Receive	1	0	4	2	7	71%	47%
Sun Serve Woman Receive	2	0	0	0	2	100%	13%
Total Score	4	0	8	3	15	80%	100%
Segment score rate(%)	100%		73%				
Segment usage (%)	27%		73%				

According to Table 5 and Table 4 that the serve in the Wang Chuqin/Sun Yingsha serve poses a certain threat to the receiving side and creates opportunities for scoring on the third board. He does a better job of connecting to the fifth board after the serve. Even if he fails to score directly on the third board during the serve, he can still score on the fifth board. Judging from the points gained and lost in the four rounds, the overall level of Wang Chuqin and Sun Yingsha in the connection stage after the attack was higher than that of the other party. Wang Chuqin/Sun Yingsha and the Japanese combination Tomokazu HARIMOTO/Hina HAYATA had fewer rounds after the 7th board. At the same time, although the scoring rate in the stalemate was the lowest among the three stages, they still had a certain advantage compared with their opponents.

Table 6 Wang Chuqin/Sun Yingsha 2023 Durban World Table Tennis Championships Mixed Doubles Finals Service Receiving System Statistics

Receive System	Receive (Boards 2 and 4)		Connection after receiving the attack (6th board)		Stalemate phase		Total Score	Round scoring rate (%)	Round usage rate (%)
	Score	lost	Score	lost	Score	lost			
Man Serve Wang Receive	3	3	0	1	1	0	8	50%	17%
Man Serve Sun Receive	1	1	0	0	0	0	2	50%	4%
Woman Serve Wang Receive	2	1	1	0	0	0	4	75%	8%
Woman Serve Sun Receive	4	2	2	2	1	0	11	64%	23%
Total Score	10	7	3	3	2	0	25	60%	52%
Segment score rate(%) 59%	50%		100%						
Segment usage (%) 35%	13%		4%						

According to Table 6 Wang Chuqin/Sun Yingsha has the highest usage rate in the receiving and grabbing period in this game's receiving and serving system, which is 35%. Their scoring rate is lower than the stalemate period and higher than the connecting period after receiving and grabbing, which is 59%. This shows that in this game in the match, Wang Chuqin/Sun Yingsha performed generally in the receiving and grabbing phase, and their performance in the receiving and grabbing phase was not as good as in the serving and grabbing phase.

Table 7 Wang Chuqin/Sun Yingsha 2023 Durban World Table Tennis Championships Mixed Doubles Finals Statistics

Receive Phase	Board 2		Board 4		Total	Score rate(%)	Usage rate（%）
	Score	Lost	Score	Lost	Score		
Man Serve Wang Receive	2	2	1	1	6	50%	35%
Man Serve Sun Receive	1	0	0	1	2	50%	12%
Woman Serve Wang Receive	2	1	0	0	3	67%	18%
Woman Serve Sun Receive	3	0	1	2	6	67%	35%
Total Score	8	3	2	4	17	59%	100%
Segment score rate(%)	73%		33%				
Segment usage (%)	65%		35%				

Combining Table 6 and Table 7, we can see that Wang Chuqin and Sun Yingsha made many mistakes in the connection after receiving the serve, and failed to maintain their advantage in receiving the serve. He can handle Hina HAYATA's serve better during the catch-and-grab phase. When the two of them received the serve from Tomokazu HARIMOTO, their performance in receiving the serve was poor, and they were more passive when connecting on the fourth board. At the same time, Wang Chuqin/Sun Yingsha produced fewer points in the stalemate in the serve-receiving system but performed better. Combining the points gained and lost in the four rounds, it can be seen that Wang Chuqin and Sun Yingsha had the advantage in the stalemate with their opponents until the 8th board and beyond.

4.1.3 Four-stage and four-round evaluation method

Table 8 Wang Chuqin/Sun Yingsha 2023 Durban World Table Tennis Championships Mixed Doubles Finals Statistical Table of Breaking Sections and Stalemate Section I

Serving Rounds	Serve phase (Boards 1、3 and 5 lost)		Stalemate phase I (Board 5 score、Board 7 and beyond)		Total Score	Round scoring rate(%)	Round usage rate(%)
	Score	lost	Score	lost			
Wang Serve Man Receive	1	0	2	0	3	100%	6%
Wang Serve Woman Receive	4	1	2	1	8	75%	17%
Sun Serve Man Receive	5	2	0	1	8	63%	17%
Sun Serve Woman Receive	2	0	2	0	4	100%	8%
Total Score	12	3	6	2	23	78%	48%
Segment score rate(%)	80%		75%				
Segment usage (%)	31%		17%				

As can be seen from Table 8, Wang Chuqin/Sun Yingsha mainly relied on serving and grabbing points in the entire game. Judging from the specific rounds, Sun Yingsha's serve effectively controlled the offense of Tomokazu HARIMOTO and the second serve, and at the same time created an advantage

for Wang Chuqin's third serve attack. There were fewer serving rounds and opponent rounds throughout the game. Judging from the specific rounds, Wang Chuqin and Sun Yingsha's overall strength is higher than their opponents at this stage, and they have the upper hand in the stalemate stage I.

Table 9 Wang Chuqin/Sun Yingsha 2023 Durban World Table Tennis Championships Mixed Doubles Finals Statistical Table of the receiving and attacking phase and the Stalemate Phase II

Serving Rounds	Receiving phase (receiving serve, 4th board)		Stalemate phase II (Board 6 and beyond)		Total Score	Round scoring rate(%)	Round usage rate(%)
	Score	lost	Score	lost			
Man Serve Wang Receive	2	3	2	1	8	50%	17%
Man Serve Sun Receive	1	0	0	1	2	50%	4%
Woman Serve Wang Receive	2	1	1	0	4	75%	8%
Woman Serve Sun Receive	5	2	2	2	11	64%	23%
Total Score	10	6	5	4	25	60%	52%
Segment score rate(%)	63%		56%				
Segment usage (%)	33%		19%				

According to Table 9, Wang Chuqin/Sun Yingsha's points gained and lost in the receiving and grabbing section of this game were mainly in receiving the serve and the fourth board. Judging from the specific rounds, Wang Chuqin pursued high quality when receiving Tomokazu HARIMOTO's serve and strived to score directly after receiving the serve, resulting in a situation of losing more points. Both Wang Chuqin and Sun Yingsha were able to gain advantages in the second stage of the stalemate. Judging from the specific rounds, as long as Wang Chuqin handles the fierce and stable relationship when receiving the serve, he can gain an advantage in the second stage of the stalemate.

In summary, it can be seen that the conclusions drawn by the three methods are generally consistent, which can prove the feasibility and effectiveness of the four-stage and four-round evaluation methods.

4.2 To analyze the actual application and performance of the world's outstanding table tennis players in mixed doubles competitions

This study will use the four-stage four-round evaluation method to evaluate the world's outstanding mixed doubles players Wang Chuqin/Sun Yingsha and Tomokazu HARIMOTO/Hina HAYATA in four rounds from the four stages of the serve, stalemate I, catch, and hold II. Hina will conduct statistics on important competitions from November 2021 to August 2023.

Table 10 Wang Chuqin/Sun Yingsha's scoring statistics in three important games from November 2021 to August 2023

Serving	Serve phase (Boards 1、 3 and 5 lost)												Total
Rounds	A				B				C				Score
	(VS Tomokazu HARIMOTO/Hina HAYATA)				(VS Lin Yun-Ju/CHENG I ching)				(VS Tomokazu HARIMOTO/Hina HAYATA)				
	Score	lost	Round		Score	lost	Round		Score	lost	Round		
			scoring rate(%)	usage rate(%)			scoring rate(%)	usage rate(%)			scoring rate(%)	usage rate(%)	
Wang Serve Man Receive	3	2	60%	10%	0	2	0%	4%	3	5	38%	12%	15
Wang Serve Woman Receive	2	0	100%	4%	3	0	100%	6%	1	3	25%	6%	9
Sun Serve Man Receive	1	2	33%	6%	2	3	40%	10%	6	2	75%	12%	16
Sun Serve Woman Receive	3	2	60%	10%	5	1	83%	12%	2	4	33%	9%	17
Total Score	9	6			10	6			12	14			57
Segment score rate(%)			60%				63%				46%		
Segment usage (%)			31%				31%				38%		

Note:
> A. in the table represents the finals of the World Table Tennis Championships in Houston in November 2021;
> B. in the table represents the WTT Singapore Grand Slam final in March 2022;
> C. in the table represents the WTT Singapore Grand Slam final in March 2023;
> The scores of the three games are A (11:2, 11:5, 11:8), B (11:3, 12:10, 11:4), C (11:2, 5:11, 11:9, 11:8)

According to Table 10 compared with Lin Yunru/Zheng Yijing, Wang Chuqin/Sun Yingsha, the Japanese combination Tomokazu HARIMOTO and Hina HAYATA performed better in the serve and grab section, and were a greater threat to Wang Chuqin/Sun Yingsha in the serve and grab section. Judging from the specific rounds, Wang Chuqin has a greater advantage when facing rounds where the opponent is a female athlete. Sun Yingsha's overall strength in the serve and grab section is strong. Regardless of whether the opponent in the round is a male athlete or a female athlete, she is in the best position. Upside.

Table 11 Wang Chuqin/Sun Yingsha's three important stalemate statistics from November 2021 to August 2023 Section I

Serving	Stalemate phase I (Board 5th Score, Board 7 and beyond)												Total
Rounds	A				B				C				Score
	(VS Tomokazu HARIMOTO/Hina HAYATA)				(VS Lin Yun-Ju/CHENG I ching)				(VS Tomokazu HARIMOTO/Hina HAYATA)				
	Score	lost	Round scoring rate(%)	usage rate(%)	Score	lost	Round scoring rate(%)	usage rate(%)	Score	lost	Round scoring rate(%)	usage rate(%)	
Wang Serve Man Receive	2	0	100%	4%	3	0	100%	6%	0	0	0%	0%	5
Wang Serve Woman Receive	2	0	100%	4%	2	0	100%	4%	1	1	50%	3%	6
Sun Serve Man Receive	1	0	100%	2%	2	1	67%	6%	2	0	100%	3%	6
Sun Serve Woman Receive	4	1	80%	10%	0	0	0%	0%	3	1	75%	6%	9
Total Score	9	1			7	1			6	2			26
Segment score rate(%)	90%				88%				75%				
Segment usage (%)	21%				16%				12%				

According to Table 11, Wang Chuqin/Sun Yingsha had a higher scoring rate in the first phase of the three important games. By watching the game video, we can find that Wang Chuqin/Sun Yingsha have a great advantage in the usage rate of scoring on the fifth board. Judging from the specific rounds of the three games, Wang Chuqin/Sun Yingsha had tacit cooperation in transitioning from the attack phase to the stalemate phase. They were proficient in using techniques and tactics and scored higher.

Table 12 Wang Chuqin/Sun Yingsha's receiving statistics in three important games from November 2021 to August 2023

Receiving	Receiving and attacking phase (Receiving and Board 4th lost)												Total
Rounds	A				B				C				Score
	(VS Tomokazu HARIMOTO/Hina HAYATA)				(VS Lin Yun-Ju/CHENG I ching)				(VS Tomokazu HARIMOTO/Hina HAYATA)				
	Score	lost	Round scoring rate(%)	usage rate(%)	Score	lost	Round scoring rate(%)	usage rate(%)	Score	lost	Round scoring rate(%)	usage rate(%)	
Man Serve Wang Receive	2	1	67%	6%	4	1	80%	10%	5	1	83%	9%	14
Man Serve Sun Receive	3	3	50%	13%	3	2	60%	10%	2	5	29%	10%	18
Woman Serve Wang Receive	7	2	78%	19%	1	5	17%	12%	4	2	67%	9%	21
Woman Serve Sun Receive	3	0	100%	6%	5	0	100%	10%	5	1	83%	9%	14
Total Score	15	6			13	8			16	9			67
Segment score rate(%)	71%				62%				64%				
Segment usage (%)	44%				41%				37%				

According to Table 12, Wang Chuqin/Sun Yingsha had a better scoring rate in the three important games in the catch-and-rush segment, and the proportion of points and losses generated in the game was larger. Judging from the specific rounds, Wang Chuqin/Sun Yingsha performed better in receiving

the serve and attacking the fourth board. However, from the two rounds with a low scoring rate, it can be seen that Wang Chuqin wanted to suppress Zheng Yijing's quality so that Sun Yingsha could score in the fourth round. Finding offensive opportunities in four boards led to more mistakes.

Table 13 Statistical table of Wang Chuqin/Sun Yingsha's three important stalemates in Section II from November 2021 to August 2023

Receiving	Stalemate phase II (Sixth Board and beyond)												Total
Rounds	A				B				C				Score
	(VS Tomokazu HARIMOTO/Hina HAYATA)				(VS Lin Yun-Ju/CHENG I ching)				(VS Tomokazu HARIMOTO/Hina HAYATA)				
	Score	lost	Round scoring rate(%)	usage rate(%)	Score	lost	Round scoring rate(%)	usage rate(%)	Score	lost	Round scoring rate(%)	usage rate(%)	
Man Serve Wang Receive	0	1	0%	2%	2	1	67%	6%	1	0	100%	1%	5
Man Serve Sun Receive	0	0	0%	0%	0	0	0%	0%	1	0	100%	1%	1
Woman Serve Wang Receive	0	0	0%	0%	0	0	0%	0%	1	2	33%	4%	3
Woman Serve Sun Receive	0	1	0%	2%	2	1	67%	6%	1	3	25%	6%	8
Total Score	0	2			4	2			4	5			17
Segment score rate(%)			0%				67%				44%		
Segment usage (%)			4%				12%				13%		

According to Table 13, Wang Chuqin/Sun Yingsha's points gained and lost in the second stage of the stalemate are the least among the four stages. This is because the nature of the second stage of the stalemate is determined on the sixth board and beyond, so it is difficult for Wang Chuqin/Sun Yingsha to win in the first three stages. Gained the advantage. Judging from the specific rounds, after 2022, generally speaking, Wang Chuqin and Sun Yingsha have an advantage when male athletes serve in the second stage of the stalemate.

4.2.2 Technical and tactical analysis of the mixed doubles competition between world-leading table tennis players Tomokazu HARIMOTO/Hina HAYATA

Table 14 Tomokazu HARIMOTO/Hina HAYATA's statistical table of starting points in three important games from November 2021 to August 2023

Serving	Serve phase (Boards 1、3 and 5 lost)												Total
Rounds	D				E				F				Score
	(VS Tomokazu HARIMOTO/Hina HAYATA)				(VS Lin Yun-Ju/CHENG I ching)				(VS Tomokazu HARIMOTO/Hina HAYATA)				
	Score	lost	Round scoring rate(%)	usage rate(%)	Score	lost	Round scoring rate(%)	usage rate(%)	Score	lost	Round scoring rate(%)	usage rate(%)	
HARIMOTO Serve Man Receive	3	3	50%	7%	4	4	50%	9%	1	4	20%	10%	19
HARIMOTO Serve Woman Receive	2	5	29%	9%	2	4	33%	6%	3	1	75%	8%	17
HAYATA Serve Man Receive	6	5	55%	14%	6	2	75%	9%	2	0	100%	4%	21
HAYATA Serve Woman Receive	8	0	100%	10%	5	3	63%	9%	9	2	82%	21%	27
Total Score	19	13			17	13			15	7			84
Segment score rate(%)			59%				57%				68%		
Segment usage (%)			40%				32%				42%		

It can be seen from Table 14 that Tomokazu HARIMOTO and Hina HAYATA have a greater advantage in the starting and grabbing stage than Lin Gaoyuan/Zhang an and Wang Chuqin/Wang Manyu. Judging from the specific round situation, Hina HAYATA, as a left-handed player, has a greater advantage in the serving phase, creating conditions for her teammates to attack the third board.

Table 15 Statistical table of Section I of three important matches between Tomokazu ARIMOTO/Hina HAYATA from November 2021 to August 2023

Serving	Stalemate phase I (Board 5th Score, Board 7 and beyond)										Total
Rounds	D				E				F		Score
	(VS Lin Gaoyuan/Zhang An)				(VS Wang Chuqin/Wang Manyu)				(VS LiM Jonghoon/SHIN Yubin)		
	Score	lost	Round		Score	lost	Round		Score	lost	Round	
			scoring rate(%)	usage rate(%)			scoring rate(%)	usage rate(%)			scoring rate(%)	usage rate(%)	
HARIMOTO Serve Man Receive	1	1	50%	2%	3	1	75%	4%	2	1	67%	6%	9
HARIMOTO Serve Woman Receive	1	0	100%	1%	2	2	50%	4%	0	0	0%	0%	5
HAYATA Serve Man Receive	1	0	100%	1%	0	4	0%	4%	0	2	0%	4%	7
HAYATA Serve Woman Receive	3	1	75%	5%	2	3	40%	5%	0	0	0%	0%	9
Total Score	6	2			7	10			2	3			30
Segment score rate(%)			75%				41%				40%		
Segment usage (%)			10%				38%				10%		

From Table 15, we can see that Tomokazu HARIMOTO and Hina HAYATA performed more tacitly in the first stage of the stalemate and had better scoring results. Judging from the specific rounds of the three games, the scoring rate in both rounds was 100%. This shows that both Tomokazu HARIMOTO and Hina HAYATA performed better than their opponents in the first stage of the stalemate.

Table 16 Tomokazu HARIMOTO Hina HAYATA's statistics on receiving and grabbing points in three important games from November 2021 to August 2023

Receiving	Receiving and attacking phase (Receiving and Board 4th lost)										Total
Rounds	D				E				F		Score
	(VS Lin Gaoyuan/Zhang An)				(VS Wang Chuqin/Wang Manyu)				(VS LiM Jonghoon/SHIN Yubin)		
	Score	lost	Round		Score	lost	Round		Score	lost	Round	
			scoring rate(%)	usage rate(%)			scoring rate(%)	usage rate(%)			scoring rate(%)	usage rate(%)	
Man Serve HARIMOTO Receive	4	5	44%	11%	3	4	43%	8%	2	0	100%	4%	18
Man Serve HAYATA Receive	3	3	50%	7%	3	6	33%	10%	3	0	100%	6%	18
Woman Serve HARIMOTO Receive	2	1	67%	4%	4	6	40%	11%	4	5	44%	17%	22
Woman Serve HAYATA Receive	6	3	67%	11%	6	3	67%	10%	3	1	75%	8%	22
Total Score	15	12		13	16	19			16	6			80
Segment score rate(%)			56%				46%				67%		
Segment usage (%)			33%				38%				35%		

According to Table 16, the points gained and lost in the receiving and grabbing phases of the three important games were second only to the points gained and lost in the serving and grabbing phases. The scoring points competed for in this game are concentrated in the receiving and grabbing section, which also reflects the importance of receiving the serve and the fourth rebound in the game. Judging from the specific rounds, Tomokazu HARIMOTO and Hina HAYATA are more adaptable to the service of Korean male athlete LIM Jonghoon and can bring offensive opportunities to their partners on the fourth board.

Table 17 Statistical table of the second period of three important matches between Tomokazu HARIMOTO/Hina HAYATA from November 2021 to August 2023

Receiving	Stalemate phase II (Sixth Board and beyond)												Total
Rounds	D				E				F				Score
	(VS Lin Gaoyuan/Zhang An)				(VS Wang Chuqin/Wang Manyu)				(VS LiM Jonghoon/SHIN Yubin)				
	Score	lost	Round		Score	lost	Round		Score	lost	Round		
			scoring rate(%)	usage rate(%)			scoring rate(%)	usage rate(%)			scoring rate(%)	usage rate(%)	
Man Serve HARIMOTO Receive	0	0	0%	0%	0	3	0%	8%	1	1	50%	4%	5
Man Serve HAYATA Receive	0	2	0%	2%	1	0	100%	10%	3	2	60%	10%	8
Woman Serve HARIMOTO Receive	5	3	63%	10%	0	1	0%	11%	0	0	0%	0%	9
Woman Serve HAYATA Receive	2	2	50%	5%	4	2	67%	10%	0	0	0%	0%	10
Total Score	7	7			5	6			4	3			32
Segment score rate(%)			50%				45%				57%		
Segment usage (%)			17%				12%				13%		

From Table 17, we can see that Tomokazu HARIMOTO and Hina HAYATA had more stalemates with their opponents in the receiving round until six boards and beyond. Judging from the specific rounds, in the stalemate between the two sides on the sixth board and subsequent rounds, Tomokazu HARIMOTO and Hina HAYATA had an advantage over the first-ever multinational combination Lin Gaoyuan/Zhang An.

Discussion
1. By comparing the data from the three technical and tactical statistical methods, the conclusions drawn are generally consistent. Because the first two technical and tactical statistical methods have been systematically tested by predecessors for a long time, they are reliable. Therefore, this article's four-stage and four-round evaluation method of mixed doubles technical and tactical statistical methods is reliable and effective.
2. Through statistical analysis of data from multiple games, it was found that Wang Chuqin/Sun Yingsha have a tacit understanding of cooperation in the first stage of the stalemate and are proficient in using techniques and tactics. Wang Chuqin/Sun Yingsha have certain disadvantages in the receiving and grabbing stage, and they are strong in multi-board stalemate rounds. Tomokazu HARIMOTO and Hina HAYATA have a greater advantage in the first stage of the fight and the first stage of the stalemate, and there are more rounds after the sixth board.
3. Through statistical analysis of data from multiple games, it was found that the eight-round three-stage index evaluation method can specifically analyze the performance of athletes' techniques and tactics in a certain round, but it cannot reflect the use of techniques and tactics by mixed doubles athletes when facing different opponents. The dual-system four-round evaluation method can analyze

the advantages and disadvantages of rounds based on the gender differences between men and women. However, it does not fundamentally solve the problem of inconsistent statistical data in each segment.

Recommendation

Practice recommendation

1. The four-stage and four-round evaluation method can solve the situation where the statistical data of each stage does not correspond and is conducive to multi-faceted technical and tactical analysis.

2. The four-stage and four-round evaluation method can not only analyze the advantages and disadvantages of mixed doubles players according to their gender characteristics but also summarize the techniques and tactics used by mixed doubles players when facing different opponents.

3. The four-stage and four-round evaluation method is more in line with the actual needs of mixed doubles projects in terms of technical and tactical statistical methods, and to a certain extent can better fill the gap in technical and tactical statistical methods of mixed doubles projects.

4. The technical and tactical statistical method proposed in this article requires continuous practice and data updating for a long time and multiple games. However, due to the small amount of data, this article can only scratch the surface in exploring the general rules of mixed doubles technical and tactical statistical methods, which still needs to be further supplemented and improved.

Further research recommendation

The four-stage and four-round evaluation method proposed in this article is a combination of the three-stage and four-stage index evaluation methods of previous technical and tactical statistical methods. Based on the segment index evaluation method, the eight-round three-segment evaluation method, and the dual series four-round evaluation method, a new technical and tactical statistical method for table tennis mixed doubles events is proposed. The four-segment and four-round evaluation method solves to a certain extent the situation where the statistical data of each segment of the players on both sides of the competition does not correspond and reflects the batting rounds to which the players have advantages or disadvantages. At the same time, it can not only specifically analyze the technical and tactical performance of athletes in a certain round, but also comprehensively analyze the data of table tennis mixed doubles competitions, and explore the general rules of technical and tactical use in mixed doubles competitions and the individual differences in the technical and tactical characteristics of mixed doubles players.

However, the four-stage and four-round evaluation method still has some limitations during the research process. First of all, although the use of the four-stage and four-round evaluation method can well analyze the technical and tactical characteristics of the world's outstanding mixed doubles players, it does not completely break away from the traditional three-stage indicator evaluation method and the four-stage indicator evaluation method. Secondly, it has only been 3 years since the mixed doubles event was included in the Olympic Games. There is little research data and difficulty in collecting it, making it impossible to conduct more in-depth research. At the same time, the technical and tactical statistical method proposed in this article is a new technical and tactical statistical method, which requires continuous practice and data updating for a long time and multiple games. However, due to the small amount of data, this article can only scratch the surface in exploring the general rules of statistical methods for mixed doubles techniques and tactics. With time, the technical and tactical statistical methods of table tennis mixed doubles still need to be further supplemented and improved.

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