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Study on the Optimal Combination of Mixed 4×100m Medley Relay Selection

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ABSTRACT. *As a new event, the speed of each baton may affect the performance of the whole team, so the men's and women's 4 × 100 meter medley relay also tests the ability of the coach to arrange the troops. However, through the investigation of domestic and foreign literature, it is found that there is no authoritative and reasonable explanation of the selection team, which makes the traditional selection method cannot fully express its objectivity and systematicness at this stage. Both subjective and objective factors affect the rationality of the selection. At this stage, how to select the best combination, sub-optimal combination and sub-optimal combination is the key. In this paper, the literature, mathematical statistics, comparative analysis and other multivariate statistical research methods are used to analyze the results of relay events in 2014-2019 international representative events as the research object, and the optimal combination of 4 × 100m medley relay. Through research and analysis, it is found that the traditional selection method for men's and women's 4 × 100m medley relay is based on the ratio selection method. Men should be selected to take part in backstroke and breaststroke, and women should be selected to take part in butterfly and freestyle. This is the best combination method for men's and women's 4 × 100m medley relay. From the perspective of the difference selection method, the difference calculation is carried out for the performance difference between men and women in each event. Men participate in the events with large performance gap between men and women, and women participate in the events with small performance gap between men and women. This is the best combination for men and women to achieve the best performance in the 4 × 100 meter medley relay.*

KEYWORDS: *Men's and women's 4 × 100m medley relay, Selection methods, Optimal combination*

1. Introduction

1.1 The Coming out of the Relay Event of Men and Women's Medley

At the 2013 Barcelona World Swimming Championships, the International Swimming Federation decided to introduce the men's and women's medley relay into the main events, that is, to freely choose two male athletes and two female athletes to form a team to compete in freestyle and medley. In December 2014, the Doha short pool World Championships for the first time joined the men's and women's medley 4 × 50m medley and 4 × 50m freestyle. With the emergence of medley relay, not only the number of medals in the World Swimming Championships has increased, but also a more comprehensive and fierce competition platform has been provided for the world powers. More fully demonstrate the average strength of men and women in various countries.

In the short-course world championships, the U.S. team, Russia team and Brazil team finished in the top three respectively in the 4x50m freestyle. In the 4x50m medley, Brazil won the championship. Sarah Chiarello (member of the international swimming association), Anna Kozina (Russian member of the international swimming association's media Committee) and Zhou Xin (Chinese member of the international swimming association's media Committee) pointed out in the American swimming magazine swimming world that the Brazilian team can win the 4x50m competition, on the one hand, it is the swimming style difference between men and women, on the other hand, it is the baton ranking. Other factors include starting and baton. Greyfus believes that the mixed relay between men and women will be an important supplement to the traditional swimming events, and the corresponding competition strategy will continue to mature and develop.

Through literature review, it is found that the men's and women's 4 × 100m medley relay is the same as the traditional medley relay as a new event, and the most test of the men's and women's medley relay is the ability of the coach to arrange his troops. Since there is no restriction on the baton of male and female players, each baton may have several men and several women entering the water at the same time, with different strengths. The

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leader of the first baton may not win the championship in the end, and those who lag behind in the first three batons may catch up with and surpass the leader with the performance of the last Baton, which is quite a bit like Tian Ji horse racing. The traditional selection method is used to explore the optimal combination of relay, providing reliable reference basis for the selection of men's and women's 4 × 100m medley relay at all levels.

1.2 Research Object

The selection method of men's and women's 4 × 100m medley relay in all international events since 2015-2019 was taken as the research object. International events include the world youth Swimming Championships (2015, 2017) and the World Swimming Championships (2015, 2017, 2019).

1.3 Research Method

Through the comparative analysis of the men and women who performed at the relay event handover and the final performance, the correlation differences between their gender perspectives were determined, providing specific conditions for the establishment of the model. In addition, the statistics of traditional selection methods and model selection methods are compared and analyzed to verify the differences between the two selection methods.

2. Results and Analysis

2.1 Analysis of the Optimal Combination of Traditional Selection Methods in the Relay of Men's and Women's 4 × 100m Medley

Through statistical analysis of the results and combinations of relay teams in the men's and women's medley 4 × 100m medley relay races in the world youth swimming championships (2015, 2017) and the world swimming championships (2015, 2017, 2019), the final results of all teams are within 4:00. Since the overall level of the 2017 World Championship is high, 13 teams in the preliminaries will swim within 4:00, so this article will make statistics on the data of 45 teams. This article does not make statistics for the teams whose scores are beyond 4:00, because the sports teams outside this score range basically do not have the strength to choose the best, so the overall scores of the sports teams outside this range do not have statistical value.

All statistical data are derived from the athletes' 100m performance in the event, and the individual performance of each athlete is arranged and combined. If there are less than 8 men and women baton in four relay swimming styles in the relay team, the results of the relay team will not be counted. According to the statistics of the competition, but a total of 9 teams do not meet this requirement, so a total of 36 teams are taken as the research object for analysis.

The traditional selection method is to calculate the percentage of each team's sex selected from the four swimming styles of yang, frog, butterfly, and from the above items. through the percentage calculation, baton with a larger proportion of male and female sex is obtained. Or by calculating the difference between men's and women's performance in each baton event, two batons with larger difference are obtained as men's baton event and two batons with smaller difference are obtained as women's baton event.

2.1.1 Statistical Analysis of Ratio Selection Method in Traditional Selection Method

The ratio selection method is actually a statistical method of percentages, which is based on the proportion of men and women's combinations in the four swimming styles of leaning, frog, butterfly and swimming.

According to statistics, among the 45 teams, 27 teams chose men to swim backstroke, accounting for 60% of the total backstroke. There are 31 teams that choose men to swim breaststroke, accounting for 68.89% of the total breaststroke. In the butterfly stroke baton, only 12 of the 45 teams chose men to swim the butterfly stroke, accounting for 26.67% of the total number of butterfly strokes. In freestyle baton, only 14 teams also chose men, accounting for 31.11% of the total freestyle baton. Statistics from the above table show that most countries in the participating teams choose men to swim backstroke and breaststroke, while women choose butterfly and freestyle.

According to the competition results of all the teams, ranking them in descending order, this paper makes statistics on all the top eight teams, and makes statistics on the proportion of male and female athletes of the

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world's highest-level teams in various swimming styles. Among the fastest existing results in the world, 6 teams chose men to swim breaststroke and backstroke, accounting for 75% of the total backstroke and breaststroke respectively, and 3 teams chose men to swim butterfly, accounting for 37.5% of the total. In the selection of freestyle, there is only one team for men, accounting for only 12.5% of the baton. It can be seen from the gender ratio that the world's leading teams use the backstroke breaststroke to swim by men, while the butterfly freestyle excellent women's swimming accounts for the largest proportion.

According to the statistics of ratio selection method, the actual selection combination method and ratio selection combination method are the same for 16 out of 36 teams, accounting for 44% of the total. Different from the ratio selection and combination method, there are 20 teams, accounting for 56%. From the analysis of the statistical results, we can see that among the 36 teams actually counted, according to the ratio combination method, the number of groups with the same difference selection combination method and actual selection combination method does not exceed 50%. According to the actual situation, this method has not been adopted by the vast majority of sports teams, with 56% of sports teams choosing other combinations.

Based on the above results, from the perspective of percentage, men's backstroke and breaststroke, women's butterfly and freestyle are the best combination. It is proved that this combination is the most frequently used in the competition at this stage. Only from the perspective of proportion, this combination is the combination with the highest proportion in all swimming styles. However, this combination cannot be determined as the best strategy combination based on the proportion of the 45 teams. Therefore, we also need to observe the statistical results of the difference selection method.

2.1.2 Statistical Analysis of Difference Selection Method in Traditional Selection Method

For the selection of the 4 × 100m medley relay for men and women, the American swimming team coach and world famous swimmer Phelps ’s coach Bowman once interviewed the previous day of the 2015 World Swimming Championships for the 4 × 100m mixed The swimming style selection of men and women in swimming will be explained. He said: “The backstroke and breaststroke of male athletes and the butterfly and freestyle of female athletes are not general rules, but in practice this is the best combination, because the difference between men and women in backstroke and breaststroke is greater than that of butterfly and Difference between men and women in freestyle.1

Table 1 -1 Analysis of the Difference in the Results of the 2015 World Swimming Championship Champion British Team

	Backstroke	Breaststroke	Butterfly stroke	Free stroke
Male Female	53.02 59.71	58.52 66.75	52.33 58.27	49.35 55.00
Difference	6.69	8.23	5.94	5.65
Ranking	2	1	3	4

Table 1-1 takes the results difference of the British team, the champion of the 2015 world swimming championship, as an example to make statistics. the actual combination of the British team is men's backstroke, men's breaststroke, women's butterfly and women's freestyle. According to the difference statistics, the difference between men and women in breaststroke is 8.23 seconds, with the largest difference ranking first. The difference between men and women in backstroke is 6.69 seconds, with the difference ranking second. The difference between butterfly and freestyle is 5.94 seconds and 5.65 seconds respectively, with the difference ranking third and fourth. From this difference, we can clearly see that the projects with large difference are men's and the projects with small difference are women's. The order of the difference is the same as the actual combination order.

Table 1 -2 Analysis of the Difference in the Results of the Fourth Place Chinese Team in the 2015 World Swimming Championships

	Backstroke	Breaststroke	Butterfly stroke	Free stroke
Male Female	52.89 59.02	60.96 66.55	51.66 57.48	47.84 53.91

[1] Robert Gibbs.USA MIXED MEDLEY RELAY:A CLOSER LOOK AT THE OPTIONS[N].Swimswam,2015.8.4(8)

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Difference	6.13	5.59	5.82	6.07
Ranking	1	4	3	2

According to the statistics in Table 1-2, it is also the top eight relay teams in the 2015 World Championship. The actual combined order of the fourth Chinese team is also men's backstroke, men's breaststroke, women's butterfly and women's freestyle. However, according to the difference statistics, the difference between men and women in backstroke is 6.13 seconds, ranking first with the largest difference. The difference between men and women in freestyle was 6.07 seconds, ranking second. The difference between butterfly stroke and breaststroke is 5.82 seconds and 5.59 seconds respectively, ranking third and fourth. From this difference, we can clearly see that men are selected for the events with large difference and women are selected for the events with small difference. Then, the combination of Chinese team is men's backstroke, women's breaststroke, women's butterfly and men's freestyle. However, the order of the Chinese team's appearance is still in accordance with the ratio selection method, which uses men's backstroke, men's breaststroke, women's butterfly and women's freestyle, so the order of the difference is not consistent with the actual combination order. If the Chinese team uses the combination sequence of difference selection method, it is likely to reach the top three in the 2015 world championship finals. However, as a decision-making level, the national team does not only consider this method.

According to the statistics of the difference selection method, the actual selection combination method and the difference selection combination method are the same for 20 out of 36 teams, accounting for 56% of the total. Different from the difference selection combination method, there are 16 teams, accounting for 44%. So far, we can only use the ratio and difference method to arrange the combination. Although the best selection method of evaluation difference selection is the most intuitive and commonly used one, its scheme is single, and it can not give more options.

Based on the above statistics and analysis, it can be concluded that there are two traditional selection methods for men's and women's 4 × 100 meter medley relay: difference selection method and ratio selection method

The difference selection method has a high proportion in practical application, accounting for 56.6% of the actual selection combination. Through analysis of the results of the difference selection method and the actual results, there is no difference between the two. This shows that the difference selection method is one of the feasible methods in practical application, but through its proportion in practical application, it can be seen that there are still more combinations that do not come from the difference selection method.

Ratio selection method is widely used in the world's highest-level teams. Through the statistics of 45 teams, the proportion of men swimming backstroke and breaststroke, women swimming butterfly and freestyle is the highest. It shows that it is also one of the feasible methods in practical application, but the combination of ratio selection method accounts for about 44% of the actual selection combination. Through the analysis of the results of the ratio selection method and the actual results, there is no difference between the two. Although there is no difference between the two, it can be seen from their proportion in practice that many teams have not adopted this selection method for combination.

3. Conclusion

The traditional selection method for men's and women's 4 × 100m medley relay. Judging from the ratio selection method, men should be selected to take part in backstroke and breaststroke, and women should be selected to take part in butterfly and freestyle, which is the best combination method for the gender ratio in the men's and women's 4 × 100m medley relay. From the perspective of the difference selection method, the difference calculation is first carried out on the difference between the male and female sub-results of each project. Men take part in events with a large gap between men's and women's performance, while women take part in events with a small gap between men's and women's performance. This is the best combination for men and women to achieve the best results in the 4×100 meter medley relay.

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