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Performance analysis of elite junior male athletes in the 800m (2021-2024) in Taiwan and Japan

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Abstract
This study conducted a comparative analysis of the performances of elite junior male athletes from Taiwan and Japan in the 800-meter preliminary and final races from 2021 to 2024. The research aimed to explore performance differences between the athletes from the two countries under different competition formats. Data sources included YouTube race videos and official result reports, with lap-by-lap analysis conducted using video analysis software. The results revealed that Taiwan's competition format, which adopts the "Top N from each group + fastest losers advance" model, encouraged athletes to maintain a conservative pace in the preliminaries, focusing on advancing smoothly and delivering stronger performances in the finals. In contrast, Japan's "time-based qualification" format led athletes to exert maximum effort in the preliminaries, resulting in excessive fatigue that adversely affected their final race performances. The design of Taiwan's format allowed athletes to conserve energy and perform exceptionally in the finals, whereas Japan's athletes exhibited intense competition in the preliminaries but suffered from depleted energy in the finals. Regarding pacing strategies, Taiwanese athletes generally adopted positive splits, while Japanese athletes showed a mix of positive splits in two years and negative splits in the other two years. Taiwanese athletes performed relatively poorly in the second lap, with a greater disparity between their first and second lap performances compared to Japanese athletes. Overall, Japanese athletes slightly outperformed Taiwanese athletes in the finals. The findings indicate that athletes' pacing strategies, competition format design, and energy management are closely interrelated and significantly influence race outcomes. This study suggests that Taiwanese athletes should enhance their second-lap pacing control and consider adjusting competition format designs to improve competitiveness on the international stage.

Keywords: Qualification design, pacing strategy, positive splits, negative splits

Introduction
The 800-meter race, as a middle-distance running event, requires athletes to complete a significant distance within a limited time, requiring efficient energy distribution and pacing control [1, 2]. Athletes must have the ability to start quickly and maintain steady output for optimal performance. A well-designed pacing strategy is crucial in 800-meter races, allowing athletes to manage fatigue and sustain competitive form throughout the race [2-6].

In the finals, while speed and endurance are crucial, pacing strategies must be dynamically adjusted based on race conditions. An athlete's energy reserves and psychological state fluctuate throughout the race, directly affecting their pacing decisions. Each strategy has a significant impact on the final performance [7-10]. Pacing strategies are generally categorized as positive splits, negative splits, and even splits. The choice of strategy depends on factors such as physical fitness, psychological resilience, and track conditions. Athletes must select the optimal strategy based on their individual characteristics to enhance performance [3-6,9-11].

This study analyzes the 800-meter performances of junior male athletes in the Taiwan Middle School Athletic Games (Taiwan-MSAG) and the Japan Junior High School Championships (Japan-JHSC) from 2021 to 2024. It examines performance differences across various stages, variations in pacing strategies, and their effects on outcomes, aiming to provide insights for optimizing race performance and guiding coaches in formulating training strategies.

Literature Review: This study analyzes the performance of junior male athletes in the 800-meter finals in Taiwan and Japan from 2021 to 2024,

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focusing on pacing strategies, energy distribution, and their impact on final results. The research data includes the athletes' split times for the first and second laps in the final, as well as the changes in total time between the preliminaries and the final race. Through this data, the study investigates the application of various pacing strategies and their relationship with performance, revealing the crucial role of pacing and energy management in improving 800-meter results.

Taiwan and Japan's Elite Junior High School Track and Field Competitions

The Taiwan Middle School Athletic Games (Taiwan-MSAG) and the Japan Junior High School Championships (Japan-JHSC) are the highest-level track and field events for junior athletes in Taiwan and Japan, attracting top athletes from across the country. These competitions are highly competitive and influential. The Taiwan-MSAG is held annually in April, while the Japan-JHSC takes place every August [12, 13]. Among these events, the 800-meter race is particularly notable for its dual challenge of physical and mental endurance. Athletes must complete a relatively long distance in a short time, requiring not only excellent explosiveness and endurance but also precise pacing and effective energy management [9, 10]. The race requires athletes to maintain high speed in the first half without excessive fatigue, followed by an effective sprint in the latter half, demanding physical capacity, strategic planning, and mental fortitude [14]. For junior male athletes, who are still in the process of learning techniques and tactics, they have not yet fully mastered optimal pacing strategies and energy regulation methods. This study focuses on their performance to analyze the impact of pacing strategies and energy distribution on final results, providing empirical evidence for future training and competitions, and further revealing the crucial role of pacing strategies in the 800-meter race.

Pacing Strategies

In middle- and long-distance races, different pacing strategies can significantly affect athletes' performance. These strategies primarily include Even-split, Positive-split, Negative-split, and Sit-and-kick. Pacing strategies not only reflect the athletes' physical condition and tactical arrangements but are also influenced by factors such as track conditions, competition, and the overall situation of the race. Therefore, selecting an appropriate strategy is not only the result of scientific training but also a flexible response to the changing dynamics of a race. Below is an introduction to each pacing strategy:

Even-split [1-8, 14-17]: Even-split refers to athletes maintaining a steady pace throughout the race, with lap times for each 400-meter segment being nearly identical. This strategy is generally suited for races that demand high endurance and consistency. Studies have shown that this strategy is ideal for athletes with good endurance, as evenly distributed effort helps maximize performance. The advantages of this strategy include energy conservation, as steady pacing reduces energy wastage caused by fluctuating speeds, and ease of control, making it suitable for athletes who can precisely manage race tempo, especially when speed variation is limited. However, a major disadvantage of the even-split strategy is its inability to adapt to sudden changes

in the race. If the race requires a quick acceleration or responding to an opponent's surge, the athlete may find themselves at a disadvantage. In races like the 800 meters, which require a fast start to establish position, even-split pacing may not be optimal to meet these high-intensity demands.

Positive-split [3-9, 16, 18]: Positive-split refers to athletes running faster in the first half of the race but slowing down in the second half due to fatigue. This strategy is often used to secure an early lead through a fast start and then attempt to maintain that advantage in the second half. A study by Tucker *et al.* [7] analyzed the split times of 26 men's 800-meter world records from 1912 to 1997, finding that the second lap time in men's 800-meter races was significantly slower than the first lap, with an average time of 52.0 seconds (±1.7 seconds) in the first lap and 54.4 seconds (±4.9 seconds) in the second lap. Only two world records showed a faster second lap than the first. This indicates that the pacing of the 800-meter race is often characterized by a fast start, with athletes unable to maintain the same speed throughout the race. The advantages of a positive-split strategy include securing a position advantage, as a fast start helps avoid congestion, particularly in the inner lanes, and an aggressive approach, which is especially suitable for athletes with strong speed capabilities who wish to dominate the race. However, the drawbacks include uneven energy distribution, leading to difficulty maintaining high speed in the latter part of the race, and a high demand on stamina, requiring athletes to have strong endurance and recovery capabilities to effectively execute this strategy.

Negative-split [1, 3-10, 18-20]: Negative-split refers to athletes accelerating in the second half of the race, usually after conserving energy in the first half. The main advantage of this strategy is that by saving energy in the first half, athletes can increase their speed in the second half to achieve their best performance. However, the negative-split strategy has obvious drawbacks. First, a slower pace in the first half may place the athlete in a disadvantageous position, such as being boxed in or falling behind the leaders. Second, this strategy places a high mental demand on athletes, who must have confidence in their ability to manage their pace and generate a strong finish. The negative-split strategy is suited for athletes who excel in tactical racing or have a powerful finishing kick, particularly when the early phase of the race is slower.

Sit-and-kick [21]: The Sit-and-kick strategy is similar to the negative-split, where athletes slow their pace in the early and middle parts of the race, waiting for the optimal moment to sprint. This strategy is common among athletes with strong explosive power, especially in highly competitive races where it can become a decisive factor. Athletes maintain position in the main pack during the early stages to conserve energy and then accelerate in the final lap (or the last 200 meters) to overtake opponents. The advantages include minimizing energy expenditure in the early stages and utilizing a burst of speed in the final moments to suppress competitors and secure a lead. However, the drawbacks are also significant. First, it is vulnerable to opponents' surges. If an opponent accelerates or creates a gap, the sit-and-kick strategy may fail to deliver its advantage. Second, this strategy requires high explosive

power, and if an athlete lacks energy in the final stages of the race, they may be unable to execute an effective sprint.

Common Advancement Systems in 800M Races [22, 23]
Top Finishers in Each Group + Fastest Losers Advancement System
This system balances the competitiveness within each group and the overall performance of all athletes, ensuring fairness and diversity in the advancement process. It is widely used in international athletics events and is referred to as 'Top N in each heat + fastest losers'. Specifically, athletes who place in fixed positions (e.g., the top 1 in each group) will automatically advance (Automatic Qualifiers), while those who do not directly qualify are selected based on their overall performance, with additional spots allocated for the 'fastest losers.' This design effectively balances fairness and competition, preventing unfair advancement due to group disparities and giving every athlete an opportunity to showcase their abilities. The 800M qualification system for Taiwan-MSAG follows this design. For example, in 2024, there were four preliminary groups, with the top 2 from each group automatically advancing, plus 8 'fastest losers' (2 per group, with a total of 8 selected from the best times), resulting in 16 advancing to the semifinals. The semifinals and final each had 2 groups (16 people), with the top 2 from each group automatically advancing, plus 4 'fastest losers' advancing to the final.

Pure Time-Based Advancement System
This system solely depends on athletes' performance, selecting the top 8 fastest times from the preliminaries to advance to the finals, without considering group assignments. It is referred to as 'Time-Based Qualification' or simply 'Top N by Time.' The feature of this system is that performance is the only criterion, eliminating the impact of group disparities on the advancement results. Athletes are required to give their best effort during the preliminaries, reducing tactical reserves, making it suitable for highly competitive events, and fairly reflecting each athlete's abilities. It ensures that only truly capable athletes advance to the finals. The Japan-JHSC 800M uses this design. For example, in 2024, there were 17 preliminary groups (135 athletes), and the top 8 fastest times advanced to the final.

Timed Finals by Heat
This system is typically used for smaller competitions with limited time or large numbers of participants. Athletes proceed directly to the final and are divided into multiple groups. Athletes are grouped according to their performance, with the strongest athletes placed in the 'fast group,' and final rankings are determined based on the times in each group. This system saves time and venue resources, making it suitable for one-day or smaller-scale events, and ensures that the best-performing athletes win, regardless of group assignments. However, athletes in the 'slow group' may lack the motivation to compete against stronger opponents, which can affect their performance.

Research Methodology
Data Collection
Race Video Analysis: This study downloaded race videos of the 800m junior male athlete preliminaries and finals in Taiwan and Japan from the YouTube platform between 2021 and 2024 [24-31]. These videos were analyzed using SHOTCUT video software. This method allowed us to precisely extract lap times and athletic performance data for each athlete, ensuring the accuracy and reliability of the data.

Official Results Reports
Official results reports were also obtained, which include detailed data on the athletes' performances in different stages (preliminaries and finals) [32-36]. These result reports assist in comparative analysis of the differences between the preliminary and final performances. To improve readability, the results are presented in total seconds, avoiding the complexity of minute and second conversions, thus simplifying data comparisons. The standardized format facilitates the calculation of averages, differences, and other indicators, promoting statistical analysis and international comparisons, thereby improving the efficiency and professionalism of data processing.

Data Analysis
Calculate the Average Performance for Each Year
The average performance for each athlete in the preliminaries and finals is calculated each year. By evaluating the overall performance trends, this provides the foundational data for subsequent analysis.

Analyze Extreme Values
Identify the fastest and slowest lap times and explore how these extreme values impact the final results. Extreme value analysis helps identify athletes with abnormal performances and allows for an analysis of their pacing strategies, energy distribution, and tactics' impact on final results.

Compare Pacing Strategies between the First and Second Laps
Analyze the difference in pacing strategies between the first and second laps, and evaluate the athletes' strategies. By comparing the lap times of the two laps, we examine whether the athletes adopted a positive pacing strategy (faster first lap, slower second lap), negative pacing strategy (slower first lap, faster second lap), or an even pacing strategy (consistent pace throughout). Based on the implementation of these strategies, their impact on performance will be explored, alongside an in-depth analysis of the athletes' physical condition and psychological adjustments.

Use Statistical Analysis to Explore the Relationship between Pacing Strategies and Final Performance:
Statistical analysis methods will be employed to explore the correlation between pacing strategies and final results, determining the role of various factors in performance differences.

Results and Discussion
Comparison of Taiwan and Japan's Elite Junior Male Athlete 800m Preliminary and Final Results
The results of Taiwan and Japan's junior male athlete 800m competition in the preliminaries and finals from 2021 to 2024 are summarized in Table 1 and Figure 1. From the average results over the four years, Taiwan's athletes had final results ranging from 118.14 seconds to 122.75 seconds, while Japan's athletes ranged from 117.34 seconds to 118.76 seconds. This indicates that Japan's athletes generally performed slightly better than Taiwan's. However, the

difference in preliminary results between Taiwan and Japan's junior male athletes is significant, which reflects the differences in the qualification systems between the two countries. Taiwan adopts the "Top in Group + Best Selection" system, allowing athletes to conserve energy in the preliminaries and focus on advancing rather than pushing for the fastest time. As a result, Taiwan's athletes' preliminary times are slower, but their final performance tends to be better. In contrast, Japan's qualification system is "Fastest Advancing," requiring athletes to compete at full effort in the preliminaries to secure a spot in the top 8, which leads to stronger preliminary results. However, due to excessive energy expenditure and insufficient recovery, athletes' performances typically decline in the finals. This system-based difference explains the significant discrepancy in performance between the preliminaries and finals for athletes from the two countries.

From 2021 to 2024, Taiwan's athletes generally performed better in the finals than in the preliminaries, while Japan's athletes showed a slight decline in final results compared to their preliminary times. For Taiwan, the final times improved relative to the preliminaries in 2021, 2023, and 2024 by 4.43 seconds, 4.55 seconds, and 2.41 seconds, respectively. This suggests that Taiwan's athletes tend to conserve energy in the preliminaries and focus on advancing, rather than aiming for the fastest time. Thus, the design of Taiwan's qualification system enables athletes to perform better in the finals.

On the other hand, Japan's athletes' results are different. According to the data, Japan's athletes' final times were slightly slower than their preliminary times each year. The time difference between the preliminaries and finals for 2021, 2022, 2023, and 2024 were 0.76 seconds, 0.63 seconds, 0.81 seconds, and 2.02 seconds, respectively. Since Japan's qualification system requires athletes to give their maximum effort in the preliminaries to secure a spot in the top 8, this leads to significant energy expenditure in the early rounds, and without full recovery, performance in the finals tends to be adversely affected.

Moreover, the performance differences show that Taiwan's athletes experience a larger gap between their preliminary and final results, reflecting their ability to conserve energy in the system's setup and focus more effectively on the finals. In contrast, Japan's athletes tend to exhaust themselves in the preliminaries, leading to poorer final results. This highlights the different competition designs in the two countries: Taiwan's system is more strategic, allowing athletes to conserve energy and perform better in the finals, while Japan focuses more on competitive intensity, which can lead to fatigue affecting final performance.

In conclusion, the performance differences between Taiwan and Japan in the 800m competition are primarily due to the differences in qualification system design. Taiwan's system emphasizes strategy, allowing athletes to conserve energy and perform better in the finals, whereas Japan emphasizes full effort in the preliminaries to enhance competitive intensity, which, however, may lead to fatigue and negatively affect final results. Therefore, Taiwan might consider adjusting its qualification system to balance competitive intensity with strategy, incorporating some elements of the "Fastest Advancing" system to increase athletes' competitiveness in the preliminaries, ultimately improving overall performance.

Table 1: Comparison of Taiwan and Japan Elite Junior Male Athlete 800m Preliminary and Final Results

Year	Taiwan			Japan		
	Preliminary Average Time (sec)	Final Average Time (sec)	Difference (Final -Preliminary) (sec)	Preliminary Average Time (sec)	Final Average Time (sec)	Difference (Final -Preliminary) (sec)
2021	122.57	118.14	-4.43	118.00	118.76	0.76
2022	121.74	122.75	1.01	117.26	117.89	0.63
2023	124.34	119.79	-4.55	116.53	117.34	0.81
2024	122.94	120.53	-2.41	116.12	118.14	2.02
Average	122.89	120.30	-2.59	116.98	118.03	1.05

a). Taiwan's qualification system: Top N in each heat + fastest losers (Top N in each heat + fastest losers).
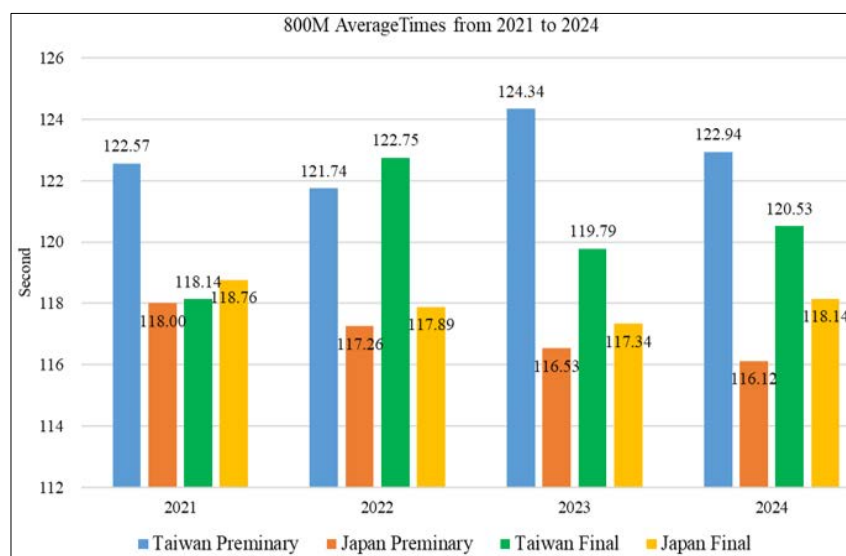b). Japan's qualification system: Time-Based Qualification.

Fig 1: Comparison of Taiwan and Japan Elite Junior Male Athlete 800m Preliminary and Final Average Results

Analysis of Taiwan and Japan Elite Junior Male Athlete 800m Final Results Distribution

The final results of the Taiwan and Japan Junior Male Athlete 800m races from 2021 to 2024, summarized in Table 2, reveal several key aspects. Taiwan's final average time fluctuated between 118.14 seconds and 122.75 seconds, with an average of 120.30 seconds, while Japan's final average time ranged from 117.34 seconds to 118.76 seconds, with an average of 118.03 seconds, slightly better than Taiwan. Despite different race structures, Taiwan's performance is more variable, with an overall level slightly lower than Japan's. Taiwan's fastest final result improved from 115.28 seconds in 2021 to 117.62 seconds in 2024, and its slowest result increased from 120.19 seconds in 2021 to 125.16 seconds in 2024. In contrast, Japan's fastest final result ranged from 117.12 seconds in 2021 to 115.86 seconds in 2024, while the slowest result decreased from 124.63 seconds in 2021 to 123.56 seconds in 2024. The difference between Japan's fastest and slowest results is relatively small, indicating better consistency. Taiwan's slowest results are generally higher and more variable, reflecting less stability in final performance compared to Japan.

Taiwan's final result difference (slowest - fastest) averaged 6.55 seconds over the four years, showing noticeable performance fluctuation. Japan's final result difference

averaged 6.12 seconds, which is relatively smaller, suggesting more consistent performance. This further indicates that Taiwan's final results are less stable compared to Japan's. The race system used by each country also has an impact on performance. Taiwan employs a "Top N in each heat + fastest losers" system, where athletes do not need to give their maximum effort in the preliminary rounds and semifinals, allowing them to conserve energy for the final. While this system helps preserve energy, the longer race duration may increase physical strain and affect final performance. In contrast, Japan uses a "Time-Based Qualification" system, requiring athletes to give their all in the preliminary rounds to secure a top 8 finish. This system leads to greater energy expenditure in the preliminaries, but Japan's advantage in recovery and race strategy helps them maintain high performance levels in the final.

Overall, Japan's elite junior male athlete 800m final results are slightly better in terms of both performance and consistency. Taiwan's results fluctuate more and often fail to reach expected levels in the final, while Japan, despite exerting more effort in the preliminary rounds, tends to perform better in the final. This difference reflects Japan's advantage in managing athletic conditioning and recovery. Taiwan could consider adjustments to the race system and improvements in athlete conditioning to enhance performance in the final and reduce the gap in results.

Table 2: Distribution of Taiwan and Japan Elite Junior Male Athlete 800m Final Results

Year	Taiwan				Japan			
	Final Average (sec)	Final Fastest (sec)	Final Slowest (sec)	Final Difference (Slowest - Fastest) (sec)	Final Average (sec)	Final Fastest (sec)	Final Slowest (sec)	Final Difference (Slowest - Fastest) (sec)
2021	118.14	115.28	120.19	4.91	118.76	117.12	124.63	7.51
2022	122.75	119.26	126.19	6.93	117.89	115.20	119.84	4.64
2023	119.79	116.42	123.27	6.85	117.34	114.85	119.47	4.62
2024	120.53	117.62	125.16	7.54	118.14	115.86	123.56	7.70
Average	120.30	117.15	123.70	6.55	118.03	115.76	121.88	6.12

Lap-by-Lap Performance and Pacing Analysis of Taiwan and Japan Elite Junior Male Athlete 800m Finals

The lap-by-lap performance of Taiwan and Japan's Junior Male Athletes in the 800m finals from 2021 to 2024 is summarized in Table 3 and Table 4, focusing on pacing strategies and lap times. Taiwanese athletes consistently employed a positive split strategy over the four years, where the first lap was faster, followed by a gradual slowdown in the second lap. The average first lap time for Taiwan was 57.95 seconds, which was 0.8 seconds faster than Japan's, demonstrating stronger explosiveness at the start. However, the average second lap time for Taiwan was 62.41 seconds, 3.12 seconds slower than Japan's 59.29 seconds. This indicates insufficient energy management in the latter half of the race, leading to an inability to maintain stable performance and ultimately affecting the overall result.

In contrast, Japanese athletes used two different pacing strategies over the four years: positive split (2023, 2024) and negative split (2021, 2022). Japan's lap times were more consistent, with an average difference of only 0.54 seconds between the first and second laps, suggesting more balanced

pacing. Notably, under the negative split strategy, Japan showed significant improvement in the second lap (e.g., 57.85 seconds in 2022), reflecting good energy management and race strategy. Japanese athletes were able to close the gap in the second lap and achieve better overall results.

Overall, Japan's average total time over the four years was 118.03 seconds, 2.27 seconds faster than Taiwan's 120.30 seconds. This difference is largely attributable to Japan's stability and improved performance in the second lap. While Taiwanese athletes demonstrated strong performances in the first lap, excessive energy expenditure at the start often led to fatigue in the second lap, negatively impacting their overall results.

To improve overall performance, Taiwanese athletes should adjust their training focus, particularly on enhancing endurance and speed maintenance in the second lap. Experimenting with a more balanced pacing strategy in future races may also yield better outcomes. In conclusion, Japan's stability and flexible pacing strategies provided them with a competitive edge, offering valuable insights for improving Taiwan's future training and race strategies.

Table 3: Lap-by-Lap Average Results and Pacing Strategy of Taiwan Elite Junior Male Athlete 800m Finals

Year	Taiwan				
	1st Lap Average (sec)	2nd Lap Average (sec)	Difference(2nd-1st) (sec)	Final Average (sec)	Pacing Strategy
2021	57.29	60.84	+3.55	118.14	Positive Split
2022	58.78	63.96	+5.18	122.75	Positive Split
2023	57.91	62.23	+4.32	119.79	Positive Split
2024	57.81	62.63	+4.82	120.53	Positive Split
Average	57.95	62.41	+4.46	120.30	

Table 4: Lap-by-Lap Average Results and Pacing Strategy of Japan Elite Junior Male Athlete 800m Finals

Year	Japan				
	1st Lap Average (sec)	2nd Lap Average (sec)	Difference(2nd-1st) (sec)	Final Average (sec)	Pacing Strategy
2021	59.90	58.86	-1.04	118.76	Negative Split
2022	60.04	57.85	-2.19	117.89	Negative Split
2023	57.43	59.90	+2.47	117.34	Positive Split
2024	57.62	60.53	+2.91	118.14	Positive Split
Average	58.75	59.29	+0.54	118.03	

Analysis of Average and Extreme Performance in the Elite Junior Male Athlete 800m Final of Taiwan and Japan

The average and extreme performances of Taiwan and Japan in the Junior Male Athlete 800m finals are shown in Figure 2. Firstly, the performance of Taiwanese athletes shows greater fluctuations, particularly in the second lap, where their speed decreases more significantly. Notably, performances in 2022 and 2024 exhibited larger fluctuations. For example, in 2022, the second lap average time was 63.96 seconds, which was 5.18 seconds slower than the first lap time of 58.78 seconds, indicating greater instability. This may be attributed to energy distribution or strategic planning, especially in managing physical endurance during the latter half of the race, which led to weaker second-lap performance. In contrast, Japan athletes showed more stability in their lap performances, with the difference between their fastest and slowest times being relatively small in both laps. For instance, in 2023, the first lap time for Japan athletes was 57.43 seconds, while the second lap time was 59.58 seconds, with only a 2.15-second difference, demonstrating a more balanced pacing strategy. This suggests that Japan athletes distribute their energy more effectively throughout the race, maintaining a high level of performance in both the initial and final stages.

Overall, Taiwan athletes displayed more variability in performance, especially showing instability in fatigue and energy loss during the second lap. Meanwhile, Japan athletes were able to maintain consistent performance with more balanced energy distribution and better strategic execution. This indicates that Taiwan athletes may consider enhancing their training for the latter half of the race and adjusting their strategies to improve overall race stability, narrowing the gap with Japan athletes.
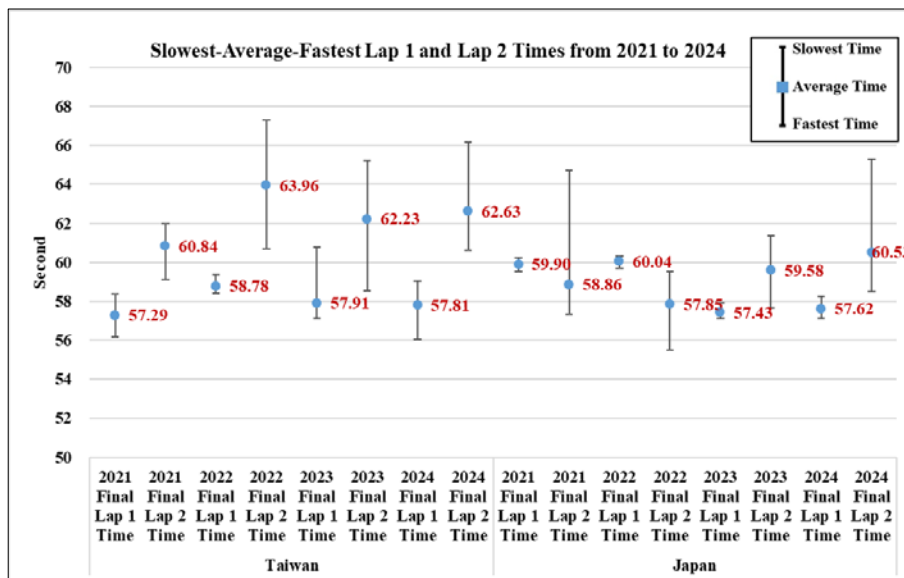

Fig 2: Average Lap Time and Extreme Distribution of Taiwan and Japan Elite Junior Male Athlete 800m Finals

R² Analysis of the Final Ranking and Time Performance of Elite Junior Male Athletes in the 800m Final (Taiwan VS Japan)

In the analysis of the 800m final performances of junior male athletes from Taiwan and Japan, the second lap time shows a significant impact on the final ranking. Based on the R^2 analysis from Table 5 and Table 6, the correlation between the second lap time and ranking is stronger than that of other variables across the four years of data, and its influence varies over time.

For Taiwanese athletes, the correlation between the second lap time and ranking is extremely strong in 2022 and 2023, with R^2 values of 0.9494 and 0.9534, respectively. This indicates that performance in the second lap plays a critical

role in determining the final ranking. While this correlation fluctuates in 2021 and 2024, it remains relatively high, with R^2 values of 0.7275 and 0.6432. Despite variations over the years, second-lap performance consistently emerges as a critical factor.

The correlation between the first lap time and ranking varies significantly. For example, in 2021, an R^2 value of 0.9971 indicates a very strong correlation, but this sharply decreases in 2022 and 2023, reflecting a weaker influence of first-lap performance on the final ranking. Similarly, the correlation between the second lap time and the time difference between the two laps shows substantial fluctuations, with particularly low correlations in 2021 and 2024 (R^2 values of 0.2538 and 0.1164, respectively). However, the correlations in 2022 and 2023 are relatively higher, though still lower than the second lap time's correlation with ranking.

For Japanese athletes, the correlation between the second lap time and ranking is exceptionally strong in 2022 and 2023, with R^2 values of 0.9493 and 0.9689. Even in 2024, the R^2 value remains strong at 0.7395, indicating that second-lap performance continues to be a significant determinant of final ranking. In comparison, the correlation between the first lap time and ranking in 2022 and 2023, while relatively strong (R^2 values of 0.8902 and 0.7486), is still lower than the second lap's impact. The correlation between the second lap time and the time difference between the two laps is weaker in 2021 ($R^2 = 0.2949$), and though it rises from 2022 to 2024, it remains less impactful than the second lap time itself.

For both Taiwanese and Japanese athletes, the correlation between the second lap time and final ranking has consistently been the most decisive factor across the four years of competition. The performance in the second lap has a stronger influence on final ranking than first-lap performance or the time difference between the two laps. This relationship is particularly evident in 2022 and 2023, where the second lap time most effectively explains the final ranking. Therefore, for both groups of athletes, the second lap time is a more reliable predictor of final rankings in the 800m competition.

Table 5: R^2 Analysis of Final Ranking and Time Performance for Taiwan Elite Junior Male Athletes in the 800m Final

Year	Taiwan					
	1st Lap vs. Rank	R^2 Classification	2nd Lap vs. Rank	R^2 Classification	(2nd Lap - 1st Lap) vs. Rank	R^2 Classification
2021	0.9971	Very Strong Relationship	0.7275	Strong Relationship	0.2538	Low Relationship
2022	0.0788	Very Low Relationship	0.9494	Very Strong Relationship	0.9022	Very Strong Relationship
2023	0.2985	Low Relationship	0.9534	Very Strong Relationship	0.6250	Strong Relationship
2024	0.6432	Strong Relationship	0.6389	Strong Relationship	0.1164	Very Low Relationship

Table 6: R^2 Analysis of Final Ranking and Time Performance for Japan Elite Junior Male Athletes in the 800m Final

Year	Japan					
	1st Lap vs. Rank	R^2 Classification	2nd Lap vs. Rank	R^2 Classification	(2nd Lap - 1st Lap) vs. Rank	R^2 Classification
2021	0.0276	Very Low Relationship	0.5558	Moderate Relationship	0.5586	Moderate Relationship
2022	0.8902	Very Strong Relationship	0.9493	Very Strong Relationship	0.9109	Very Strong Relationship
2023	0.2949	Low Relationship	0.9689	Very Strong Relationship	0.9259	Very Strong Relationship
2024	0.1177	Very Low Relationship	0.7486	Strong Relationship	0.7395	Strong Relationship

Conclusion

This study compares the performance of Taiwan and Japan elite junior athletes in the 800m race from 2021 to 2024, highlighting significant differences in race format design, pacing strategies, and energy distribution between the two countries.

Taiwan's Top N + fastest loser qualification system encourages athletes to adopt a more conservative pace during the heats, enabling them to conserve energy and perform better in the finals. Conversely, Japan's time-based qualification system requires athletes to push their limits in the heats, enhancing their competitiveness but also leading to excessive energy expenditure, which can negatively affect their final performance.

In terms of pacing strategies, Taiwanese athletes generally follow a positive pacing strategy, with faster first laps followed by slower second laps. Japanese athletes exhibit more diverse pacing patterns, alternating between positive pacing in some years and negative pacing strategies—where the second lap is faster—in others. Additionally, Japanese athletes demonstrate smaller time differences between their first and second laps, reflecting greater pacing stability compared to their Taiwanese counterparts. Despite these differences, Japanese athletes, on average, slightly outperform Taiwanese athletes in the final results.

The findings suggest that pacing strategy, race format design, and energy management are closely interconnected and significantly influence race outcomes. For future training, Taiwanese athletes could focus on improving second-lap pacing control and consider adjustments to the race format to enhance their competitiveness on the international stage. Tailored training regimens emphasizing pacing stability and energy optimization may provide a competitive edge for both countries' athletes in high-stakes races.

Reverences

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