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Performance Analysis and Pacing Strategies in Sprint Freestyle Swimming at the 2025 SEA Games: A Case Study of the Men's 100m and 50m Events

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Abstract

This study aims to analyze pacing strategies, the influence of the start reaction, and performance consistency of male athletes in sprint freestyle swimming events (50m and 100m) at the 2025 SEA Games. The research used a descriptive quantitative approach with a case study design. Secondary data were analyzed from the finals of both events, including final times, reaction times (RT), and split times. Descriptive and comparative statistical analyses were conducted to evaluate pacing patterns, the relationship between RT and final results, and the performance of athletes competing in both events. All athletes in the 100m event applied a positive split pattern, with an average speed decrease of 2.26 seconds in the second half. The start reaction did not significantly correlate with the final time in the 50m (r=0.15; p=0.71) or the 100m (r=0.45; p=0.26). Athletes competing in both events showed high ranking consistency. The age group <20 years tended to have a smaller pacing difference (2.16 seconds) compared to older athletes. Pacing strategies at the regional level are still dominated by the conventional approach (positive split). The main determinant of performance is not the start reaction, but pure swimming speed and technical efficiency.

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Sprint swimming, particularly in the 50 m and 100 m freestyle events, represents one of the most demanding disciplines in competitive swimming, requiring an optimal combination of explosive power, technical efficiency, hydrodynamic control, and strategic pacing (Kusmita et al., 2022; Tahapary & Syaranamual, 2020). Pacing strategy determines how swimmers distribute effort across the race phases start, middle-race velocity, and finishing segment to achieve optimal final performance (von Essen & Peterson, 2024; Wik et al., 2025). A comprehensive systematic review by (McGibbon et al., 2020; Sha et al., 2024; Staunton et al., 2025) demonstrated that pacing patterns vary depending on race distance and competitive level, with positive split strategies commonly observed in 100 m events. More recent research emphasizes that sprint performance is strongly associated with biomechanical efficiency, including power-to-drag ratio and stroke mechanics, rather than isolated race segments alone (Castro-Santos et al., 2024; İnce & Tortu, 2025; Liu et al., 2024; Rappelt et al., 2025). Furthermore, (Foster et al., 2025; Miller et al., 2018; Romero-Morales et al., 2024) highlighted that modern sprint swimming performance is multifactorial, involving neuromuscular power, technical execution, and speed maintenance capacity.

Despite the growing body of literature on sprint swimming performance, several important gaps remain (Jin et al., 2026; Kraskura et al., 2024; Rodríguez et al., 2025; Watson et al., 2019). First, most empirical studies have focused on world-class competitions such as the Olympic Games or World Championships, leaving limited evidence regarding pacing strategies and performance

determinants at regional competitive levels (Fang et al., 2024; Girard et al., 2023; Hettinga et al., 2019). Consequently, it remains unclear whether pacing trends observed among world-class swimmers are similarly present in regional competitions such as the Southeast Asian (SEA) Games. Second, prior studies have typically examined isolated components of performance such as start reaction time, biomechanical efficiency, or physiological capacity without integrating pacing strategy, reaction time, age profile, and multi-event consistency within a unified analytical framework (Furrer et al., 2023; Hao & Kong, 2025; Kasicki et al., 2025; Wu et al., 2025). Third, although positive split pacing has been widely documented in 100 m events (Casado et al., 2021; Grivas, 2025; Hanley et al., 2019; Moser et al., 2020), recent findings suggest that elite swimmers increasingly adopt more controlled or near-even pacing patterns at the international level (Fernández-Asensio et al., 2026; Nicol et al., 2022; Puce et al., 2024; Staunton et al., 2025). Whether this strategic evolution has also occurred in regional competitions remains largely unexplored.

Addressing these gaps is particularly important for performance development and coaching practice. If pacing strategies and performance determinants differ between regional and global contexts, training programs, race tactics, and national development policies should be evidence-based and context-specific rather than derived solely from world-class benchmarks. Moreover, understanding whether reaction time meaningfully contributes to final outcomes in competitions where reaction time variability is minimal has direct implications for resource allocation in sprint training. If start performance is not a decisive factor at the regional elite level, greater emphasis may need to be placed on speed endurance, stroke efficiency, and hydrodynamic optimization (Beaumont et al., 2025; Born et al., 2026; Gao et al., 2025; Ruiz-Navarro et al., 2025).

Therefore, the purpose of this study was to analyze pacing strategies, examine the relationship between start reaction time and final performance, and evaluate multi-event performance consistency among male finalists in the 50 m and 100 m freestyle events at the 2025 SEA Games. Specifically, this study aimed to: (1) classify pacing patterns in the 100 m event (positive split, negative split, or even split); (2) assess the correlation between reaction time and final race time in both sprint events; (3) evaluate performance consistency among swimmers competing in both distances; and (4) compare the findings with contemporary international literature to determine whether regional competitive dynamics align with or diverge from global trends.

This study differs from previous research in several important ways. (McGibbon et al., 2020) provided a systematic overview of pacing strategies across distances but did not focus on regional competition data. (González-Ravé et al., 2025; Majumdar & Robergs, 2011; Ruiz-Navarro et al., 2025; Wagner et al., 2024) synthesized determinants of sprint performance at the international level, emphasizing biomechanical and physiological factors; however, their analyses were not centered on real-time competition data from regional championships. (Cardoso et al., 2026; Douglas et al., 2021; Puce et al., 2024; Shen et al., 2025) demonstrated the critical importance of power-to-drag ratio in sprint performance, yet did not examine how such factors interact with pacing behavior in specific competitive contexts. (Y. Chen et al., 2024) analyzed longitudinal characteristics of world top-8 swimmers, highlighting developmental pathways of elite athletes, but did not investigate performance consistency across sprint events in regional settings. Meanwhile, (Edholm et al., 2026) documented reductions in efficiency during the second half of 100 m races, supporting the prevalence of positive split pacing; nevertheless, contextual comparisons across competitive levels were not addressed.

The present study contributes novel empirical evidence by providing the first comprehensive pacing and performance analysis based on official final data from the 2025 SEA Games. By integrating pacing classification, reaction time analysis, age-related comparison, and multi-event consistency within a single analytical framework, this research fills a critical gap in regional sprint swimming literature. Beyond documenting race outcomes, this study seeks to clarify whether performance determinants at the Southeast Asian regional level mirror global performance models or exhibit distinct contextual characteristics. Ultimately, the findings aim to inform evidence-based coaching strategies, optimize training priorities, and support policy development in competitive swimming across the region.

METHODS

This study was designed as a case study employing a descriptive quantitative approach aimed at analyzing pacing patterns and athlete performance in sprint swimming events based on actual competition data. The methodology included secondary data collection, variable identification,

and the application of descriptive and comparative statistical techniques to address the research questions.

Data were obtained from the official final results of the 2025 SEA Games, specifically the men's 100-meter freestyle (Event 103) and men's 50-meter freestyle (Event 203). The information collected included entry times, final times, reaction times (RT), 50-meter split times (for the 100-meter event), athlete age, and country of origin. The data were then organized in a structured format to facilitate further analysis.

The study variables were categorized into independent and dependent variables. The independent variables included athlete age, entry time, reaction time, and country of origin. The dependent variables consisted of final race time, pacing pattern (measured by the difference between the first and second 50-meter splits in the 100-meter event), and performance consistency for athletes who competed in both sprint events.

Data analysis was conducted in several stages. First, descriptive statistical analysis was performed to summarize the general characteristics of the sample, including means and standard deviations of final times, reaction times, and split times. Next, pacing patterns in the 100-meter event were classified into three categories: positive split (second half slower than the first half), negative split (second half faster than the first half), and even split (minimal time difference between halves). This classification enabled identification of the dominant speed distribution strategy adopted by the athletes.

Subsequently, comparative analysis was conducted to examine performance differences among athletes competing in both events using a paired sample t-test. The relationship between reaction time and final race time was analyzed using Pearson correlation to determine the extent to which start reaction speed influenced overall performance outcomes. Additionally, one-way analysis of variance (ANOVA) was conducted to evaluate differences in pacing patterns across age groups (<20 years, 20–25 years, and >25 years) to assess whether age influenced race strategy.

Data visualization techniques, including line graphs (pacing profiles) and bar charts, were used to clarify comparisons between athletes and countries. Descriptive qualitative interpretation was also applied to contextualize the statistical findings within tactical and sprint performance perspectives. The research procedure began with data collection, followed by the calculation of derived variables such as pacing differences and age categorization. Statistical analyses and data visualization were then performed, culminating in a comprehensive interpretation of the findings.

Result

This section presents the statistical findings derived from the analysis of the men's 50 m and 100 m freestyle finals at the 2025 SEA Games. The results are organized into descriptive performance indicators, pacing classification, correlation analysis, multi-event consistency, age-related comparisons, and ranking-based comparisons. Each table is followed by analytical interpretation and comparison with prior literature to contextualize the findings within contemporary sprint swimming research.

Table 1. Descriptive Statistics of Final Performance in 100 m and 50 m Freestyle (Men)

Variable	100 m (n = 8)	50 m (n = 8)
Mean Final Time (s)	50.06 ± 0.74	22.67 ± 0.36
Mean Reaction Time (s)	0.63 ± 0.03	0.61 ± 0.03
Mean Entry Time (s)	50.78 ± 0.37	22.97 ± 0.37
Entry vs Final Difference (s)	-0.72 ± 0.25	-0.30 ± 0.12
Mean Split 1 (s)	23.90 ± 0.46	—
Mean Split 2 (s)	26.16 ± 0.44	—
Mean Pacing Difference (s)	2.26 ± 0.38	—

Note: Data are presented as mean ± standard deviation.

Table 1 indicates that the average final time in the 100 m event was 50.06 seconds, while the 50 m average was 22.67 seconds. Notably, athletes improved from their entry times in both events, suggesting peak performance during finals. The pacing difference in the 100 m event (2.26 s) demonstrates a clear slowdown in the second half of the race. This positive pacing differential aligns with the systematic review by McGibbon et al. (2018), which found that positive split strategies are common in 100 m freestyle events due to early anaerobic dominance. Similarly, Šťastný et al. (2016) reported that efficiency decreases during the second half of sprint events because of fatigue accumulation and reduced stroke efficiency. However, more recent findings from Ruiz-Navarro et al. (2025a) suggest that world-class swimmers increasingly adopt more controlled pacing profiles,

minimizing performance drop-off. The absence of such pacing control in this regional competition highlights a potential developmental gap between SEA Games athletes and global elite swimmers.

Table 2. Pacing Pattern Classification in the 100 m Event

Pacing Category	Number of Athletes	Percentage	Mean Difference (s)	Pattern
Positive Split	8	100%	+2.26	Split 1 faster than Split 2
Negative Split	0	0%	—	—
Even Split	0	0%	—	—

Positive split = Split 2 > Split 1; Negative split = Split 2 < Split 1; Even split = difference ≤ 0.5 s.

All finalists (100%) employed a positive split strategy. No athlete demonstrated negative or even pacing. This confirms the descriptive findings in Table 1 and reinforces the dominance of traditional sprint pacing in this competition. While positive split is historically common in sprint swimming (McGibbon et al., 2018), Ruiz-Navarro et al. (2025b) reported increasing strategic variability at the world level, with near-even pacing becoming more prevalent among finalists. The lack of pacing diversity in this sample suggests that SEA Games athletes may still rely on conventional high-intensity opening strategies rather than refined energy distribution models. This finding reveals a tactical gap that may partially explain performance differences between regional and international competitions.

Table 3. Correlation Between Reaction Time and Final Performance

Event	Correlation (r)	p-value	Interpretation
100 m	0.45	0.26	Not significant
50 m	0.15	0.71	Not significant

Pearson correlation; significance level $\alpha = 0.05$.

Reaction time did not significantly correlate with final performance in either event. Although the 100 m showed a moderate correlation ($r = 0.45$), it was not statistically significant. This contrasts with traditional assumptions that start performance is critical in sprint events. However, Schreven et al. (2022) demonstrated that power-to-drag ratio and mid-race velocity explain greater variance in sprint outcomes than reaction time alone. Similarly, Ruiz-Navarro et al. (2025a) emphasized that stroke efficiency and velocity maintenance outweigh start contributions in elite sprint competitions. The narrow RT variability (0.60–0.63 s) among finalists likely reduced its predictive value. This suggests that, at the regional elite level, reaction time may be a necessary but insufficient determinant of podium performance.

Table 4. Performance Comparison of Athletes Competing in Both Events

Athlete	Country	100 m Final (s)	Rank 100 m	50 m Final (s)	Rank 50 m	Rank Difference
A	Singapore	48.65	1	21.92	1	0
B	Vietnam	50.05	4	22.86	5	-1
C	Thailand	50.38	5	22.89	6	-1

Athletes anonymized. Rank difference = 50 m rank – 100 m rank.

Athletes competing in both events showed high ranking consistency, particularly the gold medalist who maintained first place in both distances. This suggests transferable sprint capacity across distances. Chen et al. (2024) found that top-8 world swimmers exhibit strong physiological overlap across sprint events. However, at the international level, specialization is more pronounced. The relatively stable cross-event ranking in this study indicates that regional athletes may possess generalized sprint capabilities rather than highly specialized race profiles. This highlights an opportunity for targeted event specialization within SEA Games preparation programs.

Table 5. Influence of Age on 100 m Pacing and Performance

Age Group	n	Mean Final Time (s)	Mean Pacing Difference (s)	Mean RT (s)
<20 years	2	50.20 ± 0.25	2.16 ± 0.15	0.615 ± 0.021
20–25 years	5	49.97 ± 0.82	2.22 ± 0.41	0.626 ± 0.032
>25 years	1	49.45	2.37	0.60

The 20–25 age group achieved the fastest mean performance, aligning with evidence that peak sprint performance typically occurs in the early-to-mid 20s (Chen et al., 2024). Interestingly, younger athletes (<20 years) demonstrated slightly smaller pacing differences, possibly indicating more conservative pacing strategies.

This partially supports developmental models suggesting that tactical maturity influences pacing aggressiveness. However, the small sample size limits inferential conclusions, indicating a need for broader longitudinal analysis in future studies.

Table 6. Reaction Time and Performance by Ranking Group

Ranking	Mean RT 100 m (s)	Mean Final 100 m (s)	Mean RT 50 m (s)	Mean Final 50 m (s)
1–3	0.627 ± 0.025	49.37 ± 0.70	0.613 ± 0.040	22.27 ± 0.29
4–8	0.633 ± 0.034	50.40 ± 0.31	0.612 ± 0.026	22.85 ± 0.23

No significant RT differences between ranking groups ($p > 0.05$).

Top-ranked swimmers (1–3) were consistently faster in final time but did not differ significantly in reaction time from lower-ranked athletes. This reinforces earlier findings that swimming velocity, rather than start performance, distinguishes podium finishers.

These results align with (Dai et al., 2025), who reported that hydrodynamic efficiency is a stronger determinant of sprint performance than start metrics. The findings also emphasize a contextual gap: while start performance is often highlighted in coaching discourse, its practical impact at this competitive level appears limited compared to speed endurance and stroke efficiency.

DISCUSSION

The results of this study indicate that all athletes (100%) in the men's 100 m freestyle final at the 2025 SEA Games adopted a positive split pacing pattern, meaning that the second 50 m was slower than the first 50 m. The average pacing difference reached 2.26 seconds, with relatively small inter-athlete variation (SD = 0.38 seconds). This finding is consistent with sprint swimming literature suggesting that in the 100 m event, athletes typically maximize early acceleration to reach peak velocity as quickly as possible, followed by maintenance or decline in speed due to metabolic fatigue accumulation and increased hydrodynamic resistance in the latter half of the race (Healy et al., 2022). The dominance of the positive split strategy suggests that pacing at the SEA Games level remains conventional and may not yet fully explore more balanced (even split) or negative split approaches. Although positive split is often considered effective for maximizing early momentum, recent studies indicate that more controlled pacing strategies may reduce lactate accumulation and allow for stronger finishing performance. The absence of negative split strategies in this sample may reflect training characteristics, tactical preferences, or physiological maturation levels that are still developing in Southeast Asia.

Correlation analysis revealed that reaction time (RT) was not significantly associated with final performance in either the 50 m ($r = 0.15$; $p = 0.71$) or the 100 m ($r = 0.45$; $p = 0.26$) events. Although a fast start is technically considered advantageous in sprint races, this finding suggests that the variation in RT among athletes in elite competitions such as the SEA Games is relatively small (mean RT 0.61–0.63 seconds), thereby reducing its influence on final outcomes. This indicates that other factors—such as pure swim velocity, breathing technique, movement efficiency, and speed endurance—may play a more substantial role in determining final rankings. These findings align with Ruiz-Navarro et al. (2025b), who reported that at high competitive levels, mid-race velocity consistency and technical execution are more critical than start performance alone.

Three athletes who competed in both sprint events (50 m and 100 m) demonstrated high performance consistency, maintaining relatively stable rankings across both races. The Singaporean athlete who won the 100 m also secured victory in the 50 m, while athletes from Vietnam and Thailand dropped only one ranking position between events. This minor shift may be explained by race-specific demands: the 50 m relies heavily on explosive power and start reaction, whereas the 100 m requires a combination of acceleration, speed endurance, and pacing strategy.

These findings suggest that athletes who excel in the 100 m tend to possess comprehensive physiological and technical capacities that can transfer effectively to the 50 m, even if they are not always the absolute fastest over the shorter distance. This has important implications for coaches designing training programs that support multi-event sprint development.

Age-group analysis revealed that the youngest athletes (<20 years) exhibited slightly smaller pacing differences (2.16 seconds) compared to athletes aged 20–25 years (2.22 seconds) and those over 25 years (2.37 seconds). Although these differences were not statistically significant due to the small sample size, the pattern is noteworthy. Younger athletes may adopt more conservative energy distribution strategies, whereas more experienced swimmers may employ aggressive early pacing at the risk of late-race fatigue.

In terms of final time performance, the 20–25 age group achieved the fastest average time (49.97 seconds), followed by the <20 group (50.20 seconds). This finding is consistent with literature

indicating that peak sprint swimming performance typically occurs in the early to mid-20s due to physiological maturation, strength development, and accumulated competitive experience (Sokołowski et al., 2025). When athletes were categorized into two ranking groups (1–3 vs. 4–8), no significant differences in reaction time were observed across either event. However, the top-ranked group consistently achieved faster final times (49.37 seconds for 100 m and 22.27 seconds for 50 m) compared to the lower-ranked group. This indicates that elite advantage is more strongly related to swimming velocity itself rather than start performance.

Overall, this study demonstrates that all finalists in the men's 100 m freestyle at the 2025 SEA Games employed a positive split pacing pattern, with an average speed reduction of 2.26 seconds in the second 50 m. This confirms that pacing strategy at this level remains oriented toward maximal early acceleration followed by fatigue-related decline. (Casado et al., 2022; Haugen et al., 2021; Zhu et al., 2025) similarly reported that positive split pacing is prevalent in 100 m sprint events due to anaerobic system dominance during the initial race phase. Likewise, (Coelho et al., 2022; Hammerbeck et al., 2017; Lodha et al., 2021; Pniak et al., 2021) observed that reductions in stroke efficiency during the second half contribute to slower finishing times. However, in contrast to recent global trends indicating more controlled or near-even pacing strategies among world-class swimmers (Z. Chen et al., 2025; Lara & Del Coso, 2021), no pacing variation was observed in this sample. This discrepancy may be influenced by regional competitive context, training systems, physiological characteristics, and international exposure differences between Southeast Asian and world-level swimmers.

The absence of significant correlation between reaction time and final performance further reinforces that, within this competitive context, start speed is not the primary determinant of success. (Michalica et al., 2024; Polach & Born, 2023) emphasized that swimming velocity and technical efficiency during active race phases outweigh reaction time contributions at elite levels. (Sellés-Pérez et al., 2023) also demonstrated that power-to-drag ratio is a strong predictor of sprint performance, while start performance becomes decisive only when variability between athletes is substantial. Therefore, this study extends previous discussions by highlighting that, in the SEA Games context, performance determinants are more strongly related to sustained velocity and technical efficiency rather than reaction speed alone.

The consistency observed among multi-event athletes suggests effective transfer of physiological and neuromuscular capabilities across sprint distances. (Vivan et al., 2025) reported that world top-8 swimmers display stable performance characteristics across short-distance events, driven by robust anaerobic and strength profiles. The relatively stable cross-event rankings observed in this study indicate that comprehensive capacity development, rather than extreme specialization, may still characterize regional sprint swimming performance. Minor ranking differences between events can be attributed to the distinct tactical demands of 50 m and 100 m races, as described by Breen et al. (2020).

In conclusion, this study contributes novel evidence by providing a comprehensive analysis based on official final competition data from the 2025 SEA Games, a context that has been minimally explored in scientific literature. Unlike most studies focusing on Olympic or World Championship settings (McGibbon et al., 2018; Ruiz-Navarro et al., 2025a), this research enriches the field by examining Southeast Asian regional dynamics and integrating pacing, reaction time, age, and multi-event consistency within a single analytical framework. Academically, the study expands the model of sprint performance determinants at the regional level. Practically, it suggests that coaches should prioritize pacing variability and speed endurance development rather than focusing predominantly on start training. From a policy perspective, the findings may support regional federations in developing evidence-based training systems and benchmarking strategies aligned with international standards.

Nevertheless, this study has limitations. The sample size was restricted to finalists (n = 8 per event), secondary data were used without direct physiological measurements such as lactate concentration or stroke index, and age-group distribution was uneven. These constraints limit generalizability and causal inference. Future research should adopt longitudinal designs incorporating biomechanical and physiological parameters, expand sampling to preliminary rounds and higher-level competitions (Asian Games or World Championships), and experimentally test alternative pacing strategies such as near-even split models. A multidisciplinary approach combining biomechanics, exercise physiology, and predictive data modeling would further advance understanding of sprint swimming performance determinants.

CONCLUSION

Based on the analysis of the final results of the men's 50-meter and 100-meter freestyle events at the 2025 SEA Games, this study concludes that the pacing strategy applied in the 100-meter event was predominantly characterized by a positive split pattern. Specifically, athletes demonstrated an average decrease of 2.26 seconds in the second half of the race compared to the first half. This finding indicates that pacing strategies at the regional competitive level remain largely oriented toward maximal early acceleration, with an associated risk of speed decline during the latter phase of the race. Furthermore, reaction time did not show a significant correlation with final performance outcomes in either the 50-meter or 100-meter events, reinforcing the notion that factors such as pure swim velocity, technical efficiency, and speed endurance play a more decisive role in determining final race times.

This study also identified that athletes competing in both sprint events exhibited relatively high performance consistency, maintaining stable rankings despite the distinct tactical demands of the 50-meter and 100-meter races. Age group differences appeared to influence pacing patterns, with younger athletes tending to demonstrate slightly smaller pacing differentials. The practical implications of these findings suggest that coaches should consider developing more varied pacing strategies rather than relying exclusively on traditional positive split approaches, while also emphasizing improvements in speed endurance and technical efficiency to enhance overall sprint performance.

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