

## Relationships between start parameters and performance times in 50m freestyle races

Xiao Qiu and Danny Chu  
Sport Biomechanics and Technology Centre, Hong Kong Sports Institute

MARCH 2025

### Introduction

The swim start is typically defined as the time from the acoustic start signal to when the swimmer's head reaches the 15-m mark and accounts for 0.8%–26.1% of the overall race time, depending on the event distance<sup>[1]</sup>. Studies have shown a high correlation between the start time and overall race performance, especially in short events<sup>[2]</sup>. This study aimed to determine the relationship between start parameters and elite swimmers' 50m freestyle performance.

### Methodology

The top eight swimmers who participated in the 50m freestyle finals during the 2024 World Aquatics Championships (Doha, Qatar) and the 2024 Olympic Games (Paris, France) were selected. A total of 32 trials (16 male and 16 female swimmers) were included in the analysis. During the competition, a panning camera (SONY FDR-AX700, 1920 × 1080, 50 Hz) covering a 50m pool was placed at the top of the grandstand with the camera directly facing the 25m region of the pool to record the required races<sup>[3]</sup>. The video start time was synchronised with the start light of the official timing system and was used as a visible reference to set a timestamp in the race analysis software (Kinovea, version 2023.1.2).

The definitions of the selected parameters are provided in Table 1. The data distribution for each parameter was examined for normality using the Shapiro–Wilk test. Pearson's correlation coefficients were calculated to interpret the relationships between start parameters and performance times, with threshold values of 0.1, 0.3, 0.5, 0.7, and 0.9 representing low, moderate, high, very high, and nearly perfect correlations, respectively<sup>[4]</sup>. For data that were not normally distributed ( $p < 0.05$ ), Spearman's correlation coefficient was used to assess the statistical significance of the relationships between start parameters and performance. All statistical analyses and data visualisation procedures were performed using R software (version 4.0.3; R Core Team, 2020), and statistical significance was set at  $p < 0.05$ .

### Results

Among male swimmers, entry distance was strongly related to their first 25m time ( $p < 0.05$ ;  $r = -0.51$ ). The correlation between block time and first 25m time was marginally nonsignificant ( $p = 0.05$ ;  $r = 0.50$ ) (Figure 1). Among female swimmers, a high correlation coefficient was found between swim velocity and first 25m time ( $p < 0.05$ ;  $r = -0.59$ ) (Figure 2). However, no statistical significance was found between start parameters and 50m time.

### Discussion

This study aimed to determine the relationships between start parameters and the 50m freestyle performance times of elite swimmers. The results revealed that, among male swimmers, block time was likely to be related to their first 25m time ( $p = 0.05$ ). However, in previous studies, block time and take-off horizontal velocity accounted for 81% of the variance in the 15m start time<sup>[1]</sup>, suggesting that a reduction in block time could help to improve the start time and overall race performance. Additionally, a strong correlation was found between entry distance and first 25m time among male swimmers. Peterson Silveira et al.<sup>[5]</sup> revealed that the entry distance was the most relevant parameter to the 5m start performance but suggested that the entry phase be a focus during start practice to avoid inappropriate entry behaviour caused by maximising the entry distance without instruction. Interestingly, swim velocity after head resurfacing was a more important parameter in female swimmers than in male swimmers, showing a strong correlation with their 25m times. This finding highlights the importance of the ability to transfer greater momentum from underwater to the start swim phase<sup>[6]</sup>. This study provides practical recommendations for Hong Kong coaches and athletes on how start parameters affect elite swimmers' first 25m performance in 50m freestyle races.

Table 1. Definitions of the selected start parameters.

Parameters	Definitions
Block time (s)	The time from the start signal until the swimmer's toes left the block. Data were obtained from the official results.
Entry distance (m)	The horizontal distance from start to the point where the swimmer's fingers entered the water.
Underwater distance (m)	The horizontal distance from where the swimmer's fingers enter the water to head resurfaced from the water.
Underwater velocity (m/s)	$= \frac{\text{Underwater distance}}{\text{Underwater time}}$
Swim velocity (m/s)	The velocity from the swimmer's head resurfaced from water to the 15m mark.
25m/50m times (s)	The race times when the swimmer's head reached the 25m and 50m marks. The 50m race time was obtained from the official results.

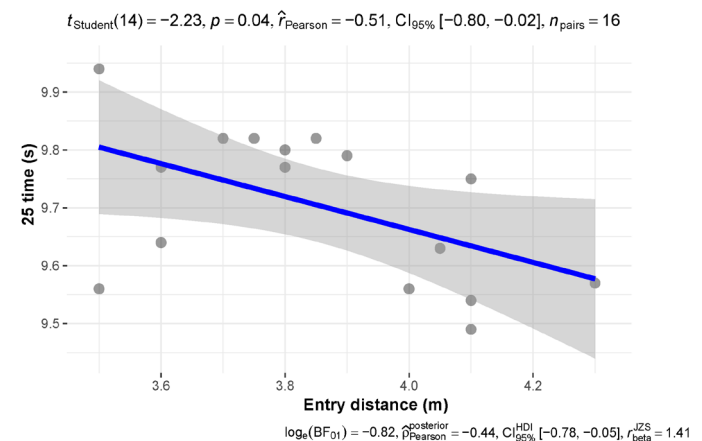
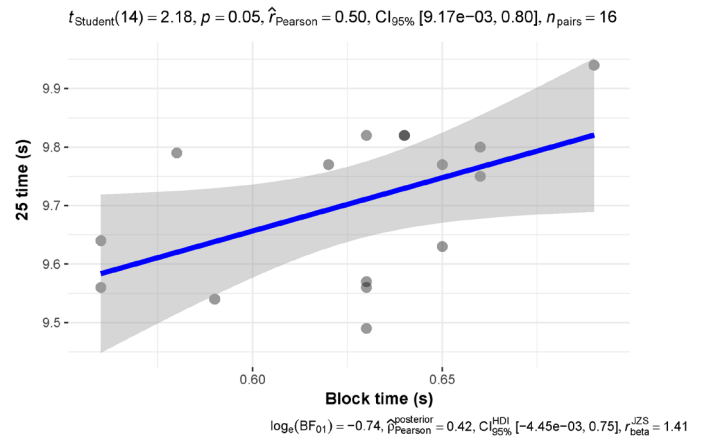


Figure 1 The relationships between start parameters and male swimmers' performance times in 50m freestyle races

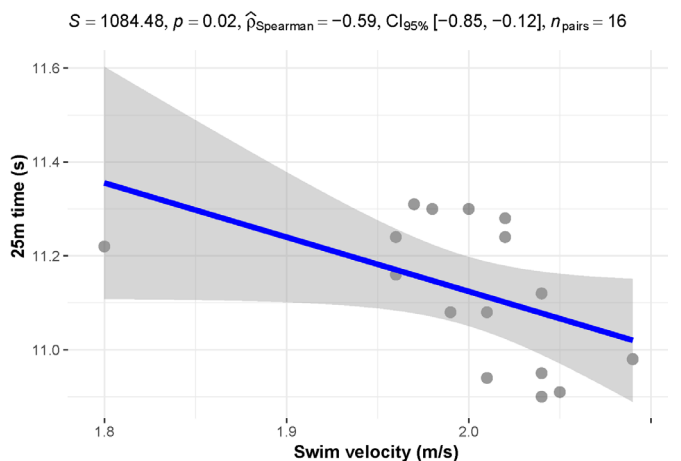


Figure 2 The relationships between start parameters and female swimmers' performance times in 50m freestyle races

### Reference

- [1] Tor, E., Pease, D. L., & Ball, K. A. (2015). Key parameters of the swimming start and their relationship to start performance. *Journal of Sports Sciences*, 33(13), 1313-1321.
- [2] Mason, B. (1999). Where are races won (and lost)? In *SWIMMING: Applied Proceedings of the XVII International Symposium on Biomechanics in ISBS '99: XVII International Symposium on Biomechanics in Sports*, Perth, WA, Edith Cowan University, School of Biomedical and Sports Science, Vol. 1, pp. 1-10.
- [3] Nicol, E., Adani, N., Lin, B., & Tor, E. (2021). The temporal analysis of elite breaststroke swimming during competition. *Sports Biomechanics*, 23(10), 1692-1704.
- [4] Hopkins, W., Marshall, S., Batterham, A., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine and Science in Sports and Exercise*, 41(1), 3-13.
- [5] Peterson Silveira, R., Stergiou, P., Figueiredo, P., Castro, F. D. S., Katz, L., & Stefanyshyn, D. J. (2018). Key determinants of time to 5 m in different ventral swimming start techniques. *European Journal of Sport Science*, 18(10), 1317-1326.
- [6] Taladiz, S., de la Fuente-Caynzos, B., & Arellano, R. (2016). Analysis of angular momentum effect on swimming kick-start performance. *Journal of Biomechanics*, 49(9), 1789-1793.