ACADEMIA International Journal for Social Sciences
Volume 4, Issue 4, 2025 ISSN-L (Online): 3006-6638

Kinematical Analysis of Swimming Start and its Effect on Performance

Asif Munir
asifmunir0358@gmail.com
M.Phil. Scholar, Department of Sports Sciences & Physical Education, Faculty of Allied Health Sciences, The University of Lahore, Punjab, Pakistan.

Mohibullah Khan Marwat
mohibullah.khan@ed.uol.edu.pk
Professor, Department of Sports Sciences & Physical Education, Faculty of Allied Health Sciences, The University of Lahore, Punjab, Pakistan

Kashif Mehmood
kashif.mehmood@sports.uol.edu.pk
Lecturer, Department of Sports Sciences & Physical Education, Faculty of Allied Health Sciences, The University of Lahore, Punjab, Pakistan.

Syed Muhammad Bilal Gillani
muhammad.bilal@sps.uol.edu.pk
Assistant Professor, Department of Sports Sciences & Physical Education, Faculty of Allied Health Sciences, The University of Lahore, Punjab, Pakistan.

Mufeez Alam
mufeez.alam@ahs.uol.edu.pk
Senior Lecturer, Department of Sports Sciences & Physical Education, Faculty of Allied Health Sciences, The University of Lahore, Punjab, Pakistan.

Corresponding Author: * Mohibullah Khan Marwat mohibullah.khan@ed.uol.edu.pk

Received: 17-08-2025 **Revised:** 27-09-2025 **Accepted:** 22-10-2025 **Published:** 15-11-2025

ABSTRACT

The swimming start is typically defined as the time from the starting signal to when the center of the swimmer's head reaches 15m. The swimming start is highly influential to overall competition performance. Depending on the length of the event, start times have been proven to contribute between 1-26% of the total race time. The sole objective of the research work was to investigate the performance of the swimmers of two universities (University of the Punjab, Lahore and Government College University Lahore) in start phase and compare the performance of both university's swimmers to identify their strengths and weaknesses. The study was cross sectional and took place in the swimming pool of Punjab international swimming complex, Lahore. Six (6) swimmers from university of the Punjab and six (6) swimmers from Government College University were selected for this study. Purposive sampling technique was used for the selection of sample. Data of swimmers were recorded with four cameras installed at the start, 5m, 10m and 15m at the height of 2m. Data were treated by using common descriptive statistics and independent t-test was used to identify the difference between the performance of two universities swimmers. The findings of this study demonstrated that the reaction time, submerge time, flight time and underwater time of swimmers have great impact on the overall start performance. When examining the sub-phases of the start, it was found that the overall start time of the University of the Punjab swimmer was 7.537s and they spent 11% (0.847 s) on the block phase, 3% (0.22 s) in the flight phase, 4% (0.277 s) in the submerge phase, 40% (3.017 s) in the underwater phase, and 42% (3.176 s) free swimming once the athlete had resurfaced. The overall start time of Government college university swimmers was 7.723 s, and they spent 11% (0.837 s) on the block phase, 3% (0.22 s) in the flight phase, 3% (0.26) in the submerge phase, 38% (2.898 s) in the underwater phase, and 45% (3.511 s) *free swimming once the athlete had resurfaced. There was no significant difference in the performance of start phase between the swimmers from University of the Punjab and Government College University.*

Keywords: *Swimming start, Swimmer performance.*

INTRODUCTION

The role of science has increased in recent decades to enhance the sports performance. Advanced knowledge of physiology, nutrition, psychology and biomechanics is helping the coaches and athletes to get better outcomes in comparison to the past results of sports performance i.e 100-meter world record has improved from John Lewis (10.34 sec, 1934) to Usain Bolt (9.58 sec, 2009). New techniques, tactics and skills were introduced with the intervention of science. Weakness and strength of the athletes were studied in the laboratories and results of these studies were implemented in the sports field (Baudry et al., 2006).

Swimming is one of the oldest recorded sports and activities in human history. Humans have been swimming for thousands of years, with evidence of swimming as a form of recreation and exercise dating back to ancient civilizations. In ancient Greece, swimming was an important part of education and military training. The Greeks viewed swimming as a vital skill for sailors and warriors. Competitive swimming also emerged in ancient Greece, with swimming races being part of the ancient Olympic Games. Swimming is not only a competitive sport but also a popular recreational activity and a crucial life skill. It offers numerous health benefits, including cardiovascular fitness, muscle strength, and improved coordination. Today, swimming continues to be enjoyed by people of all ages and is considered an essential part of many fitness and wellness routines. The earliest recorded swimming competition took place in swimming, and it was one of the original Olympic events when the modern Olympics began in 1896. Swimming experienced a resurgence in Europe during the 18th and 19th centuries. In the 19th century, swimming clubs were formed in England, and swimming as a competitive sport gained popularity. The first indoor swimming pool, the St George's Baths, was opened in London in 183. In the early 20th century, competitive swimming became more organized, and swimming associations were established to govern the sport. The Fédération International de Natation (FINA) was founded in 1908 and became the governing body for international swimming competitions. Swimming has since become a highly popular and widely practiced sport around the world. It is an Olympic sport with multiple disciplines, including freestyle, backstroke, breaststroke, butterfly, and individual medley. Swimmers such as Michael Phelps, Mark Spitz, and Katie Ledecky have achieved great fame and success in the sport, setting numerous world records and winning multiple Olympic medals.

A good start allows swimmers to conserve energy by reducing the effort needed to catch up to the leading peak (Vantorre et al., 2010a). Falling behind at the start of a race can require swimmers to exert more energy to regain lost ground, potentially leading to fatigue and a lower overall performance. The start can also present tactical opportunities for swimmers. For example, in sprint races, a swimmer with an exceptional start might try to build a significant lead early on, forcing opponents to play catch-up. On the other hand, in longer distance races, a more controlled start can be advantageous, enabling swimmers to pace themselves better throughout the race. Ultimately, a fast start can contribute to faster race times. Since swimming races are often won by mere fractions of a second, a strong start can make a significant difference in achieving a personal best time or even breaking a record (Silveira et al., 2018).

Biomechanics plays a crucial role in swimming starts, as it influences the efficiency and effectiveness of the swimmer's movements off the starting block (Pelayo & Alberty, 2011). Biomechanics helps swimmers optimize the generation and transfer of power during the start. By understanding the principles of force production, leverage, and body positioning, swimmers can generate a strong and explosive push-off from the starting block (Ungerechts & Keskinen, 2018). This allows them to convert their muscle strength into forward momentum efficiently. Biomechanics helps swimmers achieve a streamlined body position, minimizing drag in the water. Through proper body alignment, head position, and limb control, swimmers can reduce resistance and move through the water more effectively (Portus & Farrow, 2011). This is especially crucial at the start of the underwater phase, where streamlined positioning enables swimmers to maintain speed and conserve energy. It can contribute to improving a swimmer's reaction time off the starting block (Bishop et al., 2006).

Problem statement

Since this type of study has so for not been conducted on the specific component of race "Start" in Pakistan. So, there is a dire need to technically evaluate the most important phase of the race. The researcher intends to conduct a research study entitled "Kinematical analysis of swimming start and its effect on performance".

Objective

The sole objective of the research work was to investigate the performance of the swimmers of two universities (University of the Punjab, Lahore and Government College University Lahore) in start phase and compare the performance of both university's swimmers to identify the difference in performance.

Hypothesis

H_1 There is significant difference in the performance of start phase between the swimmers from Government college university and University of the Punjab.

H_o There is no significant difference in the performance of start phase between the swimmers from Government college university and University of the Punjab.

MATERIALS AND METHODS

The study took place in the swimming pool of Punjab international swimming complex, Lahore. The dimensions and specifications of the pool are in accordance to the international standard set by Fédération international de natation (FINA).

Population

Population for this study comprised of 50 freestyle swimmers from the two universities e.g. University of the Punjab and Government College University.

Sample size

The researcher included 25 freestyle swimmers from each university e.g. University of the Punjab, Lahore and Government college university, Lahore who represented their universities in the All-Pakistan Interuniversity Swimming championship 2021-22.

Sampling Technique

Purposive sampling technique was used for the selection of sample.

Sample selection

Inclusion criteria: Swimmers who participated in interuniversity swimming championship 2021-22 were included in this study.

Exclusion criteria: Swimmers who did not participated in interuniversity swimming championship 2021-22 were not the part of this study.

Equipment

Data of swimmers were recorded with four cameras. First camera was installed at the start, second camera installed at 5m from the start line to, third camera installed at 10m from the start line and fourth camera installed at 15m from the start line at the height of 2m and parallel to the cons placed on both sides of the pool at five, ten and fifteen meters**.** Strobe light was used for caution of start. Videos were transferred to computer and motion analysis software KNOVIA was used for analysis by drawing the digital lines between the cons placed at said positions.

DATA COLLECTION PROCEDURE

The study was conducted in swimming pool of Punjab international swimming complex, Lahore. The dimensions and specifications of the pool are in accordance to the international standard set by *Fédération International de Natation* (FINA). Data of swimmers were recorded with four cameras. First camera was installed at the start, second camera installed at 5m from the start line to, third camera installed at 10m from the start line and fourth camera installed at 15m from the start line at the height of 2m and parallel to the cons placed on both sides of the pool at five, ten and fifteen meters**.** Strobe light was used for caution of start. Videos were transferred to computer and motion analysis software KINOVIA was used for analysis by drawing the digital lines between the cons placed at said position. Reaction time was the time elapsed between blink of strobe light until the swimmer leaves the block. Flight time was time elapsed between the moment the feet left the surface of block and body submerge in the water. Surface break point is the point where the head of the swimmer comes out from water after diving from block first time. Time of 5, 10 and 15m were taken with the help of the camera installed at this distance and with the help of motion analysis software

RESULTS

In this chapter data analysis and interpretation of results based on the study objective have been described. Swimmers of university of the Punjab (PU) and Government college university participated in this study. This chapter consists of descriptive statistics (mean & standard deviation) of two said universities and differences in the performance of the phases of start. The main purpose of study was to identified the difference between the swimmers of the university of the Punjab and Government college university in start phase.

Table 1

Descriptive statistics of university of the Punjab swimmers

Variables	**Mean**	**Standard deviation**
Reaction time (s)	0.8467	.043
Flight time (s)	0.2200	0.031
submerge time (s)	0.2767	0.030
Surface breakpoint time (s)	3.0167	0.212
Time to 5m (s)	1.9433	0.090
Time to 10m (s)	4.5050	0.119
Time to 15m(s)	7.5367	0.167

Note. Values represent statistical measures of central tendency (mean) and dispersion (standard deviation) for each variable. Mean time of reaction time is 0.8467 and standard deviation is 0.043. Mean time of flight time is 0.2200 and standard deviation is 0.031. Mean of submerge time is 0.2767 and standard deviation is 0.030. Mean of surface breakpoint time is 3.0167 and standard deviation is 0.212. Mean of

5m time is 1.9433 and standard deviation is 0.090. Mean of 10m time is 4.5050 and standard deviation is 0.119. Mean of 10m time is 7,5367 and standard deviation is 0.167.

Table 2

Descriptive statistics of Government college university swimmers

Variables	Mean	Standard deviation
Reaction time (s)	0.8367	0.0484
Flight time (s)	0.2200	0.026
submerge time (s)	0.2600	0.034
Surface breakpoint time (s)	2.8983	0.230
Time to 5m (s)	2.1100	0.095
Time to 10m (s)	4.6683	0.103
Time to 15m (s)	7.7233	0.194

Note. Values represent statistical measures of central tendency (mean) and dispersion (standard deviation) for each variable. Mean of reaction time is 0.8367 and standard deviation is 0.048. Mean of flight time is 0.2200 and standard deviation is 0.026. Mean of submerge time is 0.2600 and standard deviation is 0.034. Mean of surface breakpoint time is 2.8983 and standard deviation is 0.230. Mean of 5m time is 2.1100 and standard deviation is 0.095. Mean of 10m time is 4.6683 and standard deviation is 0.103. Mean of 15m time is 7.7233 and standard deviation is 0.194.

Table 3

Difference between the performance of PU and GCU's swimmer

Variables	Pu's Swimmers	GCU's Swimmers	Difference
Reaction time (s)	0.8467	0.8367	0.01
Flight time (s)	0.2200	0.2200	00
submerge time (s)	0.2767	0.2600	0.0167
Surface breakpoint time (s)	3.0167	2.8983	0.1184
Time to 5m (s)	1.9433	2.1100	0.1667
Time to 10m (s)	4.5050	4.6683	0.1633
Time to 15m(s)	7.5367	7.7233	0.1866

Note. Mean difference of reaction time is 0.01 there is little bit difference in reaction tine phase of start between the swimmers of PU and GCU. Mean difference of flight time is 0.00 there is no difference in the flight phase of start between the swimmers of PU and GCU. Difference of submerge time is 0.0167. Mean difference of surface breakpoint time is 0.1184. Mean difference of 5m time is 0.1667. Mean difference of 10m time is 0.1633. Mean difference of 15m time is 0.1866.

Table 4

Comparison between the performance of PU and GCU swimmers

Variables	t-value	P-value
Reaction Time	.377	.71
Flight Time	.000	1.00

Submerage Time	.898	.39
Surface Breakpoint Time	.924	.38
5m Time	-3.114	.01**
10m Time	-2.528	.03*
15m Time	-1.782	.11

Note. The findings show that there is no significant difference in performance between the swimmers from the University of the Punjab and Government College University in the reaction time, flight time, submerge time, surface breakpoint time and time to 15m of the start. Findings also shows that there is significant difference in performance between the swimmers from the University of the Punjab and Government College University in time to 5m and time to10m of the start.

DISCUSSION

Swimmers from the University of the Punjab and Government College University constituted population for this study and pivot of the study was to determine their performance at the start stage of free style swimming event. While this study examined all the phases of the start however, focus was particularly placed on the swimming start's block phase, flight phase, and underwater phase as these stages have previously been shown to be the most crucial for evaluating overall start performance (Thow et al., 2012; Cossor & Mason, 2001). It has been demonstrated that competition performance is affected by the start, particularly in shorter distance events (Tor et al., 2014).

Results of the study indicated that block time and flight duration were the most important above-water factors. These outcomes were in line with those of an earlier study that employed correlation analysis and found a substantial correlation between these variables and the time to 15m (Breed & McElroy, 2000). As reported by Garcia Hermoso et al. (2013) an absolute time reduction of 15m would occur from a reduction in time on block. By anticipating the start and building lower body strength and power, swimmers can purposefully cut down on their on-block time (Garcia-Hermoso et al., 2013). Honda et al. (2010) utilized a different performance measure than what was employed in the current study because they used time to 7.5m rather than time to 15m. As a result, swimmers must concentrate on raising their horizontal takeoff speed without increasing their block time. The lower body's muscles could be made stronger and more powerful, making sure the swimmer is sequencing their joints properly during the diving motion is another way to guarantee momentum (West et al., 2001).

CONCLUSION

Swimmers from University of the Punjab and Government College University were employed in this research study identify important start factors and how they affect overall start performance. Although numerous factors affect swimming start performance, some start components, such as block time, flight time, time to 10m, and underwater duration, have been shown to have a greater overall impact. Based on the findings of this study's statistical analysis, swimmers should concentrate on the underwater part of the start and try to get to the 10m mark as quickly as they can. These elements have been determined to be high-priority areas where targeted training can improve start performance. The significance of the underwater phase was amplified by the fact that swimmers spent most of their time in this phase and that it significantly influenced their starting performance. In order to improve the underwater phase, coaches and athletes should concentrate on it. Travelling more underwater would allow the less resistance acting on the body of swimmers that would help swimmer to maintain a higher velocity, leading to better start performances.

The findings also show that there is no significant difference in performance between the swimmers from the University of the Punjab and Government College University during the start phase. Therefore, the null hypothesis is accepted.

REFERENCES

Baudry, L., Leroy, D., Thouvarecq, R., & Choller, D. (2006). Auditory concurrent feedback benefits on the circle performed in gymnastics. *Journal of Sport Sciences, 24*(2), 149- 156.

Bishop, D., Burnett, A., Farrow, D., Gabbett, T., & Newton, R. (2006). Sports-science roundtable: Does sports-science research influence practice? *International Journal of Sports Physiology and Performance, 1*(2), 161–168.

Breed, R., & McElroy, G. K. (2000). A biomechanical comparison of the grab, swing and track starts in swimming. *Journal of Human Movement Studies,* 39, 277-293.

Cossor JM, Mason BR (2001) Swim start performance at the Sydney 2000 Olympic Games. In: Blackwell JR, Sanders RH (eds) XIX International Symposium on Biomechanics in Sports. *International Society of Biomechanics in Sport, San Francisco,* pp 70–74.

Garcia-Hermoso, A., Escalante, Y., Arellano, R., Navarro, F., Domínguez, A. M., & Saavedra, J. M. (2013). Relationship between final performance and block times with the traditional and the new starting platforms with a back plate in international swimming championship 50 m and 100 m freestyle events. *Journal of Sports Science & Medicine, 12*(4), 698.

Honda, K. E., Sinclair, P. J., Mason, B. R., & Pease, D. L. (2010, June). A biomechanical comparison of elite swimmers start performance using the traditional track start and the new kick start. In *XIth International Symposium for Biomechanics and Medicine in Swimming* (Vol. 11, pp. 94-96).

Pelayo, P., & Alberty, M. (2011). The history of swimming research. In L. Seifert, D. Chollet, & I. Mujika (Eds.), World book of swimming: From science to performance (pp. xix–xxvi). Nova Science. Pyne, D. B., Trewin, C. B., & Hopkins, W. G. (2004). Progression and variability of competitive performance of Olympic swimmers. *Journal of Sports Sciences, 22*(7), 613–620.

Portus, M. R., & Farrow, D. (2011). Enhancing cricket batting skill: implications for biomechanics and skill acquisition research and practice. Sports Biomechanics, 10(4), 294-305.

Silveira, R.P.; Stergiou, P.; Figueiredo, P.; Castro, F.S.; Katz, L.; and 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.

Thow, J. L., Naemi, R., & Sanders, R. H. (2012). Comparison of modes of feedback on glide performance in swimming. *Journal of sports sciences*, *30*(1), 43-52.

Tor, E., Pease, D., & Ball, K. (2014). Characteristics of an elite swimming start. Paper presented at the Biomechanics and Medicine in Swimming Conference 2014, Canberra.257-263.

Ungerechts, B. E., & Keskinen, K. (2018). The significance of International Symposia on Biomechanics and Medicine in Swimming–A Multidisciplinary approach. In *Xiiith International Symposium on Biomechanics and Medicine In Swimming Proceedings* (pp. 17-25).

Vantorre, J., Seifert, L., Fernandes, R., Vilas-Boas, J. and Chollet, D. (2010a). Kinematical profiling of the front crawl start. *International Journal of Sport Medecine* 31, 16-21.

West, D. J., Owen, N. J., Cunningham, D. J., Cook, C. J., & Kilduff, L. P. (2001). Strength and power predictors of swimming starts in international sprint swimmers. *The Journal of Strength and Conditioning Research, 25*(4), 950-955.