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Araştırma Makalesi

DÜNYA UZUN KULVAR YÜZME ŞAMPİYONASINDA KURBAĞALAMA VE KELEBEK FİNALİSTLERİNİN ÜÇ YIL BOYUNCA GÖSTERDİKLERİ PERFORMANSLARIN KARŞILAŞTIRILMASI

COMPARISON OF BREASTSTROKE AND BUTTERFLY FINALISTS' PERFORMANCES OVER THREE YEARS IN THE WORLD LONG COURSE SWIMMING CHAMPIONSHIPS

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Dünya Uzun Kulvar Yüzme Şampiyonasında Kurbağalama ve Kelebek Finalistlerinin Üç Yıl Boyunca Gösterdikleri Performansların Karşılaştırılması

ÖZ

Çalışmanın amacı, son üç yılda düzenlenen Dünya Yüzme Şampiyonalarında kurbağalama ve kelebek finalistlerinin performans parametrelerini (yaş, reaksiyon zamanı, bitiş zamanı, FINA puanları, hız, tur zamanları ve tur hızları) karşılaştırmaktır. Çalışmada, 2022, 2023 ve 2024 yıllarında düzenlenen Dünya Uzun Kulvar Yüzme Şampiyonası'nda 50 metre (m), 100 m ve 200 m kelebek ve kurbağalama yarışlarında yer alan finalistler (n=69 kadın, n=77 erkek) analiz edilmiştir. Çalışmada analiz edilen yarışların sonuçları kamuya açık "World Aquatics" web sitesinden elde edilmiştir. MS Excel 16.0 dosyasından elde edilen tüm veriler IBM SPSS Statistics 24.00 analiz programına aktarılmıştır. Üç farklı yılda düzenlenen Dünya Şampiyonalarına göre 50 m, 100 m, 200 m kelebek ve kurbağalama yarışlarındaki finalistlerin yaş, reaksiyon zamanı, bitiş zamanı, puan, hız, tur zamanı ve tur hızı tek yönlü ANOVA ile analiz edilmiştir. Değişkenler arasındaki farklılıkları belirlemek için Bonferroni post hoc testi kullanılmış ve anlamlılık düzeyi $p<0,05$ olarak belirlenmiştir. Kadın ve erkeklerin 200 m kurbağalama ve kelebek puanlarında, kadınların 200 m kelebek ve erkeklerin 50 m ve 100 m kelebek bitiş zamanlarında anlamlı farklılıklar bulunmuştur. Erkekler 100 m kurbağalama ikinci tur zamanı ve hızında 2022 ve 2024 yılları arasında istatistiksel olarak anlamlı bir fark tespit edilmiştir. Erkeklerin 200 m kelebek ilk tur süresi ve hızında 2022 ve 2024 yılları arasında anlamlı bir fark gözlenmiştir. Kadınların 200 m kelebek ikinci tur süresinde ve hızında yıllar arasında farklılık bulunmuştur. Sonuç olarak, kelebek ve kurbağalama yarışlarında hız, bitiş zamanı, tur zamanı, tur hızı ve puanların son üç yılda Dünya Şampiyonalarında dalgalanmalar gösterdiği, reaksiyon süresinde ise belirgin bir değişiklik olmadığı tespit edilmiştir. Elde edilen bulgular, kelebek ve kurbağalama stillerinde yıllara bağlı olarak değişikliklerin düzenli bir gelişim göstermediğini ve antrenman yöntemlerindeki farkların bu sonuçlara katkı sağlamış olabileceğini göstermektedir.

Anahtar Kelimeler: Dünya Su Sporları, kurbağalama, kelebek, yarış analizleri

Comparison of Breaststroke and Butterfly Finalists' Performances Over Three Years in the World Long Course Swimming Championships

ABSTRACT

The study aimed to compare performance parameters (age, reaction time, finishing time, FINA points, speed, lap times, and lap speeds) of breaststroke and butterfly finalists at the World Swimming Championships organized in the last three years. In the study, the finalists (n=69 women, n=77 men) in the 50 meters (m), 100 m and 200 m butterfly and breaststroke events at the World Long Course Swimming Championships held in 2022, 2023 and 2024 were analysed. The results of the races analysed in the study were obtained from the publicly available World Aquatics website. All data derived from the MS Excel 16.0 file were transferred to the IBM SPSS Statistics 24.00 analysis programme. The age, reaction time, finishing time, points, speed, lap time and lap speed of the finalists in 50 m, 100 m, 200 m butterfly and breaststroke events, according to the World Championships held in three different years, were analyzed by one-way ANOVA. The Bonferroni post hoc test was used to determine the differences between the variables, with the significance level set at $p < 0.05$. Significant differences were found in women's and men's 200 m breaststroke and butterfly points, women's 200 m butterfly, and men's 50 m and 100 m butterfly finishing times. A statistically significant difference was observed between 2022 and 2024 in the second lap time and speed of men's 100 m breaststroke. A significant difference was observed in the 200 m butterfly first lap time and speed of men between 2022 and 2024. A difference was observed in the second lap time of women's 200 m butterfly and speed between the years. Consequently, it was established that the speed, finishing time, lap time, lap speed, points in butterfly and breaststroke events exhibited fluctuations in the World Championships over the past three years, whereas there was no discernible change in reaction time. The findings show that the changes in butterfly and breaststroke styles do not show a regular development over the years and the differences in training methods may have contributed to these results.

Keywords: World Aquatics, breastroke, butterfly, race analyses

INTRODUCTION

Swimming is defined as a sport in which the distance is completed in the shortest time with coordinated movements of the trunk and legs[1]. Since the inception of the International Symposium on Swimming Biomechanics and Medicine series in the 1970s, there has been a notable increase in research into swimming. Since that time, swimming has been analysed primarily in the fields of physiology and biomechanics[2,3,4]. Biomechanical analysis encompasses the performance analysis of swimmers. Performance analysis in swimming is the objective transfer of technical information to coaches and athletes with the intention of supporting the development of athletes from a scientific point of view[5,6]. In performance analysis, the objective is to monitor the development of performance, to observe changes over time, to identify the variables that influence performance, to determine the strengths and weaknesses of the athlete and competitors, and to assess the effectiveness of training programmes[7]. Analyses are being performed with greater frequency in international competitions[8,9,10].

Performance analysis is conducted by swimming analysts in both training and competition[2]. Analysts analyse performance in four distinct sections. The analysis of performance begins with the start, continues with the swim, encompasses the turns, and concludes with the finish[6]. Race analyses are typically conducted using official race results, such as reaction time, lap time and finishing time, which are often complemented by video footage. While official race results are useful for assessing swimmers' pacing strategies, video footage is required when detailed race information is required, such as start, clean swim, turn and finishing time during the race[11]. The variation in race distances swum is important in terms of the positive effect of good race strategy on race performance, especially during lap times[12].

In international competitions such as the Olympics, World Championships or European Championships, parameters such as reaction time, lap speed, lap time, and finishing time have been reported to vary at different distances and styles over the years[13,14,15,16]. The study sought to examine whether this difference was also present in the last three years (Doha (2024) - Fukuoka (2023) - Budapest (2022)) and to examine these parameters as well as age and FINA points. It can be seen that there are more analyses of freestyle swimming races in the literature. As a continuation of the existing research, this study aims to contribute by filling the gap in the literature on butterfly and breaststroke style race analysis in swimming. The objective of this study is to compare the performance parameters (age, reaction time, finishing time, FINA points, speed, lap times and lap speeds) of breaststroke and butterfly finalists at the World Swimming Championships held in the last three years.

MATERIAL AND METHODS

Participants

Elite level 69 women and 77 men swimmers who ranked in the top 8 in the 50 m, 100 m and 200 m butterfly and breaststroke events at the World Long Course Swimming Championships in 2022, 2023 and 2024 were analysed.

Ethical statement

Prior to commencing the data collection phase of the study, ethical approval was granted by the Haliç University Non-Interventional Clinical Research Ethics Committee

on 30th May 2024 (No: 129). The research adheres to the principles set out by the 2013 Helsinki Declaration.

Procedure

The results of the races analysed in the study were obtained from the publicly available World Aquatics website (https://www.worldaquatics.com/). Since the analyses of the races were publicly available, swimmers were not required to sign an informed consent form. The numerical values of each parameter were manually copied and entered into an MS Excel 16.0 file by the responsible researchers, based on data obtained from the official website of FINA. In order to prevent possible errors, all data were saved in separate files on different days from the relevant web page. This process was carried out three times by the researchers and all data were checked. The numerical values of age, reaction time, finishing time, points and lap times were obtained directly from the official website. The speed value was calculated in meters per second by dividing the total race distance by the elapsed time. The lap speed value was obtained in meters per second by dividing the intermediate distance (standardised as multiples of 50 meters within the total race distance) by the elapsed time.

Statistical Analyses

All data derived from the MS Excel 16.0 file were transferred to the IBM SPSS Statistics 24.00 analysis programme. Mean and standard deviation values for all parameters according to years were calculated in the analysis programme. The Kolmogorov-Smirnov test was employed as an analytical method to ascertain whether the variables exhibited a normal distribution. It was determined that they did, with a p-value greater than 0.05. The age, reaction time, finishing time, points, speed, lap time and lap speed of the finalists in 50 m, 100 m, 200 m butterfly and breaststroke events, according to the World Championships held in three different years, were analyzed by one-way ANOVA. The Bonferroni post hoc test was used to determine the differences between the variables, with the significance level set at $p < 0.05$.

RESULTS

Table 1. Comparison of Age, Reaction Time, Finishing Time, FINA Points and Speed of Woman Swimmers According to Years

	50 m BRE			100 m BRE			200 m BRE		
Age (years)	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	20.50±4.00			22.63±3.81			23.50±2.45		
2023	22.00±5.42	0.322	0.728	23.88±4.91	0.209	0.813	23.25±2.25	0.739	0.490
2024	22.13±3.94			23.25±2.49			24.50±1.77		
Rxn Time (s)	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	0.65±0.03			0.66±0.04			0.69±0.03		
2023	0.67±0.05	0.121	0.886	0.66±0.03	2.588	0.099	0.69±0.03	0.064	0.938
2024	0.66±0.06			0.69±0.01			0.69±0.05		
Finishing Time (s)	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	30.12±0.28			66.22±0.25			143.95±1.20		
2023	30.06±0.41	0.619	0.548	66.02±0.64	0.440	0.650	142.79±1.65	0.976	0.393
2024	30.30±0.59			66.23±0.59			143.78±2.34		
Point	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	920.75±25.94			907.75±10.43			899.13±22.21		
2023	926.50±39.26	1.548	0.236	916.75±27.36	0.464	0.635	921.88±31.84*c	3.602	0.045*
2024	892.88±52.91			907.50±24.08			876.50±43.85*b		
Speed (m/s)	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	1.66±0.02	0.459	0.638	1.51±0.01	0.346	0.711	1.39±0.01	1.002	0.384
2023	1.66±0.02			1.52±0.02			1.40±0.02		

2024	1.65±0.03			1.51±0.01			1.39±0.02		
	50 m FLY			100 m FLY			200 m FLY		
Age (years)	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	24.25±4.23			22.38±4.34			21.38±5.07		
2023	24.75±3.92	1.322	0.288	24.00±3.30	0.752	0.484	20.00±2.78	1.237	0.310
2024	27.13±3.09			24.50±3.12			23.25±4.27		
Rxn Time (s)	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	0.64±0.04			0.67±0.05			0.73±0.06		
2023	0.66±0.06	0.508	0.609	0.69±0.05	0.565	0.577	0.73±0.06	0.122	0.886
2024	0.66±0.04			0.67±0.04			0.72±0.07		
Finishing Time (s)	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	25.44±0.28			56.81±0.89			126.94±1.06*c		
2023	25.48±0.38	0.457	0.639	56.90±0.48	0.977	0.393	126.58±1.24*c	7.178	0.004*
2024	25.61±0.43			57.27±0.67			128.55±1.02*ab		
Point	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	886.13±29.71			932.00±42.99			883.38±21.99*c		
2023	881.75±40.29	0.401	0.674	927.00±23.85	1.007	0.382	891.25±26.72*c	6.921	0.005*
2024	869.25±45.61			909.13±32.12			850.63±20.30*ab		
Speed (m/s)	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	1.97±0.02			1.76±0.03			1.58±0.02*c		
2023	1.96±0.03	0.327	0.725	1.76±0.01	0.562	0.579	1.58±0.02*c	5.874	0.009*
2024	1.95±0.03			1.75±0.02			1.56±0.01*ab		

**p<0.05;* a=2022; b=2023; c=2024; BRE: Breaststroke; FLY: Butterfly

Table 1 presents a comparison of age, reaction time, finishing time, FINA points and speed values of women swimmers according to years. A statistically significant difference (F=3.602; p=0.045) was observed in 200 m breaststroke points according to years. This statistically significant difference was found between the 2023 and 2024 (p=0.042). A significant difference was observed finishing time (F=7.178; p=0.004), points (F=6.921; p=0.005) and speed (F=5.874; p=0.009) in the 200 m butterfly. A significant difference was identified between 2024 vs 2022 (p=0.025; p=0.030; p=0.034, respectively) and 2023 (p=0.006; p=0.006; p=0.015, respectively). However, no differences were found in age and reaction time according to years in all butterfly and breaststroke events. Furthermore, no statistically significant difference was observed in finishing time and speed in breaststroke events (p>0.05).

Table 2. Comparison of Age, Reaction Time, Finishing Time, FINA Points, Speed of Men Swimmers According to Years

	50 m BRE			100 m BRE			200 m BRE		
Age (years)	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	25.25±5.20			25.00±2.45			25.38±3.02		
2023	26.50±5.04	0.155	0.857	24.88±3.09	0.666	0.524	22.88±3.60	1.054	0.366
2024	25.63±3.34			26.38±3.07			25.25±4.80		
Rxn Time (s)	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	0.66±0.03			0.67±0.04			0.67±0.04		
2023	0.65±0.04	0.529	0.597	0.68±0.02	0.050	0.952	0.66±0.03	0.079	0.925
2024	0.64±0.04			0.67±0.04			0.67±0.02		
Finishing Time (s)	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	26.91±0.34			59.08±0.55			128.80±0.86		
2023	26.79±0.25	0.870	0.433	58.90±0.63	0.444	0.647	128.10±1.59	1.964	0.165
2024	26.72±0.28			59.13±0.29			129.22±0.83		
Point	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	897.25±34.17	0.801	0.462	892.50±25.01	0.434	0.653	938.75±18.90	3.995	0.034*
2023	908.50±25.83			900.38±29.29			950.75±35.93*c		

2024	916.13±29.44			889.88±12.92			915.25±17.63*b		
Speed (m/s)	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	1.86±0.02			1.70±0.02			1.55±0.01		
2023	1.87±0.02	0.923	0.413	1.70±0.02	0.354	0.706	1.56±0.02	1.365	0.277
2024	1.87±0.02			1.69±0.01			1.55±0.01		
	50 m FLY			100 m FLY			200 m FLY		
Age (years)	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	26.75±6.45			22.00±1.77			21.71±2.21		
2023	22.50±2.93	1.879	0.178	22.63±2.20	0.597	0.560	20.00±2.20	2.090	0.150
2024	23.50±3.59			23.50±3.85			22.13±2.17		
Rxn Time (s)	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	0.62±0.03			0.63±0.03			0.67±0.04		
2023	0.62±0.04	0.254	0.778	0.64±0.03	0.275	0.762	0.65±0.03	1.236	0.312
2024	0.63±0.02			0.63±0.02			0.65±0.03		
Finishing Time (s)	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	22.90±0.22*c			51.06±0.42			113.94±1.80		
2023	22.96±0.23	4.285	0.028*	50.82±0.45*c	6.202	0.008*	114.07±0.96	3.223	0.061
2024	23.19±0.17*a			51.47±0.22*b			115.42±0.97		
Point	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	919.25±26.18*c			908.38±22.80			918.43±45.14*c		
2023	912.63±27.34	4.317	0.027*	921.13±24.91*c	5.928	0.009*	905.00±22.87	4.206	0.030*
2024	885.38±18.95*a			886.25±10.96*b			873.50±22.06*a		
Speed (m/s)	*X*±std	F	p	*X*±std	F	p	*X*±std	F	p
2022	2.18±0.02*c			1.96±0.01			1.75±0.03		
2023	2.18±0.02	3.780	0.040*	1.97±0.02*c	6.939	0.005*	1.75±0.02	2.763	0.087
2024	2.16±0.02*a			1.94±0.01*b			1.73±0.01		

**p<0.05;* a=2022; b=2023; c=2024; BRE: Breaststroke; FLY: Butterfly

Table 2 shows a comparison of age, reaction time, finishing time, FINA points and speed values of men swimmers according to years. A difference was found between years in the points of the 50 m butterfly, 100 m butterfly, 200 m breaststroke and 200 m butterfly (F=4.317 p=0.027; F=5.928 p=0.009; F=3.995 p=0.034; F=4.206 p=0.030, respectively). In the 200 m breaststroke and 100 m butterfly, a statistically significant difference was observed between 2023 and 2024 (p=0.034 and p=0.008, respectively). A statistical difference was identified between the 50 m butterfly and 200 m butterfly in 2022 and 2024 (p=0.036; p=0.034, respectively). Furthermore, there were differences in the finishing time (F=4.285, p=0.028; F=6.202, p=0.008, respectively) and speed (F=3.780, p=0.040; F=6.939, p=0.005) in 50 m and 100 m butterfly. At the 50 m, the observed difference was between 2024 and 2022 (p=0.036; p=0.043). At the 100 m, the observed difference was between 2024 and 2023 (p=0.007; p=0.004). However, no differences were found in age and reaction time according to years in all butterfly and breaststroke events. Furthermore, no statistically significant difference was observed in finishing time and speed in breaststroke events (p>0.05).

Table 3. Comparison of Breaststroke Lap Times and Lap Speed According to Years

	Years	Gender	50 m BRE	100 m BRE	150 m BRE	200 m BRE
Lap Times (s)	2022	Women	30.73±0.36	35.49±0.38		
	2023		30.77±0.45	35.25±0.22		
	2024		31.09±0.47	35.14±0.40		
	2022	Men	27.71±0.39	31.37±0.30*c		
	2023		27.44±0.33	31.46±0.37		

	2024		27.33±0.24	31.80±0.23*a		
	2022		32.56±0.40	36.57±0.26	37.02±0.33	37.80±0.74
	2023	Women	32.35±0.62	36.36±0.38	36.65±0.37	37.43±0.67
	2024		32.63±0.51	36.49±0.62	36.99±0.77	37.67±0.78
	2022		29.32±0.32	32.72±0.16	33.21±0.42	33.56±0.87
	2023	Men	29.07±0.44	32.60±0.29	32.97±0.69	33.45±1.21
	2024		29.41±0.44	32.86±0.44	33.20±0.29	33.76±0.83
Lap Speed (m/s)	2022		1.63±0.02	1.41±0.02		
	2023	Women	1.63±0.02	1.42±0.01		
	2024		1.61±0.02	1.43±0.02		
	2022		1.80±0.03	1.59±0.02*c		
	2023	Men	1.82±0.02	1.59±0.02		
	2024		1.83±0.02	1.57±0.01*a		
	2022		1.54±0.02	1.37±0.01	1.35±0.01	1.32±0.03
	2023	Women	1.55±0.03	1.38±0.02	1.36±0.01	1.34±0.02
	2024		1.53±0.02	1.37±0.02	1.35±0.03	1.33±0.03
	2022		1.71±0.02	1.53±0.01	1.51±0.02	1.49±0.04
	2023	Men	1.72±0.03	1.53±0.01	1.52±0.03	1.50±0.06
	2024		1.70±0.02	1.52±0.02	1.51±0.01	1.48±0.03

**p<0.05;* a=2022; b=2023; c=2024; BRE: Breaststroke

Table 3 presents a comparison of the lap times and speeds of men and women swimmers in 100 m and 200 m breaststroke, categorised by year. A statistically significant difference was observed between 2022 and 2024 in the second lap time (F=4.299, p=0.027) and speed (F=4.302, p=0.027) of men's 100 m breaststroke (p=0.034; p=0.037, respectively). No statistically significant difference was found in the lap times and lap speeds in the 200 m breaststroke (p>0.05).

Table 4. Comparison of Butterfly Lap Times and Lap Speed According to Years

	Years	Gender	50 m FLY	100 m FLY	150 m FLY	200 m FLY
Lap Times (s)	2022		26.36±0.45	30.45±0.62		
	2023	Women	26.37±0.30	30.52±0.30		
	2024		26.66±0.41	30.61±0.43		
	2022		23.68±0.20	27.37±0.42		
	2023	Men	23.71±0.33	27.11±0.38		
	2024		23.97±0.22	27.51±0.23		
	2022		28.64±0.61	32.15±0.32*c	32.79±0.39	33.36±0.51
	2023	Women	28.49±0.57	31.98±0.35*c	32.84±0.62	33.27±0.64
	2024		29.10±0.33	32.69±0.45*ab	33.09±0.40	33.67±0.24
	2022		25.08±0.45*c	28.69±0.48	29.71±0.64	30.46±0.90
	2023	Men	25.41±0.23	28.84±0.32	29.70±0.30	30.11±0.74
	2024		25.59±0.23*a	29.05±0.36	29.88±0.28	30.90±0.55
Lap Speed (m/s)	2022		1.90±0.03	1.64±0.03		
	2023	Women	1.90±0.02	1.64±0.01		
	2024		1.88±0.03	1.63±0.02		
	2022		2.11±0.02	1.83±0.03		
	2023	Men	2.11±0.03	1.85±0.03		
	2024		2.09±0.02	1.82±0.02		
	2022		1.75±0.04	1.56±0.02*c	1.53±0.02	1.50±0.02
	2023	Women	1.76±0.03	1.56±0.02*c	1.52±0.03	1.50±0.03
	2024		1.72±0.02	1.53±0.02*ab	1.51±0.02	1.49±0.01
	2022		1.99±0.04*c	1.74±0.03	1.68±0.04	1.64±0.05
	2023	Men	1.97±0.02	1.73±0.02	1.68±0.02	1.66±0.04
	2024		1.95±0.02*a	1.72±0.02	1.68±0.02	1.62±0.03

**p<0.05;* a=2022; b=2023; c=2024; FLY: Butterfly

Table 4 presents a comparison of the lap times and speeds of women and men swimmers in 100 m and 200 m butterfly, according to years. A significant difference was observed in the 200 m butterfly first lap time (F=5.091, p=0.016) and speed (F=4.691, p=0.021) of men between 2022 and 2024 (p=0.015; p=0.019, respectively).

A difference was observed in the second lap time of women's 200 m butterfly (F=7.771, p=0.003) and speed (F=8.350, p=0.002) between the years. The statistical analysis revealed that the difference was between 2024 vs 2022 (p=0.025 and p=0.023, respectively) and 2023 (p=0.006 and p=0.002, respectively). No statistically significant difference was found in the lap times and lap speeds in the 100 m butterfly (p>0.05).

DISCUSSION

The objective of this study was to compare the performance parameters (age, reaction time, finishing time, FINA points, speed, lap times and lap speeds) of breaststroke and butterfly finalists in the World Swimming Championships, which were held over the past three years. The study revealed significant differences in the speed and finishing times of female swimmers in the 200 m butterfly and male swimmers in the 50 m and 100 m butterfly. A discrepancy was observed in the second lap time and lap speed of male participants in the 100 m breaststroke, in the first lap time of male participants in the 200 m butterfly, and in the second lap speed and lap time of female participants. In 2024, the speed was found to be lower and the time was higher than in the other years, although not to the same extent.

Although swimmers complete a certain distance in the same time, according to Reischle, (1993)[17], this can occur in different ways. The total race time is dependent on several factors, including the start time, swim time, turn time and finishing time[18]. The study of the dynamics of change between the performances of elite swimmers recorded at specific Olympic Games revealed several interesting trends in the results of men and women examined separately and in the relationships between them. It was observed that the discrepancy between the performance of male and female athletes decreased as the swimming distance increased and that the difference between the gold medalist and the athlete who finished last in the final remained relatively consistent[19]. This study is supported by the findings of Silva et al. (2020)[13], who demonstrated that female swimmers achieved superior final times in the 2016 Rio Olympics compared to the previous Olympics. In the 1994 Olympics, Mason et al. (1995)[20] found that for the 100 m breaststroke in men and women, the average speed (r = 0.91) exhibited the highest correlation with the final time, followed by the start time (r = 0.63) and the turn time (r = 0.50). In 200 m races, the average speed (r = 0.95) was found to be the most correlated with the finishing time, followed by the average turn time (r = 0.85) and then the start time (r = 0.65). The correlation between start time and finishing time was found to be statistically significant in the majority of events analysed[20]. In the study to predict times at the 2024 Olympics, both past Olympic Games and World Championships were analysed. Significant changes were observed in 13 of the 14 Olympic events for both genders. The majority of these changes emphasised the improvement of these events, with the mean improvement being: The mean improvement for men was -0.72% (± 0.81%), while for women it was -0.60% (± 0.81%). The study found that over the past decade, the majority of swimming events have exhibited improvement in at least one performance category[14]. Previously, retrospective analyses of swimmers who placed in the top 16 at both the 2008 and 2012 Olympics reported that male swimmers exhibited an average improvement of 2.3% and 9.4% in their performance over the four and eight years preceding their peak performance, respectively. Female swimmers demonstrated an average improvement of 2.6% and 9.6% over the same periods[21]. In the present study, differences were

identified in the finishing times of the 200 m butterfly for women and the 50 m and 100 m butterfly for men. It can be posited that this phenomenon is attributable to the fact that elite swimmers are currently engaged in preparations for the Olympic Games, with the 2024 edition of the Games being designated as the Olympic year.

In his analysis of Olympic athletes, Maglischo, (2003)[22] posited that the pace of athletes may exhibit uniform or negative patterns. In the study by Silva et al., the lap times of the swimmers demonstrated uniformity, with the swimmers maintaining a consistent pace throughout the race. However, it was observed that the swimmers increased their speed in the final 50 m. Furthermore, the authors observed that the lap times exhibited minimal fluctuations throughout the three Olympic Games. Both male and female athletes employed similar strategies for each race, with only notable discrepancies observed in the 100 m and 200 m women's events. No significant differences were identified in any of the men's events across the different Olympic Games[13]. In this study, although the difference between the lap times in the third and last 50 m of the 200 m was relatively minor, there was a notable increase in time and a corresponding decrease in speed compared to the first 50 m. The partial times exhibited by male and female athletes exhibited approximately four-second differences. The time differences between the second, third, and fourth 50 m lap times were less than one second. The lap times for the butterfly style were 34 seconds for women and 31 seconds for men, while the lap times for the breaststroke style were 38 seconds for women and 34 seconds for men.

A study analysing the age of swimmers at the Olympic and World Championships by year (n=412) revealed that the age of peak swimming performance remained constant across most race distances for world champions and across all race distances for Olympic champions. The 200 m and above race distances (female ~20 years, male ~22 years) were completed by younger champions than the 50 m and 100 m race distances (female ~22 years, male ~24 years)[23]. This study found no significant age difference between years in breaststroke and butterfly swimmers. The mean age of male competitors in the butterfly (mean 24.25-22.71-21.28 years) and breaststroke (mean 25.79-25.42-24.50 years) decreased as the race distance increased. In women, the same result was obtained in butterfly style (mean 25.38-23.63-21.54 years), whereas the mean age of women competing in breaststroke style (mean 21.54-23.25-23.75 years) increased as the race distance increased.

As stated by Hay, (1988)[24], reaction time accounts for between 5 and 11% of the overall finishing time. Castro and Mota, (2011)[25] posit that the initial 50 m of a swimming race is influenced by the exit from the starting block, due to the horizontal push-off distance compensated for by the block. This assertion is corroborated by Ruschel et al. (2007)[26], who posit that enhancing the reaction time will result in a reduction in the finishing time. Silva et al. (2020)[13] reported that the reaction time of male and female athletes showed a decrease in both short-distance (100 m, 200 m) and middle-distance races (400 m) during the three Olympic Games (2008, 2012, 2016). The results of this study indicate that there is no significant difference in reaction time between butterfly and breaststroke races across different years. Nevertheless, as the distance increases, the reaction time also increases to a slight degree. This study underscores the significance of reaction time in swimming, where miliseconds can make a difference.

The results of this study indicate that there has been variability in the times achieved in butterfly and breaststroke races at the World Championships over the past three years. In particular, the average times have increased in 2024. The initial 50 m time is demonstrably faster than the other partial distances. The most intriguing aspect of the study is the lack of change in reaction time. However, it can be posited that as the distances of the butterfly and breaststroke races increase, so too does the reaction time. In the 200 m butterfly and breaststroke races, women achieved the highest FINA points in 2023. This result was also obtained for men swimming 200 m breaststroke and 100 m butterfly. However, men swimming 50 m and 200 m butterfly reached the highest FINA points in 2022. In light of the findings of this study, it is advised that athletes should endeavour to reduce the discrepancy between their lap times through targeted training. In future research, it would be beneficial to replicate the biomechanical factors obtained from international competitions. It is recommended that an investigation be conducted to determine whether there is a relationship between these factors and stroke mechanics in different styles, with the objective of understanding the optimal performance. For example, analysing body position for different swimming styles or examining the effects of training methods used to optimise reaction time may be of interest for future studies. The limitations of the study are that the data covered only a three-year period and the swimming styles of butterfly and breaststroke were analysed.

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