Pacing profiles, variability and progression in 400, 800, and 1500-m freestyle swimming events at the 2021 European Championship

López-Belmonte, Ó[1]; Gay, A[1]; Ruiz-Navarro JJ[1]; Cuenca-Fernández, F[1]; González-Ponce, A[1]; Arellano, R[1]

[1] Aquatics Lab. Department of Physical Education and Sports, Faculty of Sport Sciences, University of Granada, Spain

Corresponding author:

Raúl Arellano Colomina

Aquatics Lab. Department of Physical Education and Sports, Faculty of Sport Sciences

Ctra. Alfacar S/N, 18011 Granada. Spain

University of Granada

email: r.arellano@ugr.es

Telf: +34626976150

TWITTER

Óscar López-Belmonte: @Oscarlobel95

Ana Gay: @AnaGayP

Jesús J. Ruiz-Navarro: @Ruiz_NavarroPhD

Francisco Cuenca-Fernández: @Cuenca_Fernandz

Raúl Arellano: @R_Arellano_C

Pacing profiles, variability and progression in 400, 800, and 1500-m freestyle swimming events at the 2021 European Championship

ABSTRACT

Performance intra-variability has not been studied in long-distance swimming. The aims were to describe the pacing profile in 400-, 800- and 1500-m freestyle events and to analyse the variability (coefficient of variation[CV]) and performance progression (%Δ) within and between rounds. A total of 256 swims of 130 elite-swimmers (70 males and 60 females) were analysed at the 2021 European-Championship (indoor long-course). Linear mixed-effect models were applied for each swimmer and race-time performances to obtain the CV and %Δ between each lap and rounds (i.e. heats and final). T-test was conducted to compare the CV between medallist and non-medallist. First and last laps were the fastest ($p < 0.001$) in all events compared to the intermediate laps which showed an evenly-pace. Parabolic pacing profile was adopted in all events. Male swimmers obtained a CV-average of 0.52 ± 0.49% between rounds (−0.64 ± 0.8%Δ) and females, a CV-average of 0.70 ± 0.45 (−0.71 ± 0.92%Δ). Medallist swimmers obtained higher CV between rounds (1.00–1.08%) compared to non-medallist finalist (0.22–0.47%). Parabolic pacing profiles were adopted in 400-, 800-, and 1500-m races. The best swimmers adopt conservative strategies in heats to improve their performance in final, obtaining higher CV and %Δ between rounds.

Keywords: competition analysis, elite swimmers, performance, strategies, variation.

INTRODUCTION

In endurance performance, athletes should manage their energy expenditure during a competition (Foster et al., 2012). For sport scientists, this phenomenon is known as pacing or pacing strategy (Abbiss & Laursen, 2008). The optimal energy distribution depends on each athlete and their own metabolic characteristics, although it can also be affected by external factors that influence pacing (e.g., environmental elements) (Roelands et al., 2013). Therefore, athletes might develop different pre-planned pacing strategies to optimise their performance during the competition (Edwards & Polman, 2013). Based on pacing strategy or how the athlete distribute their energy expenditure, some pacing profiles have been identified in endurance sports, like positive (i.e., performance decrease), negative (i.e., performance increase), or even (i.e., evenly performance) (Abbiss & Laursen, 2008).

Pacing strategies are more important in swimming than in other cyclic sports due to the effect of the resistance forces (e.g., hydrodynamic drag), which increases exponentially with an increase in velocity (Marinho et al., 2011); hence, velocity variations during the race could lead to higher energy cost for swimmers (Mauger et al., 2012). Pacing analysis have been considered useful in middle-distance events like 400-m and, especially, in long-distance events like 800- and 1500-m freestyle because of the large number of laps and times performed by swimmers (Lipińska et al., 2016b). Previous studies have described the pacing profile in the referred events (i.e., 400-, 800-, and 1500-m), where it has been identified a parabolic or U-shaped profile (Lipińska et al., 2016a; Lipińska et al., 2016b; Mauger et al., 2012). Those profiles are characterized by a fast start followed by an evenly paced mid-section and a fast end-spurt in the later laps of the race (Skorski et al., 2014). Moreover, in 800- and 1500-m events, elite swimmers adopt a small decrease in performance in the intermediate laps (McGibbon et al., 2018). Therefore, this suggests that swimmers may employ different tactics or strategies to conserve energy during the race.

The analysis of variability and progressions in performance times within and between races is essential in swimming competitions (Stewart & Hopkins, 2000). The coefficient of variation (CV) is used for the study of performance variability, which is defined as the percentage of random variation in the athlete performance (Hopkins et al., 1999). In major swimming events, like European, World Championships, or Olympic Games, swimmers can participate in several races with short recovery periods between heats, semi-finals, and finals. Hence, the swimmers' progression must guarantee the qualification for the semi-final and later for the final, where the peak performance must be achieved (Mujika et al., 2019; Pyne et al., 2004). In addition, to reduce the accumulated fatigue during the previous round and to reach the performance peak at the final, swimmers should adopt pacing patterns to reduce as much as possible the energy expenditure (Foster et al., 2003; Mauger et al., 2012).

In a major competition, like the 2021 European Championship, swimmers' performance progression between rounds is required to get a medal (Mujika et al., 2019). In contrast with other swimming events (e.g., 50-, 100-, or 200-m) where heats, semi-finals, and finals are performed, in 400-, 800-, and 1500-m freestyle races only two rounds are performed (i.e., heats and final). Thus, the best swimmers should improve by ~1% their performance variability between heats and final to increase the chances of success (Pyne et al., 2004). To appreciate this difference between swimmers' level, an interesting option might be to study the CV values between rounds in medallist and non-medallist swimmers. Hence, performance variability and the values obtained in CV within and between rounds must be considered to get relevant information about the current competitive swimming and thus, the swimmers' progression.

Knowing the relevance of pacing and performance variability, there are no recent studies that bring together the pacing profiles, CV, and performance progressions in 400-, 800-, and 1500-m in major swimming events. Therefore, the aims of the present study were (1) to describe the pacing profile in 400-, 800-, and 1500-m freestyle events and, (2) to analyse the variability (coefficient of variation [CV]), and performance progression (%Δ) within and between rounds. It was hypothesized that swimmers would adopt a parabolic profile in the three events. The first and last laps would be the fastest laps, while the intermediate laps would present an evenly pace. The best swimmers (i.e., medallist) would adopt a conservative pacing strategy in the heats, presenting a higher CV values and progression than non-medallist in the final.

MATERIALS AND METHODS

Subjects

A total of 256 swims (208 heats and 48 finals) of 130 elite swimmers (70 males [age: 22.21 ± 3.22 years] and 60 females [age: 20.68 ± 3.64 years]) were analysed, being 108 of 400-m races, 85 of 800-m races, and 63 of 1500-m races.

Data collection

Official race time and 50-m lap times for 400-, 800- and 1500-m of elite swimmers at the 2021 European Championships (indoor long-course) were obtained from the official web site of the European Swimming League: (www.len.eu). Informed consent and ethical approval were not required, since all the information is available in the public domain.

For each event, the results of the two rounds (i.e., heats and final) were analysed. The official data was downloaded by applying a Web Scraping routine in Python®. Once the automated process was completed, two independent researchers checked that the results of all events had been downloaded and verified that no information was missing. The downloaded data consisted of "distance", "stroke", "round", "rank", "lane", "swimmer name", "reaction time", "lap times", and "final time". Subsequently, the following variables were calculated:

- The pacing laps CV, which represents the pacing lap time variability (i.e., every 50-m) in each event between rounds (i.e., heats and final).
- The intra-athlete CV, which represents the random variation in performance between rounds, obtained between heats and final (Hopkins et al., 1999).
- The inter-athlete CV, which represents the dispersion of ability among athletes in the two rounds. Two different inter-athlete CVs were obtained: 1) obtained from

the performance of the participants in the heats; and 2) obtained from the performance of the finalists.

- Relative change (%Δ) in performance between rounds was obtained with the following formula:

$$\%\Delta = \frac{Round\ 2\ performance - Round\ 1\ performance}{Round\ 1\ performance} \times 100$$

where Round 2 performance refers to the race time of the final and Round 1 performance refers to the race times of the heats. The criterion for performance progression, no change, or regression was %Δ being lower, equal, or higher than 0, respectively (Mujika et al., 2019).

- Relative change (%Δ) in laps performance between rounds was calculated by the average of the %Δ between the heat and the final for the finalists in every lap.

Statistical Analysis

Statistical procedures were carried out using SPSS 24.0 (IBM, Chicago, IL, USA). The normality of the distribution was inspected with Kolmogorov Smirnov test and the homoscedasticity was verified with the Levene test. All analysis were conducted differentially by distance and sex (Shapiro et al., 2021). Average times for 50-m laps were obtained for the pacing profiles analysis. Linear mixed-effects models were applied in finalist swimmers to obtain CV and changes for each lap and also it was applied for all swimmers and race time performances to obtain the CV and %Δ between rounds (i.e., heats and final). Independent samples t-test were conducted to compare the mean difference of CV between medallist and non-medallist swimmers. Pacing variability was assessed through repeated-measures analysis of variance (ANOVA) to analyse the variation per 50-m lap and Bonferroni post-hoc test was used to verify significant differences between each pairwise. The same test was applied to explore differences in CV and %Δ between distances. Significance level was set at $p < 0.05$ for all the analysis.

RESULTS

The pacing profiles for finalist swimmers in heats and finals in 400-, 800-, and 1500-m are shown in Figures 1, 2, and 3, respectively. The highest values of the pacing laps CV in all events were obtained in the last lap, except in the 1500-m females where it was obtained in the second lap. The first lap was significantly faster ($p < 0.001$) than the rest of laps in the 400- and 800-m races in both sexes, and in 1500-m females. In 400-m and 800-m races across both sexes, the last lap was faster ($p < 0.001$) than the rest, except with the second lap where no significant differences were found ($p > 0.05$). In the case of 1500-m males, first and last lap were faster than the rest ($p < 0.001$), but no differences were found between them ($p > 0.05$). In 1500-m females, last lap was significantly faster ($p < 0.05$) than the first and laps from 15 to 29.

(Please insert Figure 1 near here)

(Please insert Figure 2 near here)

(Please insert Figure 3 near here)

The results of the linear mixed-effects model analysis, within-subject CVs and %Δ between the two rounds and distances, are presented in Table 1. Inter-athlete CVs in heats and finals, are presented in Table 2. The linear mixed-effects model analysis revealed interactions in CV and %Δ for swimmers who qualified for finals compared to heats, with 62% and 50% of the female and male swimmers, respectively, obtaining a CV greater than 0.4% and with 83% of both female and male swimmers achieving performance improvements. Independent samples t-test showed higher CVs and %Δ for medallist than non-medallist swimmers (Table 3). One-way ANOVA testing revealed no differences in within-subject CV and %Δ between the heats and finals ($p > 0.05$).

(Please insert Table 1 near here)

(Please insert Table 2 near here)

(Please insert Table 3 near here)

DISCUSSION

The aims of the present study were to describe the pacing profile, and to analyse the variability and performance progression in 400-, 800-, and 1500-m elite swimmers. The first and last laps were the fastest laps in all events. In the intermediate laps, swimmers adopted an evenly pace. The parabolic pacing profile was adopted in 400-, 800-, and

1500-m races. In the three events analysed, male swimmers obtained a CV average of 0.52% between rounds and females a CV average of 0.70%. As it was hypothesized, medallist swimmers obtained higher CV values between rounds compared to non-medallist.

Parabolic pacing profiles adopted by the participants of the European Championship in 400-, 800-, and 1500-m (Figures 1, 2, and 3) are in agreement with the profiles observed in previous studies (Lipińska et al., 2016a, 2016b; Mauger et al., 2012). Pacing in swimming competitions is highly influenced by the start in the first lap and by an emphasis to finish the race in the last lap (Lipińska et al., 2016b), as observed in the present study. The faster lap times in the first one are a consequence of the dive and underwater undulatory swimming, thus, the second lap was possibly also faster by the contribution of the faster swimming speed of the first lap (Lipińska et al., 2016b). Furthermore, pacing change in the last two laps of 800- and 1500-m events has also been specifically analysed (Neuloh et al., 2020). The end-spurt was evident in both swimming events and also in 400-m, where swimmers increased their swimming velocity in the last lap. Besides, as it was observed the end-spurt in 800- and 1500-m events was crucial to achieve a medal, being a more pronounced end-spurt in medallist compared to non-medallists swimmers (Neuloh et al., 2020). Hence, the pacing behaviour during the competition, like the cited end-spurt, could explain the highest values of the pacing laps CV obtained in the last laps.

At the 2021 European Championship, a large number of swimmers performed 800- and 1500-m events. Six of the eight female finalist swimmers repeated in 800- and 1500-m events, even two of these females swam also the 400-m final. In the case of males, three of the eight swimmers repeated in 800- and 1500-m finals. The similarity of energy requirements between these swimming events causes swimmers to double their efforts in major championships (Pyne & Sharp, 2014). Likewise, swimmers might develop their own performance templates (i.e., pacing strategy) based on their experience, to improve their performance in the different rounds, or even, to impose their preferred pace from the start of the event (Foster et al., 2009). These reasons could justify the similar pacing strategies between the 800- and 1500-m, since high percentages of swimmers repeated events. Hence, pacing could have a significant role in these events as all swimmers chose the same strategy, regardless of their final result or their sex (Lara & Del Coso, 2021).

Although it has previously shown that at least a 0.5% progression in swimmers' performance is needed to be considered an effective strategy for success (Stewart & Hopkins, 2000), several studies have reported different values within and between swimming races (Pyne et al., 2004). Similar performance improvements on variability compared with the results of the present study has been reported between performance races for junior and elite swimmers, where it was observed an improvement of 1.2% between heats and final (Skorski et al., 2014; Skorski et al., 2013). A study with Australian and US Olympic sprint distances swimmers (i.e., 50-, 100-, and 200-m events), it was observed a performance improvement of 0.6-0.7% and 0.5-0.7% respectively between semi-finals and finals (Pyne et al., 2004). On the other hand, for the analysed 400-, 800-, and 1500-m races, higher values were described than those obtained at the 2021 European Championship (Tables 1 and 2), reporting a 1.1% for 400-m and 1.4% for 800- and 1500-m of average performance improvements between heats and finals (Pyne et al., 2004). The within swimmer CVs obtained (Table 1) were similar for 400-m

Australian and US Olympic swimmers (0.6%); instead, for 800- and 1500-m races the CVs were higher (1.0%) (Pyne et al., 2004) than the results obtained at the European Championships.

In 400-m, 800-m, and 1500-m swimming events, where there are only two rounds, the swimmers must achieve a balance between an optimal performance to qualify and, at the same time, a reduction of the energy expenditure during these middle and long distance events (Lipińska et al., 2016b; Mauger et al., 2012). Therefore, the pacing strategy adopted may allow to reduce accumulated fatigue and compete in the final with greater guarantees of success. In this sense, successful swimmers present higher CV between rounds to save their best performance for the final (Thompson et al., 2004). Previous studies had established that swimmers must improve by ~1% their performance variability between heats and final (Pyne et al., 2004), as it observed in the results of the present study with medallist and non-medallist finalist (Table 3). The medallist obtained higher CV average between rounds (1.00% for males and 1.08% for females) compared to non-medallist (0.22% for males and 0.47% for females). Hence, it could suggest that best swimmers perform conservative pacing strategies in heats to improve their race times in final.

The CVs obtained could be affected by the competitive context of the event. In this study, the results of the European Championship were obtained just nine weeks before Tokyo 2020 Olympics Games. For this reason, having two major events in a relatively short period, requires coaches and swimmers to program with block periodization where athletes vary their performance peak (Issurin, 2008). Although in some research, a cycle based on 8 to 16 weeks has been considered a typical period in swimming to produce the desired adaptations (Hellard et al., 2017), which could allow the participants of the European Championship to simulate the optimal performance for a major event. Also it has been analysed swimmers' performance over 3-weeks period (I Mujika, Padilla, & Pyne, 2002), 12-month period (Pyne et al., 2004), and even performance progression in major events over 7 years (Mujika et al., 2019). Therefore, the variability analysis should consider the different events that may affects to the performance competition during a specific period.

The relevance of pacing could be valuable for performance enhancement in a swimming event, since adopting the right pacing strategy might lead to a better competition result. Moreover, the analysis of variability and progressions provide useful information about the smallest changes in performance. It is important to highlight that the results obtained here may be useful both for coaches and swimmers due to the recent inclusion of the men's 800-m and women's 1500-m freestyle in the 2020 Tokyo Olympics Games. For these reasons, the study of pacing strategies, variability, and progression, especially in these two events, provide information for the development of current competitive swimming.

CONCLUSION

Elite swimmers adopted a parabolic profile and increased their variability and performance progression in 400-, 800-, and 1500-m races during the 2021 European Championship between heats and finals. Medallist swimmers showed higher CV values and progression compared to non-medallist finalist between rounds. In this study, only race times achieved in a major event were analysed; therefore, future research should consider the competitive context, since being an Olympic year, coaches and swimmers could consider the European Championship as a preparatory competition in their schedule.

ACKNOWLEDGMENTS

This study was supported by grants awarded by the Ministry of Science, Innovation and Universities (Spanish Agency of Research) and the European Regional Development Fund (ERDF); **PGC2018-102116-B-I00** 'SWIM II: Specific Water Innovative Measurements: Applied to the performance improvement' and the Spanish Ministry of Education, Culture and Sport: **FPU 19/02477**, **FPU 16/02629**, and **FPU17/02761** grants.

DISCLOSURE STATEMENT:

The authors have no conflicts of interest to report.

REFERENCES

Abbiss, C. R., & Laursen, P. B. (2008). Describing and understanding pacing strategies during athletic competition. *Sports Medicine*, *38*(3), 239-252.

Edwards, A., & Polman, R. (2013). Pacing and awareness: brain regulation of physical activity. *Sports Medicine, 43*(11), 1057-1064.

Foster, C., De Koning, J. J., Bischel, S., Casolino, E., Malterer, K., O´Brien, K., . . . Van Tunen, J. (2012). Pacing Strategies for Endurance Performance. In I. Mujika (Ed.), *Endurance Training: Science and Practice* (pp. 89).

Foster, C., De Koning, J. J., Hettinga, F., Lampen, J., La Clair, K. L., Dodge, C., . . . Porcari, J. P. (2003). Pattern of energy expenditure during simulated competition. *Medicine and Science in Sports and Exercise, 35*(5), 826-831.

Foster, C., Hendrickson, K. J., Peyer, K., Reiner, B., deKoning, J. J., Lucia, A., . . . Wright, G. (2009). Pattern of developing the performance template. *British Journal of Sports Medicine, 43*(10), 765-769.

Hellard, P., Scordia, C., Avalos, M., Mujika, I., & Pyne, D. B. (2017). Modelling of optimal training load patterns during the 11 weeks preceding major competition in elite swimmers. *Applied Physiology, Nutrition, and Metabolism, 42*(10), 1106-1117.

Hopkins, W. G., Hawley, J. A., & Burke, L. M. (1999). Design and analysis of research on sport performance enhancement. *Medicine and Science in Sports and Exercise, 31*(3), 472-485.

Issurin, V. (2008). Block periodization versus traditional training theory: a review. *Journal of Sports Medicine and Physical Fitness, 48*(1), 65.

Lara, B., & Del Coso, J. (2021). Pacing Strategies of 1500 m Freestyle Swimmers in the World Championships According to Their Final Position. *International Journal of Environmental Research and Public Health, 18*(14), 7559.

Lipińska, P., Allen, S. V., & Hopkins, W. G. (2016a). Modeling parameters that characterize pacing of elite female 800-m freestyle swimmers. *European Journal of Sport Science*, *16*(3), 287-292.

Lipińska, P., Allen, S. V., & Hopkins, W. G. (2016b). Relationships between pacing parameters and performance of elite male 1500-m swimmers. *International Journal of Sports Physiology and Performance, 11*(2), 159-163.

Marinho, D. A., Barbosa, T. M., Rouboa, A. I., & Silva, A. J. (2011). The hydrodynamic study of the swimming gliding: A two-dimensional computational fluid dynamics (CFD) analysis. *Journal of Human Kinetics, 29*, 49.

Mauger, A. R., Neuloh, J., & Castle, P. C. (2012). Analysis of pacing strategy selection in elite 400-m freestyle swimming. *Medicine and Science in Sports and Exercise*, *44*(11), 2205-2212.

McGibbon, K. E., Pyne, D., Shephard, M., & Thompson, K. (2018). Pacing in swimming: A systematic review. *Sports Medicine*, *48*(7), 1621-1633.

Mujika, I., Padilla, S., & Pyne, D. (2002). Swimming performance changes during the final 3 weeks of training leading to the Sydney 2000 Olympic Games. *International Journal of Sports Medicine, 23*(08), 582-587.

Mujika, I., Villanueva, L., Welvaert, M., & Pyne, D. B. (2019). Swimming fast when it counts: A 7-year analysis of Olympic and world championships performance. *International Journal of Sports Physiology and Performance, 14*(8), 1132-1139.

Neuloh, J. E., Skorski, S., Mauger, L., Hecksteden, A., & Meyer, T. (2020). Analysis of end-spurt behaviour in elite 800-m and 1500-m freestyle swimming. *European Journal of Sport Science*, 1-9.

Pyne, D. B., & Sharp, R. L. (2014). Physical and energy requirements of competitive swimming events. *International Journal of Sport Nutrition and Exercise Metabolism, 24*(4), 351-359.

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.

Roelands, B., de Koning, J., Foster, C., Hettinga, F., & Meeusen, R. (2013). Neurophysiological determinants of theoretical concepts and mechanisms involved in pacing. *Sports Medicine, 43*(5), 301-311.

Shapiro, J. R., Klein, S. L., & Morgan, R. (2021). Stop 'controlling' for sex and gender in global health research. *BMJ Global Health, 6*(4), e005714.

Skorski, S., Faude, O., Caviezel, S., & Meyer, T. (2014). Reproducibility of Pacing Profiles in Elite Swimmers. *International Journal of Sport Physiology and Performance, 9*, 215-225.

Skorski, S., Faude, O., Rausch, K., & Meyer, T. (2013). Reproducibility of pacing profiles in competitive swimmers. *International Journal of Sports Medicine, 34*(2), 152-157.

Stewart, A. M., & Hopkins, W. G. (2000). Consistency of swimming performance within and between competitions. *Medicine and Science in Sports and Exercise, 32*(5), 997-1001.

Thompson, K. G., MacLaren, D. P., Lees, A., & Atkinson, G. (2004). The effects of changing pace on metabolism and stroke characteristics during high-speed breaststroke swimming. *Journal of Sports Sciences, 22*(2), 149-157.

TABLES AND FIGURES CAPTIONS

Figure 1. Pacing profile in heats and finals, coefficient of variation (CV), and relative change (%Δ) between rounds in the finalist of 400-m races.

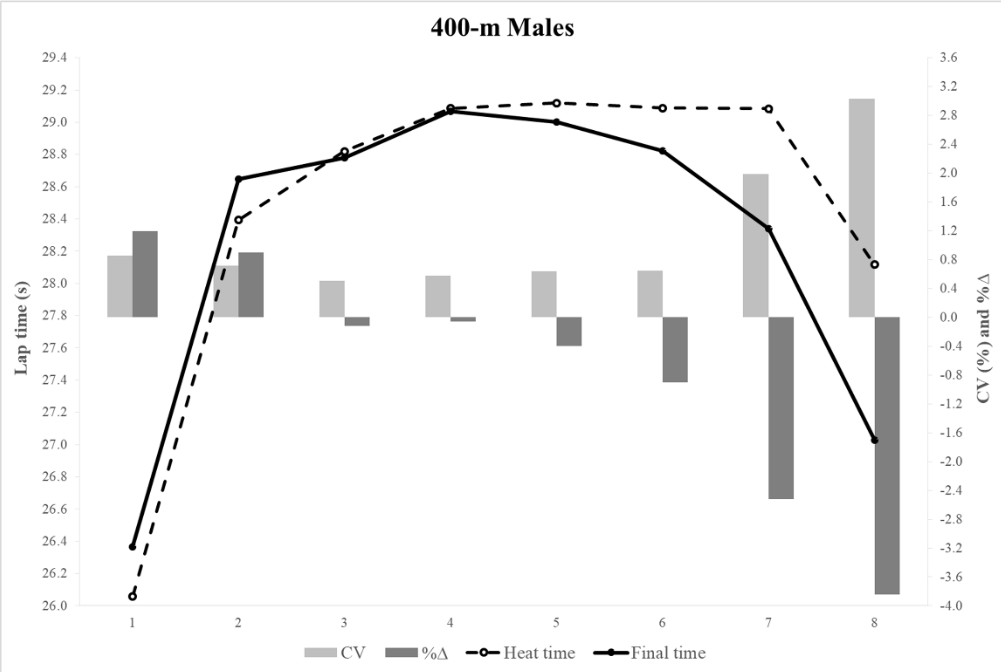
Figure 2. Pacing profile in heats and finals, coefficient of variation (CV), and relative change (%Δ) between rounds in the finalist of 800-m races.

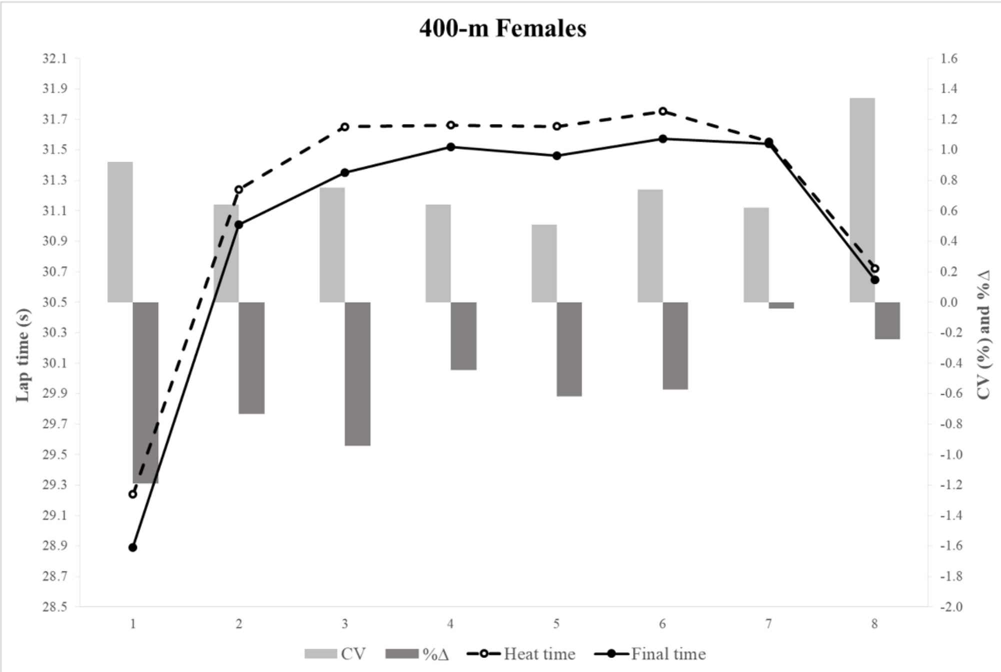
Figure 3. Pacing profile in heats and finals, coefficient of variation (CV), and relative change (%Δ) between rounds in the finalist of 1500-m races.

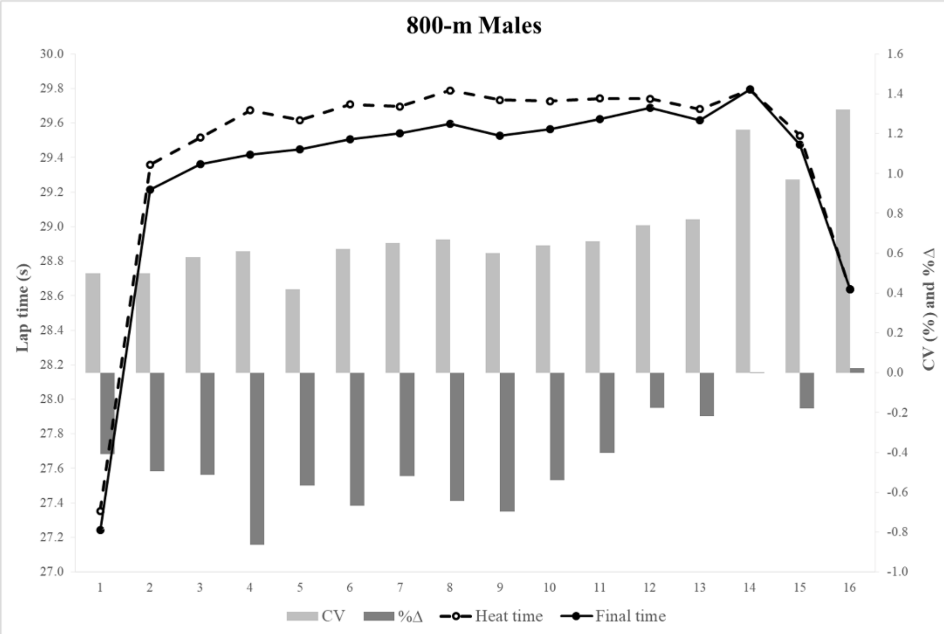
Table 1. Within-athlete coefficient of variation (CV) and relative change (%Δ) between heats and final.

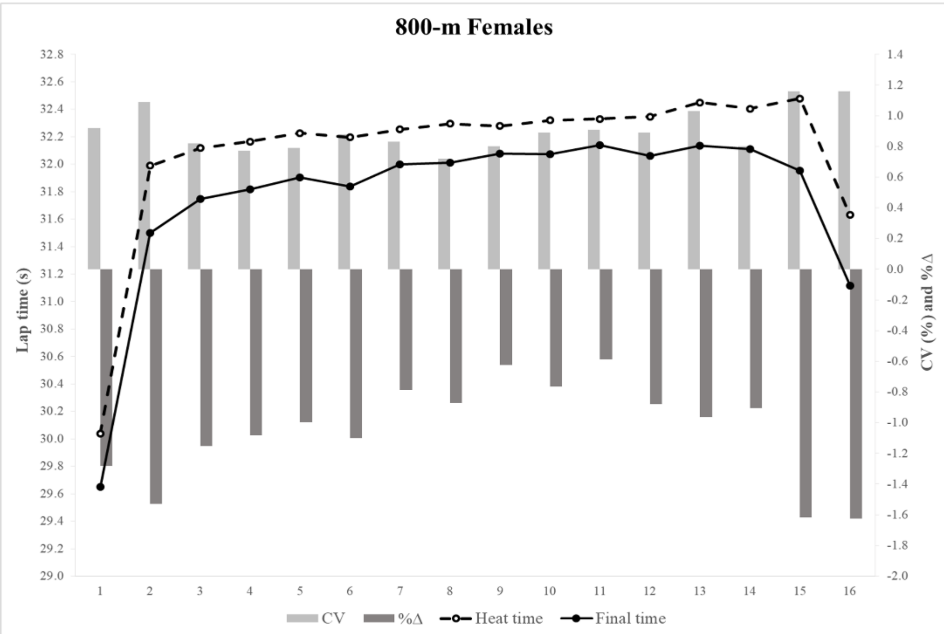
Table 2. Inter-athlete coefficient of variation (CV) in heats and final.

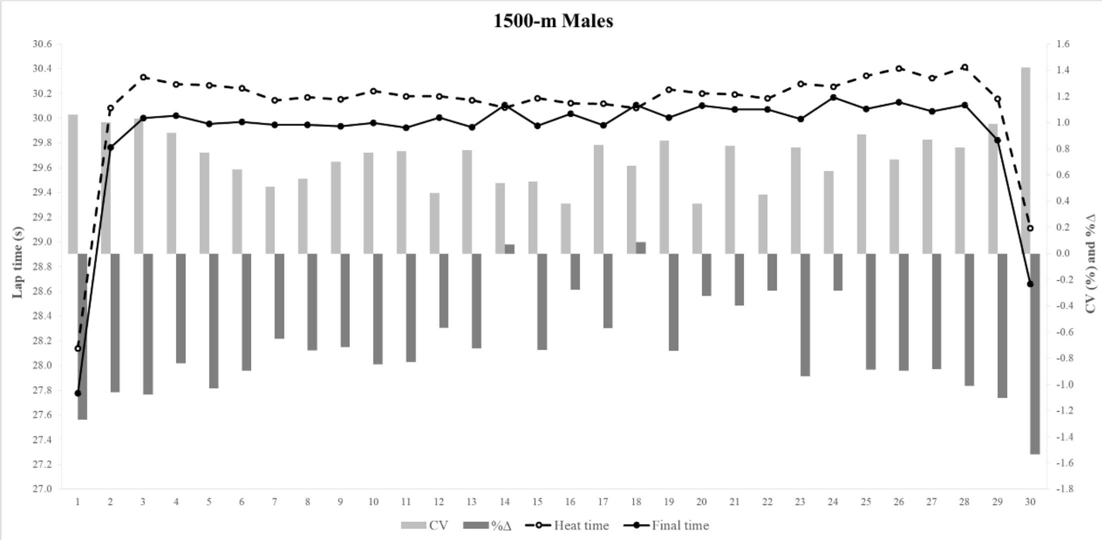
Table 3. Comparison of coefficient of variation (CV) between medallist and non-medallist swimmers.


400-m Males
Lap time (s)
CV (%) and %Δ
CV
%Δ
Heat time
Final time


400-m Females
Lap time (s)
CV (%) and %Δ
CV
%Δ
Heat time
Final time


800-m Males
Lap time (s)
CV (%) and %Δ
30.0
29.8
29.6
29.4
29.2
29.0
28.8
28.6
28.4
28.2
28.0
27.8
27.6
27.4
27.2
27.0
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
CV
%Δ
Heat time
Final time


800-m Females
Lap time (s)
CV (%) and %Δ
32.8
32.6
32.4
32.2
32.0
31.8
31.6
31.4
31.2
31.0
30.8
30.6
30.4
30.2
30.0
29.8
29.6
29.4
29.2
29.0
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
CV
%Δ
Heat time
Final time


1500-m Males
Lap time (s)
CV (%) and %Δ
CV
%Δ
Heat time
Final time

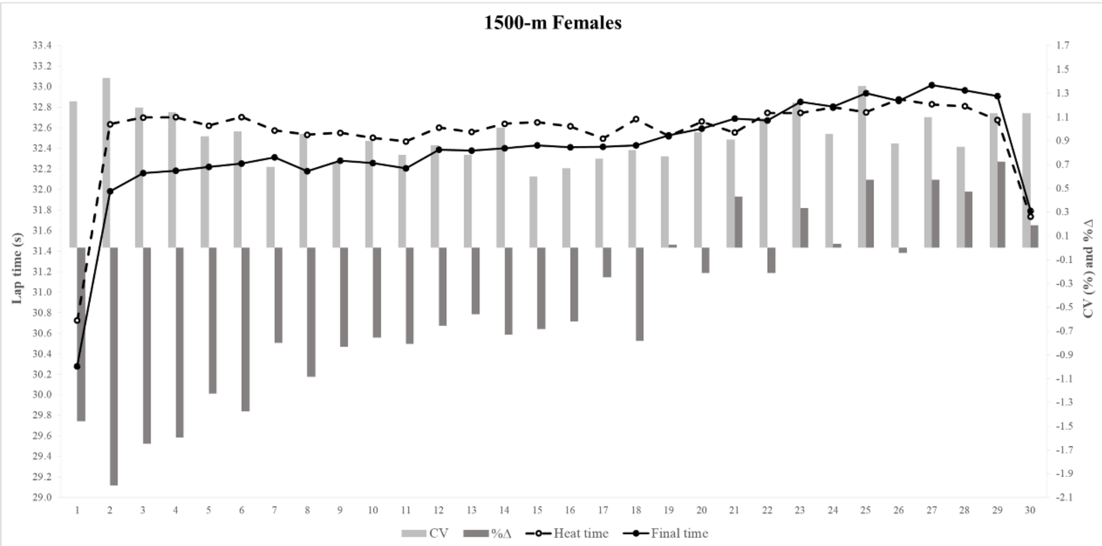

1500-m Females
Lap time (s)
CV (%) and %Δ
CV
%Δ
Heat time
Final time

Table 1. Within-athlete coefficient of variation (CV) and relative change (%Δ) between heats and final.

EVENT	Males			Females		
	CV	p	%Δ	CV	p	%Δ
400-m	0.53 ± 0.40	0.003	-0.75 ± 0.57	0.65 ± 0.29	0.038	-0.59 ± 0.82
800-m	0.47 ± 0.46	0.073	-0.43 ± 0.81	0.75 ± 0.57	0.003	-1.04 ± 0.80
1500-m	0.55 ± 0.68	0.030	-0.73 ± 1.01	0.71 ± 0.48	0.062	-0.50 ± 1.15
MEAN	0.52 ± 0.49		-0.64 ± 0.80	0.70 ± 0.45		-0.71 ± 0.92

Table 2. Inter-athlete coefficient of variation (CV) in heats and final.

EVENT	Males		Females	
	Heats	Final	Heats	Final
400-m	2.9%	0.6%	3.7%	0.9%
800-m	2.6%	1.0%	3.4%	1.0%
1500-m	2.6%	1.2%	2.0%	1.2%
MEAN	2.7%	1.1%	3.0%	1.0%

Table 3. Comparison of coefficient of variation (CV) between medallist and non-medallist swimmers.

EVENT	Males		Females	
	Medallist	Non-medallist	Medallist	Non-medallist
400-m	0.96 ± 0.20	0.28 ± 0.21	0.90 ± 0.36	0.50 ± 0.12
800-m	0.93 ± 0.25	0.20 ± 0.30	1.26 ± 0.35	0.44 ± 0.45
1500-m	1.13 ± 0.80	0.20 ± 0.29	1.10 ± 0.20	0.48 ± 0.46
MEAN	1.00 ± 0.41	0.22 ± 0.26	1.08 ± 0.30	0.47 ± 0.34