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200 Meters Freestyle Responses and Strategy Differences During Different Competition Rounds in Youth Competitive Swimmers

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ABSTRACT

The aims of the study were to analyze the physiological and perceptual responses, performances and strategy differences between competition rounds in youth competitive swimmers by examining possible differences between heats and semi-finals within the same competition day during the 200 meters freestyle event. Twenty-Two male swimmers volunteered to participate in this study. Only thirteen out of the sixteen qualified semi-finalists (age 16.8±0.6 years; weight 69.8±2.2 kg; height 178.3±3.9 cm) were taken into account for data analysis. Significant differences within and between groups were found for T200, HR, RPE and BLa ($p < 0.001$). From heats to semi-finals, Top 8 swimmers improved their performance by 5.72% with an increased value of HR (10.20%), RPE (35.56%) and BLa (67.30%), However, the remaining semi-finalists only saw a 2.92% improvement in timing and with an increased value of HR (5.17%), RPE (16.13%) and BLa (20.25%). These findings demonstrated that while the Top 8 swimmers swam more slowly in the heats, they exerted more effort in the semi-finals. This might be a tactic to conserve energy in order to provide their best effort in the semi-finals and rank in top to advance to the finals.

Keywords: *swimming, competition, strategy, blood lactate, rate of perceived exertion, heart rate.*

1. Introduction

Performance evaluation of swimmers is a major key point to attain success in short, medium and long-term. Furthermore, the evaluation of physiological and sport-specific performance measures provides fundamental information to the coach, athlete and sport scientist on the athlete's response to the training program (1).

The first level evaluation should be the competitive performance itself, since it is at this juncture that all elements interplay and provide the "highest form" of assessment (1).

Competitive swimming provides an ideal model for characterizing the blood lactate (BLa) response during competition with events that range in duration from about 20 s (50 m freestyle) to 15 min (1500 m freestyle). Several groups of investigators have reported that BLa following competitive swim races is highest after 100 m and 200 m race distances (2-5).

The glycolytic contribution to maximal effort exercise lasting 20–120 s results in the accumulation of muscle and blood lactate (6, 7). Peak BLa concentration following maximal exercise is positively related to performance in swimming events (r = .633) (4). Evaluation of BLa following competitive races also provides evidence of the physiological stress for an individual athlete in a given event. Thus assessing BLa in athletes participating in events with a large glycolytic contribution is important for a variety of training and competitive purposes (8).

In addition to BLa, heart rate (HR) is one of the most used variables in the effort intensity control. It mainly occurs due to the easiness of its measurement, which makes it quite practical, as well as its relation with the VO_2 in a determined effort level (9).

Considering the many physiological indicators, which can be used in the effort intensity control, some are difficult to be applied to the water environment due to the high cost and measurement difficulty, such as, the blood lactate production and the VO_2 (10, 11). Hence, the choice for more practical indicators, which present reduced costs, has been adopted, especially in group work. Concerning the water environment exercises prescription, one of the most applied on a daily basis indicators is the Borg's Rate of perceived exertion scale (RPE) (12, 13) considers the Borg's scale a good instrument to evaluate the relative intensity of the exercise in swimming. Likewise, the Aquatic Exercise Association –AEA (2001) recommends the use of the scale in the estimate of the exercises intensity in water gymnastics (14). Some studies investigated the relation of the RPE responses with other effort intensity indicators in swimming, as well as in exercises performed out of water. Among them, the study by Ueda and Kurokawa (1995) correlated the RPE with the HR, the VO2 and the BLa during the tied swimming (15).

The multi-factorial nature of sports performances means that intra-individual competitive performances will generally differ (16). Successful competitive swimming performance requires that a talented swimmer has developed his/her technique and physical conditioning to a high level and that the competition performance is reliable (consistent high-quality swimming) through the heats, semi-finals (when necessary) and finals (1).

The issue of progression of performance times within and between races is fundamental to competitive swimming. Progressions are generally required to ensure that a swimmer qualifies for the semi-final and then the final in a given event, and that their peak performance is produced in the final, where medals are decided (17).

Additionally, competitors sometimes prefer to leave their best performance until the final of a competition and attempt to conserve energy during the heats (16). For example, Thompson (1998) reported a 2.8% improvement in finishing time between the heat and final races of national standard breaststroke swimmers (18). Furthermore Mohamed et al., (2021) reported 2.51% to 7.68% performance improvements from heats to semifinals in youth competitive swimmers in a 400 meters freestyle event (19).

During a meet, sport scientists endeavor to provide the coach with both individual results and summary results from all swimmers participating in an event before the next session begins (i.e. heat results before semi-finals/finals) (1). The information obtained in competition analysis is collected in a scientific manner to reduce error of measurement so that accurate data can be used by a coach within a swimming meet or between numerous international events (1) and provides a framework or reference model for the preparation of swimmers in training. The annual training plan, the detail of the macro- and micro-cycles, and the prescription of individual training sessions and sets, is all based on the competitive race model that also can be used to alter a swimmer's strategies in subsequent races (20).

Therefore, it can be assumed that more research on the variations in strategy between competition sessions is still required, given the expected improvement in swimmers' performance between heats and semi-finals/finals and the paucity of data pertaining to young competitive swimmers.

Consequently, our study's objectives were to analyze the physiological and perceptual responses, time performance, and strategy differences among youth competitive swimmers during the 200-meter freestyle event. We also looked at the interactions between these variables and potential differences between heats and semi-finals held on the same competition day. According to our hypothesis, swimmers' physiological and perceptual reactions will differ

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depending on the approach they employ between the heats and the semi-finals.

2. Methods and Materials

2.1. Study Design and Participants

22 youth male swimmers consented to take part in the study and provided signed informed consent from their parents. Each measure was treated in accordance to the standard ethical guidelines of the ethics committee of the higher institute of sport and physical education of Tunisia, which had approved the experimental protocol.

In a national 4-day age-group swimming championship, which consisted of two sessions for each of their respective events (heats and semi-finals), the front-crawl specialists who participated in our study were evaluated while they competed in the 200-meter freestyle event on the second day.

Out of the 16 individuals that advanced to the semi-finals, only 13 (age 16.8±0.6 years; weight 69.8±2.2 kg; height 178.3±3.9 cm) were included in the study; the other three semi-finalists did not have parental consent to participate.

The TOP 8 swimmers (n=7; height 178.3 ± 3.8 cm; weight 69.9 ± 1.8 kg; age 16.9 ± 0.7 years) who finished first to eighth in the semi-final session advanced to the major national open championship finals, which will take place a week later, while swimmers who placed ninth to sixteenth in the semi-finals (n=6; age 16.6 ± 0.4 years; weight 69.6 ± 2.8 kg; height 178.2 ± 4.5 cm) were eligible to compete in further regional competitions.

2.2. Testing Protocol

All of the heats took place between 9 and 11 a.m., while the semi-finals took place between 5 and 7 p.m. On the morning of the competition's first day, prior to the warm-up, the anthropometric measurements were evaluated. A stadiometer was used to measure the subject's height while they were barefoot and with their back against a vertical wall, with measurements taken to the closest half centimetre. To the closest 0.1 kg, mass was measured on a Tanita HD 317 electronic scale.

The 200-meter freestyle swim time performance (T200) was taken straight from the official competition results. A Polar S610 HR Monitor (Polar Electro Oy, Kempele, Finland) was placed directly against the participant's chest to measure HR as soon as the event was over.

After being separated from other swimmers, participants were asked to rate their RPE on the Borg RPE scale (6–20) as they awaited the display of their heart rate. A 5µl capillary blood sample was obtained from the fingertip and used to test BLa twice (at 3 and 6 minutes after the event had finished). The analyzer (LactatePro LT-1710, Akray, Japan) employs a reagent strip, and the results are known in 60 seconds. To determine the peak and removal, [La-] samples are usually taken at various intervals; it has been observed that the peak and removal reach their maximum approximately three minutes after the conclusion of an all-out test (21).

Other investigators have reported collecting blood samples for lactate analysis between 3 and 5 min (5, 21-23), while Bonifazi et al. (2000) observed peak BLa around 6-7 min after competitive events, Hence, we were confident that the period we chose for sample collection was appropriate for observing peak-postrace BLa (4).

2.3. Data Analysis

All data was assessed for normal distribution via the Kolmogorov—Smirnov Test of Normality. Differences in descriptive characteristics inter-groups and intra-group were determined respectively via independent-samples and paired-samples t-test. Participant responses (BLa, HR, RPE and T) for the 200 meters freestyle heats and finals were pooled (n = 13) and assessed for relationships via Pearson's product moment correlation. Alpha for these analyses was set at 0.05. All values are presented as mean ± standard deviation (S.D.) and analysis completed with Statistical Package for Social Sciences (v.20. SPSS, Chicago, USA).

3. Findings and Results

Participant's descriptive characteristics are presented in Table 1.

Table 1

Descriptive characteristics of the participants

	All the swimmers n=13	Top swimmers (n=7)	Other semi-finalists swimmers (n=6)
Age (years)	16.82±0.67	16.99±0.75	16.62±0.43
Height (cm)	178.30±3.96	178.34±3.80	178.25±4.50
Weight (kg)	69.82±2.25	69.93±1.83	69.68±2.84
HR200 heats (bpm)	168.62±8.09	163.86±6.74	174.17±5.81
HR200 semi-finals (bpm)	181.77±4.13	180.57±4.43	183.17±3.60
RPE200 heats	14.08±1.55	12.86±0.90	15.50±0.55
RPE200 semi-finals	17.69±1.03	17.43±1.27	18.00±0.63
BLa200 heats (mmol/l)	8.95±2.03	7.51±1.66	10.62±0.61
BLa200 semi-finals (mmol/l)	12.66±1.98	12.57±2.54	12.77±1.27
T200 heats (sec)	128.42±2.35	128.13±2.67	128.75±2.12
T200 semi-finals (sec)	122.74±2.73	120.81±1.87	124.99±1.55

Intra-group comparison of mean results for each variable between heats and semi-finals using t-test are presented in Table 2. The results indicated that there is a significant difference between heats and semi-finals mean results for all the measured variables in both groups.

Table 2

Correlation coefficients between all the measured variables of all the participants

	200heats	200 semi-finals
HR/RPE	0.65*	0.82**
HR/BLa	0.88**	0.80**
RPE/BLa	0.83**	0.70**

** Correlation is significant at the 0.01 level

* Correlation is significant at the 0.05 level.

With seven swimmers from the Top 8 positions and six from the other semi-finalists, 13 out of our 22 athletes (81.25% of the semi-finalists) have advanced to the semi-finals.

The Average improvement from heats to semi-finals of the measured variables are presented in Table 3.

Table 3

Mean results improvements from heats to semi-finals.

		HR200	RPE200	BLa200	T200
TOP 8 swimmers	% improvement	10,20%	35,56%	67,30%	-5,72%
	p value	0,0025	0,0004	0,0011	0,0006
Semi finalists swimmers	% improvement	5,17%	16,13%	20,25%	-2,92%
	p value	0,0175	0,0007	0,0050	0,0035

* Significance p <0.05

4. Discussion and Conclusion

Considering that heart rate and perceived effort are the most frequently used indicators for the control of the intensity of effort in water exercises (9), the present study investigated the performances, the physiological and perceptual responses between competition rounds in youth competitive swimmers by examining possible differences between heats and semi-finals within the same competition day during the 200 meters freestyle event.

Considering the results of t-test presented in table 2, both Top 8 swimmers and the other semi-finalists showed significant changes in the means of all the measured variables ($p<0.05$) when comparing heats with semi-finals.

More precisely when analyzing average improvement from heats to semi-finals we noticed that the Top 8 swimmers improved their performances by 5.72 % while the other semi-finalists improved it by 2.92 %, Pyne et al. (2004) described a variation of 0.7% to 1% between heats and semifinals for US and Australian Olympic swimmers while average performance improvement from heat to finals in the a study of skorski et al. (2014) was 1.2%. Furthermore a performance progression between heats and finals of 1-1.3% is cited in previous research (17, 24, 25). Our higher results in comparison with these last ones may be due to the lowest level of our youth swimmers and to the lowest challenge to qualify to finals since our competition is at a national level which is similar to the findings of Thompson (1998) who reported a 2.8% improvement in finishing time between the heat and final races of national standard breaststroke swimmers and to the recent findings of Mohamed et al. (2021) who reported 2.51% to 7.68% performance improvements from heats to semifinals in youth competitive swimmers in a 400 meters freestyle event (18, 19).

The multi-factorial nature of sports performances means that intra-individual competitive performances will generally differ. Additionally, competitors sometimes prefer to leave their best performance until the final of a competition and attempt to conserve energy during the heats.

The other semi-finalists swimmers increased their HR by 5.17% (Vs 10.2% for Top 8 swimmers), their BLa by 20.25% (Vs 67.3% for Top 8 swimmers) and their RPE by 35.56% (Vs 16.13% for Top 8 swimmers) indicating that during the heats they made more effort than the Top 8 swimmers to try to qualify to the semi-finals in the top 8 positions.

Changes in pacing were previously thought to be responsible for this progression (Pyne et al., 2004), however, tactical approaches were more likely to explain these differences; elite swimmers obtain lower average velocity in heats compared to finals (17, 25). This enabled energy conservation in the earlier stages of competition and best performance to be produced in finals where medal positions are decided (16, 25).

During the heats RPE was correlated with HR ($r=0.65$;$p<0.05$) and highly correlated with BLa ($r=0.83$:$p<0.01$) the same observations were noticed during the semi-finals where we have found that RPE was highly correlated with HR and BLa ($r=0.82$ and $r=0.7$ respectively :$p<0.01$) our results confirms previous findings of Maglischo (1999) who considers the Borg's scale a good instrument to evaluate the relative intensity of the exercise in swimming. Likewise, the Aquatic Exercise Association (2006) recommends the use of the scale in the estimate of the exercises intensity in water gymnastics(14) (13). Some other studies investigated the relation of the RPE responses with other effort intensity indicators in swimming, as well as in exercises performed out of water. Among them, the study by Ueda and Kurokawa (1995) correlated the RPE with the HR, the VO_2 and the blood lactate during the tied swimming.

There was also a high correlation between HR and BLa ($r=0.88$:$p<0.01$) during the heats and ($r=0.8$:$p<0.01$) during the semi-finals (15). Keskinen et al. (2007) found that Bla and HR curves for the short and long course swims were nearly identical in 5x200m testing (22).

Large quantities of the energy required for 200m performance is produced via anaerobic metabolism (26), leading to high blood lactate concentrations 8.9-14.0 $mmol.L^{-1}$ (8, 27, 28). The high blood lactate lowers muscular pH and increases the accumulation of hydrogen ions, which interfere with the muscle contraction mechanism (29). These blood lactate concentrations were similar to those noticed in our research 8.95 $mmol.L^{-1}$ during heats and 12.66 $mmol.L^{-1}$ during semi-finals.

A performance improvement between heats and semi-finals is cited in previous researches, changes in pacing were previously thought to be responsible for this progression. However, tactical approaches were more likely to explain these differences; experienced swimmers obtain lower average velocity in heats compared to semi-finals and/or finals. This permitted energy conservation in the earlier stages of competition and best performance to be produced in finals where medals and best positions are decided. Although, caution is advised with this strategy as swimmers must ensure qualification from heats to semi-finals and/or finals. They must thus master it before using it in competition. This can be accomplished by practicing daily at intensities close to the 200-meter race pace in order to improve their experience and decision-making. Lastly, they can test it in small competitions or by setting up simulated

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competitions where the tactics used will be examined and swimmers will be provided with race-related information. Despite the importance of this topic, research remains limited and further investigation is warranted, swimmers and coaches could benefit from a comparison of different round strategies to inform these tactics in both elite and youth competitive swimmers.

Authors' Contributions

All authors equally contributed to this study.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

The study placed a high emphasis on ethical considerations. Informed consent obtained from all participants, ensuring they are fully aware of the nature of the study and their role in it. Confidentiality strictly maintained, with data anonymized to protect individual privacy. The study adhered to the ethical guidelines for research with human subjects as outlined in the Declaration of Helsinki.

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