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COORDENATION AND KINEMATICS IN 200 M FRONT CRAWL SWIMMING ALL OUT

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SUMMARY
The aim of this study was to compare coordinative and kinematics parameters along the four laps of a 200 m front crawl stroke all out. Fifteen male swimmers performed a 200 m trial, all out, in front crawl. Index of coordination (IdC), swimming velocity (SV), stroke length (SL), stroke rate (SR) and stroke phase's duration along the laps were measured and compared. Results were: SR increased while SL and SV decreased; IdC was in superposition and stroke phase's duration were similar. Probably these results are related to the physiological environment along the 200 m and the attempt to keep the swimming velocity constant.

INTRODUCTION
Index of coordination (IdC) and the stroke propulsive (B and C phases) and non-propulsive (A and D phases) phases duration (in relative values to the total cycle duration) are influenced by the mean swimming velocity (SV) [1]. Previous results [2] from sprint swimmers showed that in 100 and 200 m front crawl, all out, SV and mean stroke length (SL) decrease along the races, however IdC has increased. The identification of the adopted kinematic and coordinative parameters behaviors, such as IdC, SV, SL and stroke rate (SR), can be useful in the technique training, which is affected by the energetic profile and could be changed by the individual strategy in a race, as the 200 m freestyle. So, the aim of this study was to compare IdC, SV, SL, SR and stroke phase's duration along the laps of an 200 m performed in front crawl, in maximal intensity (all out).

METHODS
Fifteen male distance swimmers (age: 21.1 ± 7.1 years old; height: 180.1 ± 6.1 cm; arm span: 187.3 ± 8.1 cm; body mass: 72.1 ± 10.1 kg) participated voluntarily in this study, which was approved by the local ethics committee.

Protocol
The 200 m trial was performed in a 25 m long pool (water temperature: 29.5 ± 0.7°C), in the same time of the day for every swimmers, between 2 and 6 PM; it was performed after a 800 m free swimming warm up and in maximal intensity, and without start from the block.

Data colection
Data acquisition was performed with manual time keeping and with 2D videogrametry system. For the hand timing system, a space of ten meters, from 10 to the 20 m of the lap, was marked. Three experienced timekeeper registered: time to swim the 10 m (head as the reference) and time to perform three consecutive and complete stroke cycles. Than, these data were used to calculate SV (10 m/time in sec to perform the distance), SR (3 cycles/time in sec to perform the three cycles) and SL (SV/SR).
Images from the swimmer sagittal plane were obtained at 60 Hz from each lap before the 50, 100, 150 and 200 m (respectively, L1, L2, L3 and L4) of the 200 m trial. Two camcorders (Sanyo) were positioned under and above water in an rigid arm fixed to a chariot which was over trails along the lateral swimming pool board. This chariot was pushed, in the same velocity of the swimmer, by an experienced researcher. Both cameras were focused to the swimmier shoulder and were, previously, synchronized with a light flash.

Data analyses
Stroke phases are determined as (for the same arm):

A. Entry and catch: time gap between the hand's entry in the water and its first movement backward; no propulsive phase;
B. Pull: time gap between the hand's first movement backward and its position just above the shoulder; propulsive phase;
C. Push: time gap between the hands position just above the shoulder and its released from the water; propulsive phase;
D. Recovery: time gap between the man released from the water and its entry in the water; no propulsive phase.

To determine the adopted coordination model it was used the IdC values proposed by Chollet, Chalies e Chatard [1]: IdC < 0% means catch up model; IdC = 0% indicates opposition model and IdC > 0% indicates superposition model. These models refer to time gap between the propulsive phases of both arms, specifically, catch up model: when the B phase of one arm starts before the C phase of the other arm finish; opposition model: there is no time gap between B phase of one arm and C phase of the other arm and superposition: B phase of one arm starts before the C phase of the other arm finish.

Statistical analyzes were performed with descriptive and inferential methods. Normality distribution was tested with Shapiro-Wilk Test and mean ± standard deviation were calculated. Among the kinematic. Repeated ANOVA was applied, sphericity was verified with Mauchly Test. When necessary, correction factor Epsilon of Greenhouse-Geisser was used. Main effects were verified with Bonferroni Test; α=0.05.

RESULTS AND DISCUSSION

Performance in 200 m front crawl was 130.7 ± 6.5 s, relative to 76.1% of the world record. Mean velocity was 1.53 ± 0.07 $m.s^{-1}$. Main results are in Table 1. SR has increased from L1 to L4 as IdC has increased from L2 to L4 ($p < 0.05$). SL has decreased from L1 to L2, L3 and L4 and SV decreased from L1 to L2 ($p < 0.05$). No differences were found among the duration phases along the laps of the 200 m.

Main objective of this study was to compare coordinative (IdC) and kinematics parameters (SV, SL, SR and stroke phase's duration) along the laps of a 200 m front crawl all out. Identified increases in IdC could be explained by simultaneous SR increase and SL decrease. The attempt to keep or to increase SV in the 200 m, when the physiological environment tends to deteriorate is the responsible for the SR and SL behaviors found in this study and previously found [3]. IdC values increased from 1.1 to 3.8% from L1 to L4, indicating superposition model of coordination, similar to those results reported by Seifert et al. [4], which showed IdC values from 1.12 e 2.78%, however, in 100 m front crawl. Although, comparing the IdC results of the present study to those reported by Seifert et al. [4] from 200 m too, they ere different. Seifert et al. [4] found IdC values related to catch up model (- 5.9± 4.6%). Larger IdC values in this study, when compared to those cited [4] could be explained by the main characteristic of the swimmers. In this study, they were long distance swimmers, and in a 200 m event, they possibly adopt a coordinative model quite similar to sprint swimmers in shorter events [2, 4]. To the stroke phases, results were similar to those reported by Seifert et al. [4].

CONCLUSIONS

For the 200 m front crawl all out, four main conclusions are described: 1) there is an increase in SR and decrease in SL along the laps; 2) SV decreased just from the first to the second lap, than it has stabilized; 3) even that IdC has changed from the second to the last lap, it was always in superposition model; 4) there is no difference in the duration of the stroke phases.

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Table 1. Stroke rate (SR), stroke lenght (SL), swimming velocity (SV), index of coordination (IdC), duration of the four phases (A, B, C and D) of the strokes in the four laps (L1 to L4) of the 200 m front crawl; n = 15.

	L1	L2	L3	L4
SR (Hz)	39.51 ±4.5	40.14 ±4.9	40.90 ±4.5	42.06 ±3.1†
SL (m)	2.18 ±0.15	2.06 ±0.14†	2.02 ±0.15†	1.97 ±0.15†
SV ($m.sec^{-1}$)	1.43 ±0.13	1.37 ±0.09†	1.36 ±0.07	1.38 ±0.09
IdC (%)	1.10 ±10.7	1.10 ±11.8	3.66 ±9.4	3.87 ±10.5#
Phase A (%)	26.11 ±10.7	25.38 ±11.6	24.55 ±11.4	23.2 ±10.9
Phase B (%)	27.1 ±8.2	27.06 ±9.2	27.48 ±8.3	28.4 ±8.6
Phase C (%)	23.48 ±3.1	23.57 ±2.9	24.34 ±3.3	24.61 ±3.0
Phase D (%)	23.38 ±3.3	23.17 ±3.3	23.13 ±3.5	23.26 ±3.3

† Significant differences to the lap L1 ($p < 0.05$). # Significant differences to the lap L2 ($p < 0.05$).