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ESTABLISHING THE CHANGES IN ELITE SWIMMERS' ENERGETIC AND BIOMECHANICAL PROFILE DURING A WINTER SEASON

INTRODUCTION

Researchers are constantly trying to identify the factors that can predict with higher accuracy the swimming performance. This massive research has given special emphasis to the energetic and biomechanical assessments as the major determinants to enhance swimming performance (e.g. Barbosa et al., 2008). A very recent review study suggested a hierarchical relationship between these factors. The performance is strongly linked to the energetic assumptions, since these, in turn, are dependent on the biomechanical behaviour and the motor strategies adopted by swimmer (Barbosa et al., 2010).

Tracking changes in energetical and/or biomechanical variables is quite important for swimmers and coaches, because might help those finding realistic goals and training procedures. Main advantages are: (i) monitoring the progression on swimmers' energetic and biomechanical profile during or between seasons or; (ii) determine a hierarchical contribution for the variables that can better predict the swimming performance during a season or during swimmers career; and (iii) establish temporal relationships between swimmers energetic and biomechanical profiles.

For two consecutive seasons was reported a significant improvement in biomechanical and energetical factors for young male (Latt et al., 2009a) and female (Latt et al., 2009b) swimmers. Authors also stated that biomechanical factors (stroke index) best characterized the 400-m freestyle performance in both genders. Monitoring changes in test measures for 3.6±2.5 years, the stroke frequency at 4 mmol.L^{-1} blood lactate concentration (SF@V4) for males and the skinfolds for females showed to be reliable parameters to predict the breaststroke performance (Anderson et al., 2008).

At the moment, a couple of papers investigated longitudinal data concerning the changes in energetic or biomechanical variables. However, those earlier studies only focused their attention in a single domain (energetics or biomechanics), and/or measured very few parameters.

So, the aim of this study was to analyze the changes in elite swimmers' energetic and biomechanical profile during a winter season.

METHODS

SUBJECTS: Seven elite male swimmers (19.86±3.58 years of age; 1.77±0.05 m of body height; 71.77±7.55 kg of body mass) volunteered to serve as subjects. Swimmers had regular participation in national and international competitions in the last two years.

STUDY DESIGN: Subjects were assessed in two different evaluation moments: November (EM_1) and March (EM_2) of the 2009-2010 season. In a single session an incremental step test of 7x200-m Front Crawl, with an increase in speed of 0.05-m.s^{-1} and 30-s of recovery between bouts was performed, to assess the energetic and biomechanical variables in a 50-m swimming pool. The initial velocity was determined by approximately 0.3-m.s^{-1} lower than the best performance of each subject at the 200-m Front Crawl event. It was evaluated: (i) the velocity of maximal equilibrium of lactate levels estimated to be at the 4-mmol (V4, m.s^{-1}) as energetic variable; (ii) the stroke length at V4 (SL@V4, m), stroke frequency at V4 (SF@V4, Hz), stroke index at V4 (SI@V4, m^2.c^{-1}.s^{-1}) and propelling efficiency at V4 (np@V4, %) as biomechanical variables.

DATA COLLECTION: The V4 values were obtained by the interpolation of the average lactate value (4 mml.L^{-1}), with the exponential curve of lactate/speed. The SF was measured with a crono-frequency meter (Golfinho Sports MC 815, Aveiro, Portugal) from three consecutive stroke cycles, in the middle of each lap. The SF@V4 was obtained by the interpolation of the SF value in the V4 by the curve SF-speed. SL@V4 was calculated by the equation (Craig et al., 1985):

$$SL@V4 = \frac{V4}{SF@V4}$$

The SI@V4 was calculated by the equation (Costil et al., 1985)

$$SI@V4 = V4 \cdot SL@V4$$

The np@V4 was obtained according to Zamparo et al., (2005):

$$\eta_p @V4 = \left(\frac{V4 \cdot 0.9}{2\pi \cdot SF@V4 \cdot l} \right) \cdot \frac{2}{\pi}$$

STATISTICAL PROCEDURES: The normality of the distributions was assessed with the Shapiro-Wilk test. The comparison between the two EM was performed based on the non parametric Wilcoxon Test ($P \leq 0.05$).

RESULTS AND DISCUSSION

Figure 1 presents the V4 variation between the two evaluation moments. A significant increase was verified between November and March ($V4_{EM1}$=1.43±0.07; $V4_{EM2}$=1.45±0.06).

Figure 2 presents de variation of biomechanical parameters. Also a significant increase in SF@V4 was observed $SF@V4_{EM1}$=32.71±3.09; $SF@V4_{EM2}$= 34.14±3.67).

The SL@V4, SI@V4 and the np@V4 presented stable without significant variations:

$SL@V4_{EM1}$=2.64±0.19;$SL@V4_{EM2}$=2.56±0.22;

$SI@V4_{EM1}$=3.77±0.33;$SI@V4_{EM2}$=3.70±0.34;

$np@V4_{EM1}$=41.83±4.05;$np@V4_{EM2}$=40.66±4.49).

We can appoint the training process as the main reason for this V4 enhancement during the winter season as suggested in previous studies (e.g., Reis & Alves., 2006).

On the other hand, the motor control and stagnation in the anthropometric characteristics are reasons that can explain the significant increase in SF@V4 and the stagnation in SL@V4. At some point of the competitive season, elite swimmers reach a maximal standard of technical ability, were improvements in swimming velocity only are capable by increasing the SF and maintaining the SL. Similar results about the stagnation in biomechanical parameters were reported during a training season for young swimmers (Minghelli & Castro., 2006). However in our study, when concerning an individual analysis, four of the seven swimmers have increased their SI@V4. So, we can state that each swimmer as an individual optimal capacity to combine this key biomechanical elements to improve their performance.

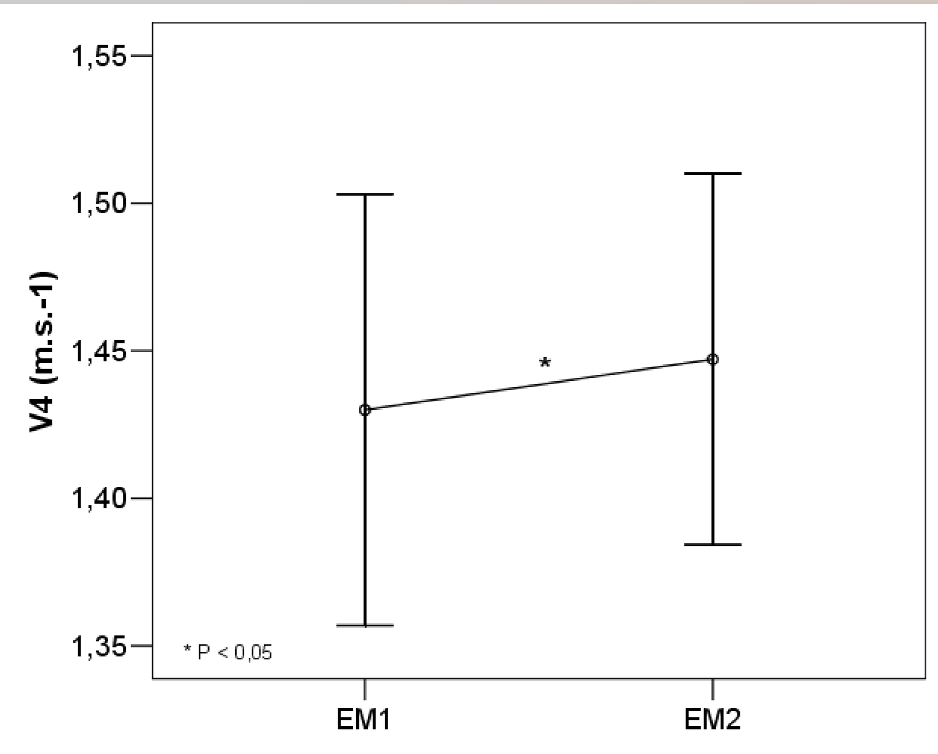

Figure 1. Mean (+1 SD) variation of V4 between the two evaluation moments.

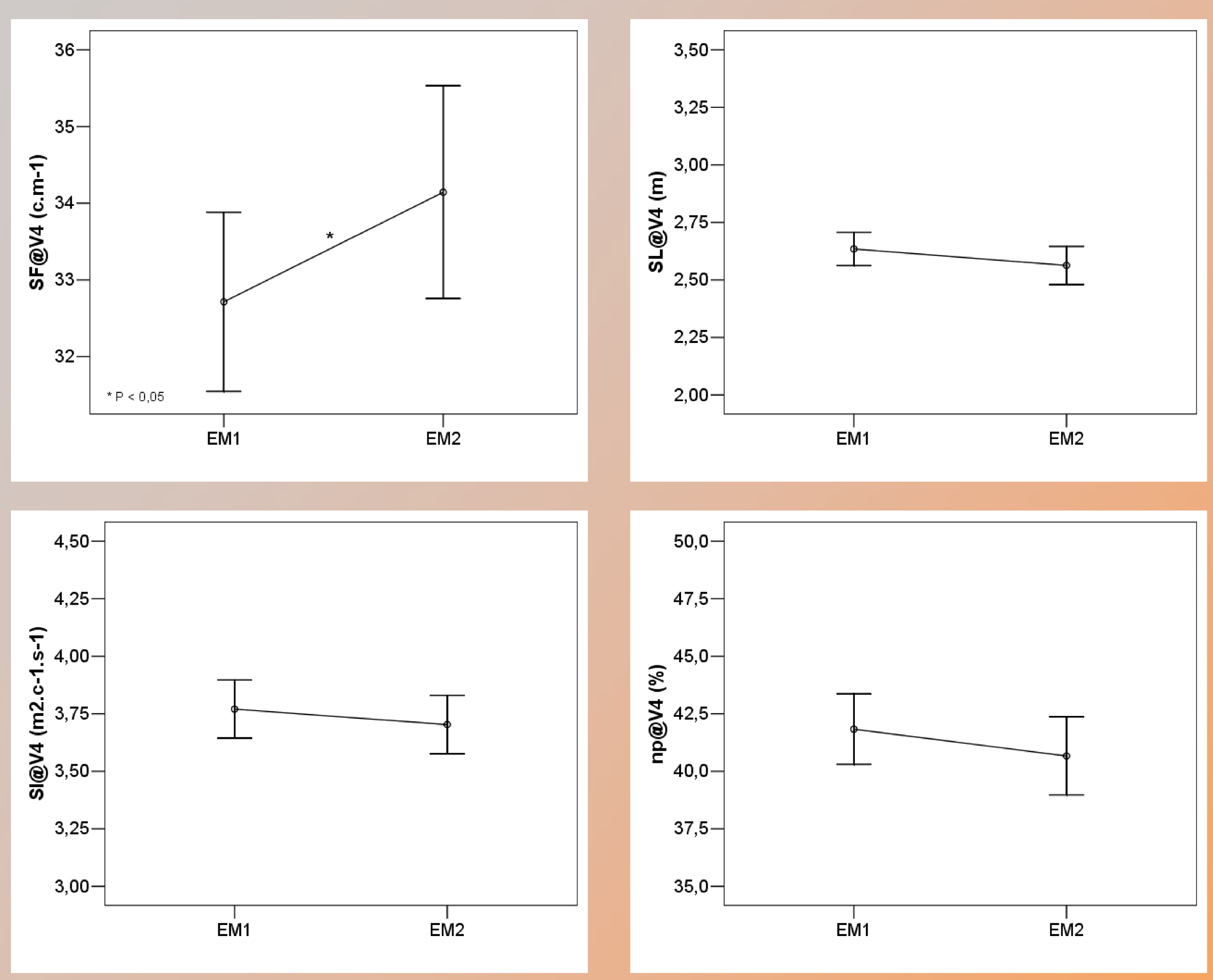

Figure 2. Mean (+1 SD) variation of biomechanical parameters between the two evaluation moments.

CONCLUSION

It seems that there is a trend for a V4 increase during the winter season. Moreover, the changes in biomechanical parameters, mainly in SF@V4, can be the determinant factor for this V4 enhancement. However, an individual analysis should be considered to better explore the benefits of the training process.

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