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VARIABILITY IN YOUNG SWIMMER' PERFORMANCE AND ITS DETERMINANT FACTORS: A TWO-YEAR FOLLOW-UP

INTRODUCTION

Predicting sports performance and identifying talented athletes at early ages seems to be a challenging task for practitioners and researchers. Based on this, the follow-up of individual pathway to expertise should be a regular procedure among sports practitioners.

Competitive swimming is a sport characterized by a relationship between performance and multi-disciplinary determinant factors. Several interactions between anthropometric and kinematic variables were reported in young swimmers, having a mediate or direct effect on hydrodynamics and performance (Morais et al., 2012).

Despite the nowadays state of the art, those previous interventions highlighted the universal perspective (i.e. mean data is reported and analyzed) instead of individual trends. Mean data express intra-individual changes that are shared by every subject. It is considered a non-variance between subjects, or if there is assumed as random error or noise in the dataset.

Hence, this universal perspective focuses on the modal or normative behavior. Recent reviews about the dynamics of talent development suggest that each athlete should be seen as a unique individual, where a complex and dynamical athlete-environment relationship exists (Philips et al., 2010). There is a lack of training interventions and follow-ups in swimming that explored individual trends through a competitive season, namely in young swimmers.

The aim of this study was to: follow-up the overall, intra- and inter-individual stability of young talented swimmers' performance and its determinant factors (anthropometrics, kinematics, hydrodynamics and efficiency) during two competitive seasons.

METHODS

Thirty young swimmers (14 boys: 12.33 ± 0.65 years; 16 girls: 11.15 ± 0.55 years; both genders in Tanner stages 1-2 by self-evaluation) were evaluated. They had at the beginning of the assessment 3.40 ± 0.56 years of training experience (training sessions per week: 5.09±0.87; average volume per session: 4.86±0.97 km).

METHODS

Performance

The official short course 100-m freestyle race (i.e. 25-m length swimming pool) was chosen as a performance measure.

Anthropometrics

For all measurements swimmers were asked to wear only a textile swimsuit and a cap. Body surface areas (in cm^2; hand surface area - HSA; foot surface area - FSA; trunk transverse surface area - TTSA) were measured with digital photogrammetry (Morais et al., 2012). Body mass (BM, in kg), height (H, in cm), arm span (AS, in cm) and chest perimeter (CP, in cm) were also measured.

Hydrodynamics

Velocity Perturbation Method was used to estimate the active drag (D_a, in N) and the coefficient of active drag (C_{Da}, adimensional) (Kolmogorov and Duplisheva, 1992). Swimmers performed two maximal trials of 25-m at front crawl with push-off start (one trial with and other without carrying on the perturbation device). Two expert evaluators with stopwatches measured the trials between the 11th and 24th meters.

Kinematics and efficiency

Both kinematics and efficiency were assessed during the same trials. Swimmers individually performed three maximal freestyle swim trials of 25-m with push-off start.

A speedo-meter's (Swim speedo-meter, Swimsportec, Hildesheim, Germany) cable was attached to the swimmers' hip.

Figure 1. Swim speedo-meter.

Swimming velocity (v, in $m \cdot s^{-1}$) was computed in the middle 15-m as: v=d/t. Stroke frequency (SF, in Hz) with a chrono-frequency counter. Stroke length (SL, in m) as: SL=v/SF. Speed fluctuation (dv, adimensional) was calculated as: dv=cv=standard deviation/ mean. Stroke index (SI, in $m^2 \cdot s^{-1}$) as: SI=v*SL and propelling efficiency (η_p, in %) as Zamparo et al. (2006).

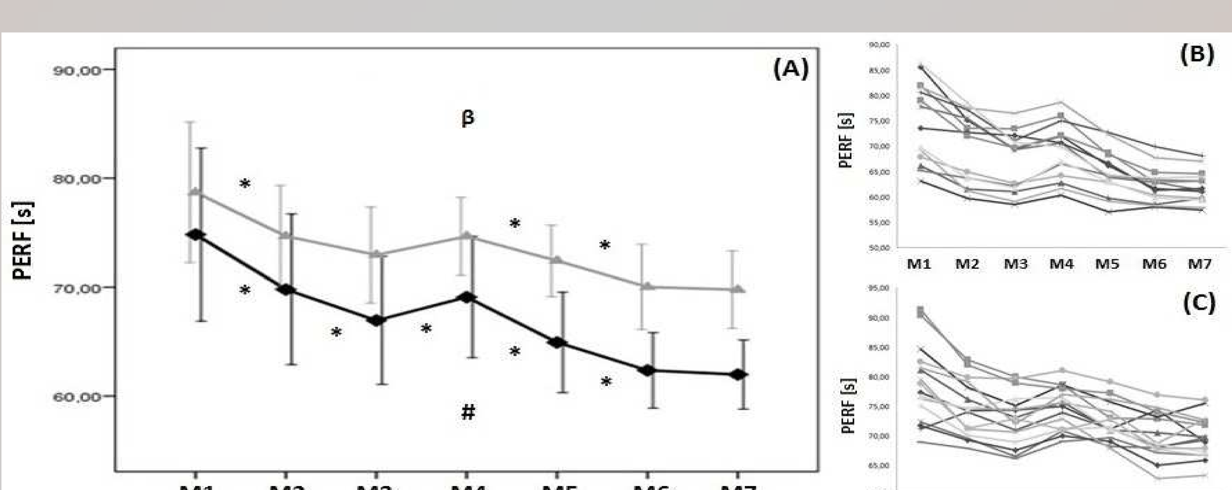

Figure 2. Performance variation along the two seasons. (A) boys and girls mean variations; (B) boys individual variations; (C) girls individual variations; PERF – performance@100free; M – moment; * – significant differences between moments for both boys and girls (p≤0.05); # – significant differences between moment one (initial) and moment seven (final) for boys (p<0.001); β – significant differences between moment one (initial) and moment seven (final) for girls (p<0.001).

RESULTS AND DISCUSSION

Mean and individual stability

Performance showed a significant improvement between first (M1) and last (M7) evaluations in both genders. Previous studies also pointed out a performance improvement for young swimmers during two consecutive years (Lätt et al., 2009). Similar trend was identified in our participants for the time-frame under study (Figure 2). Performance changes were related to very unique and individual adaptations in each one of its determinant factors. Despite the meaningful improvement observed within and between seasons for both genders, boys improved more sharply their performance than girls (boys: -20.60%; girls: -12.81%). The delayed maturation in boys may explain such phenomenon.

All anthropometric variables (i.e. lengths and body surfaces) increased significantly between M1 and M7 for both genders (Figure 3). Young swimmers, as any other children, experience physical changes as part of their normal biological development. Body mass, height, and therefore, limbs' lengths and areas are some of the anthropometric features that change with growth. Growth rate was higher in boys (5.81% to 21.43%) than girls (4.95% to 19.02%) for all anthropometric features. These data suggested that boys were in an accelerated development stage, while girls have eventually experienced such biological development before.

RESULTS AND DISCUSSION

All kinematic and efficiency variables (except the dv) increased between M1 and M7 (Figure 4). Kinematics and efficiency changed in boys (1.58% to 23.96% for) and girls (0.86% to 48.84%). Only v and SI (both genders) and SL (only girls) showed a significant increase (M1 vs M7). The improvement of swimming speed of young swimmers between two major competitions was reported as being related to SL increases and SF decreases (Tella et al., 2002). This SL-SR relationship is a result of growth (e.g. height, arm span, hands and feet dimensions). Therefore, growth plays a role in the young swimmers' mechanics (Silva et al., 2013).

Regarding hydrodynamics, both D_a and C_{Da} increased between M1 and M7 in both genders; however, only girls' D_a showed a significant increase (Figure 3). Unchanged hydrodynamics was reported for eight weeks of training at the beginning of a season (Marinho et al., 2010). The main aim of this general period of preparation was to build-up aerobic capacity and aerobic power, enhance swimming technique. However, one week of drill training with specific visual and kinaesthetic feedbacks, was enough to decrease C_{Da} in pubescent swimmers (Havriluk, 2006). So, hydrodynamic enhancement is more related to technical ability than to energetic build-up.

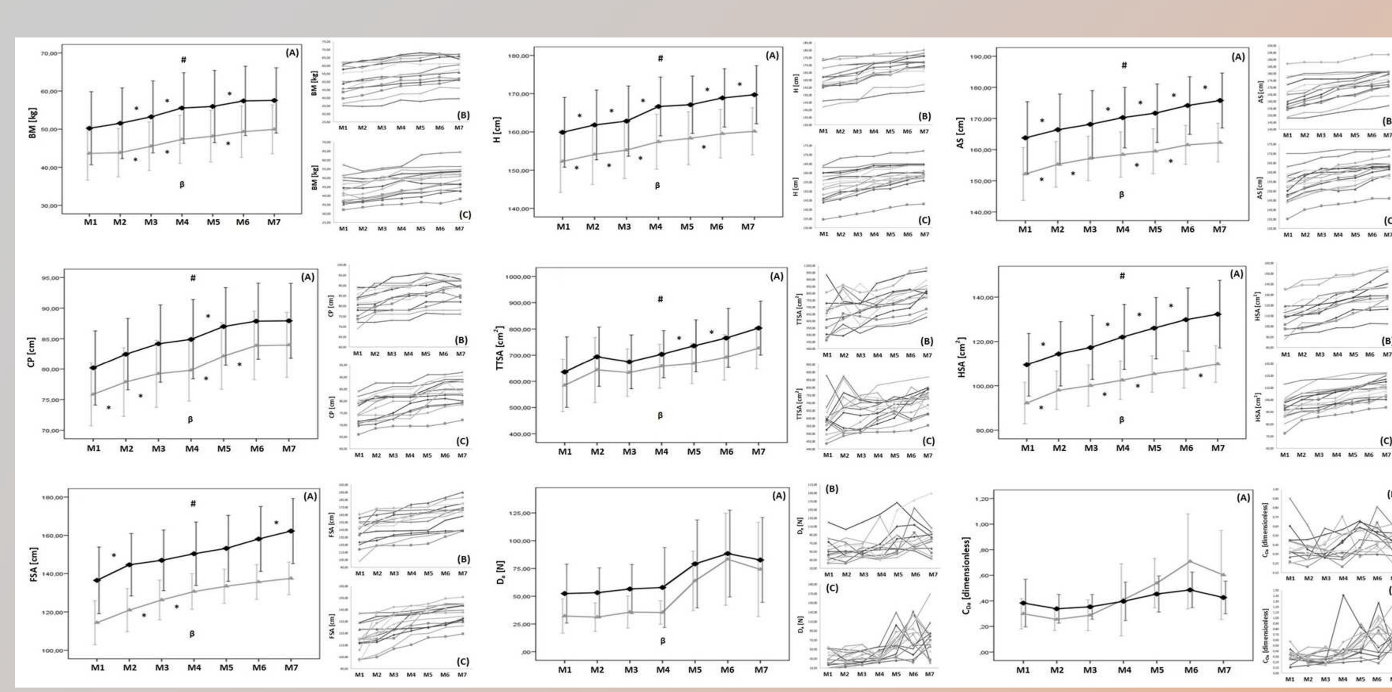

Figure 3. Anthropometric and hydrodynamic variation along the two seasons. (A) boys and girls mean variations; (B) boys individual variations; (C) girls individual variations; BM – body mass; AS – arm span; H – height; CP – chest perimeter; TTSA – trunk transverse surface area; HSA – hand surface area; FSA – foot surface area; D_a – active drag; C_{Da} – active drag coefficient; M – moment; * – significant differences between moments for both boys and girls (p≤0.05); # – significant differences between moment one (initial) and moment seven (final) for boys (p<0.001); β – significant differences between moment one (initial) and moment seven (final) for girls (p<0.05).

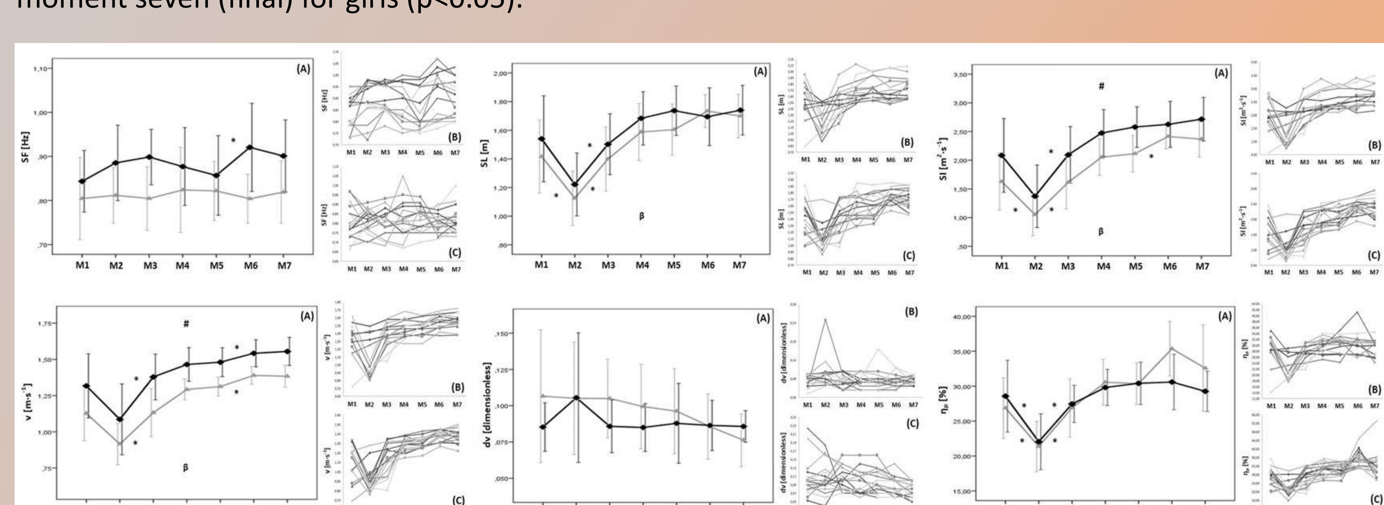

Figure 4 Kinematic and energetic variation along the two seasons. (A) boys and girls mean variations; (B) boys individual variations; (C) girls individual variations; SF – stroke frequency; SL – stroke length; v – swimming velocity; dv – speed fluctuation; η_p – propelling efficiency; SI – stroke index; M – moment; * – significant differences between moments for both boys and girls (p≤0.05); # – significant differences between moment one (initial) and moment seven (final) for boys (p<0.01); β – significant differences between moment one (initial) and moment seven (final) for girls (p<0.05).

RESULTS AND DISCUSSION

Inter-individual stability based on Cohen's Kappa quantifies the partial position of a swimmer against remaining contenders. A higher stability indicates that there are fewer changes in the partial position of the subjects throughout the time-frame under analysis. There was a moderate stability for performance and anthropometrics (boys and girls). However, kinematics, efficiency and also hydrodynamics showed a low-moderate and a low stability for boys and girls, respectively, hence a high variability. These findings suggest that growth and biological development are strongly associated with performance. In such early ages, swimmers that are in more advances stages of biological development take the lead and rank on the top. Nevertheless, not only growth and biological development can determine performance. Hydrodynamics (e.g. D_a), efficiency (e.g. SI) and kinematics (e.g. SF for boys and v for girls) should also be highlighted as major players since presented as well high correlations.

CONCLUSION

It can be concluded that young swimmers display a meaningful improvement in performance and its determinant factors.

The changes rate is higher in boys than girls and are strongly related to growth and training. Average variations of the pooled sample did not express the individual and unique changes of each swimmer.

Therefore, practitioners should designs customized training plans for each swimmer and academics put more focus on individual and dynamic analysis frameworks.

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