Changes in classical kinematics and non-linear parameters after a maximal 100-m front-crawl bout

Tiago M. Barbosa[1,2,3], Jorge E. Morais[2,3], Chen Simin1, Mario J. Costa[3,4]

1. Nanyang Technological University, Singapore; tiago.barbosa@nie.edu.sg; 2. Polytechnic Institute of Braganca, Portugal; 3. Research Centre in Sports, Health and Human Development, CIDESD, Portugal; 4. Polytechnic Institute of Guarda, Portugal

In a linear system there is proportionality between input and output. Under this framework it is expected that the amount of change in sports performance must be proportional to variations in the inputs. However, as far as elite performance goes, this is not a straightforward assumption. Sometimes the variables selected are not sensitive enough. Hence, there is the need of having non-linear concepts underpinning such analysis. The aim was to compare classical kinematics and non-linear parameters after a maximal 100-m front-crawl bout. Twenty four subjects (12 males and 12 females; 22.38±1.68-y) were invited to perform a 100-m freestyle race at maximal pace. Before (pre-test, i.e. rested) and immediately after (post-test, i.e. under fatigue) the maximal bout, they performed two maximal 25m swims at freestyle with push-off start. A speedo-meter cord (Swim speedo-meter, Swimsportec, Hildesheim, Germany) was attached to the swimmer's hip (Barbosa et al., 2015) in the two 25m trials collecting the instantaneous speed. It was computed the speed fluctuation (dv; Barbosa et al., 2015), approximate entropy (ApEn; Barbosa et al., 2015) and fractal dimension (FD; Higuchi, 1988). Repeated measures ANOVAs (pre-test vs. post-test; $P \leq 0.05$), effect sizes (eta squared) and 95% of confidence intervals (95CI) were computed. The speed was 1.44±0.24 and 1.28±0.23m/s in the pre- and post/test, respectively ($F=55.136$, $P<0.001$). The dv increased from the pre- to the post-test with moderate effect sizes ($F=15.048$, $P<0.001$, $\eta^2=0.41$). The dv increased by 20.17%, shifting the 95CI band from 0.116-0.134 to 0.140-0.161. The ApEn showed trivial variations between the pre- and post-test ($F=0.037$, $P=0.85$, $\eta^2<0.01$). There was a trend for a decrease of the ApEn by 2.23% and the 95CI of pre- and post-test overlap (pre: 0.659-0.700; post: 0.641-0.682). The FD showed a significant effect due to the fatigue with a moderate effect size ($F=5.186$, $P=0.03$, $\eta^2=0.20$). The 95CI band moved from 1.954-1.965 to 1.933-1.951. All 24 subjects increased the dv from pre- to post-test. 21 out of 24 swimmers decreased the FD from pre- to post-test and 16 decreased the ApEn. There was an increase in the dv and a decrease of both ApEn and FD. All in all, fatigue led to a higher speed fluctuation amid a more predictable and less complex motor behaviour.

References:

Barbosa, T. M., Morais, J. E., Marques, M. C., Silva, A. J., Marinho, D. A., & Kee, Y. H. (2015). Hydrodynamic profile of young swimmers: changes over a competitive season. *Scandinavian Journal of Medicine & Science in Sports*, *25*(2), e184-196. https://doi.org/10.1111/sms.12281

Higuchi, T. (1988). Approach to an irregular time series on the basis of the fractal theory. *Physica D: Nonlinear Phenomena*, *31*(2), 277–283. https://doi.org/10.1016/0167-2789(88)90081-4

Comparison of the fractal dimension among swimmers with different levels of expertise

Tiago M. Barbosa[1,2,3], Jorge E. Morais[2,3], Raul Bartolomeu[3], Mario J. Costa[3,4]

1. Nanyang Technological University, Singapore; tiago.barbosa@nie.edu.sg; 2. Polytechnic Institute of Braganca, Portugal; 3. Research Centre in Sports, Health and Human Development, CIDESD, Portugal; 4. Polytechnic Institute of Guarda, Portugal

It is known that performance is strongly related to proportional changes in the inputs. The "marginal gains theory" in sports performance gained popularity a few years ago. It encompasses the assumption that small changes in the input (or the sum of several changes) may have a significant effect on the output. Yet, it is unclear if nonlinear parameters such as fractal dimension are able to distinguish subjects with different levels of expertise. The aim was to compare the fractal dimension in swimmers with different levels of swimming expertise. Seventy five subjects in accordance to their level of expertise (highly qualified experts, experts and non-experts) were invited to perform maximal 4x25m swims in each swim stroke after a push-off start. A speedo-meter cord (Swim speedo-meter, Swimsportec, Hildesheim, Germany) was attached to the swimmer's hip (Barbosa et al., 2015) collecting the instantaneous speed. Upon that, the fractal dimension (FD; Higuchi, 1988) was computed. Two-way repeated-measures ANOVAs (group x swim stroke; $P \leq 0.05$), effect size by the eta-squared (η^2) plus Cohen's d (d) and 95% confidence interval (95CI) were computed. There was an expertise x swim stroke interaction ($F_{6,72}=3.564$; $P<0.001$; $\eta^2=0.13$) in the swim speed. Front-crawl was the fastest stroke, followed by the Butterfly, Backstroke and Breaststroke ($P<0.001$). As far as FD goes, there was a non-significant expertise x stroke interaction ($P=0.13$; $\eta^2=0.03$) albeit a moderate effect of the swim stroke ($P<0.001$; $\eta^2=0.41$) and a small effect of the expertise level

($P=0.01$; $\eta^2=0.12$) was found. The FD was higher with large effect sizes in the group of non-experts than the other two (highly qualified experts: $P=0.01$, $0.70 \leq d \leq 1.0$; experts: $P=0.05$, $0.52 \leq d \leq 0.78$). The variable was different among all pair wises ($P<0.001$) but Front-crawl vs. Backstroke. Breaststroke showed the highest FD followed by Butterfly, Front-crawl and Backstroke. There was a shift of the 95CI to the left side (i.e. a decrease of the FD) comparing non-experts with competitive counterparts. E.g., in Front-crawl the 95CI was 1.86-1.91 for non-experts and about 1.80-1.88 for highly qualified experts and experts. The FD is prone to decrease with increasing expertise. Hence, the complexity level of the motor behaviour in swimming is dependent on the swimmer's expertise.

References:

Barbosa, T. M., Morais, J. E., Marques, M. C., Silva, A. J., Marinho, D. A., & Kee, Y. H. (2015). Hydrodynamic profile of young swimmers: changes over a competitive season. *Scandinavian Journal of Medicine & Science in Sports*, *25*(2), e184-196. https://doi.org/10.1111/sms.12281

Higuchi, T. (1988). Approach to an irregular time series on the basis of the fractal theory. *Physica D: Nonlinear Phenomena*, *31*(2), 277–283. https://doi.org/10.1016/0167-2789(88)90081-4

Relationships between Functional Movement Screen scores and physical performance variables in surf athletes

Bruno Silva[1], Filipe Manuel Clemente[1,2]

1. Instituto Politécnico de Viana do Castelo, Escola Superior de Desporto e Lazer, Portugal; 2. Instituto de Telecomunicações, Delegação da Covilhã, Portugal

Functional Movement Screen (FMS) has been proposed as a battery test to simplify the assessment of movement patterns in daily sports practice. Besides the importance to predict the risk of injuries, FMS has been also associated with athletic performance. In a surf competition occurs a variety of condition that have a large effects on activity patterns (Mendez-Villanueva, Bishop, & Hamer, 2006). Nevertheless, no association between patterns and performance has been tested. Thus, the aim of this study is to analyse the relationships between FMS and athletic performance. Eighteen surf athletes (11 male) participated in the study (18.3 ± 6.3 y; 60.0 ± 9.6 kg; 168.6 ± 8.1 cm) and were tested in FMS scores, anthropometrics (weight, %visceral fat, bone mineral density, muscular mass and %fat mass tested with DEXA), strength of lower (isometric knee extension) and upper limbs (isometric handgrip), power of lower limbs (squat and countermovement jumps) and ankle mobility (knee to wall). Significant and moderate-to-strong correlations tested with Kendall's tau-b were found in the pairs: deep squat*left and right ankle mobility (T_b = 0.47 and 0.62); right hurdle step*left and right handgrip (T_b = 0.54 and 0.55), right hurdle step*left and right knee extension (T_b = 0.56 and 0.46), right hurdle step*weight (T_b = 0.45), right hurdle step*bone mineral density (T_b = 0.51) and right hurdle step*muscular mass (T_b = 0.51); right inline lunge*right ankle mobility (T_b = 0.47); left shoulder mobility*visceral fat (T_b = - 0.39); trunk stability push up*squat jump (T_b = 0.60), trunk push up*countermovement jump (T_b = 0.57), trunk push up*right handgrip (T_b = 0.57), trunk push up*left handgrip (T_b = 0.58), trunk push up*right knee extension (T_b = 0.56), trunk push up*left knee extension (T_b = 0.43), trunk push up*fat mass (T_b = - 0.52), trunk push up*visceral fat (T_b = - 0.51) and trunk push up*muscular mass (T_b = 0.55); composite FMS score*right handgrip (T_b = 0.42), composite FMS score*left handgrip (T_b = 0.46), composite FMS score*bone mineral density (T_b = 0.36) and composite FMS score*muscular mass (T_b = 0.37). The trunk stability push-up it was the most correlated test with physical variables. It is also possible to suggest that individual FMS scores can be more useful than the composite score.

Acknowledgement

The authors thank the coaches from Surfing Viana High Performance Centre and participating athletes from Surf Club de Viana.

References:

Mendez-Villanueva, A., Bishop, D., & Hamer, P. (2006). Activity profile of world-class professional surfers during competition: a case study. *Journal of Strength and Conditioning Research, 20*(3), 477-482.