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

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Introduction

Background: 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 is concerned, 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.

Aim: The aim was to compare classical kinematics and non-linear parameters after a maximal 100-m front-crawl bout.

Methods

Sample: 24 swimmers (12 males & 12 females)

Protocol:

- Pre-test (rest condition, all out 25-m front-crawl)
- All-out 100m front-crawl (impose fatigue)
- Post-test (under fatigue, all out 25-m front-crawl)

Data collection: Speedo-meter (Swim speedo-meter, Swimsportec, Hildesheim, Germany) (Fig 1) in the pre- and post-tests.

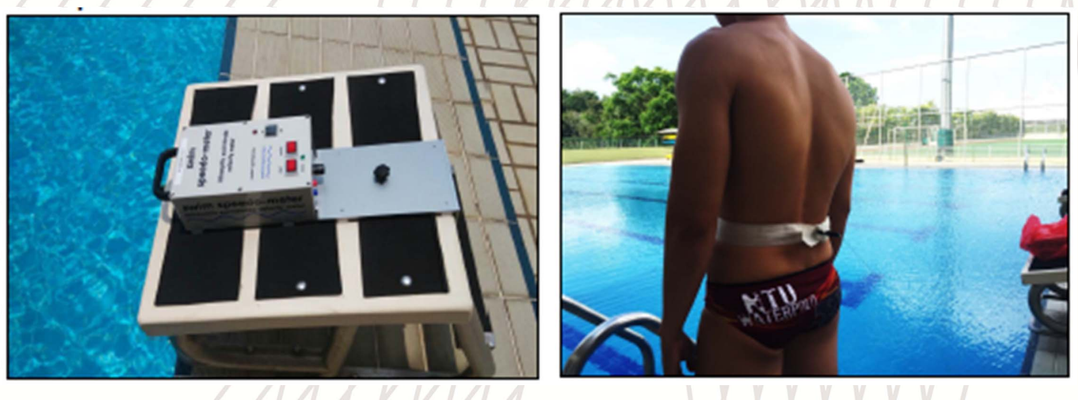

Fig. 1. The speedo-meter selected for data collection.

Data analysis: Computation of the speed fluctuation (eq. 1) [1], approximate entropy (eq. 2) [1] and fractal dimension (eq. 3) [2]:

$$dv = \frac{\sqrt{\frac{\sum_i (v_i - \bar{v})^2 . F_i}{n}}}{\frac{\sum_i v_i . F_i}{n}} \cdot 100 \quad (1)$$

$$ApEn(N,m,r) = \ln\left[\frac{C_m(r)}{C_{m+1}(r)}\right] \quad (2)$$

$$D = \frac{d \log N(L(k))}{d \log(k)} \quad (3)$$

Statistical procedures: Repeated measures ANOVAs (pre-test vs. post-test; P≤0.05), effect sizes (eta squared) and 95% of confidence intervals (95CI) were computed.

Results

Speed: It was 1.44±0.24 and 1.28±0.23m/s in the pre- and post/test, respectively ($F_{1,21}$=55.136,P<0.001).

dv: The dv increased from the pre- to the post-test with moderate effect sizes .

The dv increased by 20.17%, shifting the 95CI band from 0.116-0.134 to 0.140-0.161.

ApEn: Showed trivial variations between the pre- and post-test.

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).

D: Showed a significant effect due to the fatigue with a moderate effect size.

The 95CI band moved from 1.954-1.965 to 1.933-1.951.

Individual analysis: 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.

	Pre-test Mean ± 1SD (95CI)	Post-test Mean ± 1SD (95CI)	ANOVA (1,21) F; P	η^2
dv	0.125±0.023 (0.116-0.134)	0.150±0.025 (0.140-0.161)	15.048; <0.001	0.41
ApEn	0.679±0.048 (0.659-0.700)	0.661±0.047 (0.641-0.682)	0.037; 0.85	<0.01
D	1.959±0.012 (1.954-1.965)	1.942±0.020 (1.933-1.951)	5.186; 0.03	0.20

Conclusions

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

[1] Barbosa, T.M., et al (2010a). *Scandinavian Journal of Medicine and Science in Sports,* 25, 184-196.
[2] Higuchi, T. (1988). *Physica*, 31, 277-83.