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THE EVALUATION OF ACTIVE DRAG: A NEW PROPOSAL

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INTRODUCTION

The swimming speed is the result of the interaction between the propulsive forces generated by the swimmer and the drag force. In swimming the active drag force is the resistance encounter by the swimmer when he moving through the water. It's assumed that the drag force is related to the square of the swimming speed, thus the active drag has a strong influence on swimmers performance [1]. Therefore to evaluate the swimming performance its necessary evaluate both, the propulsive force and the active drag. For this purpose the used methods for estimating this variable need greater specificity and accuracy. The assessment of the active drag is a controversial issue due to the complexity of the flow around the swimmer and the own swimmers movements. Thus the aim of this study was measure the mean active drag of swimmers through the difference between the net force in dynamometry testing with (WD) and without displacement (ND).

METHODS

Due to drag-speed relationship, it is expected that in a without displacement test, when the speed is zero, the drag to be zero approximately [2]. Thus, the strength difference between without and with displacement tests is the drag active experienced by the swimmer on test speed with displacement. Twelve tests were conducted to measure the propulsive force with and without displacement, the minimum time of rest between attempts was five minutes. A unidirectional load cell, with sampling rate of 1000Hz, measured net force in both situations. The sequence of tests was randomized. The study included eight swimmers with performance equivalent to 81.9 ± 6.4% of the world record of 50 meters freestyle and height of 1.74 ± 0.06 m. The stroke rate and kick count, per cycle, was used to evaluate the technical differences between the tests. A camcorder with 100 fps was used to recorder the underwater motion of swimmer.

In both tests, the swimmers were wearing a belt attached to a steel cable connected to the load cell. The system composed of the steel cable and load cell was attached to another steel cable passing through a pulley fixed in a starting block and actuated by a geared motor (Ringcone RX-400, Poa, Brazil), his configuration allowed for control of the test velocity (Figure 1). In without displacement test the geared motor was set to not allow the swimmer displacement, while in with displcament test was set to allow a constant swimming velocity of 0.60 m/s according to Costill et al. [3]. In each test the swimmer performed twelve stroke cycles, where the first three cycles and last three cycles was discarded.

Data analysis was realized using Matlab 2009b (Mathworks, USA). The force data were filtered with an eighth order low-pass butterworth recursive filter with a cut-off frequency of 16 Hz. The angle between the steel cable and swimming direction was determined according to describe in Xin-Feng et al. [4] After these procedures, the mean force, stroke rate and kick count of each stroke cycle from the with and without tests were calculated.

Data normality was verified for a Kolmogorov-Smirnov test and equal variance for Levene test. The descriptive analysis consisted of calculating the mean and the standard derivation.A paired t-test was performed to assess technical differences. The level of significance was set at $p<0.05$. The measurement errors were calculated by the method of propagation of uncertainties considering the individual variability and characteristics of the measuring equipment.

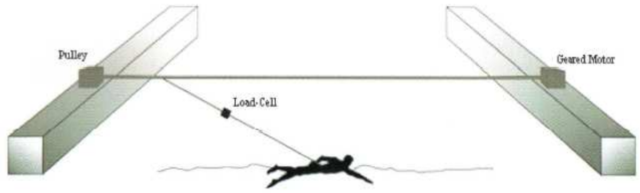

Figure 1: Schematic model of the test system.

RESULTS AND DISCUSSION

There was no significant difference between the technique evaluated from the stroke rate (ND = 1.083 ± 0.069 and WD = 1.088 ± 0.075, p> 0.05), and kick count (ND = 6 ± 0 and WD = 6 ± 0, not tested) of the different tests. The mean active drag was evaluated 153.74 ± 9.75 N with associated error estimated at 12.44%.

CONCLUSIONS

The active drag values estimated by the method are within the range of values previously reported for swimmers of similar performance (42 to 167 N) [5], furthermore, the associated error of estimate was lower than was showed in other methods, if we consider that this method measure the same phenomenon that the others, i.e. the mean active drag [5, 6, 7, 8]. Thus, the proposed method is a practicable alternative to assess the active drag of swimmers.

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