INFLUENCE OF BODY LENGTH AND FROUD NUMBER ON ACTIVE DRAG IN FRONT CRAWL SWIMMING
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Contrarily to passive drag, which is mainly influenced by body dimensions, active drag (Da) is thought to depend mainly on swimming technique. In free swimming, however, the body is displaced crossing the surface of the water, inducing pressure drag and wave drag as main components of total body drag. Nevertheless, several studies reported an association of Da with body geometrical characteristics besides cross section area, a determinant of pressure drag, as is the case of height or total body length, which has been shown to influence wave drag, expressed by the dimensionless Froud number (Fe).

The purpose of this study was to identify the main body characteristics associated to Da in front crawl swimming. 45 male national level swimmers (age: 15.90±2.49 years, height (H): 175.64±8.00 cm, body mass (Bm): 64.97±8.43 kg) were tested for Da in front crawl swimming using the velocity perturbation method (VPM) (Kolmogorov & Duplishcheva, 1992). According to this method, manual timing of a 13 m (11 to 24 m) maximal sprint freestyle swim permitted the calculation of maximal velocity (Vmax). A second timed maximal 13 m freestyle swim, in rested conditions, towing a hydrodynamic body of known characteristics, allows to use the observed difference in velocity for the calculation of the added drag, and then of Da, of the drag coefficient (CD) and of the power output (Po) of each swimmer, assuming equal power output for both trials. Estimate of Fe were done using the equation Fe = U / Square Root (g.l), assuming body height as the characteristic length (l), and being U the swimming velocity (m.s-1) and g the acceleration of gravity (9.81 m.s-2). A slenderness coefficient as the ratio between height and the squared body surface area (H/Bs2) was also calculated to account for the influence of height independent of frontal cross area. The active drag at maximal velocity was normalized for the velocity squared in order to compare velocity independent drag.

Hydrodynamic variables showed larger variation than Vmax (1.78±0.06) and physical characteristics (Da: 93.85±31.17 N; CD: 0.36±0.086; Po: 168.20±61.35 W). Da was significantly correlated (p<0.001) to Bm (r=0.681), height (r=0.541) and Bs (r=0.650). H corrected for the squared Bs showed a negative association with Da (-0.663). Correction of Da for velocity did not change the strength and direction of the association with physical characteristics. Fe showed only a weak correlation to Da (r=0.308, p=0.039).

Wave drag experienced when swimming at high velocities near or at the surface can be the largest component of the total drag on the swimmer, since it is considered to relate to the cubed velocity. The negative correlation with H/Bs2 and the association with Fe seem to confirm this assumption. Taller swimmers seem to have a hydrodynamic advantage in competitive swimming.


Keywords: Anthropometric Data, Swimming, Hydrodynamic Drag

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