Approximation of Active Drag Forces During Freestyle Swimming Using Values of Velocity, Force, and Power

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ABSTRACT

Measuring active drag in swimming is problematic due to the difficulty in assessing force produced in water without affecting the velocity of the swimmer. This problem makes the concurrent measurement of velocity and force production a difficult task and replication of effort in two independent situations may be unreliable (one to measure force and one velocity). Using a large number of subjects of varying ability in a replicable situation of maximum effort for each measurement may be one way to determine the drag velocity relationships. **PURPOSE:** To determine the relationships among the maximum velocity (v_{max}), force (F_{max}), and power (P_{max}) that can be measured during freestyle swimming and to derive the velocity (v) dependence of active drag force (F_d) in freestyle swimming. **METHODS:** 156 swimmers (17±2.3 yrs) completed three tests to measure v_{max}, F_{max}, and P_{max}. v_{max} was determined using two 13.72 m maximal effort swims. F_{max} production was measured during a maximal effort swim with the subject tethered to a computer and force transducer system using a length of elastic tubing. Power was calculated using the product of average velocity and resistance force from a weight and a pulley system over a 10 m maximal effort swim. Pmax was determined by progressively increasing the force of resistance until the measured power peaked and began to decrease. **RESULTS:** Past estimates of active swimming drag have utilized power fits for example $F_d=20.72v^{2.48}$ (Sanders et al., 2001). Using this type of analysis the relationships of force and power to velocity were $F_d=46.664v^{1.8168}$ ($R^2=0.70$) and $P=11.416v^{3.3717}$ ($R^2=0.85$). However, the data obtained was more closely fit by the exponential functions $F_d=14.949e^{1.2376v}$ ($R^2=0.73$) and $P=1.4529e^{2.2645v}$ ($R^2=0.87$). **CONCLUSION:** v_{max}, F_{max}, and P_{max} are highly associated despite being measured independently. Furthermore, these three variables can be used to examine the relationship between drag force and velocity in freestyle swimming.