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Swimming Critical Velocity Physiological Meaning Is Affected by Testing Distances

Ricardo J. Fernandes[1,2*]

[1]Centre of Research, Education, Innovation and Intervention in Sport (CIFI2D), Faculty of Sport, University of Porto, Porto, Portugal

[2]Porto Biomechanics Laboratory (LABIOMEP), University of Porto, Porto, Portugal

Abstract

Swimming is a human activity that relies heavily on individual physiological capabilities. In fact, the swimming general performance equation, proposed several years ago by di Prampero [1], highlighted the energy expenditure, the propulsive efficiency and the hydrodynamic drag as its main determinants. Therefore, coaches and exercise physiologists have been proposing a number of testing protocols aiming to diagnose the swimmers physiological training status. However, most of these protocols are invasive, time consuming and costly (e.g. the oxygen uptake assessment and the blood lactate concentrations determination). In addition, some of these tests have some constraints, as the use of a cumbersome breathing valve for respiratory data collection(cf. [2]) and the selection of an averaged value of blood lactate concentrations as an non individualized index oendurance performance [3,4].

Corresponding author: Ricardo J. Fernandes, [1]Centre of Research, Education, Innovation and Intervention in Sport (CIFI2D), Faculty of Sport, University of Porto, Porto, Portugal

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[2]Porto Biomechanics Laboratory (LABIOMEP), University of Porto, Porto, Portugal,

Email: dr_eman_hashem@yahoo.com

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Intruduction

These (and other) limitations leaded to the emergence of a number of functional tests, used frequently in swimming daily practices, some of them based on continuous exertions, as the 30 min, 2000 m and maximal lactate steady state tests [5,6]. Nevertheless, these tests are hard to control and not appellative [7], leading frequently to false results. A nice alternative to those monotonous evaluations is the critical velocity test that was adapted for swimming by Wakayoshi et al. [8] based on the critical power concept [9]. Critical velocity is accepted as the theoretic maximal swimming speed that can be maintained without exhaustion for a long period of time, being c onceptually related with the swimming intensity at the anaerobic threshold and, consequently, to the aerobic capacity training [9,10].

Critical velocity is expressed as the slope of a straight line established between, at least, two swimming distances and their corresponding exercise durations, i.e., the slope of the regression line determined between the test distances and the time needed to cover them at maximum intensity. This is an easy to accomplish test that allows evaluating the maximal velocity of a swimmer in a regime of physiological aerobic balance [11], with its final value being considered as a predictive variable of aerobic performance and an optimum indicator to prescribe aerobic training [12]. However, to save time during training control routines (as coaches are reluctant to loose time with testing sessions in or in-between swimming practices), critical velocity is frequently assessed with short bouts. This does not respect the criterion of using a test distance of approximately 15 min to avoid its overstimation [13] and its consequences might be disastrous. In fact, when using (for example) maximal bouts of 100 and 400 m (that lasts around 1 and 4-5 min, respectively), both the aerobic and the anaerobic energy systems are very active, compromising the scientific validity of the critical velocity value.

So, critical velocity might be an excellent alternative to non-invasive measurements in swimmers physiological evaluation and respective training control but coaches and exercise physiologists should be careful with its determination, particularly by always including a test distance that depends greatly on energy of aerobic provenience (of, at least, 15 min). In fact, if they do not choose the most adequate testing distances/durations, significant errors might happen when analysing training and predicting performance, limiting significantly the application of information to the training process. If critical velocity is assessed respecting its methodological meaning, it could be very useful for the determination of training intensities, particularly on the moderate intensity domain (also known as aerobic capacity). Swimming below that pace will be optimal for warming up and recovering routines (low intensity domain) and swimming slightly higher the critical velocity will recruit the anaerobic metabolism in a significant way (heavy intensity domain), even though not reaching maximal oxygen uptake.

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