Individual anaerobic threshold assessment in a swimming incremental test for VO$_2$max evaluation

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Introduction
Specifically in swimming related studies, the speed at blood lactate steady state is considered one of the primary areas of interest. In this sense, there are some previously described methods to assess the exercise intensity after which the lactate production exceeds its removal, i.e., the anaerobic threshold (AnT) (Brooks et al., 2000). One of the most used methods for AnT assessment is based on the averaged value of 4 mmol/L of blood lactate concentration [La$^-$], proposed by Mader et al. (1976). However, [La$^-$] corresponding to AnT has been reported to have great variability between swimmers. Other methodologies for AnT determination have been proposed to find more specific and individualized values for this parameter. These methods also contain some limitations, namely: (i) the subjectivity of the observation of the [La$^-$]/velocity curves’ inflection point; (ii) the use of long test distances with significant velocity differences between steps (MaxLass) and (iii) the necessity of very high values of [La$^-$] (15 mmol/L), which implies strenuous exercise intensities (cf. Bunc et al., 1982).

Thus, the purpose of this study was to present a new mathematical approach to assess individual AnT (IndAnT) trough a previous validated intermittent incremental protocol for VO$_2$max evaluation.

Methods
Thirty-two (19 male and 13 female) trained swimmers were studied: 18.9 (3.7) yy, 171.5 (7.7) cm and 62.8 (8.4) kg. Each subject performed, in a 25 m indoor swimming pool, an intermittent incremental test for freestyle VO$_2$max assessment, with increments of 0.05 m/s each 200 m stage and 30 s intervals, until exhaustion (Fernandes et al., 2003). Velocity was controlled using a visual pacer with flashing lights on the bottom of the pool. In-water starts and open turns were used. [La$^-$] were assessed at rest, during the 30 s intervals, immediately after each step and at minutes 3 and 5 of the recovery period (YSI1500LSport auto-analyser). The velocity corresponding to 4 mmol/L [La$^-$] (v4) was determined by linear inter or extrapolation of the [La$^-$]/velocity curve (v3.5 was also assessed as a more adequate value for trained swimmers, as suggested by Heck et al., 1985). IndAnT was determined by [La$^-$]/velocity curve modelling method (least square method), as described in Figure 1. IndAnT was assumed to be the intersection point, at the maximal fit situation, of a combined pair of regressions (linear and exponential). The individual ventilatory threshold was also calculated to validate the metabolic IndAnT. Mean (SD) computations for descriptive analysis were obtained for all variables. Pearson’s correlation coefficient and t-test for repeated measures were also used. A significance level of 5% was accepted.

Results
Concerning the swimming velocity, significant differences were observed between v4 and the velocity@IndAnT (Table 1). [La$^-$]@IndAnT averaged 2.89 (1.46) mmol/L, which was significantly lower than the 4 mmol/L value (as well as than the 3.5 mmol/L value).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>v4</th>
<th>v3.5</th>
<th>IndAnT</th>
</tr>
</thead>
<tbody>
<tr>
<td>V (m/s)</td>
<td>1.27 (0.16)</td>
<td>1.24 (0.17)</td>
<td>1.22 (0.14)</td>
</tr>
</tbody>
</table>

Table 1: Mean (SD) values of swimming velocities for the v4, v3.5 and IndAnT methods. * represents statistical significant differences between methods (p < 0.01).

Discussion/Conclusion
The protocol for VO$_2$max assessment used in the present study is specific for VO$_2$ kinetics analysis, but seems also to allow a specific and precise individual AnT assessment. The presented results seem to confirm the fact that v4 does not represent the individualized lactate threshold in trained swimmers. The present AnT assessment methodology could be useful in increasing the efficiency of training control and advising, resulting from VO$_2$max assessment programs. In the circumstance where the present protocol and methods are not applicable, the v3.5 could be better used than v4 in prescribing the training velocities for development of aerobic capacity in groups of trained subjects.

References