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Abstract

Estimating maximal metabolic steady state using critical power: which model is best?

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1. Introduction

It has been advocated that critical power (CP) should be considered the gold standard to determine the maximal metabolic steady state (MMSS) (Jones, Burnley, Black, Poole, & Vanhatalo, 2019). However, the choice of the model affects the estimation of CP (Bergstrom et al., 2014; Bull, Housh, Johnson, & Perry, 2000; Gaesser, Carnevale, Garfinkel, Walter, & Womack, 1995; Mattioni Maturana, Fontana, Pogliaghi, Passfield, & Murias, 2018). The purpose of this study was to investigate which of the models, exponential (CP_{exp}), 3-parameter hyperbolic ($CP_{3\text{-}hyp}$), 2-parameter hyperbolic ($CP_{2\text{-}hyp}$), linear (CP_{linear}), and inverse of time ($CP_{1/time}$), estimates MMSS best.

2. Materials and Methods

Eleven male participants (Age: 31 ± 11 years, Body mass: 70.5 ± 5.6 kg) performed three time-trials (12-, 6-, and 3-min long) to determine CP from the five models. On three subsequent visits, participants cycled for 30-min, or until task failure, at the CP estimated by each model.

3. Results

CP_{exp} estimated the highest CP (303 ±69 W), followed by $CP_{1/time}$ (272 ±66 W), CP_{linear} (270 ±64 W), $CP_{2\text{-}hyp}$ (266 ±65 W) and $CP_{3\text{-}hyp}$ (262 ±63 W). Oxygen uptake ($\dot{V}O_2$) stabilised at a significantly lower value than peak $\dot{V}O_2$ ($\dot{V}O_{2peak}$) during exercise at CP_{linear}, $CP_{2\text{-}hyp}$, and $CP_{3\text{-}hyp}$ (94 ±5%, p = .041; 87 ±4%, p < .001; 86 ±4%, p < .001, respectively). $\dot{V}O_2$ stabilisation was not significantly different to $\dot{V}O_{2peak}$ during exercise at CP_{exp} and $CP_{1/time}$ (98 ±2%, p = 1.000; 94 ±6%, p = .130, respectively). For all conditions, $\dot{V}O_2$ did not increase significantly after stabilisation (p = 1.000). Rate of perceived exertion significantly increased over time during exercise at $CP_{1/time}$ (p < .001) and CP_{linear} (p = .006) but was unchanged between minute 15 and end-exercise during $CP_{2\text{-}hyp}$ (p = .762) and $CP_{3\text{-}hyp}$ (p = .569). Lactate increased significantly in the last 10, 15, and 20 minutes of the exercise for all models. No model had an increase of ≤ 1 mmol · L^{-1} from minute 10 to 30

4. Conclusions

These results suggest that $CP_{2\text{-}hyp}$ or $CP_{3\text{-}hyp}$ should be favoured when CP is used to assess MMSS.

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