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Discussion: "Can measures of critical power precisely estimate the maximal metabolic steady-state?" - Is it still necessary to compare critical power to maximal lactate steady state?

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Discussion: “Can measures of critical power precisely estimate the maximal metabolic steady-state?” - Is it still necessary to compare critical power to maximal lactate steady state?

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Draft

I read with great interest the study of Mattioni Maturana et al. (2016) published online in Applied Physiology, Nutrition, and Metabolism. However, I wish to raise some concerns regarding this study, especially considering two other studies of the same research group (Keir et al. 2015; Mattioni Maturana et al. 2017). In my opinion, these studies might cause some confusion with the reader. So, the question that is raised when reading these papers is: the critical power (CP) occurs at the same intensity of maximal lactate state-steady intensity (MLSS), or not? The answer is: it depends!

In general terms, the aforementioned studies (Keir et al. 2015; Mattioni Maturana et al. 2016; Mattioni Maturana et al. 2017), which aimed to compare the critical power (CP) and maximal lactate steady-state intensity (MLSS), have used different criteria to set CP, providing divergent conclusions.

Since the first publication of the CP concept, this endurance index has been related to the notion of a sustainable aerobic intensity, with a metabolic stability mainly seen by the blood lactate steady-state response. The original concept of CP proposed by Monod and Scherer (1965) stated: *“The critical power of a muscle (or a muscular group) corresponds to the maximum rate it can keep up for a very long time without fatigue”*. Since then, this statement has been used to support the studies comparing CP with the concept of maximal lactate steady-state intensity (Moritani et al. 1981, Wakaiohi et al. 1993, Dekerle 2003). However, a great body of evidence published in the past decades showed that regardless of the sensitivity of CP determination (i.e the number and duration of trials, mathematical models) the range of time limit associated with this intensity is set between 20 and 60 min (de Lucas et al. 2002, Brickley et al. 2002, Dekerle et al. 2003, de Lucas et al. 2012), and in the majority of cases is not associated with the lactate steady-state response at least, during continuous exercise

(Dekerle et al. 2010, de Lucas et al. 2012). Even so, there are still several studies looking for similarities between these two endurance capacity indices.

It is well known that the ‘classical’ determination of CP is protocol-dependent, being influenced by the number/duration of constant work rate trials and the mathematical model applied. Within the current literature, there are numerous studies demonstrating that CP exceeds the intensity which MLSS occurs, at least when the CP is derived from trials ranging between 2 and 15 min, and by using the 2-parameter models in different sport modalities (Pringle and Jones 2002; Dekerle et al. 2003). Moreover, this difference is independent of status training as verified by Greco et al. (2012).

Surprisingly, even so, Keir et al. (2015) modelled CP using trials between 1 and 20 min, and the 3-parameter model proposed by Morton (1996), which it is known to produce the lowest CP derivation, as demonstrated by Bull et al. (2000). Although, the authors assume the likely constraint regarding methodological approaches of CP determination, they declare that it is not possible to discriminate if the similarities were mechanistic or coincidental. Regardless of the discussion about which CP derivation is ‘better’, it is factual that this model (i.e. 3-parameter) is only applicable in laboratory conditions, being far from field applicability and athletes’ usage. In addition, the longer the times to exhaustion included in the model, the lower the CP estimate (Bishop et al. 1998).

Thus, Keir et al. (2015) conclude that ‘critical power’ and MLSS occurred at the same power output (and VO_2), overlooking the protocol-dependence of CP, and several other studies in the literature. Subsequent studies by Mattioni Maturana et al. (2016, 2017) found the obvious, when using a 2-parameter hyperbolic model for CP determination. Therefore, the conclusion was different from the previous study: CP

intensity is higher (about 5%) than MLSS intensity. Strangely, these authors wrote that even modelling the CP by other fittings (e.g. 3-parameter model hyperbolic model), the results were the same (data not presented), contradicting their previous study (Keir et al. 2015).

When reading these papers, one would argue, why are there differences? In those papers the authors attributed great variability of measurements and a narrow difference between those indices. However, analysing the standard error of estimate (SEE) of CP in the study of Mattioni Maturana et al. (2017), it is possible to observe a value of 0.6%, that is, a very low error to believe in the great variability cited.

Finally, the applicability of CP for athletes is more suitable in field conditions by using 2 or 3 time trials comprising between 2 and 12 min. In this case, we would use the distance-time linear model to estimate CP (or critical speed - CS) and that intensity will be for sure higher than MLSS, at least when performing during a continuous session (de Lucas et al. 2002, Dekerle et al. 2010). On the other hand, if an athlete exercises at CP/CS using an extensive interval session it would produce blood lactate balance and would prolong the time limit (Dekerle et al. 2010, de Lucas et al. 2012).

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