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Conference Abstract

Modelling Human Endurance: Power laws vs Critical power

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Abstract: The power–duration relationship describes the time to exhaustion for exercise at different intensities. It is generally believed to be a "fundamental bioenergetic property of living systems" that this relationship is hyperbolic. Indeed, the critical- power model which formalises this belief is the dominant tool for studying endurance exercise, e.g. in cycling, running, rowing, or swimming. However, this model is now the focus of a heated debate because it unrealistically represents efforts that are short (< 2 minutes) or long (> 15 minutes). We contribute to this debate by demonstrating that the power--duration relationship is not hyperbolic (and thus cannot be adequately described by a "critical power'' parameter). Rather, the power–duration relationship is more adequately represented by an alternative power-law model. In particular, the often-observed good fit of the critical-power model to exercise durations between 2 and 15 minutes should not be taken as proof that the power–duration relationship is hyperbolic. Rather, in this range, a hyperbolic function just happens to approximate a power law fairly well. Additionally, we show that the power-law model sheds light on the strengths and limitations of many popular rules of thumb for performance prediction such as Jack Daniel's "VDOT" tables in running and FTP in cycling. For instance, for the latter, it explains why the 95-% rule for estimating a cyclist's 60-minute power output from a 20-minute effort is too optimistic.

Keywords: Power law, critical power, FTP, Jack Daniels