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EDITORIAL

Quantifying metabolic energy contributions in sprint running

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The prediction of athletic performance from energetic measurements in athletes is a long-lasting dream of exercise physiologists. The most elegant energetic model proposed so far to this aim was developed by di Prampero et al. (1993). Their model allows calculation of the maximal metabolic power ($\dot{E}_{\max}$) that a given runner can maintain over a given distance, whence the best theoretical time attainable by that runner over that distance can be obtained. It was the result of attributing an energetic significance, along the lines defined by the School of Milano (di Prampero 1981; Ferretti 2015), to the hyperbolic relationship initially conceived by Scherrer and Monod (1960) and further developed by Wilkie (1980), whence the critical power models were eventually derived (Morton 2006).

di Prampero's approach requires knowledge of the athlete's maximal aerobic power (i.e., maximal oxygen consumption) and of the metabolic power that can be derived from the full exploitation of the anaerobic (lactic and alactic) energy sources (di Prampero 2003). These are summarized in what has been called the general equation of the energetics of muscular exercise (Ferretti 2015). This equation, the first formulation of which appeared in di Prampero (1981), tells that $\dot{E}_{\max}$ is the sum of three terms, representing the maximal powers of aerobic, anaerobic lactic, and anaerobic alactic metabolisms. In the 1993 paper, $\dot{E}_{\max}$ was estimated for sprint to middle distance running (100–800 m) and shown to be lower the longer the distance to be covered (di Prampero et al 1993), coherently with critical power models. $\dot{E}_{\max}$ is also equal to the product of the energy cost of running (C) and the highest mean running speed ($v_{\max}$) that a given runner is able to sustain over a given distance. Since the C of running is invariant and independent of speed, $\dot{E}_{\max}$ increases linearly with v_{max}(di Prampero 1986).

To note, during short distance running, the cost of acceleration must be accounted for. In the paper of di Prampero et al. (1993), this additional cost was estimated from the kinetic energy changes (from 0 to $v_{\max}$) and by assuming an efficiency of muscular contraction of 0.25. Then, by comparing the time course of $\dot{E}_{\max}$ (as calculated with the two methods described above), the best performance times of a runner can be estimated: the match is fairly good, the ratio of actual to estimated time was 1.03 in elite runners and 1.08 in medium level runners (di Prampero et al. 1993). Yet this was an estimate.

More recently, di Prampero et al. (2005) proposed an alternative approach to determine the cost of acceleration, by relating accelerated running on flat terrain to uphill running at constant velocity (the "equivalent slope method"). This made it possible to determine the time course of the metabolic power during the acceleration phase of a sprint based on data of running speed and energy cost (at an equivalent slope). The average metabolic power calculated with this method was similar to that of previous estimates (di Prampero et al. 1993), although the peak metabolic power in the first seconds exceeds the values that can be estimated based on the maximal exploitation of the anaerobic alactic energy stores.

The paper of Briand and colleagues published in this issue of the Eur J Appl Physiol represents a step forward in the development of the bioenergetic model that was proposed by di Prampero et al. (1993) to predict running performance. In Briand et al. (2025), the time course of metabolic power is modelled in 100–400 m sprints using velocity and time split data from the 2009 World athletic championship, and incorporating the energy cost of accelerations determined using the equivalent slope method: velocity in the acceleration phase is assumed to increase exponentially up to maximal velocity and the deceleration phase is modelled as a linear decline in speed. In the acceleration phase metabolic power is then calculated according to the equivalent slope method (di Prampero et al 2005).

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Then, Briand and colleagues propose and test new equations to estimate the anaerobic (lactic and alactic) contributions (that in many studies are not considered separately), modelling their time courses and calculating the maximal lactic and alactic capacities by using the general equation of the energetics of muscular exercise (di Prampero 1981). Data indicate that, despite being maximal efforts performances, in these events (100–400 m) only a fraction of the available anaerobic lactic and alactic capacities is utilized. In addition, it appears that, even in the shortest running races, the contribution of the lactic energy sources could help in understanding the reason of the high peak in metabolic power values observed right after the start when applying the equivalent slope method.

In conclusion, Briand et al. (2025) propose the first comprehensive analysis of the energetics of sprint running, with full inclusion of the energetics of the acceleration phase, making a remarkable step forward in our understanding of running performances. These data eventually allow a full description of the energetics of running from the 100 m dash to the marathon under an energetic perspective, leading to a possible interpretation of running records in the context of the critical power models.

Author's contribution PZ and GF contributed to the conception and design of the manuscript and approved the final version.

Declarations

Conflict of interest The authors have no conflicts of interest to declare.

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