Jumping depends on impulse not power

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To the editor-in-chief,

We read with interest the manuscript by Russel et al. (2015) and noted their use of power to characterise performance in jumping. Such use is widespread in sport and exercise science, but it is also incorrect.

The success of either a vertical or horizontal jump is determined by velocity at take-off or departure. From Newton's second law of motion outlined in *Principia* that was published in 1687, this velocity is determined by the preceding impulse generated by an athlete. In the context of jumping, misuse of the construct power was highlighted several decades ago by Adamson and Whitney (1971). Because velocity is a vector quantity, it possesses both magnitude and direction. Newton's second law is expressed as the impulse-momentum relationship and the relationship allows precise identification of velocity at departure. The mathematical link that identifies this velocity is irrefutable.

Adamson and Whitney's (1971) objections were followed by others (Cronin & Sleivert, 2005; Knudson, 2009; Knuttgen, 1978; Rodgers & Cavanagh, 1984; Winter, 2005; Winter & Fowler, 2009) to clarify misconceptions. In spite of this authors often continue to *associate* and at worst attempt to *explain* jumping performance in scientific literature by means of "power" as if it were a clearly defined key performance variable (Knudson, 2009). The definition of power from classical (Newtonian) mechanics is *the rate of doing work* ($J \cdot s^{-1}$) (Rodgers & Cavanagh, 1984).

It is problematic to consider short-duration, discrete projectile activities as 'power' events and hence incorrect to extend assessments of power to describe and explain performance in impulsive activities such as jumping.

When a jump is performed on a force platform, a key metric is the integral of force and time i.e. the area under the force-time curve. Information from this curve can be used beguilingly to provide a velocity-time profile of the body's centre of mass. At this point it is worth considering that power is also frequently but erroneously calculated as:

$$F \cdot v$$

such that instantaneous values of power, especially the peak, can be derived from force platforms. However, in doing so, there is no account of the values that precede and follow the calculated maximum (Winter & Fowler, 2009). Moreover, the use of "power" is often justified by citing existing malpractice that is typically accompanied by a correlation coefficient that indicates a strong relationship between peak power and jump height. This practice should be redundant since impulse has a perfect correlation ($r = 1$) with jump height (Winter, 2005).

Objection to the use of power in attempts to explain jumping performance should not be confused with academic nitpicking (Knuttgen, 1978). Abuse of terms and nomenclature and misuse of mechanical principles hinder the advancement of sport and exercise science (Winter & Knudson, 2011) . An effective sport and exercise scientist elucidates principal factors that describe and explain performance (Mendez-villanueva & Buchheit, 2013). Effectiveness is not demonstrated by misuse of mechanical constructs, especially as here, power.

This preference for research and practice to assess and develop power is misplaced at best (Cronin & Sleivert, 2005). If sport and exercise science is to advance, research into jumping that seeks meaningful explanations of performance should focus on factors such as height, impulse and rate of force development, not power.

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