

# The relationship between vertical leg stiffness and gross mechanical efficiency in cyclists

JD Hughes <sup>1</sup> ✉, G Pitchers <sup>1</sup>, SC How <sup>1</sup> and M Cole <sup>1</sup>

## Abstract

**Background:** Professional cyclists have been shown to have a mechanical efficiency that is 11% higher compared to amateur cyclists (Coyle et al. 1991: *Med Sci Sports Exerc*, 23 (1), 93-107). The variations in power between professional and amateur cyclists are associated with a greater torque development at the first phase of the pedal revolution (Coyle et al. 1991). It has also been shown in cyclists that a relationship exists between vertical leg stiffness and the peak power output (PPO) ( $r = 0.75$ ,  $p < 0.01$ ) achieved during a 30 s Wingate test (Pitchers et al. 2013: The relationship of vertical leg stiffness, peak power output and  $\dot{V}O_{2max}$  in recreationally active cyclists: identification of the interface between human and bike. 9<sup>th</sup> Annual Conference of the United Kingdom Strength & Conditioning Association, Nottingham, UK). Vertical leg stiffness may be important to cycling performance as the majority of the force produced is vertical and optimisation of the stretch shortening cycle may limit energy wastage during the propulsive phase (So et al. 2005: *Phys Ther Sports*, 6, 89-96; Fonda & Sarabon 2010: *Sport Sci Rev*, 19 (1), 187-210). The relationship between vertical leg stiffness and mechanical efficiency during cycling has yet to be examined.

**Purpose:** To assess the relationship between vertical leg stiffness and gross mechanical efficiency (GE) in cycling.

**Methods:** In a single group, within subjects design, 11 recreationally active male cyclists (age  $34 \pm 6$  y,  $\dot{V}O_{2max}$   $57.4 \pm 7.5$  ml·kg<sup>-1</sup>·min<sup>-1</sup>, body mass  $81 \pm 1.2$  kg, stature  $1.81 \pm 0.06$  m) completed two testing sessions, with a minimum of 48 hr rest between each session. In the first testing session participants completed a stiffness familiarisation before an incremental cycle test to establish  $\dot{V}O_{2max}$ . At the second session participants completed 20 sub-maximal bilateral hops at a frequency of 2.3 Hz. This was followed by three 8 min sub-maximal cycling bouts at 50, 55 and 60 % of the participants' individual maximal minute power (MMP) to establish GE (Table I).

**Results:** Mean values for GE and vertical leg stiffness were  $19.0 \pm 1.4$  % and  $34.1 \pm 9.0$  kN·m<sup>-1</sup>, respectively. Pearson's correlation coefficient revealed no relationship between vertical leg stiffness and GE ( $r = -0.07$ ,  $p = 0.85$ ).

**Discussion:** The main finding is that in recreationally active male cyclists there is no relationship between vertical leg stiffness and GE. In this group these findings indicate that GE is likely influenced more by other biological systems rather than the mechanical properties of the musculoskeletal system. However, these data may not be reflective of an elite sample where higher leg stiffness might be more likely to influence GE at higher power outputs.

**Conclusion:** Whilst vertical leg stiffness has been shown to have a strong relationship with PPO (Pitchers et al 2013) in recreational cyclists, this is not the case for GE. Further work is needed to establish if this is also the case in an elite population.

✉ **Contact email:** [jhughes1@glos.ac.uk](mailto:jhughes1@glos.ac.uk) (JD. Hughes)

<sup>1</sup> Exercise & Sport Research Centre, University of Gloucestershire, Gloucester, United Kingdom.

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