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Gross efficiency is improved in standing position with an increase of the power output

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Abstract

Background: Gross efficiency (GE) has been shown to be one of the most relevant parameter influencing cycling performance but to the best of our knowledge, just one study focused on measuring GE in seated and standing positions during field conditions (Millet et al., 2002: Medicine & Science in Sports & Exercise, 34(10), 1645-52). Other authors investigated the effects of change in body position (seated vs. standing) on energy expenditure, heart rate (HR) or pulmonary ventilation (VE) but there were large changes in the results (Ryschon & Stray-Gundersen, 1991: Medicine & Science in Sports & Exercise, 23, 949-953; Swain & Wilcox, 1992: Medicine & Science in Sports & Exercise, 24, 1123-1127) due to the different protocols. Indeed, the cross effect of slope and intensity on GE in standing compared to seated position has not been studied. Thus, we found interesting to measure GE in real locomotion with elite cyclists at different intensities and slopes.

Purpose: This study was designed to examine the effects of standing position on GE compared to seated position at different intensities and slopes.

Methods: After a period of familiarisation, 13 elite participants performed on a motorised treadmill with their own bike one session during which they rode in a randomized order seated vs. standing positions with several slopes (5, 7.5 and 10%) and intensities (3.8, 4.2 and 4.6 $W.kg^{-1}$). GE was calculated for each condition using the ratio of power output (PO) measured with a Powertap G3 hub (CycleOps, Madison, USA) and the oxygen uptake (VO_2) measured with a portable gas analyzer (Metamax 3B, Cortex, Leipzig, Germany).

Results: GE was significantly higher (+4.5%) in standing position (21.5 ± 5.2 %, CV = 5.2%) compared to seated position (20.6 ± 1.1 %, CV = 5.5%) for all the intensities and slopes. This improvement was due to a significant ($p < 0.001$) increase of PO in standing position (+4.5%) associated with a stabilization of VO_2. The more the slope was low and the intensity was high, the more the pedaling cadence was high. That leads to higher PO changes between standing and seated positions ($R = 0.93$, $p < 0.001$) (Figure 1).

Discussion: The main finding of this study shows that in standing position, GE was increased from a higher PO. The non-significant increase in VO_2 is in accordance with the previous results of Millet et al. (2002). It's the first time that a study shows an increase in PO in standing position. The difference in PO is linked to an increase of the pedaling cadence. We hypothesize that the increase in PO is due to the technique adopted in standing position, the latter has an impact on the mechanical deformation both of the tires and the bike frame. The loss of energy in the bike and the tires would require to increase the PO in standing position according to the technique of each cyclist.

Conclusion: Despite a significant decrease of GE, the standing position involves a significant increase in PO probably due to an increase of the deformation of both the tires and the bike frame according to the pedaling techniques of the cyclist.

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