BOOK OF ABSTRACTS

Oxygen uptake kinetics during uphill and flat cycling in laboratory and field conditions

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Abstract

Background: Previous studies have shown ~5% higher power outputs during a 20-min uphill time-trial¬ compared to a flat time-trial (Nimmerichter et al., 2012: European Journal of Applied Physiology, 112(1), 69-78) and a more even distribution of torque during the pedal revolution during uphill cycling on a treadmill (Arkesteijn et al., 2013: Medicine and Science in Sports and Exercise, 45(5), 920-926).

Purpose: To analyse the effect of gradient, cadence and intensity on the primary response of oxygen uptake in laboratory and field conditions.

Methods: Thirteen trained cyclists (mean ± s: age 23 ± 5 years; stature 178.5 ± 5.2 cm; body mass 68.7 ± 7.8 kg) performed an incremental ergometer test to determine Pmax (403 ± 43 Watt), $\dot{V}O_2max$ (68.2 ± 4.7 mL·min-1·kg-1), the first ventilatory threshold (VT) and the intensity corresponding to 70% (Δ70%) between VT and Pmax. On two separate days the participants performed four trials of 6-min in a seated position on level ground (1.5%) and uphill cycling (5%) at 60 and 90 rev.min-1 at two exercise intensities at 90%VT (159 ± 20 W) and Δ70% (336 ± 35 W) in laboratory and field conditions. Power output was measured with a SRM professional power crank (Schoberer Rad-Messtechnik, Jülich, Germany), which was mounted on a 26-inch mountain bike. To simulate the gradient in laboratory conditions, the bicycle was mounted on an indoor trainer (TACX Elite, Netherlands) and was fixed on a treadmill. Oxygen uptake was measured breath-by-breath with a portable gas analyser (MetaMax3B, CORTEX, Germany). The $\dot{V}O_2$ breath-by-breath data were interpolated at 1-second intervals and the time constant and the amplitude of the exponential primary phase were resolved by least square regression (GraphPad Prism 6.0, GraphPad Software, USA). A factorial ANOVA with gradient, cadence, intensity and condition as model factors was used for statistical analyses. The level of significance was accepted at $P < 0.05$.

Results: The time constant was significantly affected by the gradient ($F_{1,12} = 10.3$, $P = 0.008$; uphill: 17.9 ± 2.6 sec, flat: 20.9 ± 2.1 sec), the cadence ($F_{1,12} = 5.0$, $P = 0.045$; 60 rev.min-1: 20.3 ± 2.5 sec, 90 rev.min-1: 18.5 ± 1.8 sec) and the intensity ($F_{1,12} = 15.8$, $P = 0.002$; 90%VT: 17.2 ± 2.5 sec, Δ70%: 21.6 ± 2.7 sec). No significant difference was observed between laboratory (19.2 ± 2.1 sec) and field conditions (19.6 ± 2.2 sec) ($F_{1,12} = 0.3$, $P = 0.613$). The amplitude was significantly affected by the cadence ($F_{1,12} = 97.7$, $P < 0.001$; 60 rev.min-1: 1818 ± 95 mL, 90 rev.min-1: 2083 ± 249 mL), the intensity ($F_{1,12} = 425.2$, $P < 0.001$; 90%VT: 1292 ± 234 mL, Δ70%: 2608 ± 260 mL) and the condition ($F_{1,12} = 6.8$, $P = 0.023$; field: 2040 ± 281 mL, laboratory: 1861 ± 216 mL). No significant difference was observed between uphill (1969 ± 213 mL) and flat cycling (1932 ± 234 mL) ($F_{1,12} = 1.5$, $P = 0.244$).

Discussion: The faster oxidative response observed during uphill compared to flat cycling reduce the oxygen deficit, can improve exercise tolerance and therefore can possibly increase performance. Although the amplitude was significantly higher at the higher-cadence, the $\dot{V}O_2$ on-kinetics were significantly faster. Thus, a high-cadence starting strategy at the onset of exercise might be beneficial. The higher amplitude during field compared to laboratory conditions indicate an increased energy demand during outdoor cycling.

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