TITLE : Power and force-velocity relationships during international olympic cross-country mountain bike competitions.

Authors : Cyril GRANIER[1,2], Anaël AUBRY[1], Yvon VAUCHEZ[2], Sylvain DOREL[3], Christophe HAUSSWIRTH[4] & Yann LE MEUR[1,5]*

[1] French Institute of Sport (INSEP), Research Department, Laboratory Sport, Expertise and Performance (EA 7370), Paris, France.
[2] French Cycling Federation, Saint Quentin en Yvelines, France.
[3] Laboratory "Movement, Interactions, Performance" (EA4334), Faculty of Sport Sciences, University of Nantes, Nantes, France.
[4] Côte d'Azur University, Nice Sophia Antipolis University, Laboratory of Human Motricity, Sport and Health Expertise, Nice, France.

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Last decades, researchers demonstrated that cross-country mountain bike (XCO-MTB) was an activity promoting aerobic metabolism (Baron. 2001; Impellizzeri et al. 2002, Impellizzeri et al. 2005; Impellizzeri et al. 2007). Furthermore, despite correlations between aerobic capacities related to body mass and performance, the intermittent nature of the activity encouraged them to evaluate anaerobic abilities (Baron et al. 2001; Stapelfeldt et al. 2004; Impellizzeri et Marcora. 2007 ; Inoue et al. 2012). Moreover, Macdermid et al. (2012) displaying the necessities for athletes to frequently decelerate and accelerate in regard to the geographical race profile, emphasizing the anaerobic nature of the work demand and the production of supra-maximal efforts, impacting the power and force-velocity relationships. The purposes of this study were 1) describe the P and F-V relationships in world-level xco mountain bikers during laboratory test 2) to examine the F-V distribution adopted during international competitions and 3) to evaluate the intermittent nature power output production during XCO-MTB.

Eight elite male off-road cyclists of the French Olympic cycling team participated in this study. Each cyclist performed an incremental and a Force – velocity cycling test (F-V$_{test}$) on four separate occasions over two competitive seasons (twice per season). Participants were monitored over 13 international races (2 World Championships, 1 European Championship, 1 European game and 9 World Cups) within two competitive seasons (2014 and 2015). During these events, each athlete rode a twenty-nine inches hardtail fitted with a Stages crank-based power meter (Stages Power system, Boulder, Colorado, United States) allowing us to monitor PO, HR, speed and cadence. Data were recorded at a frequency of 1Hz and transmitted to a Garmin Edge 810 (Garmin GPS system, Kansas City, United States) fixed on the handlebar.

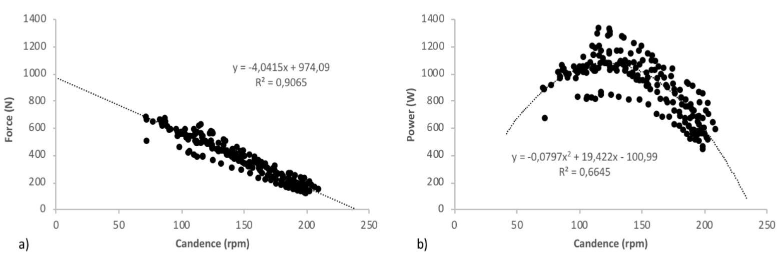

Figure 1.represents a) the force-velocity relationship and b). Power velocity relationship of XCO-MTB athletes (n=8), fitted by average downstroke values obtained from three sprints of 6-s duration in sitting position.

The mean (± SD) age, height and body mass of XCO-MTB atletes were 22.4 ± 3 .4 yr, 179 ± 3 cm and 65.4 ± 3.5 kg respectively. The physiological findings from the incremental test reveals a VO_{2max} of 5.2 ± 0.3 l.min^{-1} (79.9 ± 5.2 ml.min^{-}

^{1}.kg^{-1}), an HR_{max} of 183 ± 16 bpm and a MAP of 6.3 ± 0.4 w.kg^{-1} (411 ± 18 W). Mechanical variables mesured during F-V_{test} (Figure 1) shows a V_{max} of 235 ± 11 rpm and a F_{max} of 1087 ± 128 N (16.5 ± 1.8 N.kg^{-1}). The power-velocity relationship denotes a V_{opt} of 118 ± 6 rpm, for a P_{max} of 1161 ± 128 W (17.7 ± 1.7 W.kg^{-1}).

During races, the average cadence was 68 ± 8 rpm (CV of 11%) and 83 ± 7 rpm if we remove the time spent without pedaling (18 ± 5% of the race time). The mean force was 246 ± 21 N (CV of 8%) for a mean torque of 43 ± 4 N.m^{-1}. Cadence was very likely lower (-4.7 ± 2.3%, ES: small) and force almost certainly lower in L1 when compared with SL (-10.7 ± 2.9%, ES: moderate). Cadence decrease very likely to almost certainly in L3 (-3.0 ± 1.0 %, ES: small), Ln-1 (-4.9± 1.0 %, ES: moderate) and Ln (-5.5 ± 1.3%, ES: moderate), compared to L1. The force follows a sharp decline, with an almost certainly decrease from L2 to Ln compared with L1 (from -5.2 ± 1.2 to -7.3 ± 1.7%, ES: small to moderate).

Furthermore, we found that 26 ± 5% of time was spent above maximal aerobic power (MAP). We discover that mountain bikers from French cycling team are able to repeat 130 ± 28 accelerations above MAP (18 ± 4 spurts above MAP each lap), representing a high-intensity burst each ~40 ± 14 s lasting 7.2 ± 1.5 s. Each period of high intensity depicts a PO of 559 ± 46 W for a cadence of 85 ± 5 rpm, a force of 367 ± 10 N and a torque of 64 ± 2 N.m^{-1}.

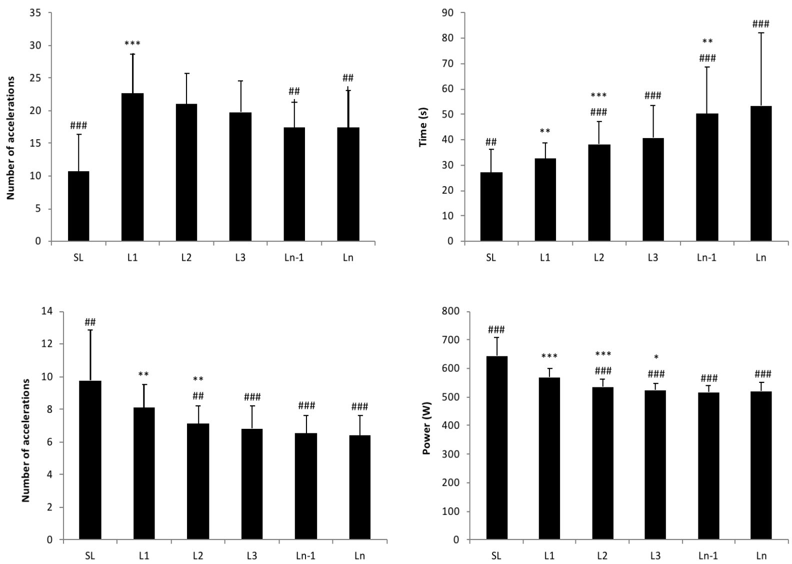

Figure 2. Represents the accelerations above maximal aerobic power (MAP) each passing lap of races. a) is the number of accelerations above MAP, b) the time difference between accelerations, c) the duration of accelerations and d) the power output production of accelerations.
, Difference with the previous lap; #, Difference with the first Lap; (* or # , likely; ** or ##, very likely; * or ###, almost certain)*

During races (figure 2) the number of surges is stable between L1, L2 and L3 but very likely decrease in Ln-1 (-21.9 ± 9.7%, Small) and Ln (-24.2 ± 13.6%, Small) compared to L1. The acceleration length decreases during all laps compared to L1. The longer the race, the longer the duration between surges almost certainly step up from L1 to the end of competition with values of 16.5 ± 5.5 (ES: Small), 22.[illegible] ± [illegible].6 (ES: Moderate), 49.1 ± 8.[illegible] (ES: Large) and 51.1 ± 11s (ES: Large) respectively for L2, L3, Ln-1 and Ln. Conversely, PO almost certainly decline from SL to Ln with a stabilization between Ln-1 and Ln.

This study indicates that the stochastic nature of XCO-MTB promotes a higher anaerobic contribution than previously reported and that XCO-MTB athletes must be able to recover very rapidly from short anaerobic effort throughout races.