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Abstract

The influence of prior accumulated fatigue on power output in professional cyclists

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1. Introduction

The use of power meters in road cycling, both in training and racing, enables an in-depth view of the cyclists' performance capability. Maximum performance capacity, i.e., power profile of a cyclist, could be assessed in the field through the analysis of mean maximal power output (MMP) over different durations. Only little is known about how prior accumulated fatigue influences MMP. Several studies analysed MMP data in professional cyclists of training and racing (Leo et al 2020; Van Erp et al 2021). These authors highlighted that the decline in MMP after an amount of work could be an important parameter for assessing fatigue resistance in professional cycling. For this reason, our aim is to investigate whether prior continuous or intermittent exercise before an MMP test may influence a decline in performance.

2. Materials and Methods

Nine professional riders of a UCI pro continental team (age: 26.22 ± 4.06 years; body mass: 66.66 ± 5.50 kg; height: 1.76 ± 0.41 m) were recruited for a pilot study during December and February training camps. All riders completed both training camps, where they did a 12-min field test in a fresh and pre fatigued state ($MMP12_{fresh}$). $MMP12_{fresh}$ test was proceeded by a 30-min low-intensity warmup. In December, cyclists performed a continuous exercise (CON) of 2.5 h, before completing a 12-min field test ($MMP12_{fatigued}$). In February, a 2.5h race simulation, including multiple intermittent high intensity exercise (INT) bouts, was performed before completing $MMP12_{fatigued}$. Power output data were recorded using a crank arm system (Stages LR; Stages Cycling Europe, Kirchzarten, Germany). Prior work and intensity were calculated as total work and percentage of time spent in 4 zones: 0-1.9 W/kg, 2-4.9 W/kg, 5-7.9 W/Kg, >8 W/kg. (Metcalfe et al. 2017). Training Peaks Software (Peaksware LLC, Lafayette, CO, USA) was used for power data analysis.

3. Results

As shown in Table 1, paired Samples T-tests did not show differences between CON and INT for body mass, and $MMP12_{fresh}$, $p > 0.05$. Before $MMP12_{fatigued}$ time spent was higher in CON (174.02 ± 19.05 min) than in INT (141.63 ± 20.97 min), $p = 0.001$. Work done before $MMP12_{fatigued}$ was higher in CON (29.86 ± 3.61 kJ/kg) than in INT (25.35 ± 4.71 kJ/kg) $p < 0.001$. Average power output sustained before $MMP12_{fatigued}$ was lower in CON (2.91 ± 0.15 W/kg) than in INT (3.32 ± 0.22 W/kg), $p < 0.001$. In both conditions, $MMP12_{fatigued}$ was lower than $MMP12_{fresh}$, $p = 0.002$ in CON, and $p = 0.014$ in INT, respectively. $MMP12_{fatigued}$ was higher in CON (5.54 ± 0.21 W/kg) than in INT (5.02 ± 0.63 W/kg), $p = 0.022$. (Figure 1). During

MMP12$_{fatigued}$, percentage of time spent below 1.9 W/kg, and above 8 W/kg were not different between groups, ($p > 0.05$). Time spent between 2 and 4.9 W/kg, was higher in CON (81.24 ± 6.61%) than in INT (67.26 ± 4.70%), $p = 0.001$. Time spent between 5 and 7.9 W/kg was lower in CON (2.18 ± 1.03%) than in INT (11.11 ± 5.18%), $p = 0.002$. (Figure 2).

4. Discussion

The main finding of the present study is that an exercise bout, prior to a 12MMP, had an influence in performance. Interestingly, 12MMP$_{fatigued}$ was impaired by previous exercise in both conditions. These findings demonstrated that changes in intensity and duration posed different challenges that contribute differently to the reduction of subsequent performance.

Volume alone, represented by total work might be not indicative enough to explain the decline in power output (Kesisoglu et al. 2021). Adding an intensity measure, i.e., time spent in different power output zones, could be beneficial to determine how much prior high intensity work has been already accomplished (Leo et al. 2020). It can be argued that 12MMP$_{fatigued}$ is influenced by pacing strategy and motivation during previous workload. It seems that, after a race simulation, cyclists were able to sustain longer an effort at a higher intensity. But they failed to perform better than after continuous exercise. Self-paced trials as in continuous exercise can be influenced by uncontrolled variation in pacing and motivation regulated by intrinsic biological control processes. In race simulation there is a highly variable, dynamic, and irregular nature of pacing that can influence motivation for sustaining high power for a long time. The main limitation of our study is the lack of heart rate and perception of effort data. This could have helped to better understand the role of fatigue in 12MMP$_{fatigued}$, from a cardiovascular and perceptual points of view. For this reason, future research is required to develop a standardized and formal protocol on how to determine fatigue resistance in field conditions.

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Table 1. Detailed results.

	Body mass (kg)	$MMP12_{fresh}$ (W/kg)	Time pre $MMP12_{fatigued}$ (min)	Work pre $MMP12_{fatigued}$ (kJ/kg)	Average PO pre $MMP12_{fatigued}$ (W/kg)	$MMP12_{fatigued}$ (W/kg)
CON	66.66 ± 5.50	5.74 ± 0.22	174.02 ± 19.05	29.86 ± 3.61	2.91 ± 0.15	5.54 ± 0.21
INT	66.34 ± 5.83	5.69 ± 0.37	141.63 ± 20.97*	25.35 ± 4.71*	3.32 ± 0.22*	5.02 ± 0.63*

CON = continuous. INT = intermittent. PO = Power output. Data presented as Mean ± SD. * denotes difference between conditions ($p < 0.05$).

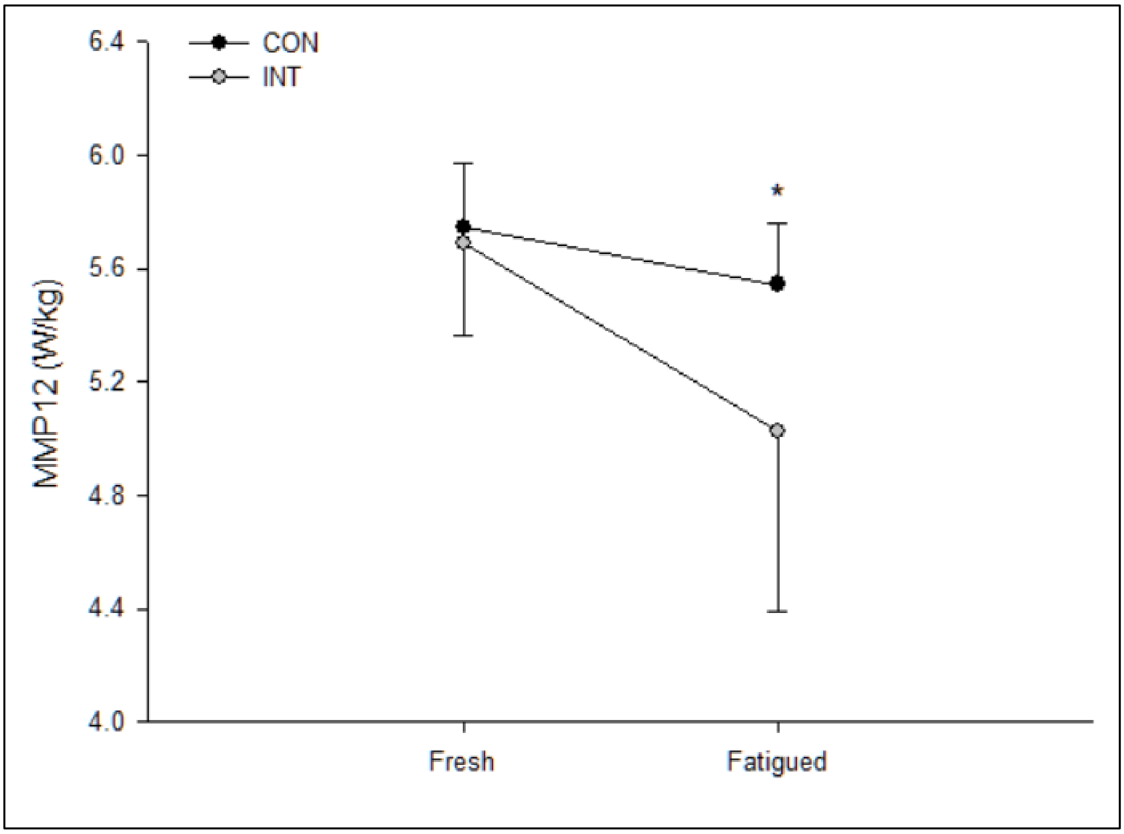

Figure 1. 12-minute Mean maximal power output test performance. CON = continuous. INT = intermittent. Data presented as Mean ± SD. * denotes difference between conditions ($p < 0.05$).

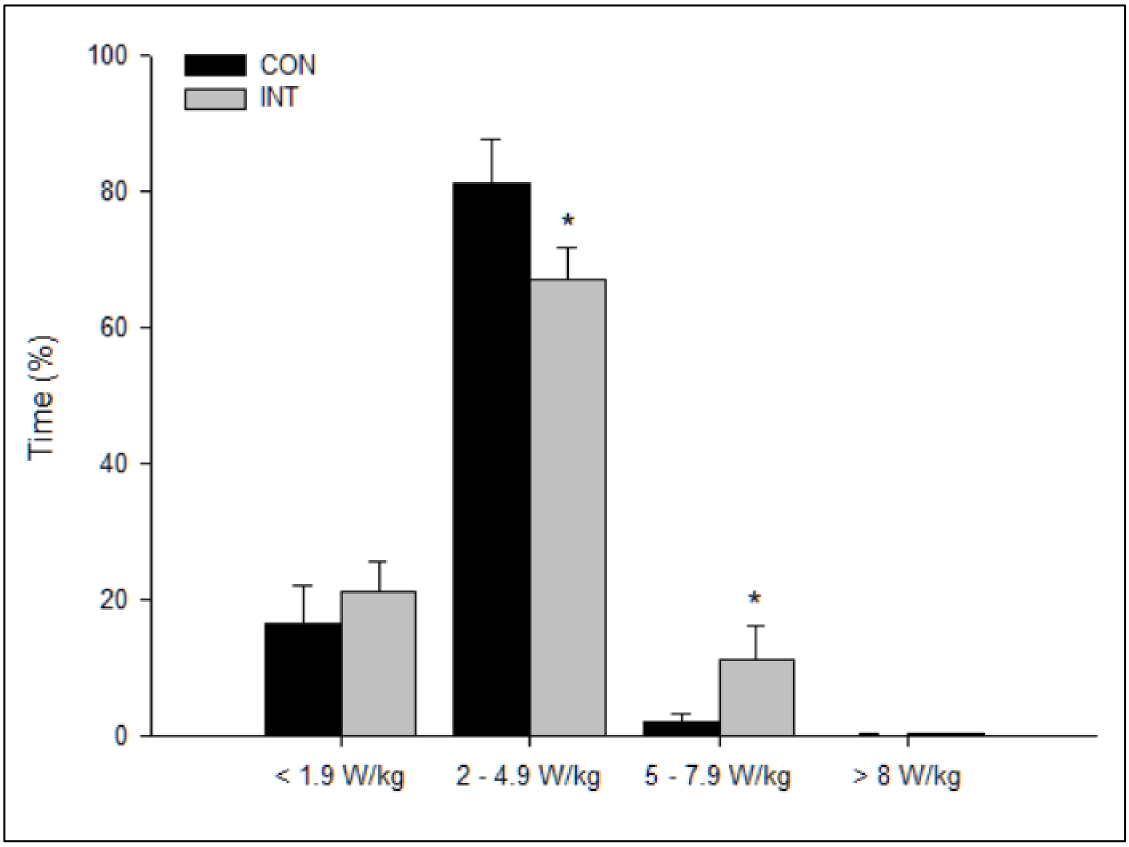

Figure 2. Percentage of time spent in each intensity zone during the 12-minute Mean maximal power output test under fatigued conditions. CON = continuous. INT = intermittent. Data presented as Mean ± SD. * denotes difference between conditions ($p < 0.05$).