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Conference paper

Cycling performance after accumulated load: does durability change during a cycling season?

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1. Introduction

Durability is the ability to produce high power outputs after accumulated load (at the end of a race), which has been shown to be an important success factor in professional road cycling (van Erp et al. 2020; Leo et al. 2021; Mateo-March et al. 2022; Muriel et al. 2022). Gross efficiency (GE), fat oxidation (FATox) and carbohydrate oxidation (CHOox) have been proposed as underlying physiological factors for durability, as changes have been shown to be related to a decrease in performance after accumulated load (Noordhof et al. 2020; Passfield & Doust, 2000; Stevenson et al. 2022), although there is much debate on this topic. Therefore, the aim of this study is to investigate durability and the underlying physiological factors in semi-professional cyclists. Secondly, this study investigates how durability and certain physiological factors changed during a cycling season.

2. Materials and Methods

In total, 16 semi-professional cyclists (10min PO: 379±22 W) visited the lab on 3 occasions: Start of pre-season (PRE), start of race season (START), and halfway into the race season (IN). Testing days included: a warm-up at 55% of VO2peak power at which GE, FATox and CHOox were determined, followed by a 1min and 10min time trial to measure power output ($TT1min_{fresh}$, $TT10min_{fresh}$). After 3hours of endurance training (31±5 KJ/kg) the same protocol was repeated to investigate the influence of accumulated load on performance ($TT1min_{fatigued}$ and $TT10min_{fatigued}$) and physiological parameters (GE, FATox and CHOox). Differences between PRE vs START vs IN and fresh vs fatigued were investigated using a mixed-effects multilevel model. When significant ($p<0.05$) main effects occurred, Bonferroni post-hoc was executed for pairwise comparisons.

3. Results

No differences were found between $TT1min_{fresh}$ at PRE, START and IN and $TT1min_{fatigued}$ at PRE, START and IN, however $TT1min_{fresh}$ was significantly higher than $TT1min_{fatigued}$ at PRE, START and IN (figure 1). $TT10min_{fresh}$ did not differ from $TT10min_{fatigued}$ on all occasions, however, both $TT10min_{fresh}$ and $TT10min_{fatigued}$ were lower at PRE compared to START and IN (figure 1). CHOox (PRE and START) and GE (START) were lower in fatigued compared to fresh state, while FATox was higher in fatigued compared to fresh (PRE and START). In addition, GE_{fresh} was higher at START and IN compared to PRE, while there was a decrease in $FATox_{fatigued}$ from

PRE and START to IN. Lastly, an increase was noted from PRE to START in $CHOox_{fatigued}$ and PRE to IN in $GE_{fatigued}$ and $CHOox_{fatigued}$.

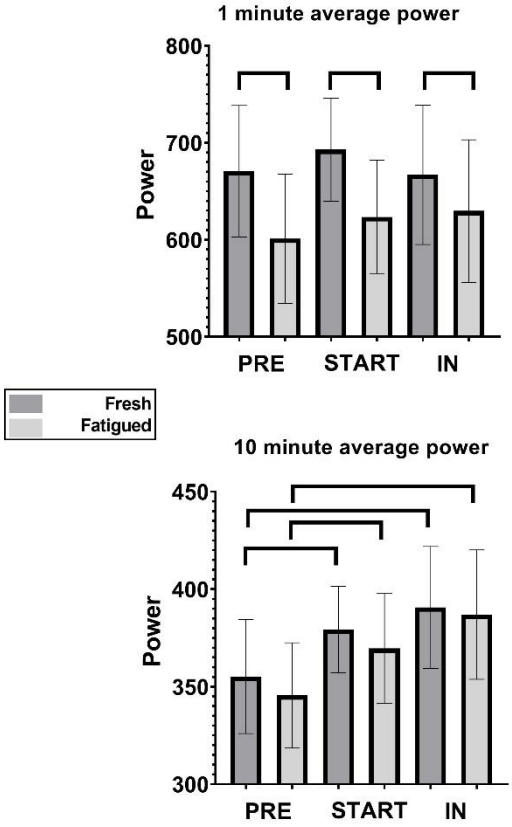

Figure 1: Changes in power output before and after accumulated load during a cycling season. Abbreviations: PRE, Start of Pre-season; START, start of race season; IN, halfway into the race season

4. Discussion

This study is to the best of the authors knowledge, the first to present the changes in power output, gross efficiency and substrate oxidation before and after accumulated load during a full cycling season.

Performance over short efforts (TT1min) is affected by fatigue but doesn't improve from PRE to IN. Performance over longer efforts (TT10 min) is not significantly affected by accumulated load, however, improves throughout the season (from PRE to IN). As the total load at the beginning of the fatigued test was ± 40 KJ/kg, it could be suggested that the protocol in the current study was not fatiguing enough, with decline in performance in professional cyclists found after 50 KJ/kg (van Erp et al. 2020). However, other studies already found an earlier decline in performance (Leo et al. 2021; Mateo-March et al. 2022; Muriel et al. 2022). Also, previous studies are based on race data. As not only the accumulated load, but also the intensity of that load plays a role in an impaired performance after exercise (Vermeire et al. 2023), it could be suggested that the intensity of the races was higher as compared to the controlled environment in the current study.

Not only the load, but also intensity plays a role in an impaired performance after exercise

Gross efficiency was not affected by the accumulated load in the current study, which is in contrast with previous research (Noordhof et al. 2020; Passfield & Doust, 2000) . As the level of the cyclist in the current study is higher as compared to previous research, it could be argued that the protocol was not fatiguing enough to result in a decreased efficiency. However, GE seems to improve throughout the season (from PRE to IN).

Substrate oxidation changes after accumulated load with FATox increasing and CHOox decreasing, as in line with previous research (Stevenson et al. 2022). However, this difference diminishes from PRE to IN, because of higher CHOox and lower FATox after accumulated load. It could be suggested that this shows a better durability during the season compared to the pre-season and that the ability to maintain CHOox high in fatigued state results in better performance (although not significant).

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References

(1) van Erp, T.; Sanders, D.; Lamberts, R. Maintaining Power Output with Accumulating Levels of Work Done Is a Key Determinant for Succes in Professional Cycling *Medicine & Science in Sports & Exercise* **2021**, *53* (9), 1903-1910, DOI: 10.1249/MSS.0000000000002656

(2) Leo, P.; Spragg, J.; Mujika,I.; Giorgi, A.; Lorang, D.; Simon, D.; Lawley, J.S. Power Profiling, Workload Characteristics, and Race Performance of U23 and Professional Cyclists During the Multistage Race Tour of the Alps *Int J Sport. Physiol Perform* **2021**, *16* (8), 1089-1095, DOI: https://doi.org/10.1123/ijspp.2020-0381

(3) Mateo-March, M.; Valenzuela, P.L.; Muriel, X.; Gandia-Soriano, A.; Zabala, M.; Lucia, A.; Pallares, J.G.; Barranco-Gil, D. The Record Power Profile of Male Professional Cyclists: Fatigue Matters *Int J Sport. Physiol Perform* **2022**, *17* (6), 926-931, DOI: https://doi.org/10.1123/ijspp.2021-0403

(4) Muriel, X.; Mateo-March, M.; Valenzuela, P.; Zabala, M.; Lucia, A.; Pallares, J.G.; Barranco-Gil, D. Durability and repeatability of professional cyclists during a Grand Tour *Eur J Sport. Sci* **2022**, *22* (12), 1797-1804, DOI: 10.1080/17461391.2021.1987528

(5) Noordhof, D.A.; Øfsteng, S.J.; Nirenberg, L.; Hammarström, D.; Hansen, J.; Rønnestad, B.; Sandbakk, Ø. Performance-Determining Variables in Long-Distance Events: Should They Be Determined From a Rested State or After Prolonged Submaximal Exercise? *Int J Sport. Physiol Peform* **2020**, *16* (5), 647-654, DOI: https://doi.org/10.1123/ijspp.2019-0987

(6) Passfield, L. and Doust, J.H. Changes in cycling efficiency and performance after endurance exercise *Med. Sci. Sports Exerc.* **2000**, *32* (11), 1935-1941, DOI: 10.1097/00005768-200011000-00018

(7) Stevenson, J.D.; Kilding, A.E.; Plews, D.J.; Maunder, E. Prolonged cycling reduces power output at the moderate-to-heavy intensity transition *Eur J Appl Phsyiol.* **2022**, *122* (12), 2673-2682, DOI: 10.1007/s00421-022-05036-9

(8) Vermeire, K.M.; Caen, K.; Bourgois, J.G.; Boone, J. Training Load and Acute Performance Decrements Following Different Training Sessions *Int J Sport. Physiol Perform* **2023** *18* (3), 284-292, DOI: https://doi.org/10.1123/ijspp.2022-0157