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Predicting power outputs in a fatigued state: A pilot study

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Abstract:

Power output predictions from a novel test were compared to those achieved in hill and mountain top finishes in professional cyclists. Power output was overestimated by 2W ±5W from the novel test across durations from 491-1860s. This is in comparison to power output estimates from a traditional power profile test which overestimated power outputs by 23W ± 18.

Keywords: Critical Power; Durability; Power Profiling, Racing

1. Introduction

Research has suggested that the power profile in a fatigued state is a better predictor of performance than maximal (fresh) values (Leo et al., 2020; Muriel et al., 2021; van Erp et al., 2021). However, to date, no test has been developed that can predict power outputs, and therefore performances, in a fatigued state. Therefore, the aim of this study was to compared power output predictions from a novel power profile test to those values achieved in hill and mountain top finishes.

2. Materials and Methods

Participants completed a power profile test in a fresh stage and following a novel fatiguing protocol (see below) CP and W' values in both a fresh and fatigued state were derived. Both tests were completed within a 2-week period. Power output predictions derived from these values were compared to power output values in mountain and hilltop finishes achieved in the subsequent 4 months.

Participants:

Four U23 professional cyclists participated in this case study. All participants provided informed written consent and were active members of a UCI Continental team during the cycling season(s) analyzed.

Power Profile Test:

This test consisted of 3-, and 12-min maximum effort trials conducted in a standardised location (Simpson & Kordi, 2017). The 3- and 12-min efforts were interspersed by 40-min of active recovery during which the Borg 10 point scale of perceived exertion (Borg, 2001) was used and participants were instructed to not exceed an RPE of 2 out of 10 (corresponding to the verbal anchor of "light exertion") before proceeding to the subsequent effort. Prior to each effort participants were encouraged to produce the highest possible workload and asked to maintain a cadence between 80 and 100 revolutions per minute (rev·min^{-1}). Power output values from the 3- and 12- min maximum effort trials were plotted against

1/t (t = the corresponding duration) to linearize the power duration relationship (Whipp et al., 1981). A least sum of squares linear regression was then applied. The intercept of the regression line with the y axis represents CP and the slope of the regression line represented W

Fatiguing Protocol:
This was completed prior to the described power profile test and consisted of 20 mins at 50-70% of CP (derived from the initial CP test) followed by 5 x 8 min efforts at 105-110% of CP. Each 8 min effort was followed by 8 min of active recovery in which participants were instructed to not exceed an RPE of 2 out of 10 on the Borg 10-point scale (Borg, 2001) (corresponding to the verbal anchor of "light exertion") before proceeding to the subsequent effort. Participants were free to use a self-selected cadence during the fatiguing protocol. Before commencing the power profile test participants were instructed to ride for 40 mins at an intensity that did not exceed an RPE of 2 out of 10 on the Borg 10 point scale (corresponding to the verbal anchor of "light exertion"). Carbohydrate intake was standardised at $60 g \cdot hr^{-1}$ with a 1:1 ratio of glucose and fructose via both energy drinks and gels. Participants were instructed to refrain from consuming caffeine during the fatiguing protocol. In addition to the standardised carbohydrate, intake participants were free to drink water ad libitum.

Power Output Predictions:
Power output predictions for the duration of the hill and mountain top finish were derived from fresh and fatigued CP and W′ values. The following equation was applied

$$P = W'/t + CP$$

Equation 3, P = power output (W), t=duration of effort (s), W′ - work above critical power, CP – critical power

3. Results

A total of 4 performances were analyzed. The range of durations for the hill and mountain top efforts was 491-1860s.

Power output estimates derived from fresh CP and W′ values overestimated power output by 23W ± 18 (5.87% ± 4.72). Power outputs estimates derived from fatigued CP and W′ values overestimated power out by 2W ± 5 (0.6% ± 1.2) - see figure 1.

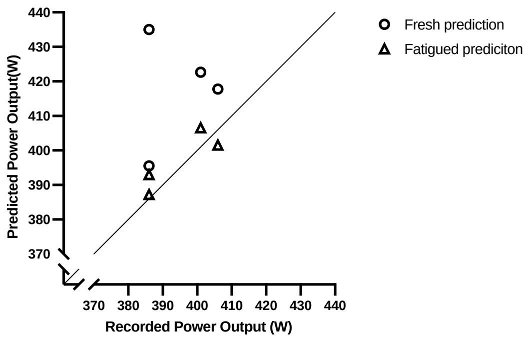

Figure 1 – Recorded and predicted power outputs. The diagonal line represents the line of identity

4. Discussion

These results suggest that values derived from a fresh power profile test are less accurate in terms of predictive ability than those derived in a fatigued state via a novel power profile test. This is of particular importance as recent research has suggested that the power outputs that professional cyclists can produce in a fatigued state are both a differentiator of overall performance between groups (Leo et al., 2020; Muriel et al., 2021) and ultimately what matters in terms of results at the finish line (van Erp et al., 2021). This research suggests that if we want to predict performance in these key moments of a professional cycle race then we should be also conducting formal testing, to derive a power-duration relationship, in a fatigued state.

5. Practical Applications

Power estimates for performances in a fatigued state can be predicted from CP and W′ values derived from a novel power profile test.

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Conflicts of Interest: The authors declare no conflict of interest.

References

Borg, G. (2001). Borg's range model and scales. *International Journal of Sport Psychology*, *32*(2), 110–126.

Leo, P., Spragg, J., Mujika, I., Giorgi, A., Lorang, D., Simon, D., & Lawley, J. S. (2020). Power Profiling, Workload Characteristics, and Race Performance of U23 and Professional Cyclists During the Multistage Race Tour of the Alps. *International Journal of Sports Physiology and Performance*, 1–7. https://doi.org/10.1123/ijspp.2020-0381

Muriel, X., Mateo-March, M., Valenzuela, P. L., Zabala, M., Lucia, A., Pallares, J. G., & Barranco-Gil, D. (2021). Durability and repeatability of professional cyclists during a Grand Tour. *European Journal of Sport Science*, 1–8. https://doi.org/10.1080/17461391.2021.1987528

Simpson, L. P., & Kordi, M. (2017). Comparison of critical power and W′ derived from 2 or 3 maximal tests. *International Journal of Sports Physiology and Performance*, *12*(6), 825–830. https://doi.org/10.1123/ijspp.2016-0371

van Erp, T., Sanders, D., & Lamberts, R. P. (2021). Maintaining Power Output with Accumulating Levels of Work Done Is a Key Determinant for Success in Professional Cycling. *Medicine and Science in Sports and Exercise*. https://doi.org/10.1249/MSS.0000000000002656

Whipp, B. J., Huntsman, D. J., & Storer, T. (1981). A constant which determines the duration of tolerance to high-intensity work. *Federation Proceedings*, *41*, 1591.