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# The Relationship Between Durability and Simulated Cycling Performance

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## 1 Introduction

Durability, or the resilience to a downward shift in physiological markers of endurance performance following prolonged exercise, has been proposed as an important additional component of endurance performance. Durability could be particularly important in cycling races where performance is often determined by the ability to produce high power outputs after large quantities of accumulated work. However, the extent to which durability explains variation in performance is not yet fully understood, and there are a wide range of protocols to measure durability, which could lead to inconsistent findings. Therefore, the aims of this study were to a) determine whether the type of fatiguing protocol (continuous or intermittent) influences the effectiveness of durability to predict cycling performance and b) determine whether considering the durability of the markers of endurance performance helps predict cycling time trial (TT) and road race (RR) performance.

## 2 Material and Methods

### 2.1 Participants

Competitive cyclists ($n$ = 8 data; target sample size $n$ = 14), 31 ± 9 years, mass: 79 ± 6 kg, $\dot{V}O_{2max}$: 59 ± 4 ml·kg·min$^{-1}$, volunteered for this study.

### 2.2 Methodology

Participants completed five laboratory visits. The first visit consisted of an incremental test to assess gross efficiency (GE), lactate threshold (LT), $\dot{V}O_{2max}$, and peak power output, followed immediately by an all-out test to determine critical power (CP) and W′. In visits 2 and 3, the same physiological assessment was completed after 15 kJ·kg$^{-1}$, consisting of either continuous cycling at 90% LT, or 2.5-minute efforts at 105% of CP, until 375 J·kg$^{-1}$ of work was completed above CP, interspersed by 2.5-min recovery periods at 50% CP. Visits 4 and 5 consisted of two performance trials, performed in random order: a simulated TT consisting of three laps the 2018 UCI world championships circuit, and a simulated RR simulation consisting of 4 x 5 min maximal efforts interspersed with pre-set efforts over 2h and 20 min. All tests were performed on an electromagnetically braked ergometer apart from the TT which was performed on the participants own bike.

### 2.3 Statistical Analysis

One-way repeated measures ANOVA tests were used to detect changes in physiological variables across the different conditions. In the presence of a significant effect ($p \leq 0.05$), a Bonferroni-corrected post-hoc series of paired sampled t-tests were conducted. The relationship between physiological variables (fresh, fatigued, and durability, determined as the percentage of fresh value after fatiguing protocols) and performance (TT: time taken to complete the 26.8 km (s); RR: combined mean power output (W) of all four 5-min performance measures) were assessed via bivariate Pearson correlation coefficients (0–0.09 trivial; 0.1–0.29 weak; 0.3–0.49 moderate; 0.50–0.69 strong; 0.70–0.89 very strong; 0.90–0.99 nearly perfect; and 1.00 perfect).

## 3 Results

In a fresh state, absolute $\dot{V}O_{2max}$, relative $\dot{V}O_{2max}$ peak power, GE, LT, CP and W′ were 4.65 ± 0.51 L·min$^{-1}$, 59 ± 5 ml·kg·min$^{-1}$, 407 ± 46 W, 22 ± 1 %, 233 W, 322 W, and 12033 ± 1764 J respectively. Fresh-state absolute $\dot{V}O_{2max}$, peak power, LT and CP showed nearly perfect relationships with TT duration ($r \leq 0.90$, $p < 0.01$). $\dot{V}O_{2max}$ (absolute and relative) was the only marker in a fresh state to show a correlation with RR performance ($r < 0.75$, $p < 0.05$). After 15 kJ·kg$^{-1}$ of moderate, continuous cycling, peak power declined to 373 ± 51 W, this was the only marker to exhibit a difference ($p$=0.009, $d$=0.64). Absolute $\dot{V}O_{2max}$, peak power, GE, LT, CP and the durability of GE showed very strong to nearly perfect relationships with TT duration ($r \leq 0.76$, $p < 0.05$) and $\dot{V}O_{2max}$ (absolute and relative), peak power, GE, CP and the durability of GE and W′ showed very strong relationships to RR performance ($r < 0.74$, $p < 0.05$). After 15 kJ·kg$^{-1}$ of intermittent, high intensity cycling, peak power (359 ± 44 W) declined from fresh ($p$ = 0.004, $d$ = 1.07); but there were no differences between other markers measured after continuous or intermittent cycling. After the intermittent protocol, absolute $\dot{V}O_{2max}$, peak power, GE, LT, CP and the durability of GE showed very strong to nearly perfect relationships with TT duration ($r \leq 0.79$, $p < 0.05$) and just absolute $\dot{V}O_{2max}$ and the durability of LT were related to RR performance ($r < 0.76$, $p < 0.05$).

## 4 Conclusions

This study demonstrates deterioration in physiological markers of endurance performance following 15 kJ·kg$^{-1}$ of continuous or intermittent cycling. More markers of performance are related to TT and RR performance when measured in a fatigued- rather than fresh-state. Furthermore, the durability of some of these markers such as GE

appear to be important for both TT and RR performance. Coaches and practitioners should measure physiological markers of endurance performance under fresh and fatigued conditions.

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