

Assessing Durability Using Absolute and Relative Workload Metrics: Implications for Real-World Cycling Performance

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1 Introduction

Durability refers to the downward shift in the power-duration relationship during prolonged exercise and is increasingly recognised as a contributor to endurance performance (Maunder et al., 2021). In cycling, it is typically assessed by comparing power profile parameters in a fresh versus fatigued state.

Pre fatiguing workloads are typically standardised using either absolute loads based on fixed mechanical work (kJ or kJ·kg⁻¹) (Mateo March et al., 2022), or relative loads anchored to individual physiology, such as a set duration at a prescribed relative intensity (Clarke et al., 2018). Training Stress Score (TSS) integrates relative intensity and duration into a single

load metric (Bossi et al., 2026) and may offer a practical alternative for standardising pre fatiguing workloads relative to ability. Relative and absolute approaches are fundamentally different: absolute loads may better reflect race like mechanical demands, whereas relative loads might offer tighter control of physiological strain across individuals. However, they have not been directly compared within the same cohort or evaluated against real world performance.

Aims: A) Compare cyclists' critical power and durability estimates after increasing levels of relative (TSS) and absolute (kJ, kJ·kg⁻¹) load. B) Examine how each parameter relates to real world cycling performance.



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2 Material and Methods

2.1 Participants

All cyclists competing in the North Wales Horseshoe Pass Road Race (17/05/2026) were invited to participate. To date, seventeen riders have provided complete datasets suitable for analysis, each with ≥ 12 months of power meter verified training data. Participant characteristics are presented in Table 1.

Table 1. Participants characteristics ($n = 17$).

Characteristic	Mean $\pm$ SD
Age (years)	31 $\pm$ 9
Mass (kg)	70 $\pm$ 8
Critical power (W)	319 $\pm$ 46

2.2 Methodology

Maximum mean power (MMP) data from the 365 days preceding the race were extracted for each participant using commercially available software (WKO5). This data was filtered using the approach described by Spragg et al. (2023) to model critical power (CP) under fresh conditions and after exposure to graded absolute and relative workloads. Workload bins ($\text{kJ}\cdot\text{kg}^{-1}$: 0, 10, 15, 20, 25; kJ: 0, 700, 1050, 1400, 1750; TSS: 0, 45, 70, 90, 115, 135) were derived retrospectively from the same 12-month dataset, and calibrated using the mean rider CP and body mass to produce broadly equivalent fatigue demands, while ensuring all participants had a sufficient number of rides exceeding each workload. Durability was quantified as the percentage of fresh CP retained after each condition. Race performance was defined as finishing time in the Horseshoe Pass Road Race, a mass-start event with a summit finish.

2.3 Data Analysis

Differences in CP across workload conditions were assessed using a repeated-measures ANOVA. Where

significant main effects were detected ($p \leq 0.05$), Bonferroni-corrected paired-samples t -tests identified specific between-condition differences. Associations between CP, CP-durability (percentage change in CP under each workload condition), and race performance were examined using Pearson correlation coefficients, with correlation magnitude expressed as r .

3 Results

CP declined significantly with increasing workload across all three metrics. For $\text{kJ}\cdot\text{kg}^{-1}$, workload had a significant effect, $F = 10.67$, $p < .001$, with reductions at $25 \text{ kJ}\cdot\text{kg}^{-1}$ versus Fresh ($p = 0.002$) and $10 \text{ kJ}\cdot\text{kg}^{-1}$ ($p = 0.004$). For absolute kJ, workload was significant, $F = 8.90$, $p < .001$, with reductions at 1750 kJ versus Fresh ($p = 0.011$) and 700 kJ ($p = 0.037$). For TSS, workload was again significant, $F = 9.75$, $p < .001$, with reductions at 135 TSS versus Fresh ($p = 0.004$), 45 TSS ($p = 0.025$), and 70 TSS ($p = 0.018$).

Across the three comparable workloads shown in Fig 1. ($25 \text{ kJ}\cdot\text{kg}^{-1}$, 1750 kJ, 135 TSS), %CP preserved showed similar mean declines (9%, 8.2%, and 7.5%), with no significant difference between CP at these workloads ($F = 1.54$, $p = 0.229$). TSS produced the tightest clustering of responses (CV = 7.4% vs. 8.9% for $\text{kJ}\cdot\text{kg}^{-1}$ and 9.5% for kJ).

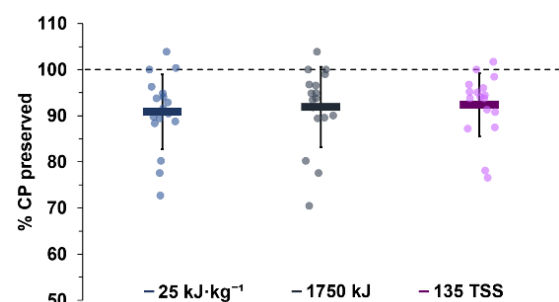


Figure 1. %CP preserved at $25 \text{ kJ}\cdot\text{kg}^{-1}$, 1750 kJ, and 135 TSS ($n = 17$).

Finish time was significantly associated with CP across all conditions: fresh CP ($r = -0.66$, $p = 0.004$); CP after 25 $\text{kJ}\cdot\text{kg}^{-1}$ ($r = -0.62$, $p = 0.008$); CP after 1750 kJ ($r = -0.61$, $p = 0.01$), and 135 TSS ($r = -0.589$, $p = 0.013$). Durability metrics (%CP preserved) were not significantly associated with finish time: after 25 $\text{kJ}\cdot\text{kg}^{-1}$ ($r = -0.082$, $p = 0.755$); after 1750 kJ ($r = -0.049$, $p = 0.853$); after 135 TSS ($r = 0.063$, $p = 0.81$).

4 Conclusions

CP showed significant and comparable reductions after 25 $\text{kJ}\cdot\text{kg}^{-1}$, 1750 kJ, and 135 TSS. Fatigued CP was strongly associated with race performance across all workloads, indicating that the ability to generate power under fatigue contributes meaningfully to real world outcomes. However, fresh CP remained the strongest predictor, showing that fresh physiological capacity still exerts major influence. Durability metrics (%CP preserved) in isolation showed no meaningful associations with performance. The weakest associations were observed under the TSS condition,

likely reflecting lower between participant variability. Although each workload metric quantifies durability, absolute and relative approaches capture different aspects of load, and further work is needed to determine their best use.

Overall, sustaining high power under fatigue contributes to performance, but it does not supersede the importance of fresh capacity in this cohort.

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

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