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Conference Abstract

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Single-Session Field-Based Evaluation of Durability in Professional Male Cyclists via 5-Minute Time Trials

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Abstract

This study investigated endurance durability in professional male cyclists using a single-session, field-based 5-minute time trial (5min-TT) protocol under fresh and fatigued conditions. Twenty elite cyclists from a UCI ProTeam participated during a pre-season training camp. The experimental session simulated race-specific demands, combining prolonged moderate-intensity cycling with repeated high-intensity efforts on a standardized uphill road segment. Following an accumulated workload of approximately 45–50 $kJ \cdot kg^{-1}$, cyclists exhibited significant declines in absolute and relative power output, torque, and PO:HR during the fatigued 5min-TT compared with the fresh condition. In contrast, heart rate and cadence remained largely unchanged. These results indicate that performance reductions were primarily driven by decreased torque rather than alterations in cadence or cardiovascular response, highlighting the role of neuromuscular mechanisms in fatigue resistance. The dissociation between power output and heart rate suggests that PO:HR decoupling may serve as a practical marker of endurance durability during high-intensity efforts. Overall, the findings demonstrate that a single-session, field-based 5min-TT is a feasible and effective method for assessing durability in professional cyclists.

Keywords

durability; professional cycling; field-based testing; 5-min time trial

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1 Introduction

Road cycling performance is traditionally defined by maximal oxygen uptake, ventilatory thresholds, and gross efficiency (Joyner & Coyle, 2008), typically assessed in laboratory settings, with maximal aerobic power derived from graded exercise tests (Pinot & Grappe, 2014). Recent studies have promoted field-based methods, including estimating VO_2 max and maximal aerobic power from a single 5-minute maximal effort (Borszcz et al., 2024; Sitko et al., 2022), or from power profile analysis (Pinot & Grappe, 2014). However, these assessments are usually conducted in non-fatigued states, overlooking durability (Maunder et al., 2021; Jones, 2024). Durability influences race outcomes despite similar physiological profiles (Van Erp et al., 2021). The durability concept has recently been integrated into training philosophies, and several methods have been proposed for its assessment through both training and competition data analysis and field-based durability testing (Leo et al., 2025; Spragg et al., 2024; Valenzuela et al., 2022)

We propose a single-session field protocol assessing 5-minute time-trial performance pre- and post-workload to evaluate durability in professionals.

2 Material and Methods

2.1 Participants

Twenty professional male cyclists, members of a UCI ProTeam, classified as Tier 4: Elite/Professional Level (McKay et al. 2021), took part in the study (mean ± SD: age 22 ± 4 years; body mass 64.8 ± 4 kg; stature 1.77 ± 0.05 m).

2.2 Design

An overview of the experimental protocol is presented in Figure 1. The study was conducted during a single testing session within a pre-season team training camp. All participants completed a standardized recovery training session 24 hours prior to testing. Exercise intensities for the experimental session were prescribed based on a preliminary incremental field test performed three days earlier to determine the lactate turnpoint (LT2).

All 5-minute time-trial bouts were conducted on the same uphill road segment (2.21 km, 6.05% average gradient) to ensure consistency of environmental and terrain conditions. The single testing session consisted of three consecutive phases:

- Phase 1 (Fresh condition): 60 minutes of cycling at 60% of LT2, followed by a 5-min TT.
- Phase 2 (Intermittent high-intensity phase): 60 minutes at 60% of LT2, followed by three repetitions of 5-minute bouts at 105–110% of LT2, each separated by 5 minutes of active recovery at 50-60% of LT2.
- Phase 3 (Fatigued condition): 60 minutes at 60% of LT2, followed by a final 5-minTT.

Throughout the entire session, participants were instructed to ingest 90 $g \cdot h^{-1}$ of caffeine-free carbohydrates. During the 5-minute TTs, cyclists maintained their preferred cadence within a range of 80–100 revolutions per minute (rpm).



Table 1. 5-min Time Trial parameters

2.3 Methodology

Data were collected using pedal-based power meters (Favero Assioma Duo, Favero Electronics srl., 84 Arcade, TV, Italy), heart rate bands, (Bryton Heart Rate Monitor, Bryton 86 Inc., Taipei City, Taiwan) and GPS units (Bryton S800, Bryton 86 Inc., Taipei City, Taiwan). All participants were instructed to calibrate their power meters prior to each session. Data were manually analysed using specific software (WKO5; TrainingPeaks LLC, Boulder, CO). Outliers were identified and manually removed using the 'Data Spike ID and FIX' chart. The following variables were extracted from the software for data analysis: absolute power output, absolute torque, absolute work, cadence, average and max HR, power to heart rate ratio (PO:HR), relative power output, relative torque, and relative work.

2.4 Statistical Analysis

All data were checked for normality using the Shappiro-Wilk test. Paired Samples T-tests were used to investigate differences between states (fresh, fatigued). To measure the magnitude of significant differences, effect sizes (ES) Cohen's d measures were used. Effect sizes greater than 0.2, 0.5, and 0.8 were considered small, medium, and large, respectively (Cohen 1988). Statistical analyses were performed using JASP (JASP 0.19.3, Amsterdam, Netherlands). Statistical significance was set at $p < 0.05$.

3 Results

After 3432 ± 242 kJ (53 ± 4 kJ/kg), the following parameters decreased significantly during the subsequent 5-min TT, compared to the one performed fresh: absolute power output ($p < 0.001$; ES = 1.02); relative power output ($p < 0.001$; ES = 1.00); absolute torque ($p = 0.041$; ES = 0.49), relative torque ($p = 0.031$; ES = 0.52), and PO:HR ($p < 0.001$; ES = 1.09). No significant differences were found for heart rate ($p = 0.456$) and cadence ($p = 0.205$). Full disclosure of the results can be found in Table 1.

Table 1. 5-min Time Trial parameters.

Variable	Fresh	Fatigued (3432 ± 242 kJ)	p
Power Output (W)	434 ± 30	418 ± 29*	< 0.001
Power Output (W/kg)	6.71 ± 0.48	6.46 ± 0.42*	< 0.001
Heart Rate (bpm)	181 ± 8	180 ± 7	0.456
Cadence (rpm)	85 ± 4	84 ± 4	0.205
Torque (Nm)	48.8 ± 4	47.7 ± 4.1*	0.041
Torque (Nm/kg)	0.76 ± 0.06	0.74 ± 0.06*	0.031
PO:HR (unitless)	2.41 ± 0.20	2.33 ± 0.18*	< 0.001

Data are presented as mean ± SD. * denotes significant differences between conditions.

4 Discussion

This study compared 5-minute time-trial (5min-TT) mean maximal power (MMP5) under fresh and fatigued conditions following a race-simulation workload (~45–50 kJ·kg^{-1}). Results showed a ~4% MMP5 decline post-fatigue, while HR responses remained stable. Findings highlight the utility of single-session 5 min-TT for evaluating endurance durability and race-specific fatigue resistance.

5 Practical Applications

A single-day field-based 5min-TT MMP5 test effectively assesses durability in professional cyclists. Post-workload power reductions were mainly due to decreased torque, not cadence. The observed dissociation between power output and HR (PO:HR decoupling) may serve as a practical marker of fatigue resistance and endurance performance.

The protocol captures both declines in performance under fatigue and underlying

physiological mechanisms, providing a practical tool for coaches to monitor training adaptations, evaluate race-specific resilience, and guide interventions aimed at sustaining high-intensity performance in elite road cycling.

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

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