Power Profiling in elite U23 riders during a competitive season

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Science & Cycling

Background & Literature

- Sustain- and reproducibility of the power-duration relationship (Jones, A. M., & Vanhatalo, A., 2017)
- Exercise tolerance and fatigue resistance (Davies & Thompson, 1986; Lepers, Maffiuletti, Rochette, Brugniaux, & Millet, 2002; Martin et al., 2010)
- Physiological boundary and responses (Jones, Wilkerson, DiMenna, Fulford, & Poole, 2008; Poole, Ward, Gardner, & Whipp, 1988; Vanhatalo et al., 2016)
- Influence of longitudinal training and racing regimes (Allen & Coggan, 2010; Pinot & Grappe, 2011, 2014; Wahl, 2015)
- Modelling approaches hyperbolic (Monod & Scherrer, 1965; Moritani, Nagata, deVries, & Muro, 1981; Morton, 2006), power law (Garcia-Manso, Martín-González, Vaamonde & Da Silva-Gigoletto, 2012; Kennelly, 1906), exponential decay (Weyand, Lin & Bundle, 2006; Wilkie, 1960; Péronnet & Thibault, 1989)

Research Questions

- Are there differences in Mean Maximal Power Outputs during a competitive cycling season?
- Are there differences in power profile parameter estimates?

Design & Statistics

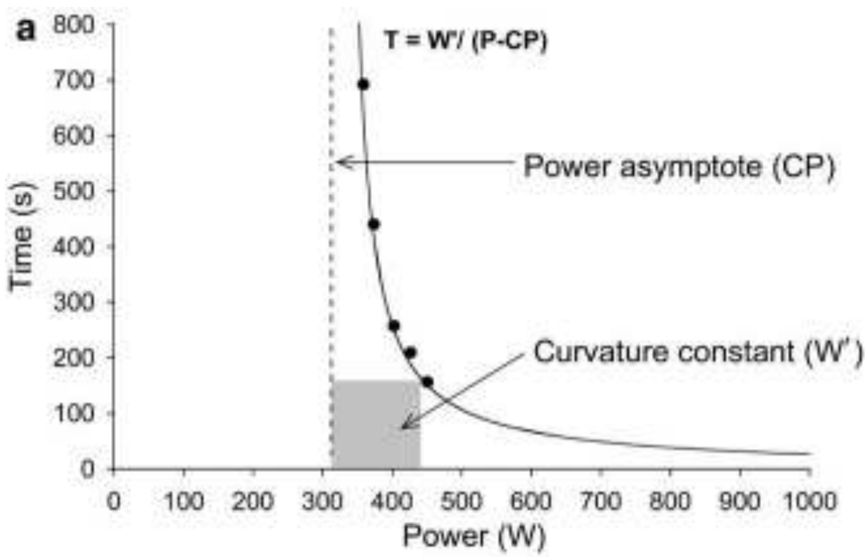
Study Design

- 13 male elite U23 cyclists (Tirol KTM Cycling Team, UCI Continental Team)
- Laboratory based testing ($\dot{V}O_{2max}$, Sprint Test)
- Three periods in 2018 season: “early season” Feb-Apr, “mid season” May-Jul, “late season” Aug-Oct
- 1s – 60-min mean maximal power (MMP) outputs
- Differences in power profile & MMP
- Training and racing data
- Retrospective analysis
- Same power meter system (Quarq) and manually calibrated (Wooles, A. L. et al., 2005).

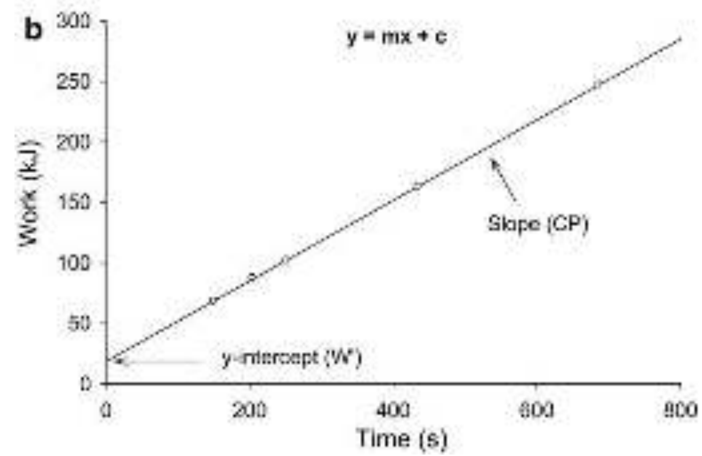
Data Analysis

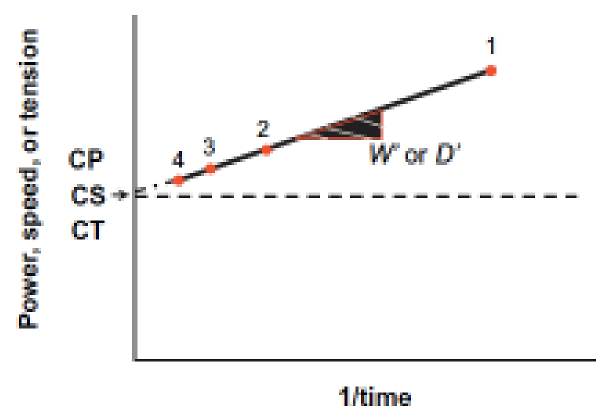
- Software WKO4, Golden Cheetah, Microsoft Excel, Graphpad Prism, SPSS Statistics, R Stats
- Power meter sampling rate 1Hz
- Mathematical modelling of power duration relationship (linear vs. hyperbole) (Burnley, M., & Jones, A. M., 2018; Jones, A. M., & Vanhatalo, A., 2017)
- Model parameters: aerobic component (critical power), anaerobic component (W'), time to exhaustion (TTE)
- Model validation: Standard Error, Coefficient of Variation, R^2 (only in linear parameter estimates)
- Statistical analysis with one-way repeated measure ANOVA & paired T-Test

Power Duration Models

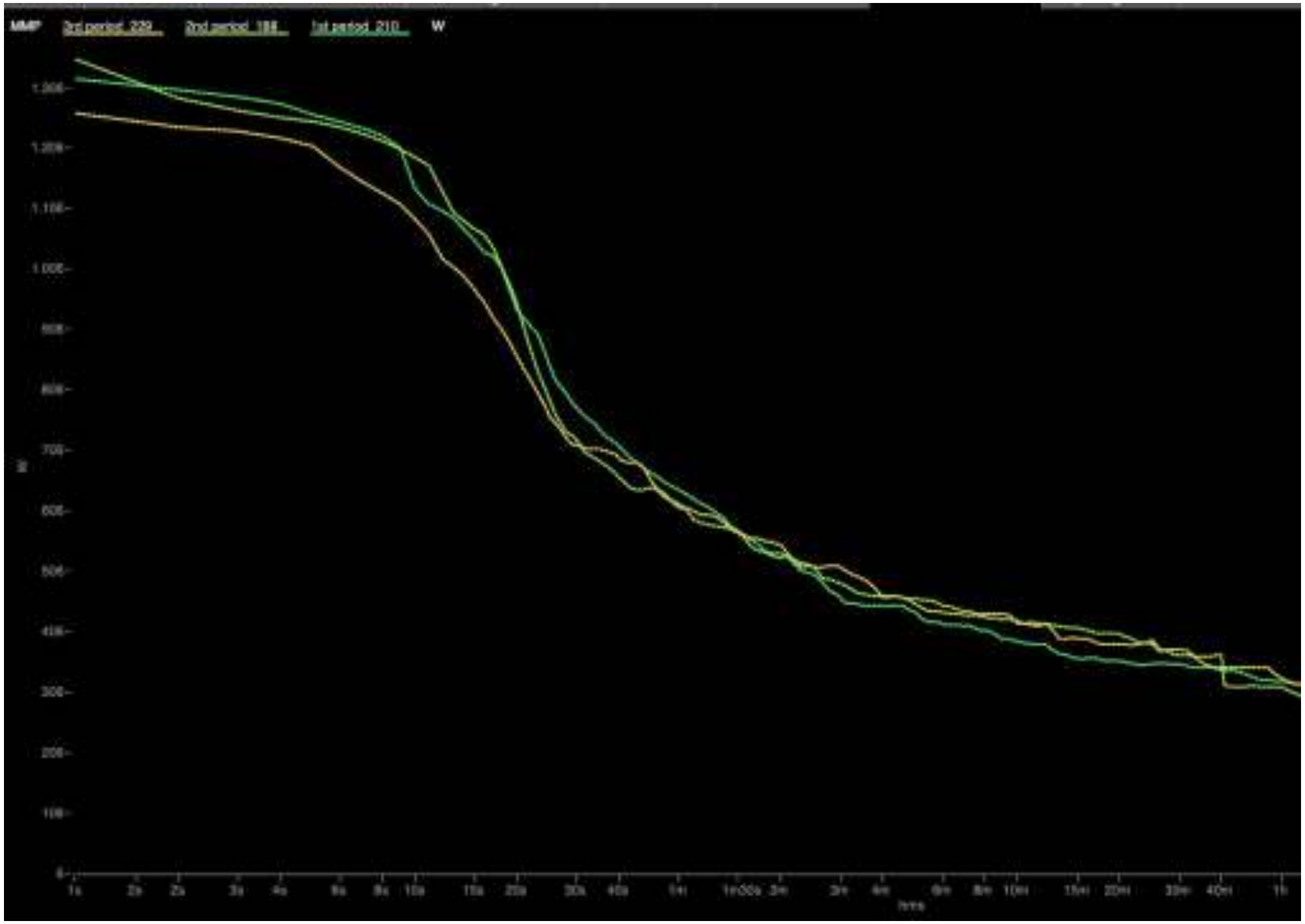


Jones, A. M., & Vanhatalo, A., 2017





Mean Maximal Power Output

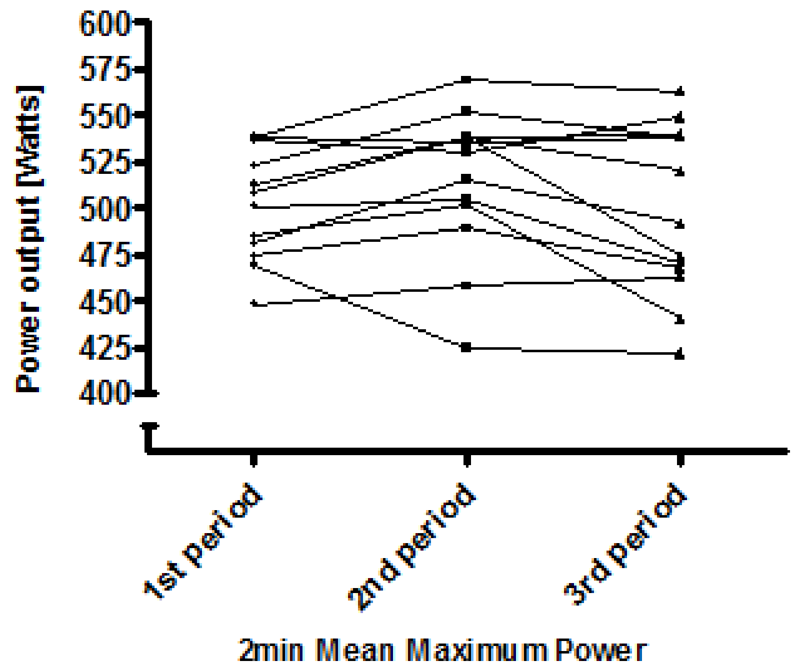


Results


UCI
2018 ROAD
WORLD CHAMPIONSHIPS
INNSBRUCK-TIROL
AUSTRIA
TISSOT
MAPEI
ŠKODA
SHIMANO
MET

2-min Mean Maximal Power (MMP)

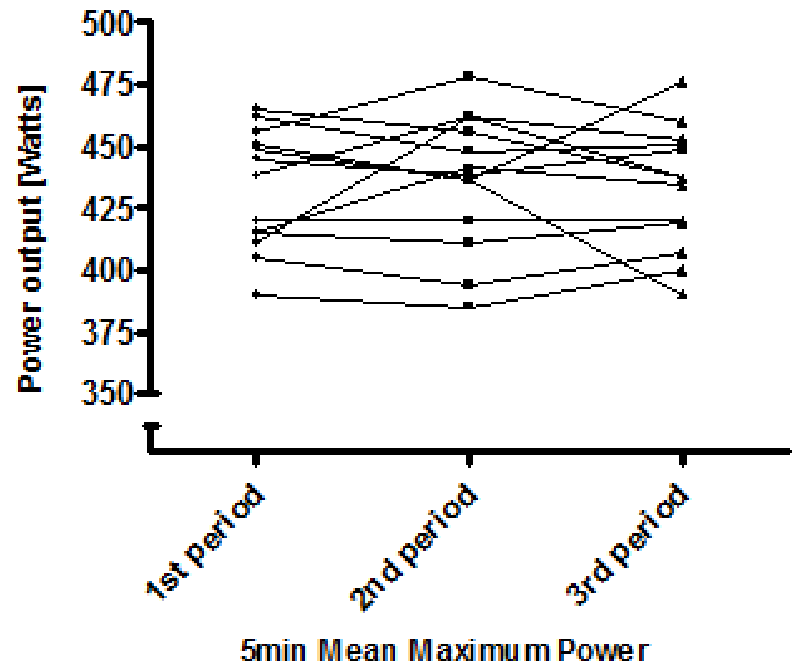
N = 13	Power (Mean ± SD, CV)
1st period (Feb-Apr)	502 ± 29, 5.78%
2nd period (May-Jul)	515 ± 40, 7.71%
3rd period (Aug-Oct)	498 ± 46, 9.16%



- No sign. differences in 2-min MMP (502 W vs. 515 W vs. 498 W)) $p > 0.05$

5-min Mean Maximal Power (MMP)

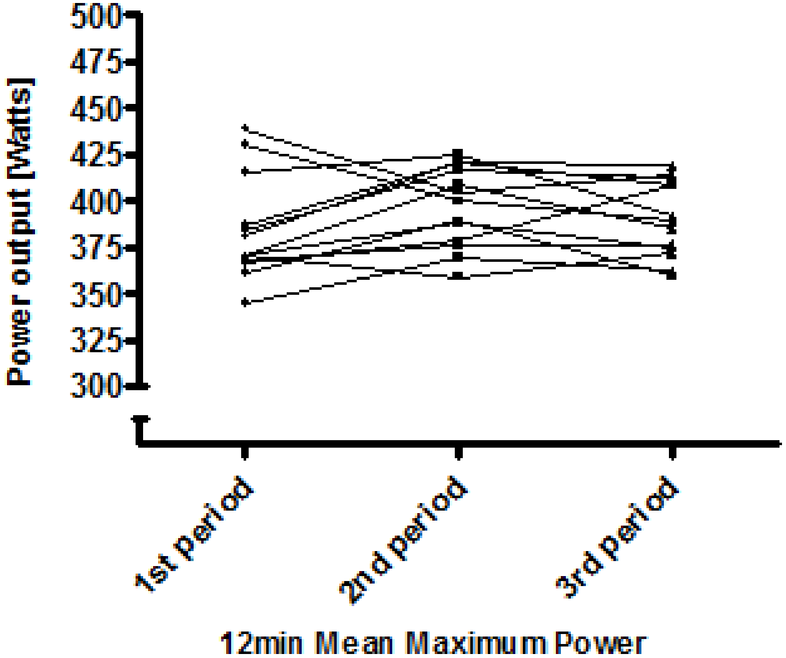
N = 13	Power (Mean ± SD, CV)
1st period (Feb-Apr)	432 ± 24, 5.61%
2nd period (May-Jul)	436 ± 27, 6.26%
3rd period (Aug-Oct)	433 ± 25, 5.80%



- No sign. differences in 5-min MMP (432 W vs. 435 W vs. 433 W) $p > 0.05$

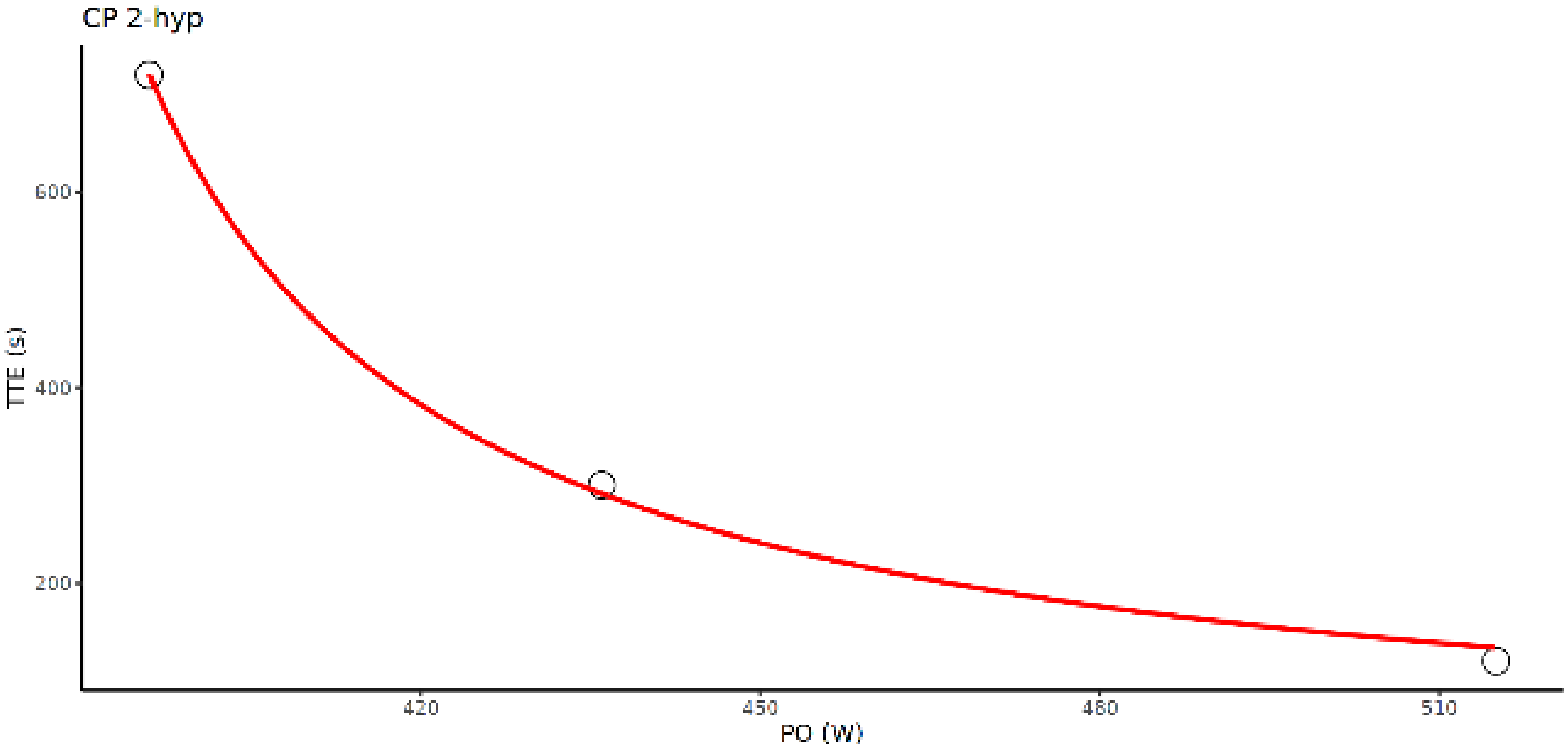
12-min Mean Maximal Power (MMP)

N = 13	Power (Mean ± SD, CV)
1st period (Feb-Apr)	384 ± 28, 7.26%
2nd period (May-Jul)	396 ± 22, 5.44%
3rd period (Aug-Oct)	390 ± 21, 5.27%



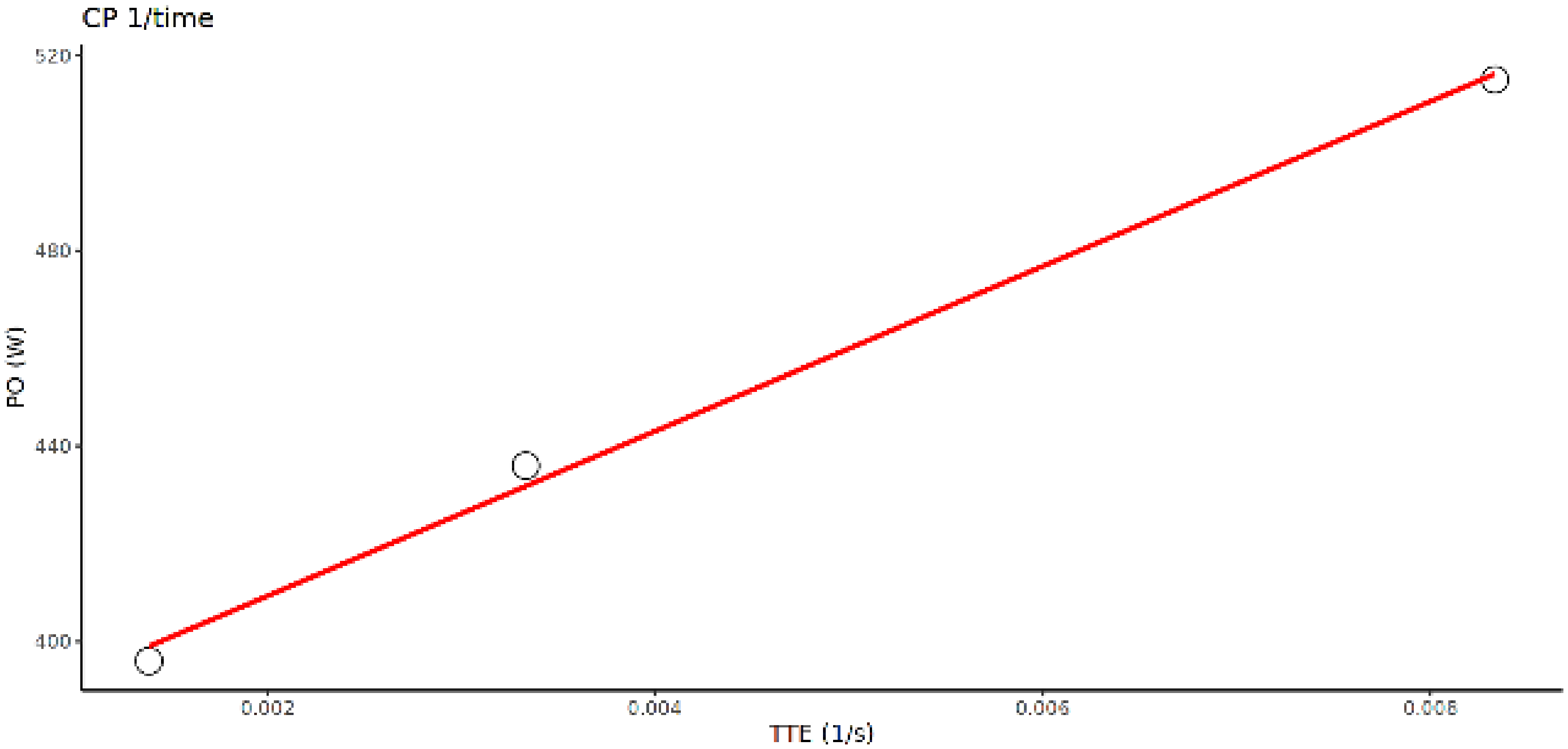
- No sign. differences 12-min MMP (384 W vs. 396 W vs. 390 W) p > 0.05

CP & W’ Concept Hyperbolic Model



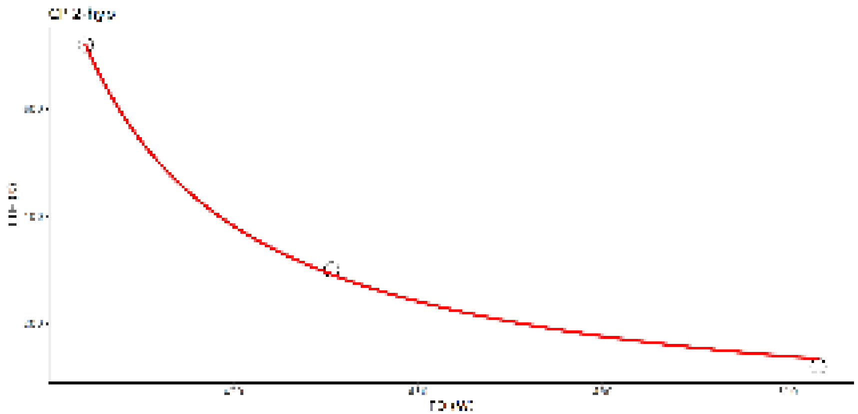
- CP: 368 W; SEE: 2.36 W; W’:19.55 kJ; W’ SEE: 1.5 kJ

CP & W’ Concept inverse linear model

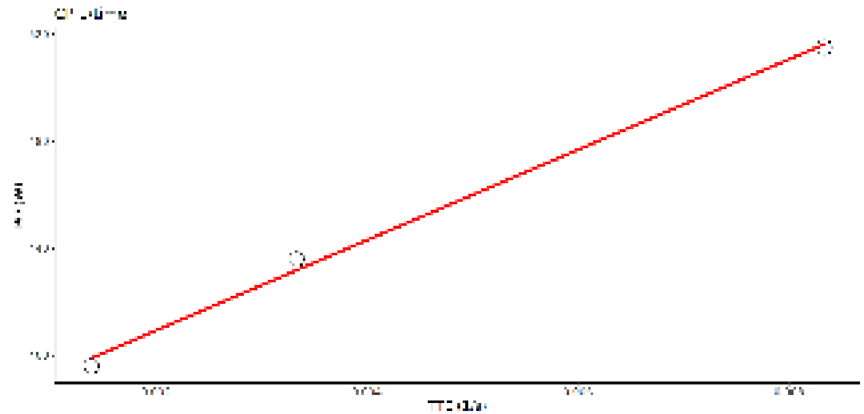


- CP: 376 W; SEE: 5.47 W; W’: 16.87 kJ; W’ SEE: 1.0 kJ

Critical Power hyperbolic vs. linear

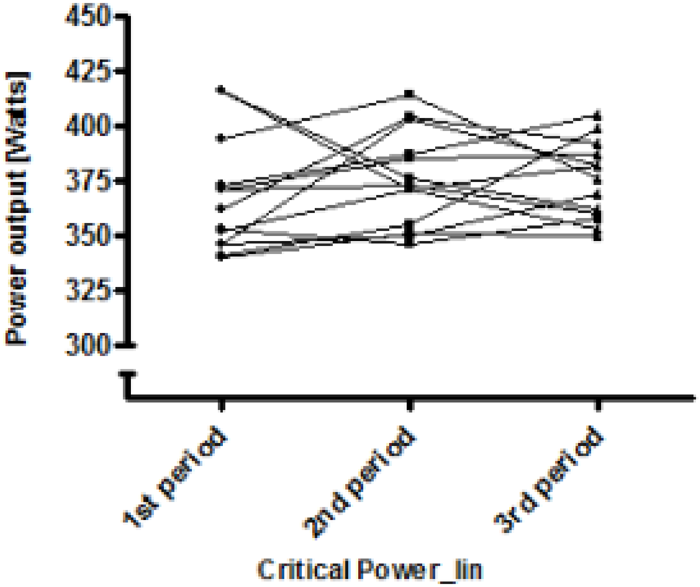


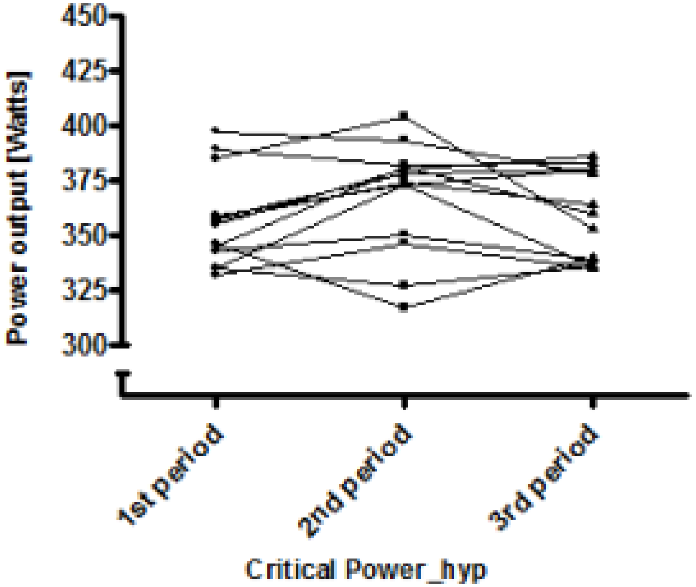
- CP: 368 W; SEE: 2.36 W; W’:19.55 kJ; W’ SEE: 1.5 kJ



- CP: 376 W; SEE: 5.47 W; W’: 16.87 kJ; W’ SEE: 1.0 kJ

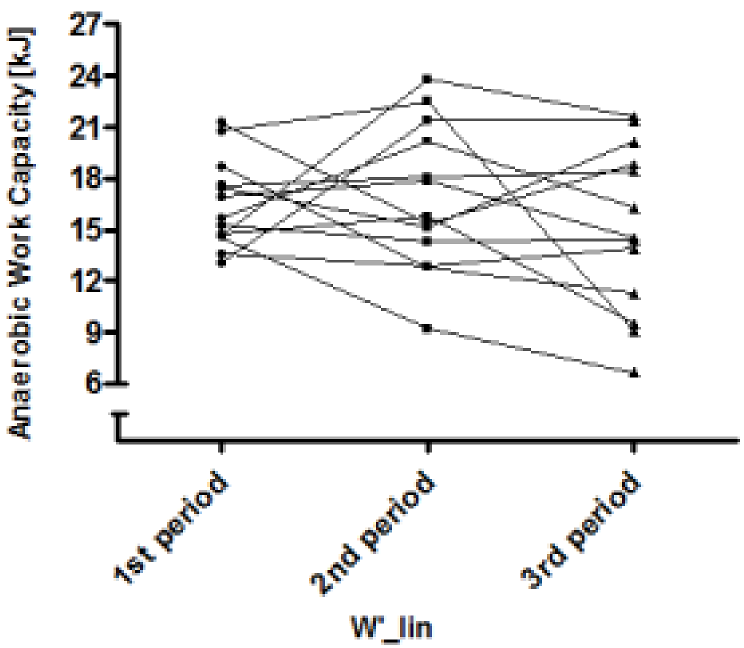
Power Duration Parameter Estimates: Critical Power

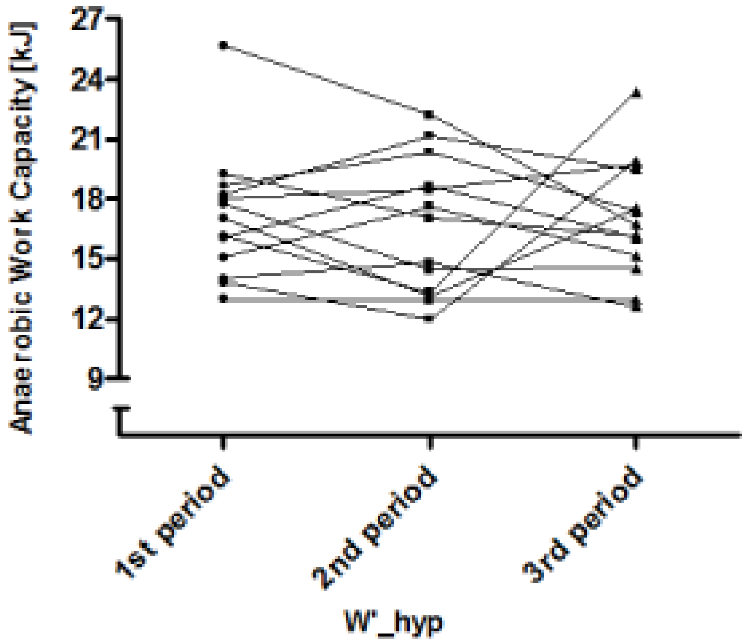




- No sign. differences in linear CP (368 W vs. 376 vs. 375 W) p > 0.05
- No sign. differences in hyperbolic CP (357 W vs. 367 W vs. 359 W) p > 0.05
- Sign. difference in linear vs. hyperbolic CP for first (p = 0.010) and third (p = 0.001) period

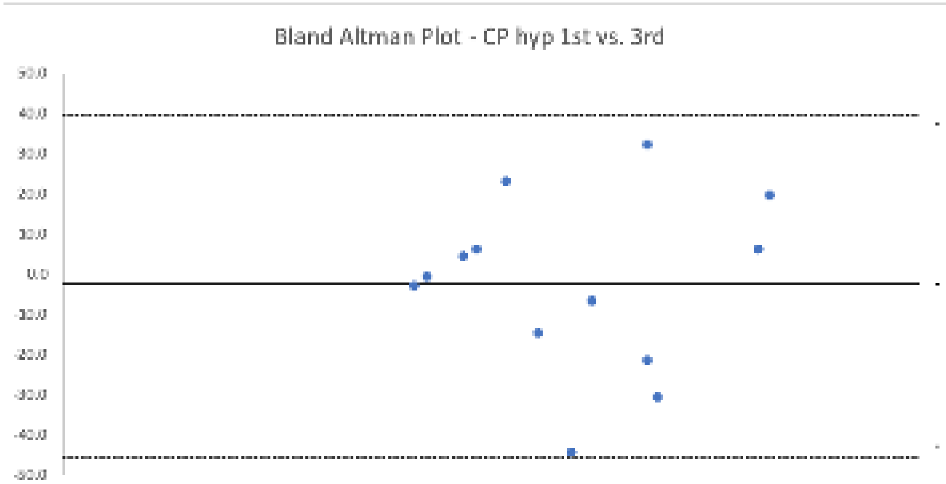
Power Duration Parameter Estimates: Anaerobic Work Capacity (W')

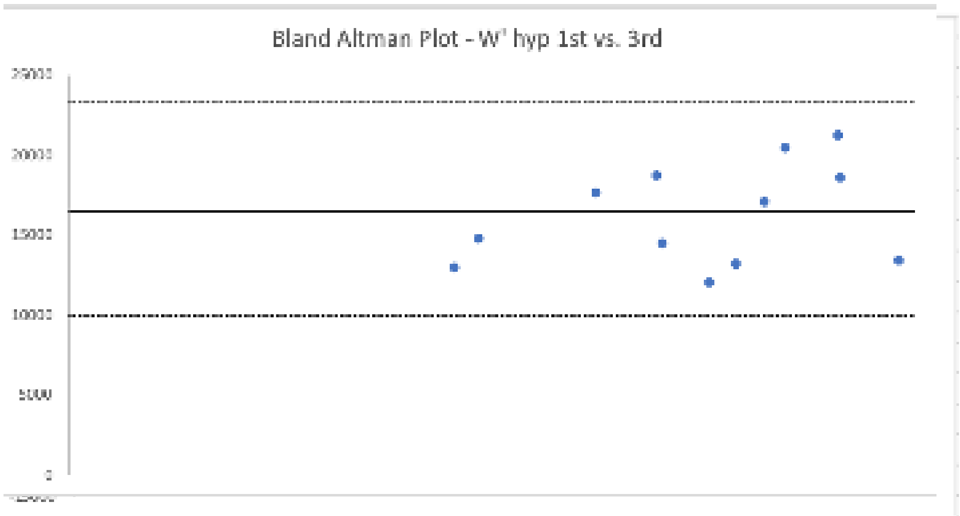




- No sign. differences in linear W' (16.4 kJ vs.16.8 kJ vs. 15.0 kJ) $p > 0.05$
- No sign. differences in hyperbolic W' (17.1 kJ vs. 16.6 kJ vs. 17.0 kJ) $p > 0.05$
- No sign. difference in linear vs. hyperbolic W' for all three periods $p > 0.05$

Reliability & Reproducibility





- Bland Altman Plot with 95% Limits of Agreement (LOA) $\pm$ 1.96 SD

Discussion & Practical Recommendations

Discussion

- Longitudinal reproducibility of mean maximal power outputs and power duration parameter estimates (Balmer, J., Davison, R. C. & Bird, S. R., 2000; Quod, M. J., Martin, D. T., Martin, J. C. & Laursen,P. B., 2010)
- Power profiling sensitive to detect training induced physiological adaptations (Balmer et al., 2000; Hawley et al., 1992; Hoogeveen et al., 1999)
- Predictive validity for performance modelling i.e. time trial events, uphill climbs (Smith et al., 2001; Quod et al., 2010)
- Power profiling as an alternative field approach to common laboratory based testing protocols (Wahl et al., 2016)
- Rider's profile assessment based on power profile (McGregor et al., 2012; Pinot et al. 2011)

Practical Recommendations

- ✓ Power profiling as an additional tool to traditional laboratory based testing
- ✓ Informal testing method
- ✓ Track psychobiological response parameters (lactate, perception of effort, heart rate)
- ✓ Mathematical model selection and verification (software)
- ✓ Standardization and validation with different field test approaches (CP & W’ concept)
- ✓ Ensure highest raw data quality (same power meter system)

Thank You

- Questions and inquiries
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