Journal of Science & Cycling
Breakthroughs in Cycling & Triathlon Sciences

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Conference Abstract

The Effect of Reducing Work Rate on Total Work Done, and Exercise Tolerance, During Severe Intensity Exercise

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Received: 5 March 2024 **Accepted:** 13 March 2024 **Published:** 10 August 2024

Keywords: Critical Power, W′, Cycling Performance, Exercise Tolerance.

1. Introduction

The hyperbolic relationship between power output and time to exhaustion during high-intensity exercise can be described by a power asymptote, critical power (CP), and curvature constant, W′. CP demarcates the heavy and severe intensity domains. W′ it is considered a fixed and finite amount of work that can be completed above CP which when depleted exhaustion will occur, or the work rate has to be reduced below CP (Fukuba et al. 2003; Morton 2006; Poole et al. 1988)

The assumption that W′ is a fixed parameter has been challenged. Although Fukuba et al. (2003) originally demonstrated that after initially depleting 50% of W′ during severe intensity exercise, subsequently increasing or decreasing the work rate, did not result in any changes to the total work done. In contrast, Dekerle et al. (2015) showed that when work rate was reduced (from 140% to 105% of CP), 20% more work above CP was done than predicted. This observation leads to the possibility that W′ may not be fixed which will have implications for predicting exercise tolerance during variable efforts (i.e., pacing), as well as the modelling of W′ depletion/reconstitution.

Therefore, the aim of this study is to (i) assess changes in total work done above CP when the work rate is reduced during severe intensity exercise (ii) assess if reducing the work rate just prior to exhaustion allows work to continue above CP.

2. Materials and Methods

Eleven healthy participants (8 males, 3 females; age: 21 [2] y, height; 1.80 [0.10] m, body mass; 68.2 [7.6] kg, $\dot{V}O_{2max}$; 56.1 [11.07] mL·min^{-1}·kg^{-1}, maximal aerobic power (MAP); 361 [76] W, CP; 253 [56] W, W′ 22.15 [7.57] kJ, mean [SD]) were recruited for this laboratory-based investigation. Participants attended the laboratory on seven separate occasions for the determination of $\dot{V}O_{2max}$, MAP, CP, W′ and three severe domain exercise trials involving stepwise reductions in work rate. All tests were performed on an electronically braked ergometer (Lode Excalibur Sport).

The first two trials consisted of exercising at a fixed work rate which would result in the depletion of 70% of W′ in 90 sec and 180 sec. At this point the work rate was reduced to CP + 20 W and the exercise continued until volitional exhaustion. The third trial consisted of exercising at a fixed work rate to achieve volitional exhaustion in 5 minutes (P_{5TTE}). At this point, when pedal cadence began to reduce (by approximately ~5 rpm which is a typical indication of exhaustion), the work rate was rapidly reduced by a work rate equal to 25% of the difference between CP and P_{5TTE}. This reduction in work rate was repeated a further two times (three work rate reductions in total) after which exercise continued until volition exhaustion. In each trial, the total work was predicted based on CP/W' ($PRED_{WORK}$) which was the same for

each condition. Total work above CP was measured during each trial ($WORK_{90s}$, $WORK_{180s}$, $WORK_{P5TTE}$).

A one-way repeated measures ANOVA were used to compare differences between predicted and total work during the three trials. Where a significant effect was observed, Bonferroni-corrected post hoc t-tests were used to locate differences. Statistical significance was accepted at $p<0.05$ and data are presented as mean [SD].

3. Results

In all three trials, more work done was completed than predicted. There were no differences in the amount of work done between the three trials.

Table 1. Predicted and measure work above CP in the three experimental trials.

Depletion Trial	$PRED_{WORK}$ (kJ)	Measured $_{WORK}$ (KJ)	Increase in work (kJ)	Increase in work (%)	*P-value*
$WORK_{90s}$	22.15 [7.57]	26.92 [7.84]	4.75 [1.44]	25%	<0.001
$WORK_{180s}$	22.15 [7.57]	27.64 [10.54]	5.49 [4.34]	22%	<0.01
$WORK_{P5TTE}$	22.15 [7.57]	24.90 [8.02]	2.75 [1.4]	12%	<0.001

P value is Measured vs. Predicted work

4. Discussion

W′ has more flexibility than originally conceptualised. Regardless of the initial work rate (~150% and 134% of CP), after 70% of *W′* has been depleted and work rate is reduced, approximately 25% ($WORK_{90s}$) and 22% ($WORK_{180s}$) more work can be performed than predicted from the CP model. It is also demonstrated that work above CP is possible (~12%) past predicted volitional exhaustion when reductions in work rate are implement as exhaustion is reached. We term this '*W′ Res*idual capacity' (W'_{RES}).

5. Conclusion

In conclusion, *W′* is not a fixed parameter of the power-duration relationship. If the work rate is reduced but still above CP, work can be continued for longer than predicted. It is also possible to continue performing work (above CP) even when theoretically depleted (i.e., *W′* reaches 0 kJ) provided the work rate continues to decline. W'_{RES}.

6. Implications for applied practitioners

These findings may have implications for pacing strategies, as it appears a positive pacing strategy leads to a greater amount of work above CP. This also may have implications for *W′*modeling as work can continue above CP with rapid drops which theoretically means W'_{BAL} can become negative.

Funding: This research received no external funding

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

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