

***Physiological responses to “all-out” and even-paced cycling intervals***

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**2012**

**This thesis is submitted as partial fulfilment of the requirements for the degree of  
Bachelor of Sports Science (Honours) at Murdoch University, Perth, Western  
Australia.**

**I declare that this thesis is my own account of my research and contains, as its main content, work which has not previously been submitted for a degree at any tertiary education institution.**

**(Miss Emma K. Zadow)**

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Thesis Title: Physiological responses to “all-out” and even-paced cycling intervals

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Year: 2013

## **ACKNOWLEDGEMENTS:**

The completion of this thesis has been both challenging, yet rewarding and could not have occurred without the invaluable support and guidance from a number of individuals:

To my supervisors, Dr Jeremiah Peiffer and Dr Chris Abbiss, I really could not have asked for better supervisors than yourselves. Your support, advice, encouragement, guidance and patience throughout this process have been second to none and I am extremely lucky to have benefited from your wisdom and your knowledge.

To Miss Nikky Gordon, thank you for being my partner in crime throughout this process and making me laugh throughout the many long hours spent inside the lab, here's too many more to come.

A study like this could not have occurred without all of the willing participants who selflessly volunteered their time to assist with this project, even with a 5am start, a 9 pm finish and weekend and public holiday sessions, thank you. It was a pleasure too work with you and you may be recalled at a future date...

Last but not least, to my family, the Zadow's, the Hand's, the Walker's and the Waghela's, thank you for all of your encouragement and support throughout this rollercoaster ride of a year. You have been there for me during the highs and the lows and I know you will continue to support any of my crazy future endeavours,  
**THANK YOU!!!**

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## ABSTRACT

**Background:** Endurance cyclists typically devote ~20% of their training regimens to performing low-volume high-intensity interval training which is associated with large physiological and performance benefits. The relationship between intensity and duration is important during high-intensity interval training as both can profoundly influence metabolic energy expenditure, fatigue development and subsequent adaptations. **Purpose:** Within the literature, most interval training is delivered using either an "all-out" or even-paced approach; however, to the author's knowledge no study has yet compared the metabolic stress, perceived exertion and fatigue resulting from such intervals. Therefore, this study compared the physiological and perceptual responses to matched mechanical work interval bouts using "all-out" and two different even-paced methodologies (i.e. computer- and athlete-controlled). **Methods:** In a randomised design, 15 male trained cyclists (age:  $39 \pm 8$  years, body mass:  $79.4 \pm 8.2$ kg,  $VO_{2max}$ :  $59.8 \pm 6.5$  ml·kg<sup>-1</sup>·min<sup>-1</sup>, peak power:  $436 \pm 27$  W) performed one incremental maximal exercise test, one familiarisation session and three experimental high-intensity interval sessions implementing one of three pacing strategies; (i) "all-out", (ii) computer-controlled and (iii) athlete-controlled. All experimental sessions were work- matched and consisted of three 3-minute intervals with three minutes of recovery. A 4 km time trial was completed twenty minutes following each experimental interval session to assess measured levels of latent fatigue. Oxygen consumption, heart rate and perceived exertion, pain and effort were recorded throughout the high-intensity interval sessions with average power output and heart rate measured throughout

the 4 km time trial. **Results:** Overall greater ( $p < 0.001$ ) oxygen consumption was observed in the “all-out” condition ( $54.1 \pm 6.6 \text{ ml.kg}^{-1}.\text{min}^{-1}$ ) compared with the computer- ( $51.5 \pm 5.7 \text{ ml.kg}^{-1}.\text{min}^{-1}$ ) and athlete-controlled conditions ( $53.0 \pm 5.8 \text{ ml.kg}^{-1}.\text{min}^{-1}$ ). Furthermore, the time spent at 85%  $\text{VO}_{2\text{max}}$  was greater ( $p < 0.001$ ) during the “all-out” trial when compared with computer- and athlete-controlled trials. Sessional perceived exertion was greater in the “all-out” trial when compared with the computer- ( $p < 0.001$ ) and athlete-controlled ( $p < 0.05$ ) conditions. Average power output measured during the 4 km time trial was lower ( $p < 0.001$ ) after the “all-out” session compared with both even-pacing strategies. **Conclusion:** Our findings indicate irrespective of work completed, greater physiological stress was observed within an “all-out” interval training approach when compared with both athlete- and computer- controlled conditions, resulting in greater latent fatigue as measured by 4 km time trial performance. The selections of pacing strategies are likely to play a key role in interval training and should be acknowledged throughout exercise prescription.

## DEFINITION OF TERMS

For consistency of interpretation the preceding words are defined:

**Active recovery:** Low-intensity exercise completed between interval repetitions.

**“All-Out”:** A maximal acceleration produced over a set period of time with a higher power output at the beginning of an exercise/interval session.

**Athlete-controlled:** Pacing selection internally controlled via the manipulation of gear ratio and cadence to achieve a nominated power output.

**Computer-Controlled:** Pacing selection with a fixed power output externally controlled for a predetermined period of time.

**High-Intensity interval training:** Physical exercise that is characterized by brief, intermittent bursts of vigorous activity, interspersed by periods of rest/low-intensity exercise.

**Interval training:** Repeated bouts of vigorous exercise interspersed with recovery periods.

## ABBREVIATIONS

Selected abbreviations used throughout the text

<b>ANOVA:</b> analysis of variance	<b>AC:</b> athlete-controlled
<b>AO:</b> “all-out”	<b>CC:</b> computer-controlled
<b>CT:</b> continuous training	<b>D:</b> day
<b>dw:</b> dry weight	<b>EVA:</b> exposure variation analysis
<b>HIT:</b> High-intensity interval training	<b>HR:</b> heart rate
<b>HR<sub>max</sub>:</b> maximum heart rate	<b>kJ:</b> kilojoule
<b>km:</b> kilometer	<b>m:</b> meter
<b>min:</b> minute	<b>mmol/L:</b> millimoles per litre
<b>PGC-1<math>\alpha</math>:</b> peroxisome-proliferator activated receptor $\gamma$ co-activator	<b>P<sub>max</sub>:</b> power associated with maximal aerobic capacity
<b>PPO:</b> peak power output	<b>PTS:</b> peak treadmill speed
<b>REP:</b> repetitions	<b>RPE:</b> rating of perceived exertion
<b>s:</b> second	<b>T<sub>max</sub>:</b> time associated with maximal aerobic capacity
<b>TT:</b> time trial	<b>VAS:</b> visual analogue scale
<b>Ve BTPS:</b> expired ventilation body temperature and pressure saturation	<b>VO<sub>2max</sub>:</b> maximal aerobic capacity
<b>VT<sub>1</sub>:</b> ventilatory threshold one	<b>VT<sub>2</sub>:</b> ventilatory threshold two
<b>W:</b> watt	<b>W:R:</b> work to rest ratio
<b>wk:</b> week	