Physiological and Performance characteristics of Elite Mountain Bike Cyclists

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A thesis submitted in partial fulfilment of the requirements for the degree of Masters of Applied Science in Sports Studies at the University of Canberra.

ABSTRACT

Cross-country (XC) mountain bike (MTB) riding is a new cycling discipline and research examining the physiological demands of MTB racing is limited. The purpose of this study was to comprehensively measure physiological characteristics, to identify the performance demands of XC and time trial (TT) MTB racing and to simulate a field MTB race in the laboratory to measure the physiological responses associated with racing.

Twelve male and four female elite MTB cyclists volunteered to take part in this study. Subjects completed maximal aerobic power and, anaerobic power and capacity tests. MTB race data was collected during TT and XC competitions with SRM MTB power cranks fitted to the subjects MTB. Five male MTB cyclists ($\dot{V}O_{2max}$ 72.0 ± 4.6 ml·kg·min^{-1}, maximum power output (MPO) 5.40 ± 0.30 W·kg^{-1}, maximum heart rate (HR_{max}) 189 ± 7 bpm) performed two laps of a MTB course in the field using their race bikes with MTB SRM power cranks fitted. A laboratory MTB race simulation was performed using a wind braked ergometer. Cyclists attempted to match the average and peak power output (W·kg^{-1}) achieved in the field trial in the laboratory. Power output (PO), heart rate (HR) and cadence (revolutions per minute, rpm) were measured during field and laboratory trials, while oxygen uptake ($\dot{V}O_2$) was determined only during the laboratory simulation.

Results showed TT MTB racing is significantly shorter in duration and distance than XC racing and significantly higher for power output and heart rate, with more time spent above anaerobic threshold (16.0 ± 2.4 and 22.8 ± 4.3% time) and MPO (38.4 ± 5.2 and 26.5 ± 9.4% time) than XC racing ($p<0.05$). Mean power output and heart rate between the field and laboratory trials were similar (4.18 ± 0.55 and 4.17 ± 0.15 W·kg^{-1} respectively, 175 ± 9 and 170 ± 8 bpm). Time spent below 2 W·kg^{-1} and above 6 W·kg^{-1} for the field and laboratory trials accounted for ~32% and ~30% of the total time, respectively. During field and laboratory trials, cyclists utilised 77.8 and 77.3% of MPO, 93 and 90% of HR_{max}, respectively. There was a significant difference between mean cadence in the field and laboratory trials (60.3 ± 9.1 and 75.2 ± 7.0 rpm, respectively, $p<0.05$). The cadence band of 60-69 rpm

showed a significant difference between the time spent in that band from the field (14.6%) to the laboratory (4.6%). The time spent above a cadence of 80 rpm in the field was 29.8% compared to the laboratory at 62.0% of the time. Mean and peak $\dot{V}O_2$ for the simulation was 57.5 ± 3.3 and 69.3 ± 4.4 $ml \cdot kg^{-1} \cdot min^{-1}$ respectively, with cyclists sustaining an average of ~80% $\dot{V}O_{2max}$.

In summary, MTB competition requires multiple short-high intensity efforts and places high demands on both the aerobic and anaerobic energy systems. The power output and heart rate responses to a MTB field race are similar when simulated in the laboratory, although in the laboratory higher cadences are selected for the higher power outputs than the field.

CERTIFICATE OF AUTHORSHIP OF THESIS

Except where clearly acknowledged in footnotes, quotations and the bibliography, I certify that I am the sole author of the thesis submitted today entitled –

Physiological and Performance characteristics of Elite Mountain Bike Cyclists

I further certify that to the best of my knowledge the thesis contains no material previously published or written by another person except where due reference is made in the text of the thesis.

The material in this thesis has not been the basis of an award of any other degree or diploma except where due reference is made in the text of the thesis.

The thesis complies with the University requirements for a thesis as set out in

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Date: ……

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DEDICATION

This Masters Thesis has been accomplished in the memory of Garry Payne, a mountain bike cyclist who tragically passed away during a training accident while cycling. Without Garry's influence on me this research project would not have been contemplated.

CONTENTS

PUBLICATIONS

- Physiological responses of well-trained cyclists to field and laboratory mountain bike race simulations. KL Linaker, DT Martin, E Lawton, B Rattray, AD Roberts. Med Sci Sports Exerc. 2003 Suppl 35 (5) pg S35 (Abstract).

  Presented at the American College of Sports Medicine Conference in San Francisco, USA in May 2003.

- Can the Power Output-Cadence relationship during MTB racing be replicated in the laboratory?

  Presented at the National Cycling Coaches Conference in Canberra, Australian Institute of Sport in December 2002.

- A comparison of the physiological demands of well-trained cyclists to field and laboratory mountain bike race simulations. KL Linaker, DT Martin, E Lawton, B Rattray, AD Roberts. J Sci Med Sport. 2002 Suppl 5 (4) pg 39 (Abstract).

  Presented at the Sports Medicine Australia Conference in Canberra, Australia in October 2002.

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ABBREVIATIONS

AIS	=	Australian Institute of Sport
Ave	=	Average
BLa	=	Blood lactate
bpm	=	Beats per minute
cm	=	Centimetres
d	=	Day
ES	=	Effect size
h	=	Hour
hPa	=	HectaPascals
HR	=	Heart rate
ITT	=	Individual Time Trial
kg	=	Kilograms
$km \cdot h^{-1}$	=	Kilometres per hour
$l \cdot min^{-1}$	=	Litres per minute
m	=	Metre
$ml \cdot kg^{-1} \cdot min^{-1}$	=	Millilitres per kilogram of body mass per minute
min	=	Minute
$mmol \cdot L^{-1}$	=	Millimoles per litre
MPO	=	Maximum power output
MTB	=	Mountain Bike
OBLA	=	Onset of blood lactate accumulation (4 $mmol \cdot L^{-1}$)
PO	=	Power Output
RPE	=	Rating of perceived exertion
rpm	=	Revolutions per minute
s	=	Second
SD	=	Standard deviation
TT	=	Time trial
$\dot{V}O_2$	=	Oxygen uptake

$\dot{V}O_{2max}$	=	Maximum oxygen consumption
W	=	Watt
$W \cdot kg^{-1}$	=	Watts per kilogram of body mass
UCI	=	Union Cycliste Internationale
^{o}C	=	Degrees Celsius