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**Competitive Mountain Bike and Road Cycling: Physiological  
Characteristics of Athletes and Demands of Competition**

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A thesis submitted in fulfilment of the Master of Applied Science degree at the  
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*“This is a real hard sport... nothing in the Tour de France compares to this. It was much harder than I expected. It’s only a two-hour race, but it was the hardest two hours of my life. I have a lot of respect for these guys”*

*Lance Armstrong, 1999*

## DEDICATION

This thesis is dedicated to my parents, the athletes and coaches with whom I have the pleasure to work and to all the people around the world who love the great outdoors.

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## ABSTRACT

Despite many studies describing the physiological characteristics of professional road cyclists and recent work describing the demands of competition, there is a paucity of similar information regarding elite mountain bike (MTB) cyclists. The aim of the present work was to describe the physiological characteristics and the demands of competition for successful MTB cyclists relative to successful road cyclists. Internationally competitive cyclists from both disciplines (seven MTB and seven road) completed the following laboratory tests: anthropometric measurements, an incremental cycle ergometer test and a 30 minute laboratory time trial. In addition, the power output profile obtained in the field from a world-class MTB cyclist riding a simulated race were compared to successful road cycling performances (placing top 3) in flat (FLAT), semi-mountainous (SEMO), high-mountainous (HIMO), individual time trial (ITT) and criterium (CRIT) road races. MTB cyclists were significantly lighter ( $65.3 \pm 6.5$  vs.  $74.7 \pm 3.8$  kg,  $P=0.01$ ) and leaner than the road cyclists (sum of 7 skinfolds:  $33.9 \pm 5.7$  vs.  $44.5 \pm 10.8$  mm,  $P=0.04$ ). The MTB cyclists produced higher power outputs relative to body mass at maximal exercise ( $6.3 \pm 0.5$  vs.  $5.8 \pm 0.3$  W·kg<sup>-1</sup>,  $P=0.03$ ), lactate threshold ( $5.2 \pm 0.6$  vs.  $4.7 \pm 0.3$  W·kg<sup>-1</sup>,  $P=0.048$ ) and during the 30 minute time trial ( $5.5 \pm 0.5$  vs.  $4.9 \pm 0.3$  W·kg<sup>-1</sup>,  $P=0.02$ ). Similarly,  $\dot{V}O_{2peak}$  relative to body mass was significantly higher in the MTB cyclists ( $78.3 \pm 4.4$  vs.  $73.0 \pm 3.4$  ml·kg<sup>-1</sup>·min<sup>-1</sup>,  $P=0.03$ ). During the MTB race, relatively more time (57%) was spent at lower cadences (<80 rpm) compared to any of the road races (3 to 33%). This was evident across a wide range of power outputs, but particularly at higher power outputs ( $\geq 7.5$  W·kg<sup>-1</sup>). Less time in absolute (26.0 vs. 62.2 to 69.5 min) and relative (19 vs. 28 to 37%) terms was spent at lower power outputs (0.75-3.74 W·kg<sup>-1</sup>) for MTB compared to the longer mass-start road races (FLAT, HIMO and SEMO). In addition, the MTB cyclist was unique for accumulating the greatest number of high intensity surges up to 7.50-8.24 W·kg<sup>-1</sup> power output range (MTB, 201 vs. SEMO, 155; HIMO, 126; FLAT, 100; CRIT, 36; ITT, 8). These results indicate that success in international MTB racing requires high power-to-weight characteristics complemented by a light and lean physique. MTB racing is associated with greater torque at the pedal crank, a more constant effort with less time at lower power outputs and a higher frequency of high-intensity surges than road racing. Therefore coaches should take into account these unique MTB racing characteristics when devising training programs for elite athletes.

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## ABREVIATIONS

AIS	Australian Institute of Sport
bpm	Beats per minute
C1	Cyclist 1
C2	Cyclist 2
C3	Cyclist 3
CK	Creatine kinase
CO <sub>2</sub>	Carbon dioxide
CRIT	Criterium road race stage
D-max <sub>mod</sub>	Modified D-max threshold
DS	Dual suspension
FLAT	Flat road race stage
FS	Front suspension
h	Hour
HIMO	High-mountainous road race stage
HR	Heart rate
ITT	Individual time trial road race stage
km	Kilometres
km·hr <sup>-1</sup>	Kilometers per hour
L·min <sup>-1</sup>	Litres per minute
La	Lactate
min	Minute
μL	Microlitres

$\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$	Millilitres per kilogram of body mass per minute
mmHg	Millimetres of mercury
$\text{mmol}\cdot\text{L}^{-1}$	Millimoles per litre
MTB	Mountain bike
$\text{O}_2$	Oxygen
OBLA	Onset of blood lactate accumulation
rpm	Revolutions per minute
s	Second
SEMO	Semi-mountainous road race stage
SRM	Schoberer Rad Messtechnik power output measuring device
UCI	International Cycling Union
$\dot{V}\text{E}$	Ventilation per minute
$\dot{V}_{\text{ESTPD}}$	Ventilation per minute at standard temperature, pressure and dry
$\dot{V}\text{O}_2$	Oxygen uptake per minute
$\dot{V}\text{O}_{2\text{max}}$	Maximal oxygen uptake per minute (reported by other authors)
$\dot{V}\text{O}_{2\text{peak}}$	Peak oxygen uptake (documented during a maximal test)
W	Watt
$\text{W}\cdot\text{kg}^{-1}$	Watts per kilogram of body mass
$\text{W}_{\text{max}}$	Maximal power output achieved in a cycle ergometer test