
Applied Physiology and Match Analysis of Professional Rugby League

A thesis submitted for the degree

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by

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CERTIFICATE OF AUTHORSHIP AND ORIGINALITY OF THESIS

I certify that the work contained in this thesis has not been previously submitted either in whole or in part for a degree at the University of Technology, Sydney or any other tertiary institution.

I also certify that the thesis has been written by me, Anita Claire Sirotic. Any help that I have received in my research work and in the preparation of this thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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23/03/08

Date Submitted

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PREFACE

This thesis for the degree of Doctor of Philosophy is in the format of published or submitted manuscripts and abides by the 'Procedures for Presentation and Submission of Theses for Higher Degrees – University of Technology, Sydney; Policies and Directions of the University'. All manuscripts included in this thesis are closely related in subject matter and subsequently form a cohesive research narrative.

During the course of this research, six manuscripts, for which the candidate is the first author, have been submitted for publication based on research developed and conducted by the PhD candidate. These papers are initially brought together by an *Introduction*, which provides background information, an explanation of the research problem and the aims of the series of studies. A *Literature Review* then follows to provide an overview of rugby league research. The methodology for individual projects is included within each of the subsequent six manuscripts. The manuscripts are presented and formatted for publication, in a logical sequence following the development of research ideas in this investigation. A final *Summary* chapter integrates the flow of research ideas and conclusions from each project and outlines avenues for future research directions and provides recommendations based on the major findings.

The manuscripts are formatted in the style of specific journals and therefore variations in formatting are apparent between the manuscripts. Figures, tables and reference numbering in all manuscripts have been retained. A joint authorship statement of the contribution made by each author precedes each manuscript.

LIST OF ARTICLES SUBMITTED FOR PUBLICATION

Journal Articles

1. **Sirotic, A.C.** and A.J. Coutts. The intra-rater reliability of using a computer-based tracking for time–motion analysis. Submitted to *International Journal of Sports Physiology and Performance*.
2. **Sirotic, A.C.**, A.J. Coutts, H. Knowles and C. Catterick. A comparison of match demands between elite and semi-elite rugby league competition. *Journal of Sports Sciences*, in press.
3. **Sirotic, A.C.**, A.J. Coutts, H. Knowles and C. Catterick. The effects of pre-season training on aerobic fitness and sprint performance in elite rugby league forwards. Submitted to *International Journal of Sports Physiology and Performance*.
4. **Sirotic, A.C.**, A.J. Coutts, H. Knowles and C. Catterick. Positional match demands of elite rugby league competition. Submitted to *Journal of Sports Sciences*.
5. **Sirotic, A.C.** and A.J. Coutts. (2007). The reliability of physiological and performance measures during simulated team-sport running on a non-motorised treadmill. *Journal of Science and Medicine in Sport*, doi:10.1016/j.jsams.2007.1004.1008.
6. Dascombe, B.J., P.R.J Reaburn, **A.C. Sirotic** and A.J. Coutts. (2007). The reliability of the i-STAT clinical portable analyser. *Journal of Science and Medicine in Sport*, 10(3), 135–140.

Book Chapters

1. **Sirotic, A.C.** and A.J. Coutts. (2008). The reliability of a repeated sprint ability test during simulated team-sport running on a non-motorised treadmill. In T. Reilly, F. Korkusuz & E. Ergen (Eds), *Science and Football VI* (pp. 1–4). London, UK: Routledge.
2. Coutts, A.J., **A.C. Sirotic**, C. Catterick and H. Knowles. (2008). Monitoring training loads in professional rugby league. In T. Reilly, F. Korkusuz & E. Ergen (Eds), *Science and Football VI* (pp. 1–6) London, UK: Routledge.

Abstracts

1. **Sirotic, A.C.**, A.J. Coutts, H. Knowles and C. Catterick. (2008). Physical and technical match demands of elite rugby league positions. Paper presented at the *Proceedings of the 3rd Australian Association for Exercise and Sports Science Conference: From research to Practice III*, Fitzroy, Melbourne.
2. **Sirotic, A.C.** and A.J. Coutts. (2007). Reliability of a repeated sprint ability test during simulated team-sport running activity on a non-motorised treadmill. *Journal of Science and Medicine in Sport*, 6(Supplementum 10) (113–114).
3. **Sirotic, A.C.**, A.J. Coutts, B.J. Dascombe, H. Knowles and C. Catterick. (2006). The effects of 5 weeks of pre-season training on aerobic fitness and simulated rugby league running performance of professional rugby league forwards. Paper presented at the *Proceedings of the 2nd Australian Association for Exercise and Sports Science Conference: From Research to Practice II*, University of New South Wales, Sydney, Australia.
4. **Sirotic, A.C.**, N. Russell and A.J. Coutts. (2005). The reliability of a team sport-specific running protocol on a non-motorised treadmill. *Journal of Science and Medicine in Sport*, 8(4), s63.
5. **Sirotic, A.C.**, N. Russell, H. Knowles and A.J. Coutts. (2005). Time–motion analysis of elite and semi-elite rugby league. *Journal of Science and Medicine in Sport*, 8(4), s67.
6. **Sirotic, A.C.**, K.M. Slattery, L.K. Wallace, A. Murphy and A.J. Coutts. (2004). Physiological and performance test predictors of prolonged, high-intensity, intermittent running performance. Paper presented at the *Australian Association of Exercise and Sports Science Inaugural Conference*, Brisbane, Australia.
7. Coutts, A.J. and **A.C. Sirotic**. (2007). Monitoring training loads in top-level professional rugby league. *Journal of Sports Science and Medicine*, 6(Supplementum 10), 75.
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9. Coutts, A.J., **A.C. Sirotic** and H. Knowles. (2006). Changes in match-specific sprinting performance in relation to training loads in elite rugby league players. Paper presented at the *11th Annual Congress of the European College of Sport Science*, Lausanne, Switzerland.
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12. Coutts, A.J., N. Russell and **A.C. Sirotic**. (2005). A comparison of different recovery practices during the half-time of a simulated team sport match on subsequent repeated sprint ability. *Journal of Science and Medicine in Sport*, 8(4), s223.
13. Coutts, A.J., K.M. Slattery, L.K. Wallace and **A.C. Sirotic**. (2007). Influence of between-match training load on match running performance and markers of recovery in team sport athletes. *Journal of Science and Medicine in Sport*, 6(Supplementum 10), 23.

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ABSTRACT

There is a limited amount of research on the match and training demands of rugby league players, particularly at the professional level. As a consequence, many of the testing procedures and training practices for professional players may not be specific to their competition demands. Therefore, the overall aim of this thesis was to gain a greater understanding of the current match demands and physical training regimes of professional rugby league. An additional aim was to develop a match-specific running test and to examine the efficacy of current training programs in professional rugby league. To achieve this, three separate studies were undertaken. Study 1 determined the reliability of a method for measuring time-motion analysis and examined the match demands of professional rugby league competition with regard to playing level and positional roles. In Study 2, a new team-sport running test was developed and the reliability of the physiological responses and physical performance to this test was determined. Study 3 examined the effects of five weeks of general preparation pre-season training on aerobic fitness and match-related sprint performance in elite rugby league forwards. The results show that differences do exist in relation to the physical and game-specific skill match demands, both between levels of competition and positional roles and that pre-season training is effective in increasing aerobic fitness and match-related sprint performance in professional rugby league forwards. Therefore, the differences identified between playing levels and positional roles within this thesis should be used when designing training programs for professional rugby league players. Additionally, it also appears that the specific rugby league testing protocol developed in this thesis can be reliably used to determine the effects of intervention on the match-related performance of professional rugby league players. Overall, this thesis entails valuable information and practical implications for sports scientists, coaches, conditioning specialists, talent scouts and other practitioners involved in the process of optimising performance in professional rugby league players.

KEYWORDS

Rugby league

Reproducibility

Intra-rater reliability

Time-motion analysis

Positional groups

Level of competition

Physical movement patterns

Game-specific skill involvement

Repeated-sprint ability

High-intensity activity

Team-sport match simulation

Aerobic fitness

Pre-season training

LIST OF ABBREVIATIONS

1RM	one repetition maximum
3RM	three repetition maximum
AFL	Australian Football League
ANOVA	Analysis of Variance
ATP	adenosine triphosphate
AU	arbitrary units
[BLa⁻]	blood lactate concentration
[BLa⁻]_{peak}	peak blood lactate concentration
beats·min⁻¹	beats per minute
CBT	computer-based tracking
CI	confidence interval
cm	centimetre
CV	coefficient of variation
d	Cohen's d effect size
DALDA	Daily Analysis of Life Demands for Athletes
g	grams
GPS	global positioning system
h	hour
HIA	high-intensity activity
HIR	high-intensity running
HR	heart rate
HR_{max}	maximal heart rate
HR-$\dot{V}O_2$	heart rate-oxygen uptake
Hz	hertz
ICC	Intraclass correlation coefficient
ISAK	International Society for the Advancement of Kinanthropometry
J·kg⁻¹	joules per kilogram
kJ	kilojoule

kg	kilogram
km	kilometre
km·h⁻¹	kilometres per hour
L	litre
L·min⁻¹	litres per minute
LIR	low-intensity running
m	metre
min	minute
MJ	megajoules
mL·kg^{-0.75}·min⁻¹	millilitres per kilogram of scaled muscle mass per minute
mL·kg⁻¹·min⁻¹	millilitres per kilogram per minute
m·min⁻¹	metres per minute
mmol·L⁻¹	millimoles per litre
m·s⁻¹	metres per second
mMP	mean maximal power
ms	millisecond
mMSS	mean maximal sprinting speed
MSFT	multistage fitness test
MSS	maximal sprinting speed
n	number
N	Newton
n·min⁻¹	number per minute
NMT	non-motorised treadmill
NRL	National Rugby League
NSWPL	New South Wales Premier League
PCr	phosphocreatine
PSSA	peak sprinting speed assessment
RER	respiratory exchange ratio
RL	rugby league
RPE	rating of perceived exertion
RSA	repeated-sprint ability

s	seconds
SD	standard deviation
TD	total distance
TE	typical error
TEM	technical error of measure
TEM%	percentage technical error of measure
TL	training load
TMA	time–motion analysis
TW	total work
VBT	video-based tracking
VE	ventilation
VHIR	very high-intensity running
V_{\max}	peak aerobic running velocity
$\dot{V}CO_2$	carbon dioxide expired
$\dot{V}O_2$	oxygen uptake
$\dot{V}O_{2\max}$	maximal oxygen uptake
VT	ventilatory threshold
VT₁	first ventilatory threshold
VT₂	second ventilatory threshold
W	watt
$W \cdot kg^{-1}$	watts per kilogram
y	year
Yo-Yo IR1	Yo-Yo Intermittent Recovery Test level one
μL	microlitre
%	percentage
%BM	percentage of body mass
°	degrees
~	approximation