Competition day preparation strategies to enhance performance in swimmers

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Dedication

This thesis is dedicated to Forbes and Ursula Carlile - pioneers of applied swimming research.
Thesis Contents

Dedication .......................................................................................................................... iii
Certificate of Authorship of Thesis ................................................................................... v
Thesis Contents ................................................................................................................... vii
Publications ......................................................................................................................... xi
  International Journals .................................................................................................... xi
  National and International Conferences ........................................................................ xi
  Awards ............................................................................................................................... xii
Figures ................................................................................................................................. xiii
Tables ................................................................................................................................... xvi
Acknowledgements ............................................................................................................ xvii
Abstract ............................................................................................................................... xxi
List of Abbreviations ......................................................................................................... xxv

CHAPTER 1: Introduction .................................................................................................. 1
  1.1 Thesis Aims and Research Questions ................................................................. 4
  1.2 Research Objectives .............................................................................................. 5

DECLARATION OF CO-AUTHORED PUBLICATION CHAPTER 2 ..................................... 7

CHAPTER 2: Literature Review - Warm-Up Strategies for Sport and Exercise: Mechanisms
and Applications ................................................................................................................. 9
  2.1 Abstract ....................................................................................................................... 9
    2.1.1 Key Points ............................................................................................................ 10
  2.2 Introduction ............................................................................................................... 10
    2.2.1 Mechanisms of Warm-Up ............................................................................. 11
  2.3 Temperature Mechanisms ..................................................................................... 11
    2.3.1 Increased Muscle Metabolism ...................................................................... 12
    2.3.2 Increased Muscle Fibre Performance ............................................................. 12
    2.3.3 Increased Muscle Fibre Conduction Velocity ................................................ 13
    2.3.4 Temperature Mechanisms Summary ............................................................. 14
  2.4 Metabolic Mechanisms ......................................................................................... 14
    2.4.1 Elevation of Oxygen Uptake Kinetics ............................................................ 14
  2.5 Neural Mechanisms ............................................................................................... 16
    2.5.1 Postactivation Potentiation ........................................................................... 16
  2.6 Psychological Mechanisms .................................................................................... 18
  2.7 Passive Warm-Up Strategies and Exercise Performance ..................................... 19
2.7.1 Hot Showers, Baths, Heated Garments and Blizzard Survival Jackets ........................................ 19
2.8 Active Warm-Up Strategies and Exercise Performance .............................................................. 21
  2.8.1 Running .................................................................................................................................. 22
  2.8.2 Cycling ................................................................................................................................. 25
  2.8.3 Swimming ............................................................................................................................ 28
  2.8.4 Football, Rugby and Repeat-Sprint Performance ................................................................. 32
2.9 Future Directions ....................................................................................................................... 37
  2.9.1 Conclusions ......................................................................................................................... 38
CHAPTER 3: Literature Review Update .............................................................................................. 39
  3.1 Swimming-Specific Warm-Up Strategies ................................................................................. 39
  3.2 Passive Heat Maintenance Strategies ..................................................................................... 45
  3.3 Ballistic-Style PAP-inducing Exercises ................................................................................ 46
  3.4 Same-Day Priming Exercise Bouts ......................................................................................... 48
  3.5 Summary and comparative analysis of dryland-based sports and swimming ........................ 54
DECLARATION OF CO-AUTHORED PUBLICATION CHAPTER 4 ................................................. 57
CHAPTER 4: Current warm-up practices and contemporary issues faced by elite swimming
coaches ................................................................................................................................................. 59
  4.1 Manuscript Information ............................................................................................................ 59
    4.1.1 Research Objectives ........................................................................................................... 59
  4.2 Accepted Manuscript ................................................................................................................ 60
    4.2.1 ABSTRACT ......................................................................................................................... 60
    4.2.2 INTRODUCTION ............................................................................................................... 60
    4.2.3 METHODS ....................................................................................................................... 62
    4.2.4 RESULTS ......................................................................................................................... 64
    4.2.5 DISCUSSION .................................................................................................................. 69
    4.2.6 CONCLUSIONS ............................................................................................................... 74
    4.2.7 PRACTICAL APPLICATIONS ......................................................................................... 74
DECLARATION OF CO-AUTHORED PUBLICATION CHAPTER 5 ................................................. 77
CHAPTER 5: Heated jackets and dryland-based activation exercises used as additional
warm-ups during transition enhance sprint swimming performance ............................................ 79
  5.1 Manuscript Information ............................................................................................................ 79
    5.1.1 Research Objectives ........................................................................................................... 80
  5.2 Accepted Manuscript ................................................................................................................ 81
    5.2.1 ABSTRACT ....................................................................................................................... 81
    5.2.2 INTRODUCTION ............................................................................................................... 81
    5.2.3 METHODS ....................................................................................................................... 83
CHAPTER 9: Discussion, practical outcomes, future directions, limitations and conclusions

9.1 DISCUSSION

9.1.1 Current warm-up practices utilised by elite swimming coaches

9.1.2 Challenges faced by elite coaches and their swimmers during the final race preparation phase

9.1.3 Additional warm-up strategies – Passive heat maintenance

9.1.4 Additional warm-up strategies – Dryland-based exercises

9.1.5 Additional warm-up strategies – Combination, passive heat maintenance and dryland-based exercises

9.1.6 Same day priming exercise bouts

9.2 PRACTICAL OUTCOMES

9.3 LIMITATIONS

9.4 FUTURE DIRECTIONS

9.4 CONCLUSIONS

APPENDIX

Summary of the performance, physiological and biomechanical changes following passive and active warm-up completion in swimming

Study 1 Swimming Coach Warm-Up Questionnaire

Study 2 Athlete Questionnaires

Study 3 and 4 Thermal Comfort and Thermal Sensation Scales

Study 3 and 4 Athlete Questionnaires

Study 5 Perception Scale

Published Manuscripts

REFERENCES
Publications

The work in this thesis has been presented at scientific meetings and/or published in peer reviewed journals as listed below:

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• McGowan CJ, Pyne DB, Raglin JS, Thompson KG & Rattray B. Current warm-up practices and the contemporary issues faced by elite swimming coaches. *Be Active - Australian Conference of Science and Medicine in Sport*, 15-18th October 2014, Canberra, Australia.


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• 2015 Recipient of the Sports Medicine Australia (ACT Branch) Best Young Investigator Award

• 2015 University of Canberra Department of Sport and Exercise Science Higher Degree Research Student of the Year

• 2014 Runner-Up University of Canberra Three Minute Thesis Competition
Figures

Fig. 1 One hundred meter freestyle time-trial times for the three additional warm-up intervention conditions (Passive, Dryland, Combo). Times were normalised against the Control condition (no additional warm-up). A) Overall 100 m freestyle time-trial times. B) Time to 15 m (start time).

Fig. 2 Change in core temperature ($T_{core}$) during the 30 min transition phase, from post-pool warm-up to pre 100 m freestyle time-trial, for each additional warm-up intervention (Passive, Dryland, Combo) and for Control (no additional warm-up).

Fig. 3 100 m time-trial performance times for the Control and Combo conditions. A) Overall 100 m time-trial times. B) Time to 15 m (start time).

Fig. 4 Change in core temperature ($T_{core}$) and skin temperature ($T_{skin}$) during the 30 min transition phase, from post-pool warm-up to pre 100 m time-trial, for the Control and Combo conditions.

Fig. 5 Fluctuation in core ($T_{core}$) and skin ($T_{skin}$) temperature from pre-pool warm-up (baseline) to 4 min post 100 m time-trial, for the Control and Combo conditions. A) Core temperature. B) Skin temperature.

Fig. 6 Schematic of testing session design.

Fig. 7 25 m split times recorded throughout the 100 m time-trial.

Fig. 8 Changes in core (A) and skin (B) temperature from morning baseline to pre 100 m time-trial, for the NoEx, SwimOnly and SwimDry conditions.

Fig. 9 Summary of thesis findings.

Fig. 10 Recommendations for competition day preparation strategies to enhance sprint (100 m) swimming performance. Concepts which have been demonstrated to improve performance in this thesis are presented in solid boxes. Concepts proposed for further investigation are presented in dashed boxes.
Tables

Table 1. Performance, physiological and biomechanical changes following active warm-up in running.................................................................23

Table 2. Performance, physiological and biomechanical changes following active warm-up in cycling.................................................................26

Table 3. Performance, physiological and biomechanical changes following active warm-up in swimming.................................................................30

Table 4. Performance, physiological and biomechanical changes following active warm-up in football, rugby and upon repeat-sprint performance.................................................................33

Table 5. Performance, physiological and biomechanical changes following active half-time re-warm-up in football, rugby and upon repeat-sprint performance.................................................................35

Table 6. Summary of research focusing on swimming warm-up, passive heat maintenance strategies and ballistic priming exercises published between May 2014 to December 2015...........................40

Table 7. Summary of studies investigating the influence of same-day priming bout completion on subsequent later day exercise performance across all sports.........................................................49

Table 8. Descriptive characteristics of the surveyed swimming coaches. ........................................65

Table 9. Main objectives of the warm-up identified by the swimming coaches........................................65

Table 10. Overview of the typical pool warm-ups prescribed by coaches for the 100, 200, and 400 m distances in terms of total distance (m), examples of specific efforts completed (including use of additional devices), type of effort (continuous: nonstop swimming for ≥50 m; build: efforts completed with the intensity increasing; and sprint: efforts completed at >90% PME). ............................................................................................................................66

Table 11. Dryland-based warm-up exercises prescribed by the swimming coaches.................67

Table 12. Issues faced by the coaches during the final competition preparation phase..........68

Table 13. Situations in which coaches request their swimmers to practice their pre-competition pool warm-up.................................................................................................................................69

Table 14. Lactate (La¯), heart rate (HR) and skin temperature (Tskin) values recorded immediately post pool warm-up and pre time-trial with calculated values sampled at 1 and 4 minutes post time-trial (peak post time-trial) presented. .................................................................................................................................88

Table 15. Standardised pool warm-up completed prior to 100 m freestyle time trial........98

Table 16. Heart rate (HR), lactate (La¯) and upper and lower body surface temperature (as determined using a thermal imaging camera) values recorded immediately post pool warm-up.................................................................
and pre time-trial with calculated values sampled at one and four min post time-trial (peak post time-trial) presented. ................................................................. 103

**Table 17.** Standardised pool warm-up............................................................................. 113

**Table 18.** Heart rate (HR), lactate ($La^-)$ and upper and lower body surface temperature (as determined using a thermal imaging camera) values recorded immediately post pool warm-up and pre time-trial with calculated values sampled at 1 and 4 minutes post time-trial (peak post time-trial) presented. .................................................................................. 116

**Table 19.** Standardised pool warm-up used for morning swimming session and prior to afternoon 100 m time trial.................................................................................. 125

**Table 20.** Performance, physiological and biomechanical changes following passive and active warm-up completion in swimming.............................................................................. 159
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Abstract

In the lead up to major competitions, swimming coaches and sport scientists spend many hours ensuring their athlete’s training and recovery strategies are appropriate to elicit optimal performance. However, on competition day itself there are additional opportunities in which event performance might be improved by utilising various preconditioning strategies, the most common being the pre-competition warm-up. Both passive and active warm-ups can enhance swimming performance, though the competition warm-up practices of elite swimming coaches are presently unknown or have been poorly documented. In addition, competitive swimmers typically experience a delay between the pool warm-up and race start (transition phase). Transition phases of > 20 min are not uncommon which is problematic given that muscle temperature declines immediately following exercise, with appreciable reductions occurring after ~15-20 min. Additional warm-up strategies within the transition phase may therefore be required to optimise performance. Recent research has also demonstrated that completion of an exercise bout several hours prior to a competitive event may provide a priming effect to improve performance later that same day. The studies contained within this thesis aimed to investigate how altering the content of these two preconditioning strategies would affect subsequent sprint swimming performance.

Study 1: An initial survey was conducted to determine the current pre-competition warm-up practices and contemporary issues faced by elite swimming coaches (n = 46) during competition. The combination of dryland-based activation exercises followed by pool-based warm-up routines appears to be the preferred approach taken by elite swimming coaches when preparing their athletes for racing. Elite swimming coaches believe the pool warm-up affords athletes the opportunity to gain a tactile “feel” for the water and surrounding pool environment. Coaches stated that transition phases were unnecessarily lengthened due to extended marshalling periods (> 15-20 min), delays in the competition schedule and the lengthy time required to don race swimsuits (~10 min). Therefore, a number of experimental studies were undertaken to address the issue of lengthy transition phases.

Study 2: In the first of these investigations, 16 national junior swimmers completed a standardised pool warm-up followed by a 30 min transition phase and a 100 m freestyle time-trial. Within the transition phase, swimmers wore a conventional tracksuit and remained
seated (Control), wore a tracksuit jacket with integrated heating elements (Passive), performed a dryland-based exercise routine (Dryland) or a combination of Passive and Dryland (Combo). Faster overall junior time-trial performances were recorded in Combo (1.1% ± 0.3%; mean ± 90% confidence limits, $p < 0.01$) and Dryland (0.7% ± 0.3%, $p = 0.02$), with start times (to 15 m) also faster for Combo (0.4% ± 0.1%, $p < 0.01$) compared to Control. Core temperature declined less during the transition phase in Combo (-0.1 ± 0.3°C, $p = 0.01$, effect size, ES, -1.18) compared to Control (-0.6 ± 0.2°C), with a smaller reduction in core temperature related to better time-trial performance ($R^2 = 0.91$, $p = 0.04$). Elite swimmers are more consistent performers (~0.8% typical variation in performance between competitions) than their less experienced counterparts (versus ~1.1%) and may not respond to the same degree to particular interventions. Therefore, the influence of the Combo additional warm-up strategy on elite swimming performance was investigated.

Studies 3 and 4: Elite sprint freestyle (n = 25) and breaststroke (n = 10; heated tracksuit pants were used) performance was examined following completion of the Control and Combo warm-up strategies. Faster start (1.5% ± 1.0%; mean ± 90% confidence limits, $p = 0.02$) and 100 m freestyle time-trial (0.8% ± 0.4%, $p < 0.01$) performances were yielded with Combo compared to Control. Core temperature again declined less during transition (-0.2°C ± 0.1°C versus -0.5°C ± 0.1°C, $p = 0.02$, ES, 0.78) within Combo compared to Control in freestyle swimmers. Total local (trapezius) haemoglobin concentration immediately prior to the 100 m freestyle time-trial was greater within Combo compared to Control (81µM ± 25µM; mean ± standard deviation, versus 30µM ± 18µM, $p < 0.01$, ES 1.45). Pre time-trial skin temperature was also higher in Combo (30.6 ± 1.0°C, $p < 0.01$, ES, 1.10) compared to Control (29.1 ± 1.2°C). Combo did not enhance elite sprint breaststroke performance ($p = 0.55$) despite significantly higher $T_{skin}$ values recorded immediately prior to the 100 m time-trial in Combo (30.1 ± 0.9°C; mean ± standard deviation, $p = 0.01$, ES, 0.70) compared to Control (29.1 ± 1.3°C). It was unclear if the decline in core temperature during the transition phase was less in Combo (-0.1 ± 0.2°C; mean ± 90% confidence limits, $p = 0.36$, ES, 0.65) in comparison with Control (-0.3 ± 0.2°C) in elite breaststroke swimmers. Completion of additional warm-up strategies during the transition phase can enhance elite senior sprint freestyle, but not breaststroke performance.

Study 5: Completion of a morning (07:30-08:30) exercise priming bout consisting of swimming exercise (SwimOnly), swimming and dryland-based resistance exercise (SwimDry)
or no exercise (NoEx) was investigated to ascertain the effect upon afternoon swimming performance (n = 13). Following a six hour break, afternoon (14:30-16:00) time-trial performance was faster in SwimOnly (1.6 ± 0.6%; mean ± 90% confidence limits, p < 0.01) and SwimDry (1.7 ± 0.7%, p < 0.01). First 50 m stroke rate was higher in SwimOnly (0.70 ± 0.21 Hz; mean ± standard deviation, p = 0.03) and SwimDry (0.69 ± 0.18 Hz, p = 0.05) compared to NoEx (0.64 ± 0.16 Hz). Before the afternoon session, core (0.2°C ± 0.1°C; mean ± 90% confidence limits, p = 0.04, ES, 1.03), body (0.2°C ± 0.1°C, p = 0.02, ES, 1.74) and skin (0.3°C ± 0.3°C, p = 0.02, ES, 0.78) temperatures were higher in SwimDry compared to NoEx. Completion of a morning swimming exercise bout alone or in combination with resistance exercises can enhance afternoon sprint swimming performance.

Swimming coaches are concerned that lengthy marshalling periods may compromise the retention of beneficial effects induced by pre-competition warm-ups. Coaches can be advised that a combination of heated jackets and dryland-based activation exercises employed within lengthy transitions can yield benefits to sprint freestyle performance in the range of 0.8% (seniors) to 1.1% (juniors). Attenuation in the decline of core temperature and augmented total local haemoglobin concentration appear as likely mechanisms. Tracksuit pants integrated with heating elements covering a greater surface area may be required to enhance core temperature maintenance during lengthy transition phases and subsequently, elite sprint breaststroke performance. Preliminary evidence suggests that afternoon sprint swimming performance is enhanced following the completion of a morning exercise bout consisting of swimming exercise alone or in combination with resistance exercises. In summary, utilising additional warm-up strategies during the transition phase between pool warm-up end and race start and completion of a morning exercise bout prior to afternoon racing was shown to significantly enhance sprint swimming performance.
List of Abbreviations

ATP – adenosine triphosphate
cm – centimetres
CMJ – countermovement jump
FINA – Fédération internationale de natation
Hb – haemoglobin
Hb\textsubscript{diff} – haemoglobin difference (where Hb\textsubscript{diff} = oxyhaemoglobin – deoxyhaemoglobin concentration)
HR – heart rate
hr – hour
Kg – kilograms
La\textsuperscript{−} – capillary blood lactate
m – metres
MFCV – muscle fibre conduction velocity
min – minutes
mmol – millimolar units
O\textsubscript{2} – oxygen
O\textsubscript{2}\textsubscript{Hb} – oxyhaemoglobin
PAP – postactivation potentiation
PCr – creatinine phosphate
RM – repetition maximum
Rpm – revolutions per minute
sec – seconds (s in chapter 2 and 4)
T\textsubscript{core} – core temperature
tHb – total haemoglobin
T\textsubscript{muscle} – muscle temperature
T\textsubscript{skin} – skin temperature
µM – micromolar units
VO\textsubscript{2} – oxygen uptake
VO\textsubscript{2}\textsubscript{max} – maximal oxygen uptake
VO\textsubscript{2}\textsubscript{peak} – peak oxygen uptake
yr – year (y in chapter 4)