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

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International Journals

- McGowan CJ, Thompson KG, Pyne DB, Raglin JS & Rattray B. Heated jackets and dryland-based activation exercises used as additional warm-ups during transition enhance sprint swimming performance. *Journal of Science and Medicine in Sport*. 2016: 19 (4) 354-358.

- McGowan CJ, Pyne DB, Raglin JS, Thompson KG & Rattray B. Current warm-up practices and contemporary issues faced by elite swimming coaches. *The Journal of Strength and Conditioning Research.* March 26th 2016. [Epub ahead of print]

- McGowan CJ, Pyne DB, Thompson KG & Rattray B. Additional warm-up strategies do not enhance elite sprint breaststroke performance. *International Journal of Sports Physiology and Performance*, January 10th 2016. [Epub ahead of print]

- McGowan CJ, Pyne DB, Thompson KG & Rattray B. Warm-Up Strategies for Sport and Exercise: Mechanisms and Applications. *Sports Medicine*. 2015: 45 (11) 1523-1546.

- McGowan CJ, Pyne DB, Raglin JS, Thompson KG & Rattray B. Current warm-up practices and the contemporary issues faced by elite swimming coaches. *Journal of Science and Medicine in Sport*, 2014: Supplement 1, (18) 82.

National and International Conferences

- McGowan CJ, Pyne DB, Thompson KG, Raglin JS, Osborne M & Rattray B. Competition day strategies to enhance sprint swimming performance. *63rd Annual Meeting of the American College of Sports Medicine*, 31st May-4th June 2016, Boston, United States of America.

- McGowan CJ, Pyne DB, Thompson KG, Raglin JS & Rattray B. Heated garments and dryland activation routines – the keys to improving sprint swimming performance? *20th Annual Congress of the European College of Sport Science*, 24-27th June 2015, Malmo, Sweden.

- 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.

- McGowan CJ, Rattray B, Pyne DB, Thompson KG & Raglin JS. Use of additional warm-up strategies in the pre-race transition period enhances sprint swimming performance. *XIIth International Symposium on Biomechanics and Medicine in Swimming*, 28th April-2nd May 2014, Canberra, Australia.

- McGowan CJ, Rattray B, Pyne DB, Thompson KG & Raglin JS. Additional warm-up strategies improve sprint swimming performance. *6th Exercise and Sport Science Australia Conference*. 10-12th April 2014, Adelaide, Australia.

Awards

- 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

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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 ± 0.9ºC; mean ± standard deviation, $p = 0.01$, ES, 0.70) compared to *Control* (29.1 ± 1.3ºC). 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_{diff} – haemoglobin difference (where Hb_{diff} = oxyhaemoglobin – deoxyhaemoglobin concentration)

HR – heart rate

hr – hour

Kg – kilograms

La^{-} – capillary blood lactate

m – metres

MFCV – muscle fibre conduction velocity

min – minutes

mmol – millimolar units

O_2 – oxygen

O_2Hb – oxyhaemoglobin

PAP – postactivation potentiation

PCr – creatinine phosphate

RM – repetition maximum

Rpm – revolutions per minute

sec – seconds (s in chapter 2 and 4)

T_{core} – core temperature

tHb – total haemoglobin

T_{muscle} – muscle temperature

T_{skin} – skin temperature

µM – micromolar units

VO_2 – oxygen uptake

VO_2max – maximal oxygen uptake

VO_2peak – peak oxygen uptake

yr – year (y in chapter 4)