

# The responses of a group of 10 to 12 year old children swimming in cold water

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## Background

- Lack of data in children on immersion in cold water
  - initial responses
  - cooling rates
- Seminal paper 1973 (Sloan & Keatinge 1973)
  - 8 – 20 year olds, 20.3 °C water
  - youngest removed from water soonest
  - $T_{\text{subling.}}$  2 °C lower in children than adults
  - greatest correlation with  $T_{\text{subling.}}$  with: subcutaneous fat  
sa : mass
- Despite advances in methodology, little evidence since.
- Protocols, management & treatment: based on adult studies or theory.

## Children vs. Adults

- Physical, physiological, psychological
- Larger surface area : mass  
Lower % Body Fat  
Smaller muscle mass  
Lower absolute MR  
Greater susceptibility to cold-related illness and hypothermia  
(Auerbach 2001)
- Subjective Interpretation;  
Can be relied upon in adult... And children?  
(Keatinge, Khartchenko *et al.* 2001)

## Studies to date: Children

- In COLD, DRY environments:
  - Thermoregulatory response as effective as adults
  - Greater relative metabolic heat production & lower skin limb temperatures (Williams 2007)
- In COLD, WET environments: ???
  - Water has greater potential for heat loss
  - Factors that render children susceptible more likely to have a greater impact
- Are children at greater risk of drowning and hypothermia on immersion in cold water?...

## Opportunity to study...

- **BEST** (Bristol English Channel Swim Team)
  - February 2009
  - Bristol, UK
  - To be the youngest to swim the English Channel
- **Study:**
  - The physiological response of children to immersion and swimming in cold water, temperature 15 ° C
  - Initial responses
  - Cooling rates whilst swimming
  - Evidence of habituation

- **17 participants:** 10 boys, 7 girls
  - Aged 10 - 11 yrs
  - University of Portsmouth
  - Medical Q, ECG, Clinical exam.

Proficient swimmers

No regular previous cold water regime

- **Anthropometry:**
  - (Height, weight, % body fat, arm span, skinfold thickness 8 sites, girth measurement 5 sites)



- 5 minute **STATIC** phase
- 40 minute **SWIM** phase  
( $T_{GI}$  ° C throughout)
- **Rewarming** phase
- Repeat at 1 year following regular cold water training



- **Anthropometry:**  
Study children (n = 17) *versus* UK data (NHS 2005)

	Study Children, aged 10 to 11 years		UK Reference, aged 10 to 11 years	
	Boys Mean Age = 10 .9 years	Girls Mean Age = 11 years	Boys Age = 11 years	Girls Age = 11 years
Mean Ht (cm)	151.1	150.9	144.4	144.5
Mean Wt (kg)	45.1	44.0	40.2	40.9
Mean BMI (kg.m <sup>-2</sup> )	19.7	19.2	19.3	19.3

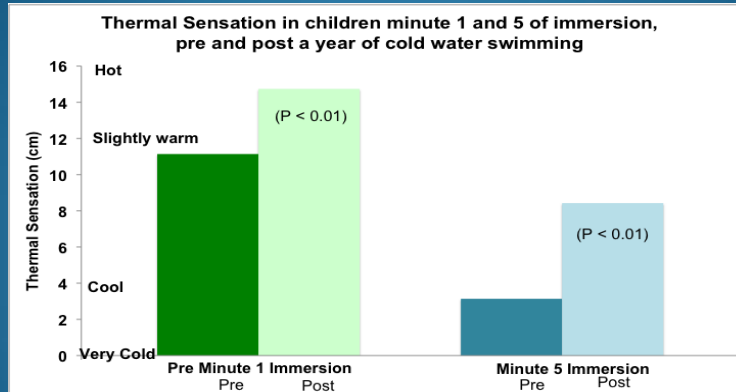
## Initial responses on STATIC immersion:

Variable (mean (SD)):	Pre training (n = 8)
Resting Respiratory frequency (fR) (breaths.minute <sup>-1</sup> )	16 (3)
fR, 1 <sup>st</sup> minute (breaths.minute <sup>-1</sup> )	35 (4)
fR, 5 <sup>th</sup> minute (breaths.minute <sup>-1</sup> )	28 (4)
Resting Heart rate (fH) (beats.minute <sup>-1</sup> )	79 (9)
fH, 1 <sup>st</sup> minute (beats.minute <sup>-1</sup> )	106 (13)
fH, 5th minute (beats.minute <sup>-1</sup> )	94 (11)
VO <sub>2</sub> 1 <sup>st</sup> minute (mL.kg. <sup>-1</sup> minute <sup>-1</sup> )	10.9 (1.061)
VO <sub>2</sub> 5th minute (mL.kg. <sup>-1</sup> minute <sup>-1</sup> ) (n = 7)	11.6 (3.4)

## Initial responses on STATIC immersion:

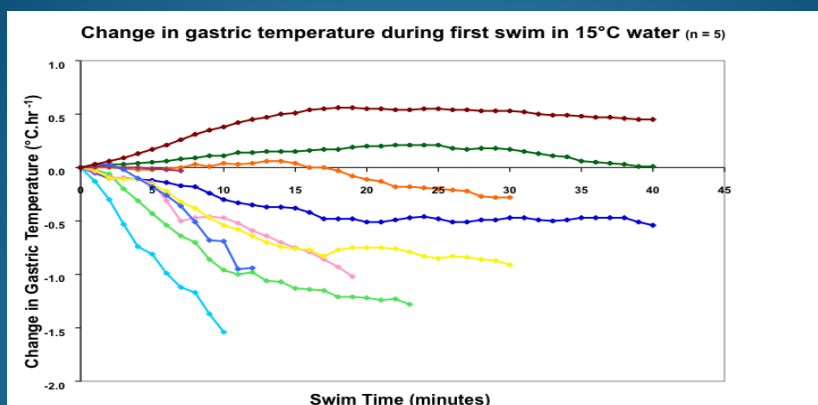
Variable (mean (SD)):	Pre training (n = 8)	Post training (n = 8)
Resting Respiratory frequency (fR) (breaths.minute <sup>-1</sup> )	16 (3)	15 (2) (n = 7)
fR, 1 <sup>st</sup> minute (breaths.minute <sup>-1</sup> )	35 (4)	34 (8)
fR, 5 <sup>th</sup> minute (breaths.minute <sup>-1</sup> )	28 (4)	26 (6)
Resting Heart rate (fH) (beats.minute <sup>-1</sup> )	79 (9)	69 (12)
fH, 1 <sup>st</sup> minute (beats.minute <sup>-1</sup> )	106 (13)	98 (15)
fH, 5th minute (beats.minute <sup>-1</sup> )	94 (11)	91 (14)
VO <sub>2</sub> 1 <sup>st</sup> minute (mL.kg. <sup>-1</sup> minute <sup>-1</sup> )	10.9 (1.061)	9.8 (1.374) * (P = 0.01)
VO <sub>2</sub> 5th minute (mL.kg. <sup>-1</sup> minute <sup>-1</sup> ) (n = 7)	11.6 (3.4)	9.5 (3.4)

- Anthropometry post habituation: ↑ weight ( $P < 0.01$ )  
↑ BMI ( $P < 0.01$ )
- Thermal Sensation (TS)

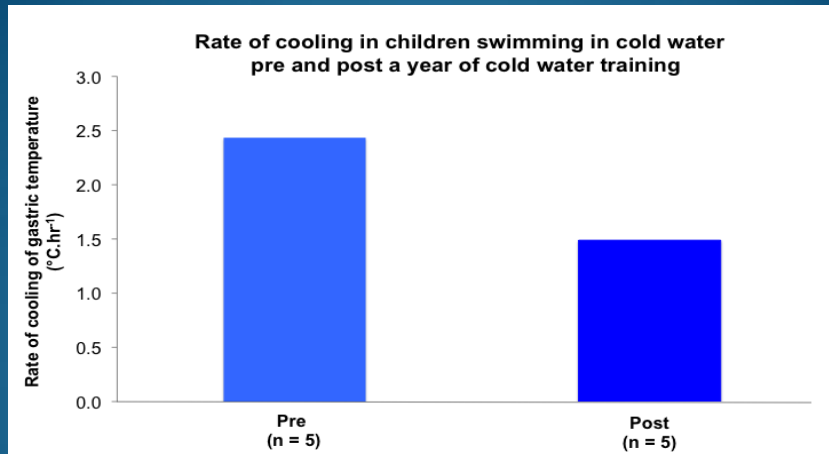


- TS & TC found to correlate

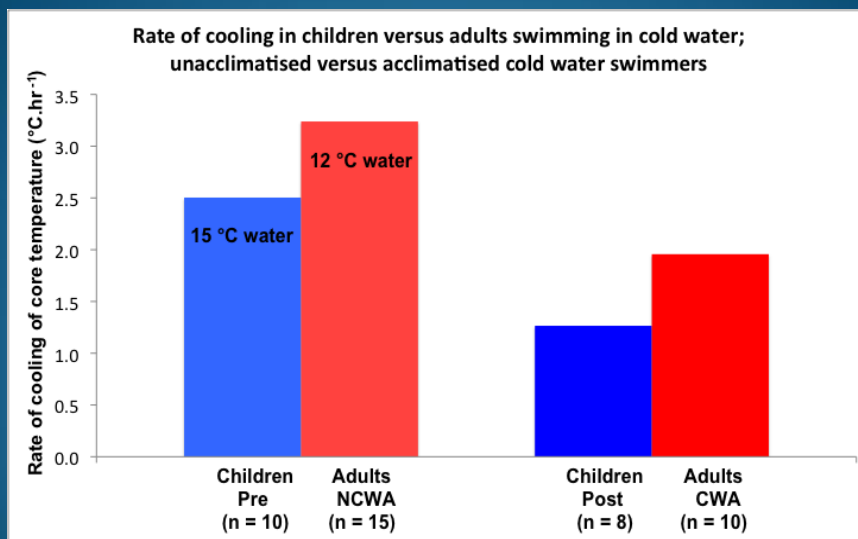
## Responses on SWIMMING



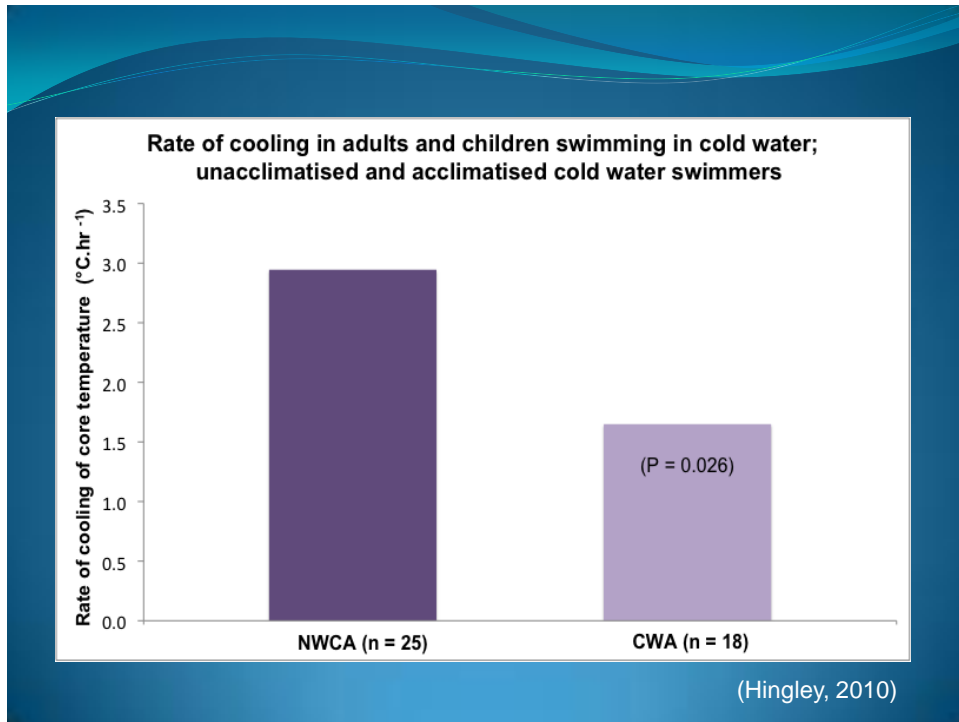
- Correlation ( $R^2$ ) with rate change  $T_{GI}$  °C:  
 $\Sigma$  skinfolds (0.4157) > triceps thickness (0.3867)  
 > % BF (0.3206) > sa : mass (0.0694)



- Matched swim speeds pre and post
- No difference in  $\text{VO}_2$  ( $\text{mL}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ )



(Hingley, 2010)



## Discussion & Conclusions

### Initial Immersion:

- 'Cold shock' response in children
- Less of a response than expected (less than adults)
- Lack of habituation of response: low response in children, or children partly habituated initially

### Cooling Rates whilst swimming:

- Children in this study maintained their core temperature as effectively as adults
- Slower cooling rates following regular cold water swimming... implies insulative adaption

## BEST - World record!

- September 2010
- Relay team of 6
- 1 hr swim, 5 hr rest
- 13.5 hours



- Youngest team to swim the Channel,  
age = 12 years 118 days

## Acknowledgements

Amateur Swimming Association

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Dr Heather Lunt

Miss Penny Porter

IMOs:

Dr Paddy Morgan

Dr Rebecca Dale

Dr Simon Guest

Dr John Brewin

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