

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 ⁻²)	19.7	19.2	19.3	19.3

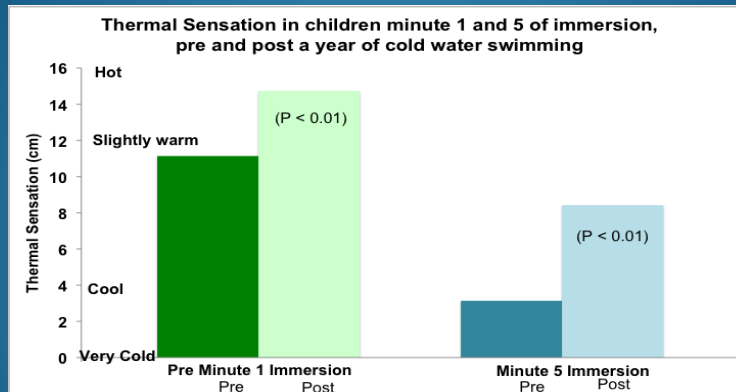
Initial responses on STATIC immersion:

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

Initial responses on STATIC immersion:

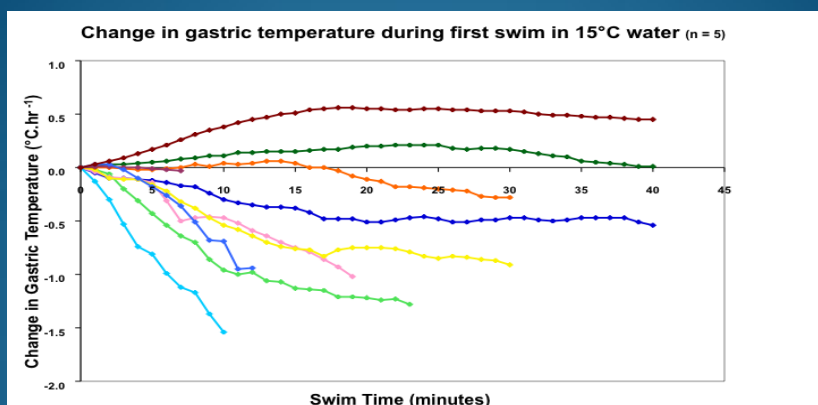
Variable (mean (SD)):	Pre training (n = 8)	Post training (n = 8)
Resting Respiratory frequency (fR) (breaths.minute ⁻¹)	16 (3)	15 (2) (n = 7)
fR, 1 st minute (breaths.minute ⁻¹)	35 (4)	34 (8)
fR, 5 th minute (breaths.minute ⁻¹)	28 (4)	26 (6)
Resting Heart rate (fH) (beats.minute ⁻¹)	79 (9)	69 (12)
fH,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

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

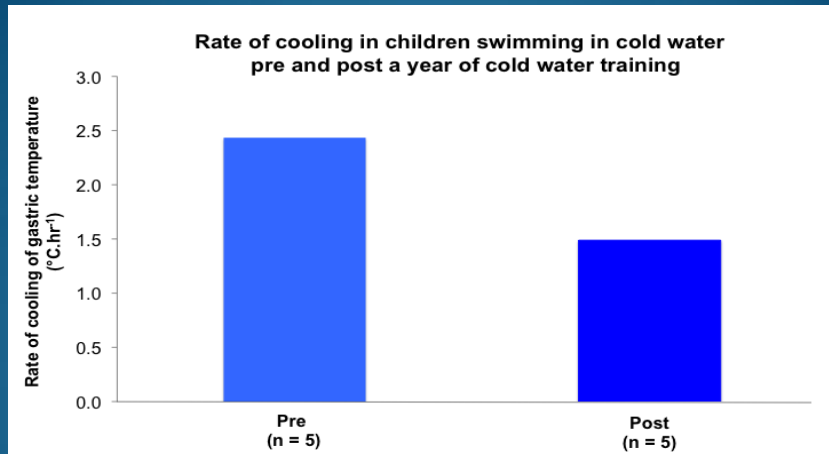


- TS & TC found to correlate

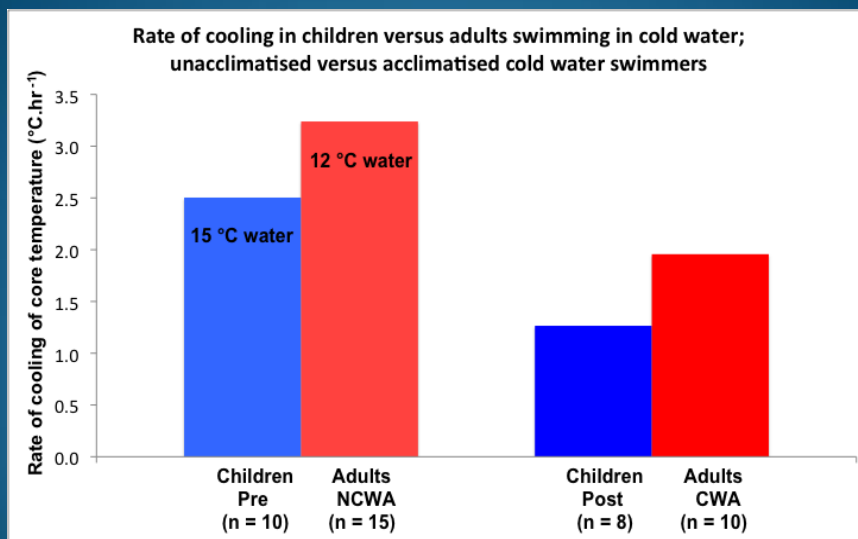
Responses on SWIMMING



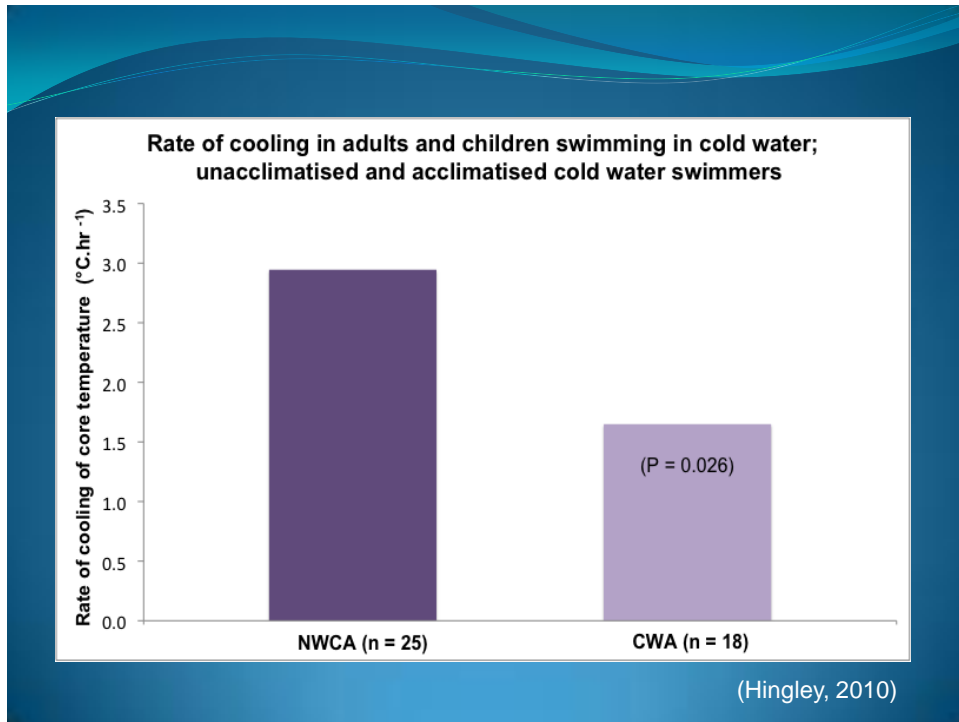
- Correlation (R^2) with rate change T_{GI} °C:
 Σ skinfolds (0.4157) > triceps thickness (0.3867)
 > % BF (0.3206) > sa : mass (0.0694)



- Matched swim speeds pre and post
- No difference in 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

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Miss Penny Porter

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Dr Paddy Morgan

Dr Rebecca Dale

Dr Simon Guest

Dr John Brewin

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