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MEETING ABSTRACT Open Access

Brain blood flow and hyperventilation on cold water immersion: can treading water help control these symptoms of cold shock?

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Introduction

Cold-water immersion (CWI) elicits the cold shock response (CSR). The hyperventilatory component of the CSR causes a decrease in cerebral blood flow velocity (CBFv) potentially causing sensations of dizziness and increasing the risk of becoming unconscious and consequently drowning [1]. In these early minutes of CWI the current advice is to 'float first' and remain stationary [2] yet this strategy may not have any effect on ventilation and therefore brain CBFv. We tested the hypothesis that leg only exercise could offset the reduction in CBFv in a resting CWI (H_1) and be absent in warm water immersion.

Methods

Seventeen participants consented and visited the laboratory 3 times; mean [SD]: age 21 [3]yrs; height 1.71 [.01] m; mass 70.9 [10.1]kg. All immersions were standardised by depth, duration, clothing (bathing suit) and time of day. Test conditions were a) a resting warm water immersion (WWI; 34.7 [2.6] °C), b) a resting CWI (CWI-R: 12.2 [0.5] °C), c) a CWI (12.1 [0.5] °C) where light exercise (leg kicking/treading water; 80 bpm^{-1}) commenced 30-seconds after water entry (CWI-K). CBFv was measured using a transcranial Doppler at a fixed depth (61 [1] mm) over the middle cerebral artery. Oxygen uptake and ventilation were measured using an online gas analysis system. Perceptions of breathlessness were measured after 1, 3 and 5 minutes using an 11-point categorical scale (0-*not at all breathless*, 10-*extremely breathless*). ANOVA was used to analyse the data to an alpha level of 0.05.

Results

CWI induced significant changes in contrast to WWI (see Table 1).

Table 1 Mean [SD] perceived breathlessness, CBFv, oxygen uptake, and carbon dioxide production in WWI (condition a), CWI-R (b) and CWI-K (c); letters denote differences between the corresponding condition.

	CBFv (Δ%)			VO_2 ($mL.kg^{-1}.min^{-1}$)			VCO_2 ($mL.kg^{-1}.min^{-1}$)		
	WWI[a]	CWI-R[b]	CWI-K[c]	WWI[a]	CWI-R[b]	CWI-K[c]	WWI[a]	CWI-R[b]	CWI-K[c]
PRE	-	-	-	387[96]	407[58]	405[90]	335[80]	377[75]	365[87]
1 MIN	5[4][b]	-6[9][a]	-3[16]	633[117][c]	671[129]	692[137][a]	518[97][b,c]	837[253][a]	880[343][a]
2 MIN	3[6][b]	-6[9][a]	2[20]	424[84][c]	437[94][c]	534[89][a,b]	375 [79][c]	482[212][c]	623[216][ab]
3 MIN	3[4]	1[10]	3[16]	390[76][bc]	432[84][ac]	537[79][a,b]	347 [76][c]	405[173][c]	497[133][ab]
4 MIN	3[4]	7[11]	8 [21]	359[66][bc]	436[101][ac]	543[84][a,b]	321[60][c]	368[135][c]	460[120][ab]
5 MIN	5[6]	7[10]	4[17]	362[72][bc]	454 [85][ac]	570[99][ab]	322[66][c]	372[108][c]	455[99][ab]

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Discussion

Leg kicking on CWI partially offset the reduction in CBFv that normally occurs on CWI; in contrast to a warm water control. WWI CBFv was only different to the CWI-R condition. This did not alleviate symptoms of breathlessness despite increased oxygen uptake and carbon dioxide production in the CWI-K condition; the hypothesis is only partially supported.

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References

1. Mantoni T, Rasmussen JH, Belhage JH, Pott FC: **Voluntary respiratory control and cerebral blood flow velocity upon ice-water immersion. Aviation.** *Space and Environmental Medicine* 2008, **79(8)**:765-768.
2. Barwood MJ, Bates V, Long GM, Tipton MJ: *Int J Aq Res Edu* 2011, **5**:147-163.

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