

Hydration indices in exertional heat stress

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Introduction. Hydration is a multi-factorial and dynamic phenomenon relating to the volume and composition of bodily fluid compartments. Nonetheless hypohydration (lower than normal body water content) can be associated with reduced cognition and endurance exercise performance especially in the heat, and possibly with increased propensity or severity of heat illnesses. In regard to heat illness and performance, functionally relevant measures of hydration may be most validly measured during or immediately after the dehydrating stress. The reduction in body mass (%) is a traditional index of hydration, but plasma volume (PV) and plasma osmolality (Osmo_p) might be viewed as having a more functional role in maintaining homeostasis under prolonged exertional heat stress.

Purpose. To examine the relationship between indices of hydration during dehydrating exercise in the heat, with variable rehydration.

Methods. Eighteen males (mean \pm SD age 25 \pm 6 y, mass 74.9 \pm 4.4 kg, cycling peak oxygen uptake 4.7 \pm 0.3 L min⁻¹) undertook two to six 90-min heat exposures involving intermittent exercise in hot humid conditions (39.5°C, 60% r.h.) or continuous exercise in warm, moderately-humid conditions (35°C, 60% r.h.), with rehydration varying from none to full water replacement orally. Hydration-related indices measured before during and after exposures included plasma indices (AVP, Aldosterone, Na⁺, Osmolality, Δ PV), thirst, urine (specific gravity (SG_U), colour, osmolality), and body mass.

Results. Baseline reliabilities (mean difference) were variable between measures; AVP_p 2.2%, Aldosterone_p 25.8%, Na⁺_p 0.3%, Osmo_p 1.5%, thirst 15.9% and SG_U 0.1%. Linear relations between hydration-related indices are shown in the table.

Measure 1 (min - max)	Measure 2 (min - max)	r ²	P
Δ body mass (-2.8 - 0.9%)	Δ PV (-20.7 - 1.0%)	14%	0.02
	Osmo _p (275 - 319 mosmol kg ⁻¹)	4%	0.36
	AVP _p (1 - 26 pg mL ⁻¹)	15%	0.03
	Aldosterone _p (20 - 993 pg mL ⁻¹)	94%	0.00
	Na ⁺ _p (136 - 149 mmol L ⁻¹)	69%	0.00
	Protein _p (61 : 113 mg mL ⁻¹)	16%	0.00
	SG _U (1.000 - 1.030 units)	3%	0.24
Thirst (4 - 9 units)	% Δ body mass	81%	0.00
	PV	13%	0.22
	Osmo _p	7%	0.45
	Na ⁺ _p	6%	0.36
	Protein _p	46%	0.00
Δ PV	Osmo _p	14%	0.11

Conclusion. Statistically-significant associations were evident between most pairs of hydration-related measures under conditions of dynamic exercise and ambient heat stress with varied rehydration. However, most associations were weak, and plasma osmolality, which is considered the most criterion measure, showed little association with other functional measures or with fieldable measures. The close relation between thirst and change in body mass has functional value but, oddly, was not reflective of a similarly close relation for factors that stimulate thirst.

Supported by research grants from DSTO and University of Otago.