# Inter-individual variation in the adaptive response to heat acclimation; impact on temperate performance

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## Background

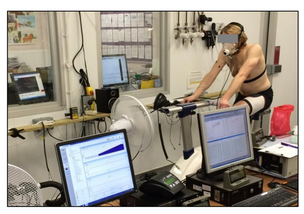
Typical heat acclimation (HA) responses are well characterised at the cohort level[1], however, individual data demonstrate considerable heterogeneity.
Recent research[2] suggests that HA indicies are independent and not influenced by aerobic capacity, previous HA or thermal dose. However, some baseline responses may be useful in estimating the potential benefits that an individual may obtain from HA. The ergogenic potential of HA and it's prospect has not been examined on an indvidual basis.

**Aim:** to establish whether the extent of individual HA will translate to thermophysiological indices and endurance performance in temperature conditions, and if these can be related to any prior variables.

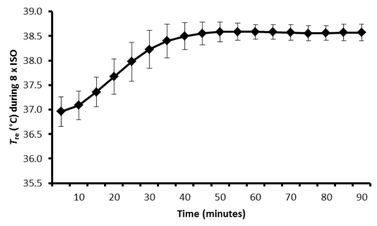
## Methods

**Participants:** 16 males ($\dot{V}O_{2max}$=57.7[8.3] mL·kg$^{-1}$·min$^{-1}$.
9 of the participants had previously undertaken a HA programme (3-18 months washout).
**Protocol** (cycling)**:**


- **GXT:** 20 mins at 85-110W followed by incremental test to exhaustion (25 W every 3 min then every 1 min above fingertip capillary blood lactate concentration >4 mmol·L$^{-1}$) (22 °C, 50% RH)
- **TT:** 30 min work done trial (22 °C, 50% RH)
- **HST:** 60 mins at 35% peak power output (40 °C, 50% RH)
- **ISO:** 90 min sessions (40 °C, 50% RH); total thermal dose $T_{re}$ < 38.5 °C 444(103) mins



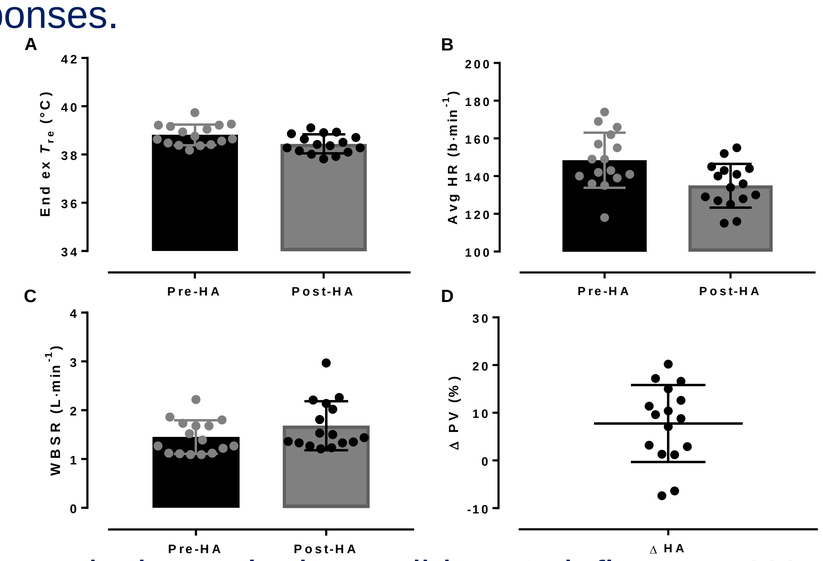
GXT & TT (22 °C, 50% RH)




HST & ISO (40 °C, 50% RH)

## Results

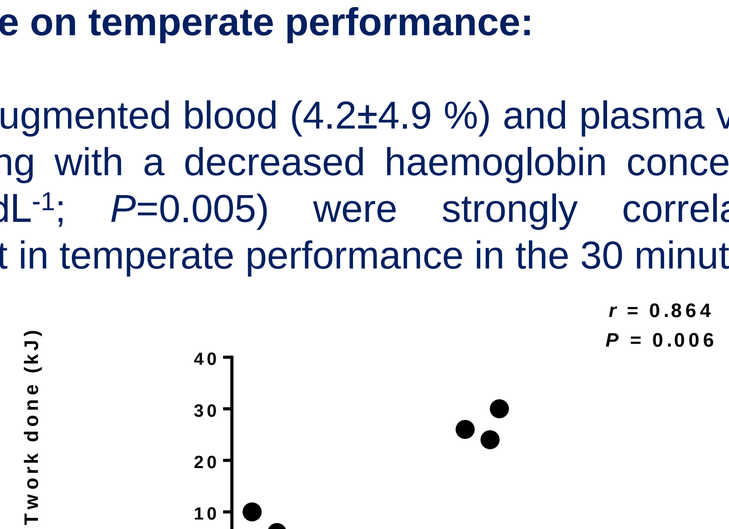
**Heat acclimation:**
At the group level HA was evident (hypervolemia, reduced rectal [$T_{re}$] and body temperature, reduced heart rate and increased sweating during HST ($P$<0.05).
However there was notable inter-individual variation in the range of adaptive responses.



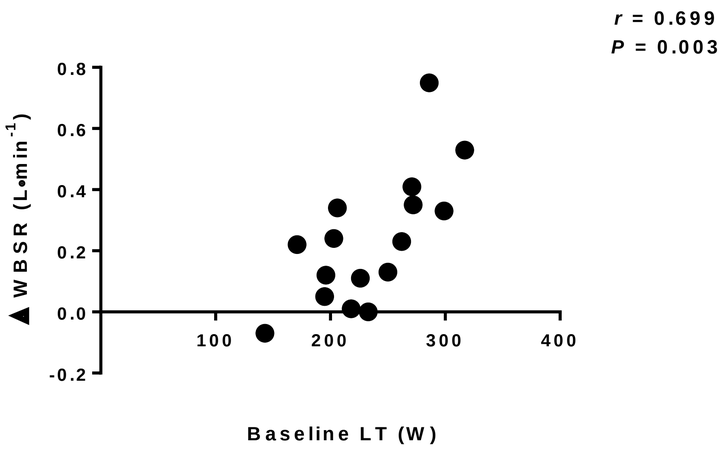

Previous HA and thermal dose did not influence HA indices ($P$>0.05).

**HA influence on temperate performance:**
10-day HA augmented blood (4.2±4.9 %) and plasma volume (7.7±8.7 %); this along with a decreased haemoglobin concentration [Hb] (-0.6±0.7 g·dL$^{-1}$; $P$=0.005) were strongly correlated with an improvement in temperate performance in the 30 minute trial.


HA reduced average heart rate during exercise in the heat (13±8 b·min$^{-1}$, $P$=0.001) and this was strongly related to a decrease in maximal heart rate achieved in the temperate graded exercise test (7±4 b·min$^{-1}$, $P$=0.001).




Baseline power at lactate threshold (temperate) is strongly related to the increase in whole body sweat rate [WBSR] (0.23±0.21 L·min$^{-1}$) during exercise-heat exposure, following 10-day HA.




## Conclusion

A medium-term HA programme utilising the isothermal strain method successfully induced HA in trained men, to a varying degree, but this was not related to thermal dose or previous heat exposure. Men with higher lactate thresholds experienced a greater increase in sweating following HA.

Some non-thermal physiological adaptations accompanying HA impact exercise in a temperate environment; those with a greater expansion in blood volumes also experienced greater ergogenic effects.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**References**

[1]Taylor NAS. (2014). Human Heat Adaptation. *Comprehensive Physiology*. 4: 325-365

[2]Corbett J, Rendell RA, Massey HC, Costello JT, Tipton MJ. (2018). Inter-individual variation in the adaptive response to heat acclimation. *Journal of Thermal Biology.* 74: 29-36