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Assessing the Repeatability of a Running Heat Tolerance Assessment in Trained and Untrained Populations



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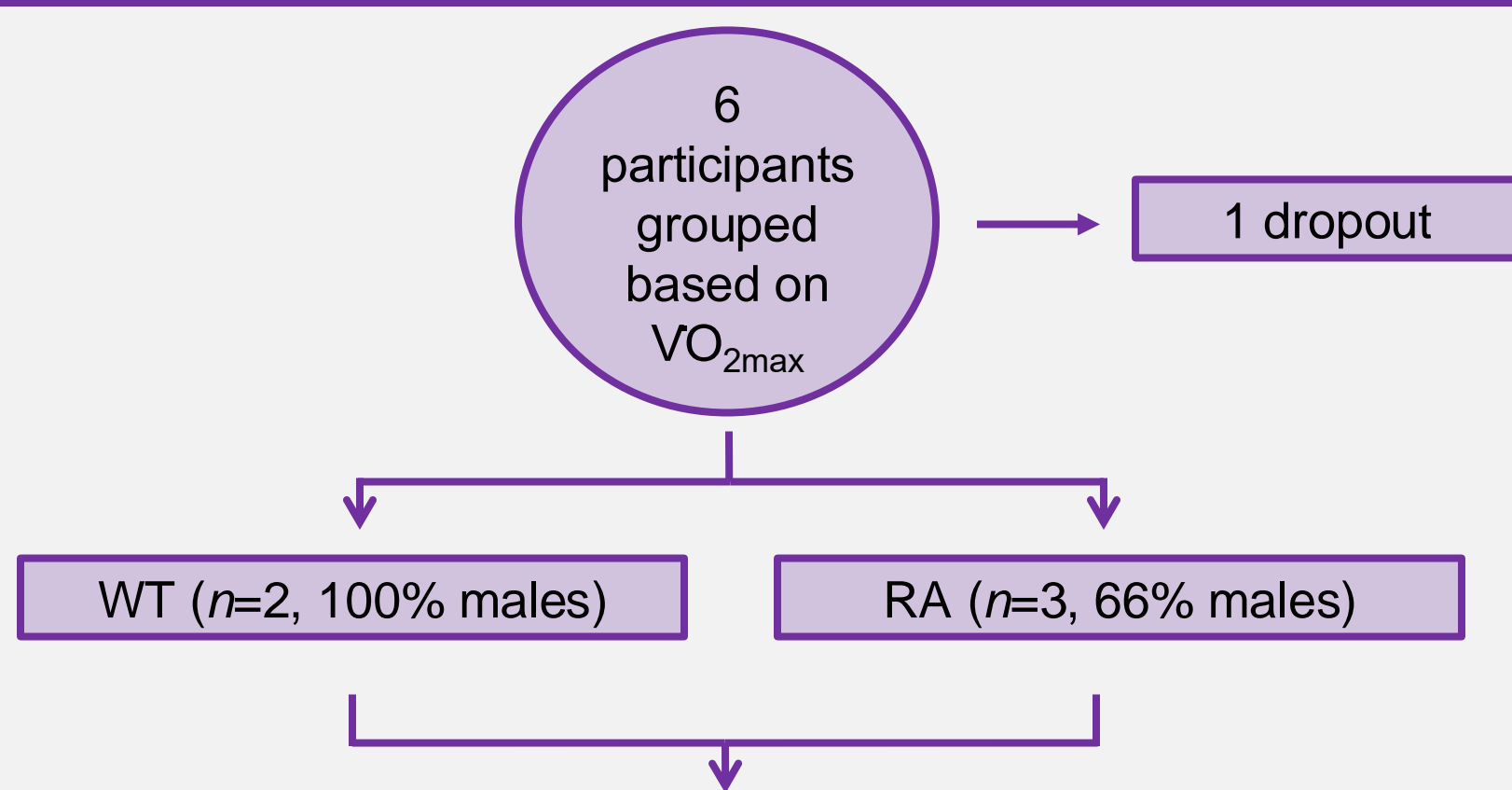
Introduction

- There is a growing need to develop measures for assessing performance and health status under heat stress, as heat-related health risks increase with global warming.¹
- The ACSM recommends that a tailored heat tolerance assessment (HTA), based upon participants' fitness levels, should be applied for individual's affected by heat related illness.²
- Aerobically-trained athletes show features of heat adaptation at baseline and, in our experience, a standardised HTA to provide robust heat stress and challenge fitter individuals is lacking.
- We designed a progressive HTA to be performed in uncompensable conditions, in order to minimise differences attributable to variation in body size and increase comparability.³

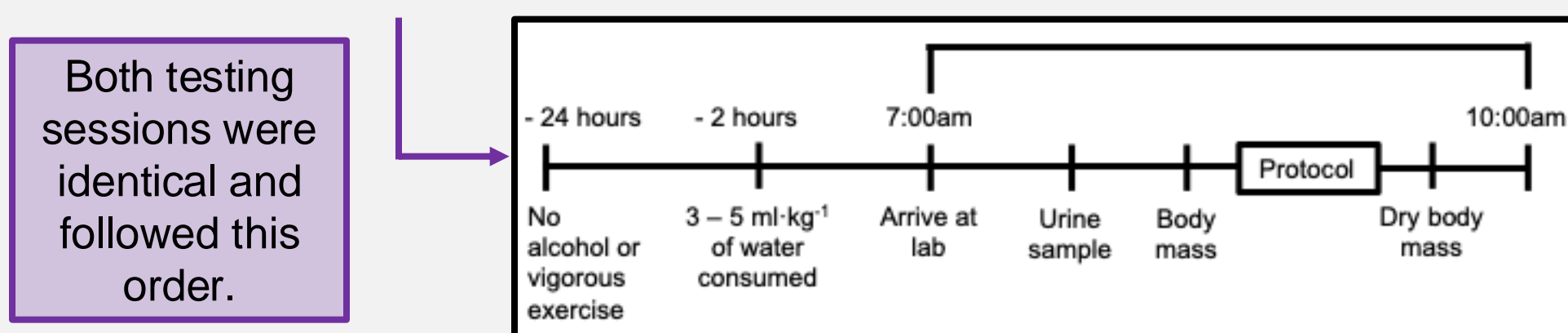
Aims

- Generate initial normative data for a running based HTA constructed using lactate thresholds (LTs)
- Investigate the repeatability of this test in well trained (WT) and recreationally active (RA) individuals.

Methods



Visit 1	Pre exercise screening and VO _{2max} test.
Visit 2	Lactate threshold test in heat chamber.
Visit 3	Heat tolerance assessment 1.
Visit 4	Heat tolerance assessment 2.



- VO_{2max} was assessed using a motorised treadmill starting at a 1% gradient and increasing 1% every minute.
- LTs were determined by blood lactate (BLa) in 40°C and 40% RH.
- HTA consisted of 30 minutes running at LT1 immediately followed by 30 minutes at LT2 in 40°C and 40% RH.
- Core temperature, skin temperature, heart rate (HR), blood lactate, sweat rate (SR) as well as RPE, thermal comfort (TC) and thermal sensation (TSS) were recorded every 5 minutes.
- The end exercise intra-class correlation coefficient (ICC) and typical error of measurement were calculated for all physiological and perceptual variables.

- ⊕ The use of lactate thresholds allowed for the individualisation of HTA, aiming to minimise the influence of exercise intensity.
- ⊕ Measuring BLa allowed us to approximate differences in metabolic efficiencies.
- ⊖ In the RA group LTs were harder to determine, leading to potential errors in standardising running speeds.

Results

- Uncompensable conditions were achieved in all participants, with a statistically significant difference in end exercise T_{core} between the WT and RA groups ($p = 0.04$, $d = 1.72$).
- ICC values for T_{core}, T_{skin}, HR and SR were all above 0.90 indicating an acceptable level of reliability for the HTA (Figure 1).
- End exercise ICC values for BLa were slightly lower at 0.8.
- Strong correlations were also evident in pre-post TSS (0.97^{***}) and mean TC (0.93^{*}) between trials.

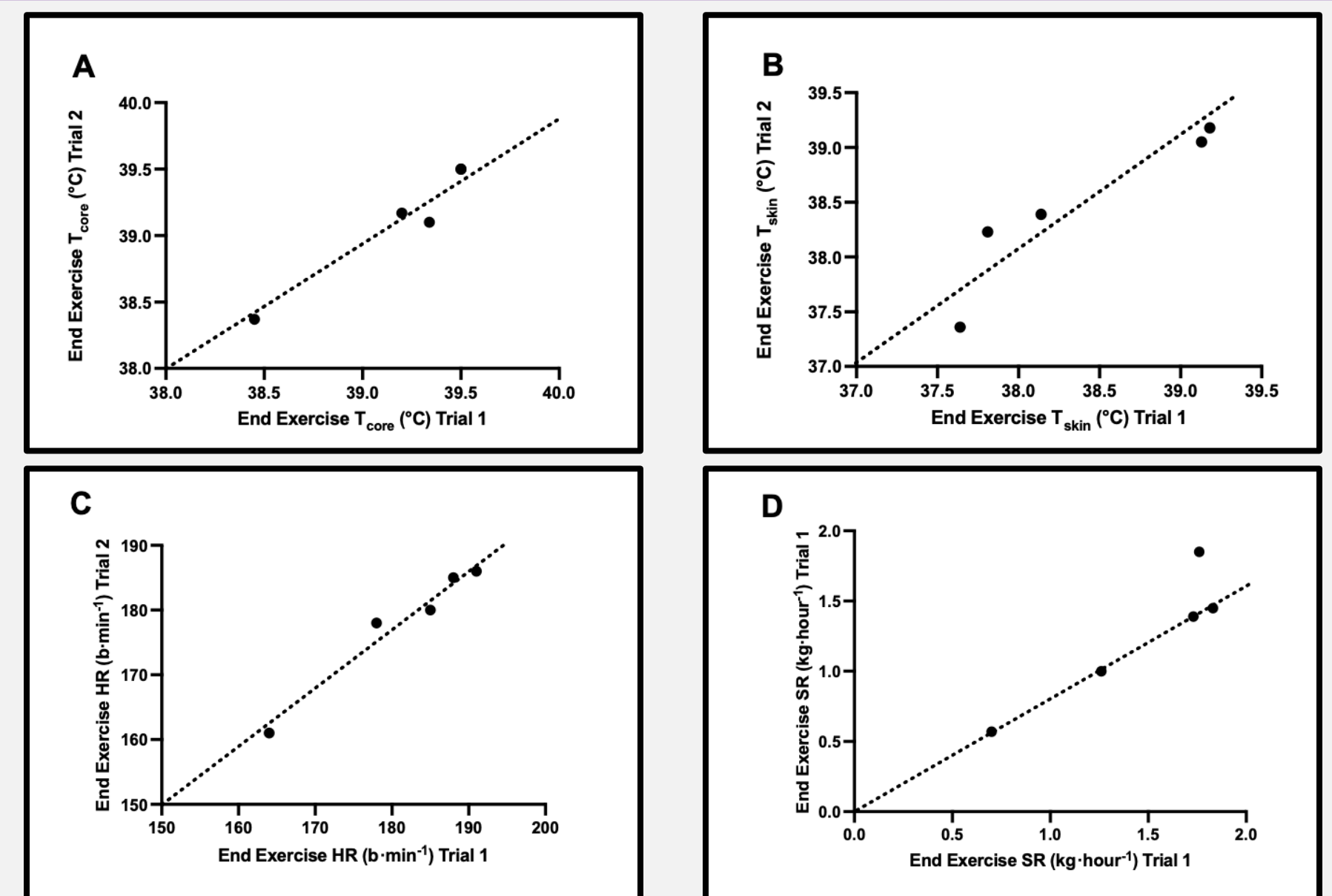


Figure 1. ICC statistics for end exercise T_{core} (0.99^{***}), T_{skin} (0.96^{**}), HR (0.99^{***}) and SR (0.96^{**}).

Table 1. Reliability statistics for inter group physiological responses.

			Mean (SD)	P	d	TEM (CV%)	Bias (LoA)
T _{core} (°C)	End Exercise	Well-trained	39.50 ± 0.00	0.04	1.72	0 (0.00)	-0.30 ± 0.02
		Recreationally active	38.94 ± 0.42			0.30 (1.18)	
T _{skin} (°C)	End Exercise	Well-trained	38.56 ± 0.54	0.28	0.34	0.45 (1.96)	0.17 ± 0.11
		Recreationally active	38.32 ± 0.84			0.54 (2.20)	
HR (b·min ⁻¹)	End Exercise	Well-trained	182.30 ± 6.01	0.73	0.43	3.58 (3.30)	3.25 ± 10.25
		Recreationally active	177.80 ± 13.61			8.78 (7.66)	
BLa (mmol·L ⁻¹)	End Exercise	Well-trained	2.07 ± 1.13	0.71	0.22	0.92 (54.79)	0.34 ± 1.00
		Recreationally active	2.36 ± 1.51			0.97 (63.81)	
SR (kg·hour ⁻¹)	End Exercise	Well-trained	1.47 ± 0.48	0.21	0.36	0.29 (32.52)	-0.37 ± 0.18
		Recreationally active	1.28 ± 0.56			0.37 (43.70)	

- Most physiological variables showed small mean bias and LoA between the two trials.
- WT showed lower coefficient of variation and predominantly lower typical error of measure when compared against RA.

Conclusion

- The HTA showed good agreement, significant correlations, and little variations across repeated trials.
- TEM values for both physiological and perceptual markers indicated little inter-participant variability.
- The absolute reliability of the test was higher in individuals with higher fitness levels.

Future Research

- HTA geared to lactate thresholds should be investigated (1) in populations affected by heat illness, and related to return-to-sport outcomes, and (2) with progressive acclimatisation.

References

1. Morimoto, T., Nakai, S. and Itoh, T. (2001) Global warming and deaths from heat stroke. *Thermotherapy for Neoplasia, Inflammation, and Pain*, pp. 107-110.
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3. Ravanelli, N., Cramer, M., Imbeault, P. and Jay, O. (2017) The optimal exercise intensity for the unbiased comparison of thermoregulatory responses between groups unmatched for body size during uncompensable heat stress. *Physiological reports*, 5(5), p. e13099.