Beat the Heat

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Background

Specialized in thermal physiology and 3D anthropometry

1990- 2016: TNO - Applied Scientific Research

2003 – : Full professor in Thermal Physiology

Contents

Heat balance and mechanisms to keep in balance

Heat strain: the Tokyo climate

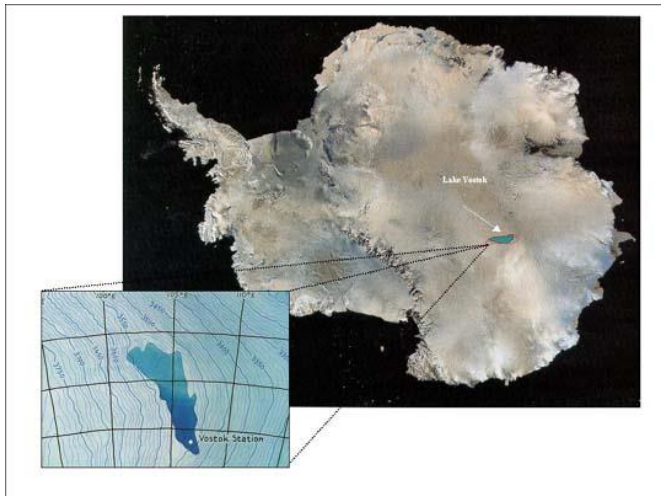
Performance decrement in the heat

How to **counteract performance loss in the heat**

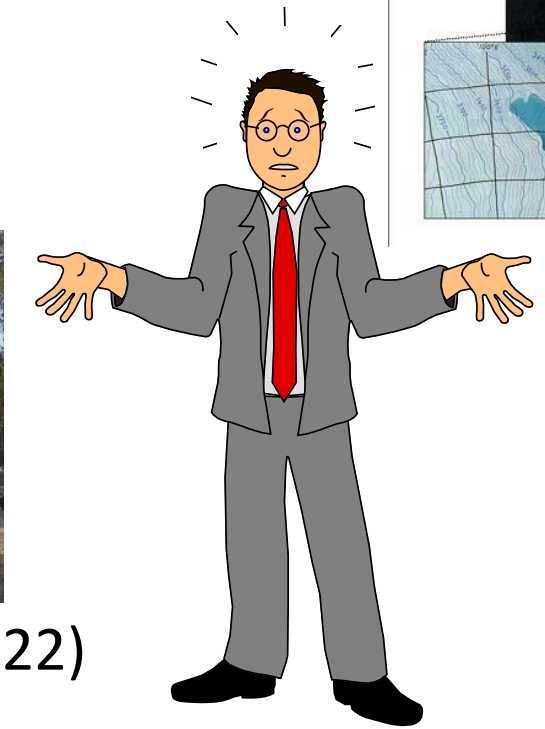
- Selection of athletes with best performance in the heat
- Acclimation to heat
- Cooling systems

Conclusions

Human surroundings

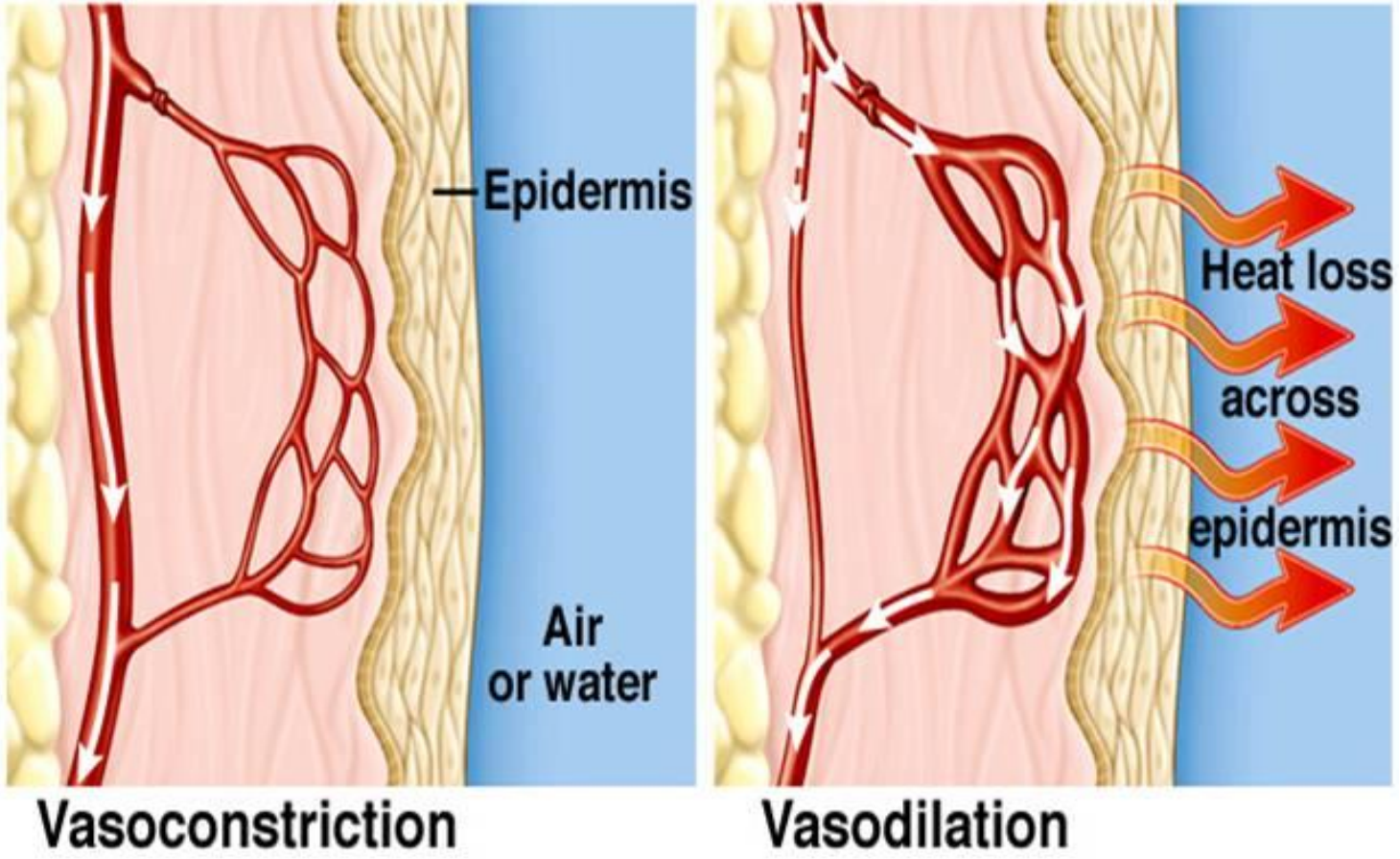


57.8°C (September 1922)



-89.5°C (July 1983)

Mechanisms to cope with thermal extremes

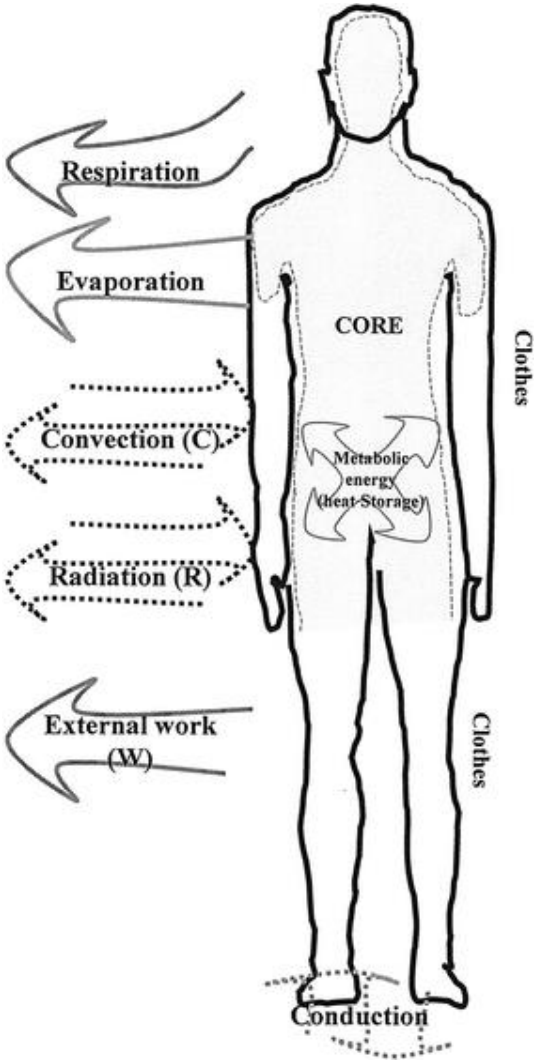


Mechanisms to cope with heat

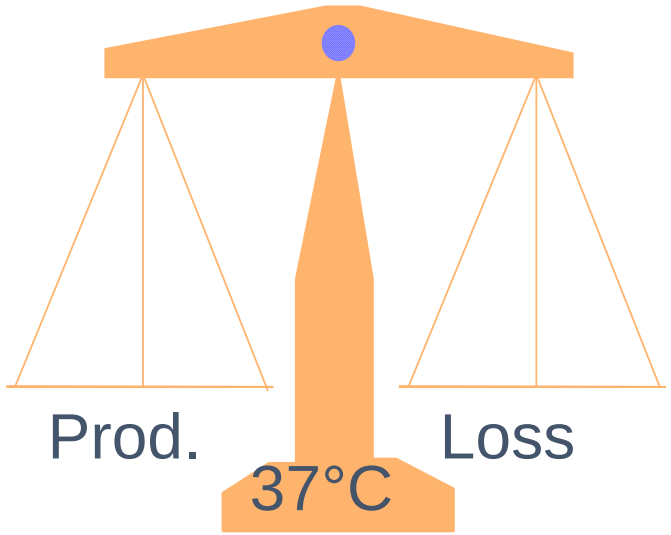
Vasodilation

Sweat evaporation (max. 3.7 l/hr = 2458 W)

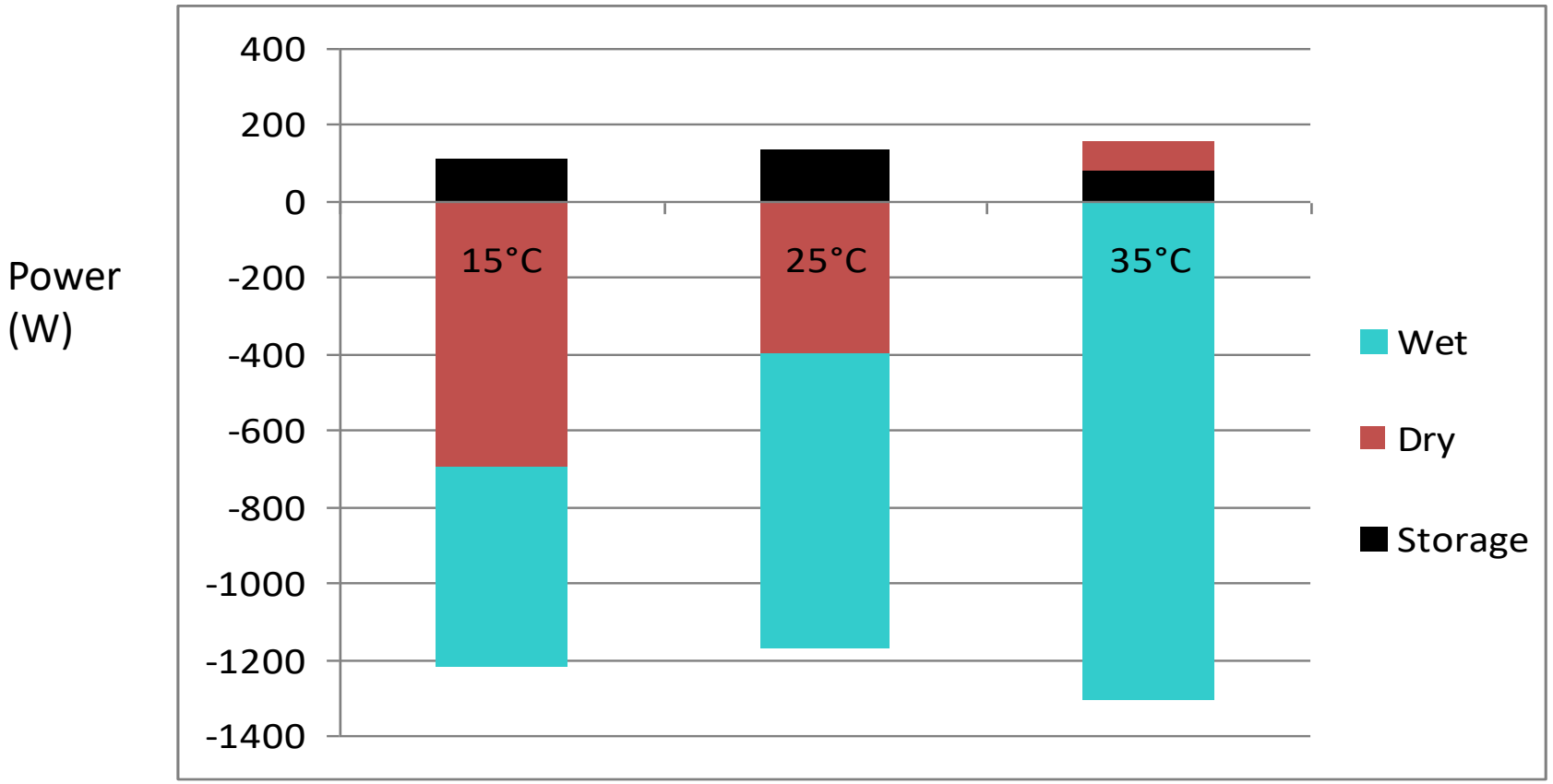
Human heat balance



Heat production – Heat loss = Heat storage



Human heat balance during 8 km run



(Marino et al., EJAP, 2000)

Esophageal temperature increase

	Temperature increase (°C)
Tetraplegia	1.9
High paraplegia	1.2
Low paraplegia	0.7
Able bodied	0.5

Forsyth et al. 2019, MSSE

Heat strain

Risc factors:

*** High Temperature**

*** High Humidity**

*** No wind**

*** Solar radiation**

*** Insulation**

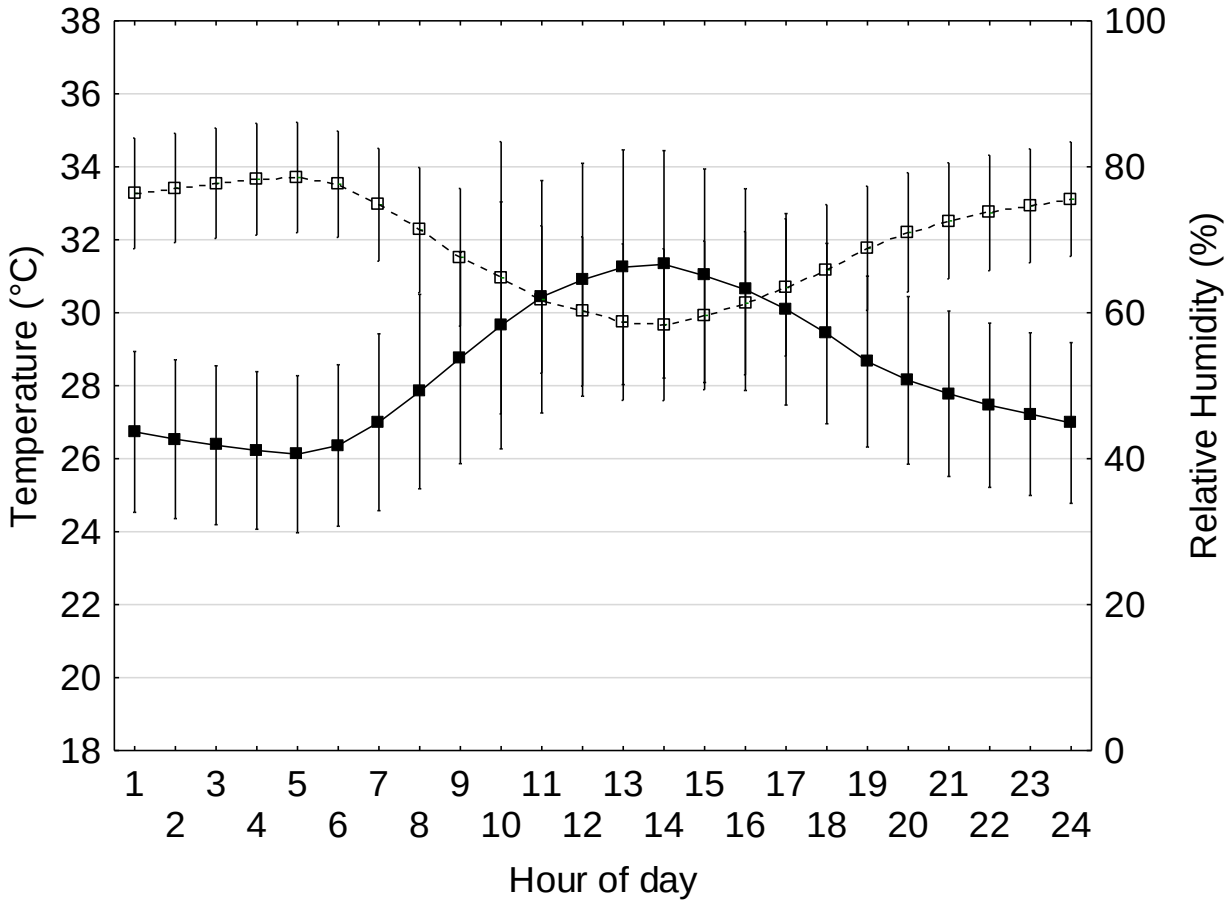
*** Exercise**

Ambient conditions prior to Tokyo 2020 Olympic and Paralympic games. Considerations for acclimation or acclimatization

Gerrett, N., Kingma, B., Sluijter, R.& Daanen, H.A.M.

Frontiers in Physiology (2019)

A



- Hourly intervals based on meteorological data from the past 29 years (1990-2018)
- Olympic period (July 24th until August 9th).
- During the hottest period of the day (14:00hrs)
  - Ambient temperature is 31.3 ± 3.1˚C
  - Relative humidity 58 ± 10%
  - WBGT 28.6 ± 2.8 ˚C

Figure 1: Temperature (black squares) and relative humidity (open squares) (A), at hourly intervals based on meteorological data from the past 29 years (1990-2018) during the dates corresponding to the Olympic period (July 24th until August 9th). Data is mean and SD.

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WBGT

Black Bulb (temp., radiation, wind)

Wet Bulb (temp., radiation, wind, humidity)

Dry Bulb (temp.)

WBGT = 0.7 WB + 0.2 BB + 0.1 DB

Average WBGT during the **Olympic games**: 27.0 ± 2.8 ˚C

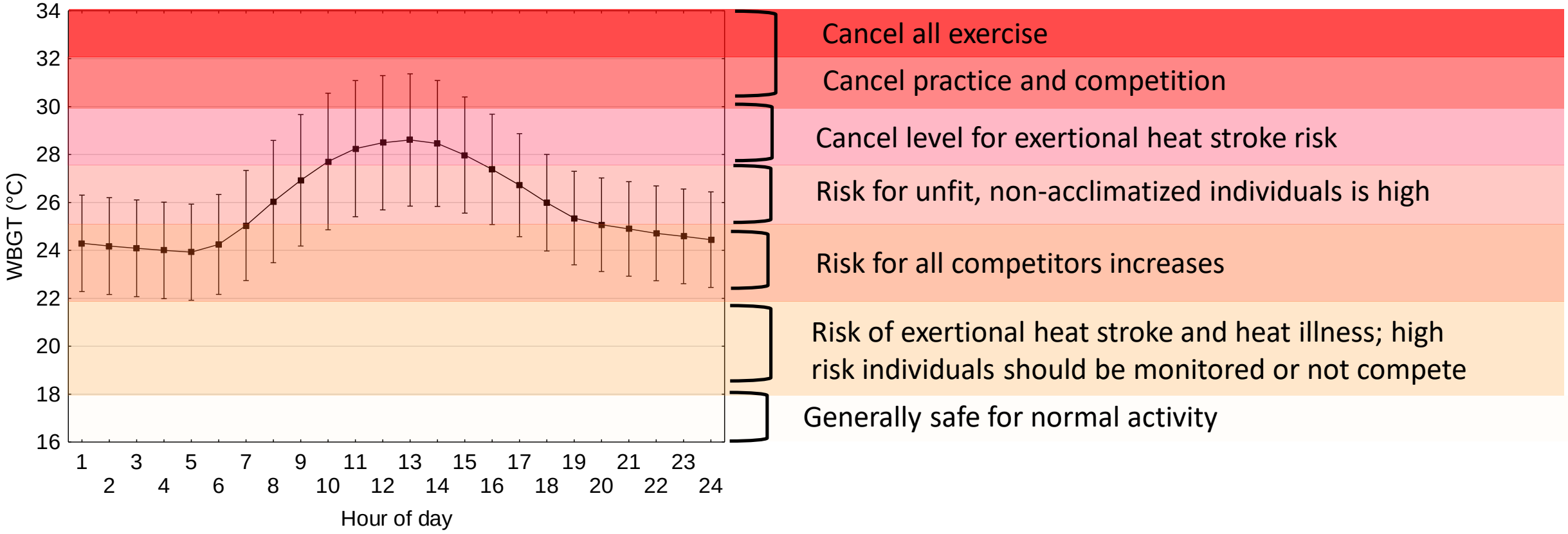

Figure 1: WBGT at hourly intervals based on meteorological data from the past 29 years (1990-2018) during the dates corresponding to the Olympic period (July 24th until August 9th).

Based on ASCM position stand (Armstrong et al. 2007)

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Average WBGT during the **Paralympic games**: 25.4 ± 3.0 ˚C

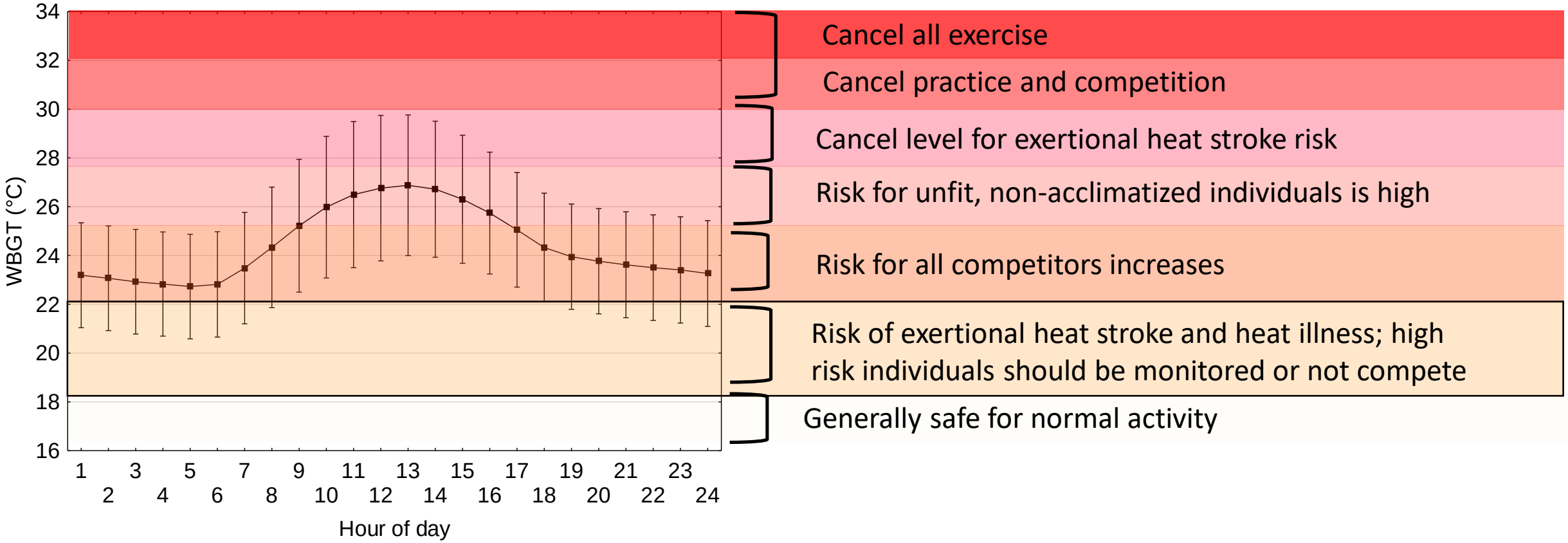

Figure 1: WBGT at hourly intervals based on meteorological data from the past 29 years (1990-2018) during the dates corresponding to the Paralympic period (July 24th until August 9th).

Based on ASCM position stand (Armstrong et al. 2007)

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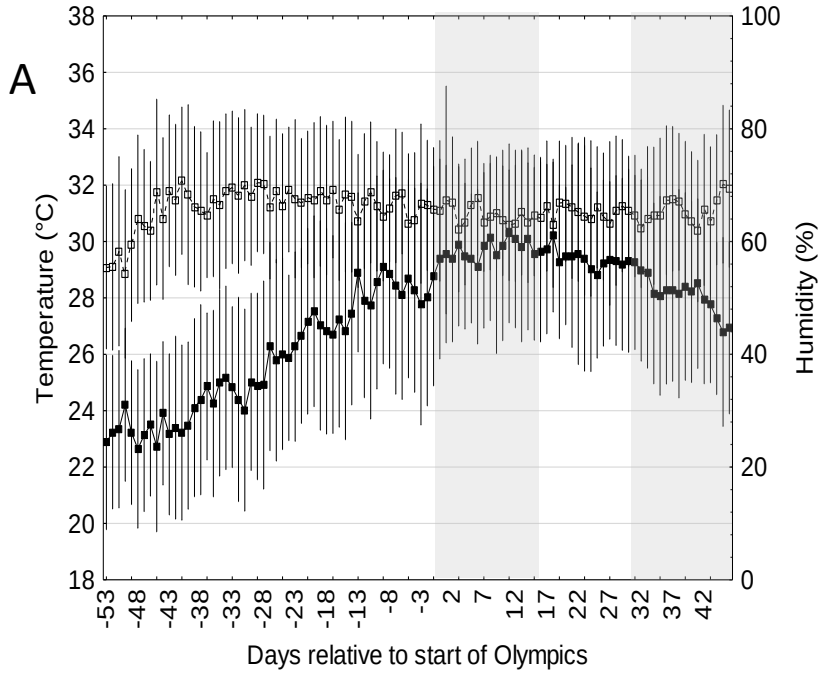


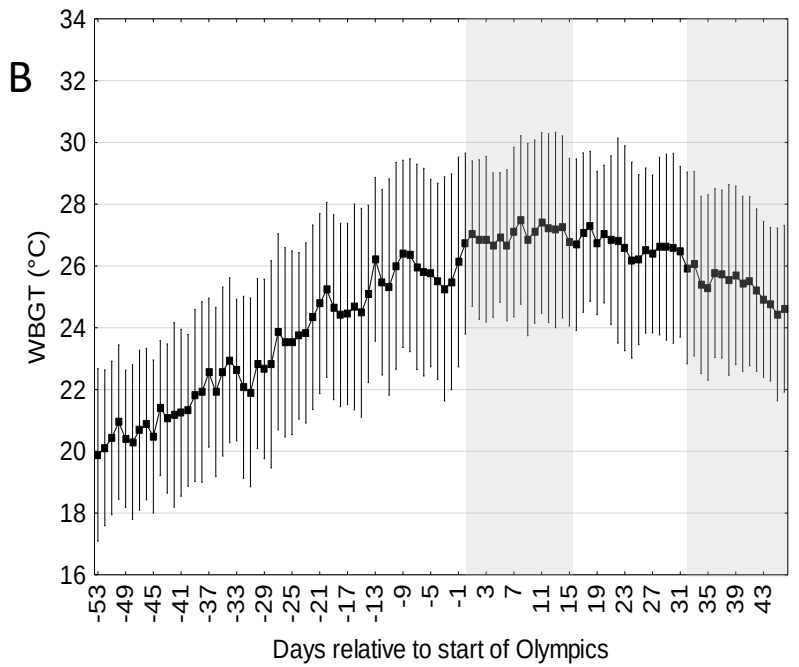
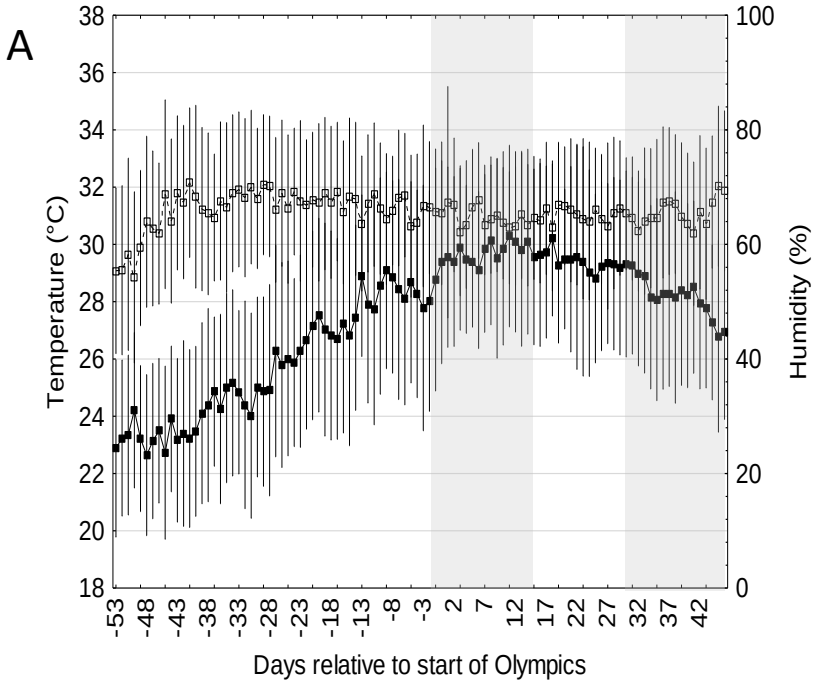


Figure 3: Temperature (black squares) and relative humidity (open squares) (A), WBGT (B), HI (C), Humidex (D) on the days prior to the start of the Olympics and Paralympics. Data is the mean (±SD) during the time period of **0800-2100hrs** obtained from hourly metrological data from the past 29 years (1990-2018).



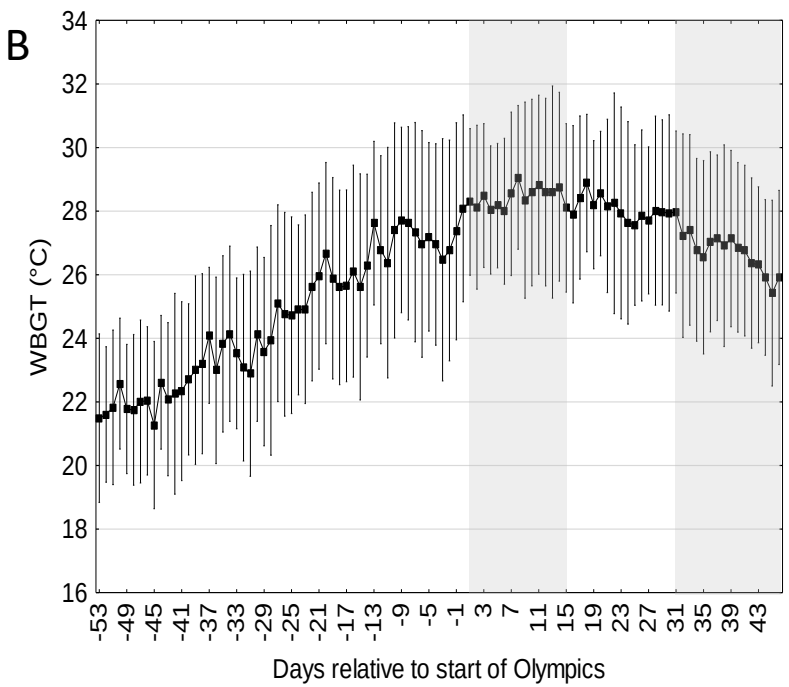


Figure 4: Temperature (black squares) and relative humidity (open squares) (A), WBGT (B), HI (C), Humidex (D) on the days prior to the start of the Olympics and Paralympics. Data is the mean (±SD) during the time period of **12:00-15:00hr**s obtained from hourly metrological data from the past 29 years (1990-2018).

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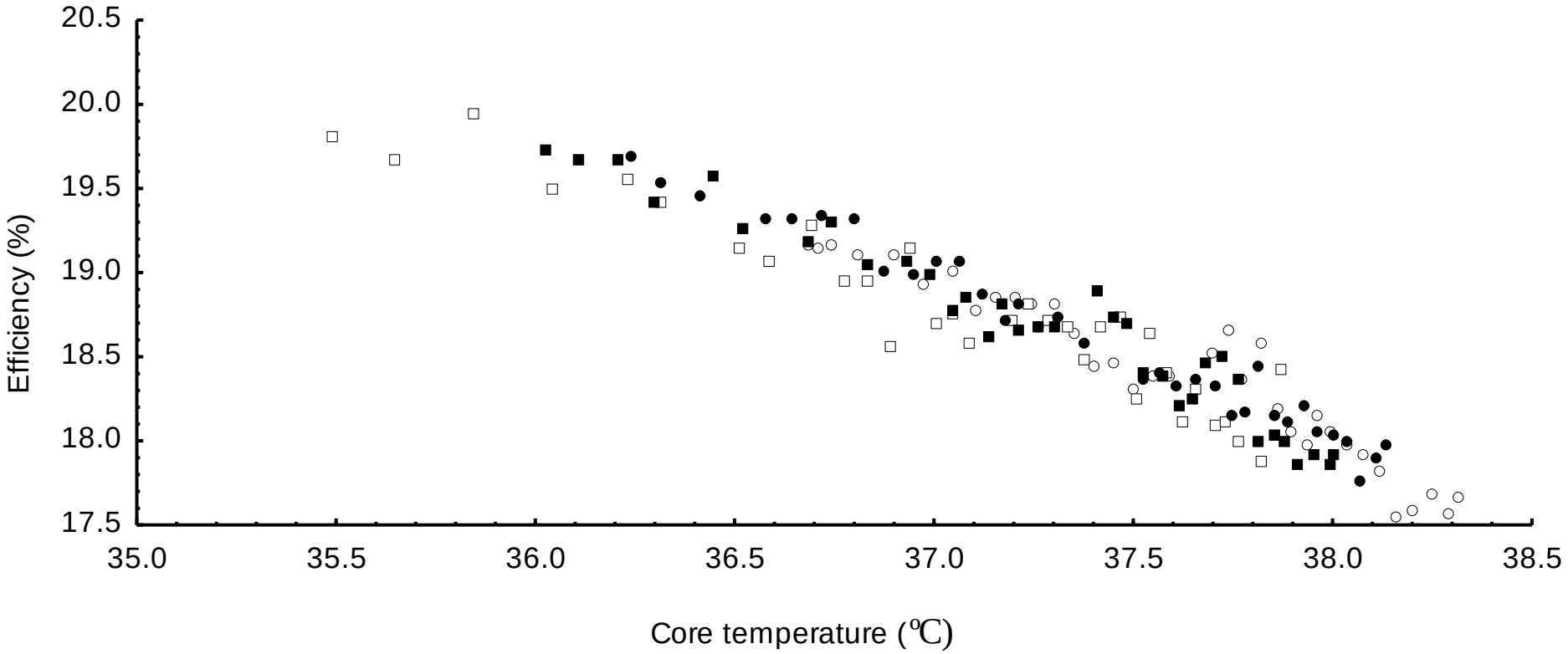
Performance decrease in the heat - physiology



Daanen et al. IJSM 2006

Taylor & Francis
Taylor & Francis Group

Temperature

ISSN: 2332-8940 (Print) 2332-8959 (Online) Journal homepage: https://www.tandfonline.com/loi/ktmp20

Heat-related issues and practical applications for Paralympic athletes at Tokyo 2020

Katy. E. Griggs, Ben.T. Stephenson, Michael. J. Price & Victoria. L. Goosey-Tolfrey

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Techniques to reduce performance decrease in the heat

Selection – best equipped for heat

Pacing strategy

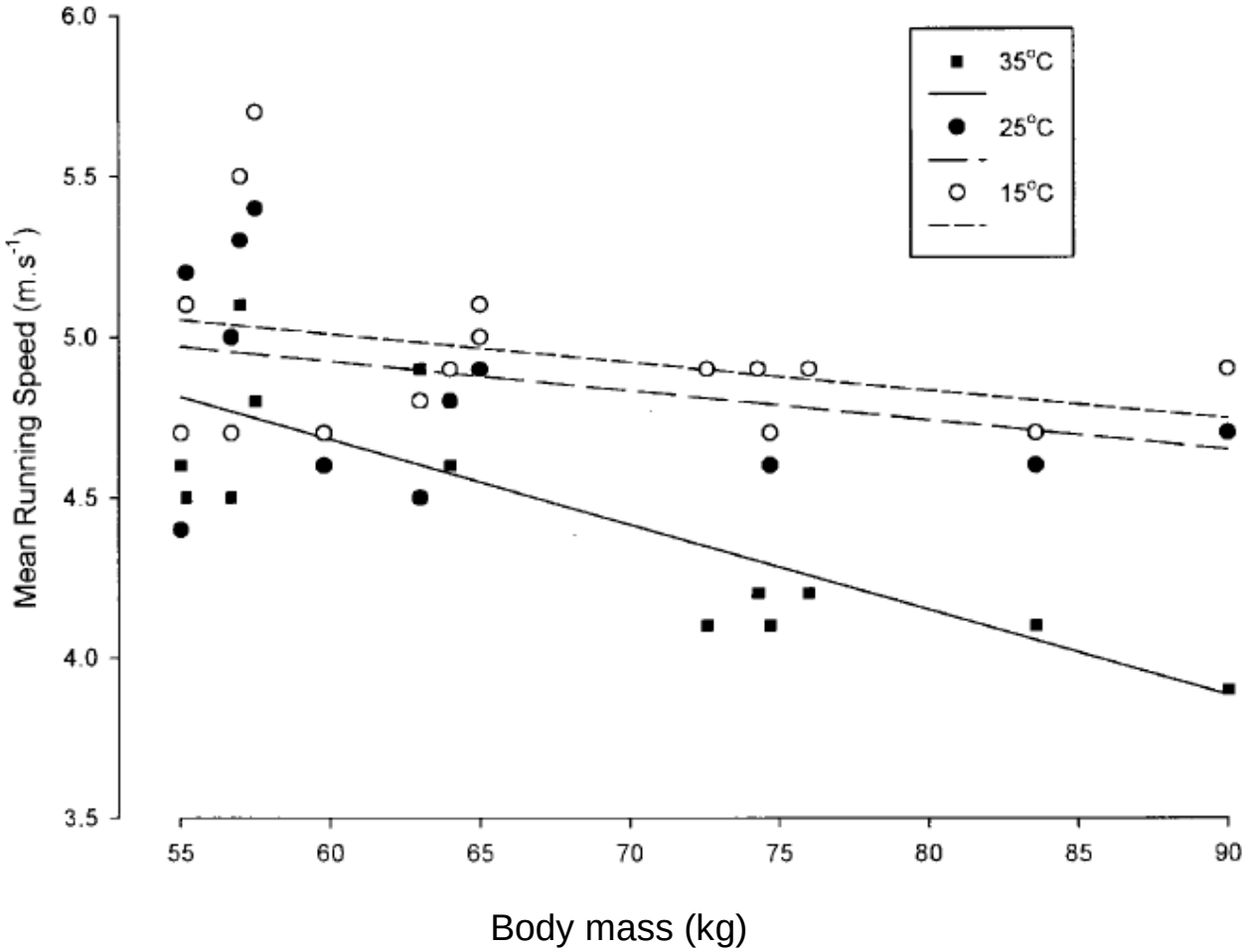
Physiological adaptations - Acclimatization or acclimation

Physical training (cross acclimatisation)

Cooling (prior, during and after exercise)

Drinking

Selection



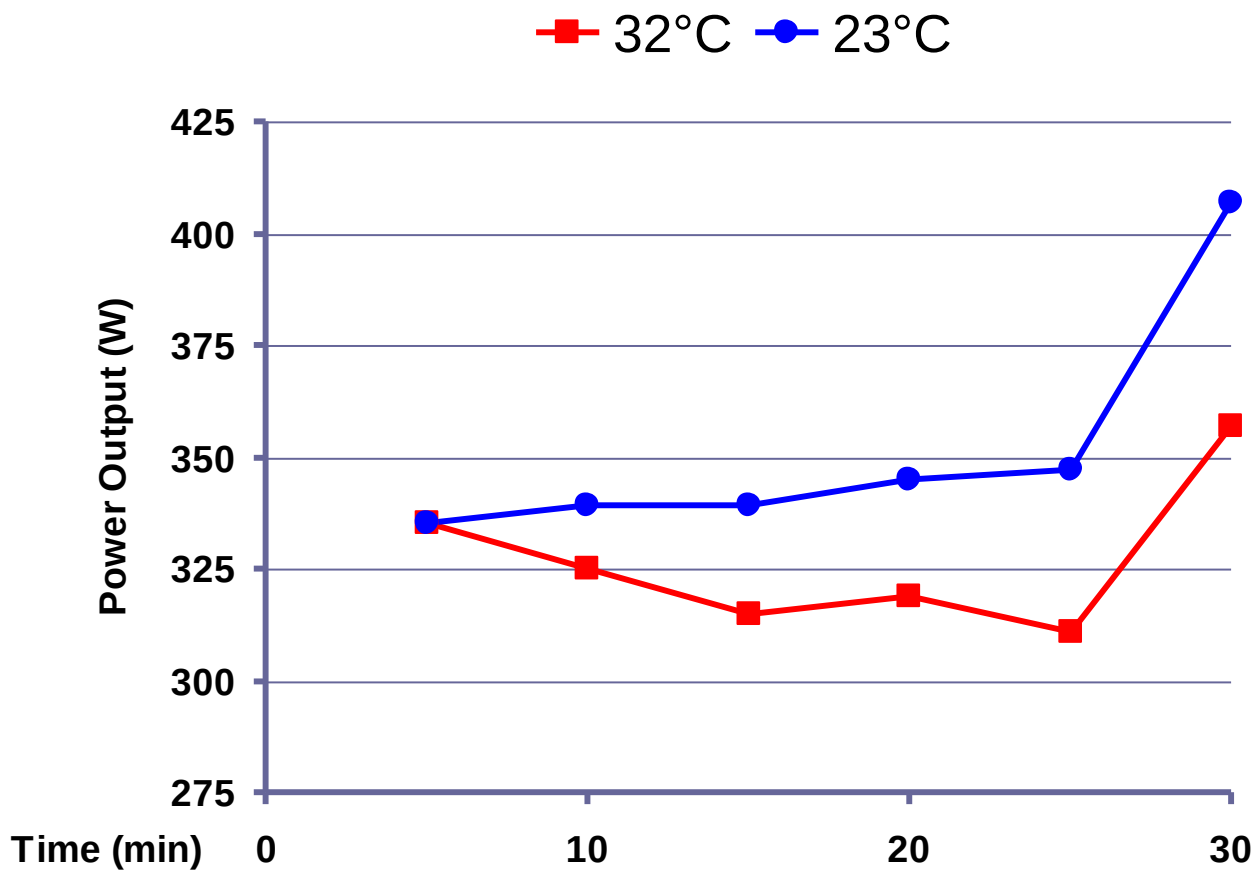
Light runners have a benefit in the heat.

African runners are generally lighter than Caucasians

Marino et al., EJAP 2000

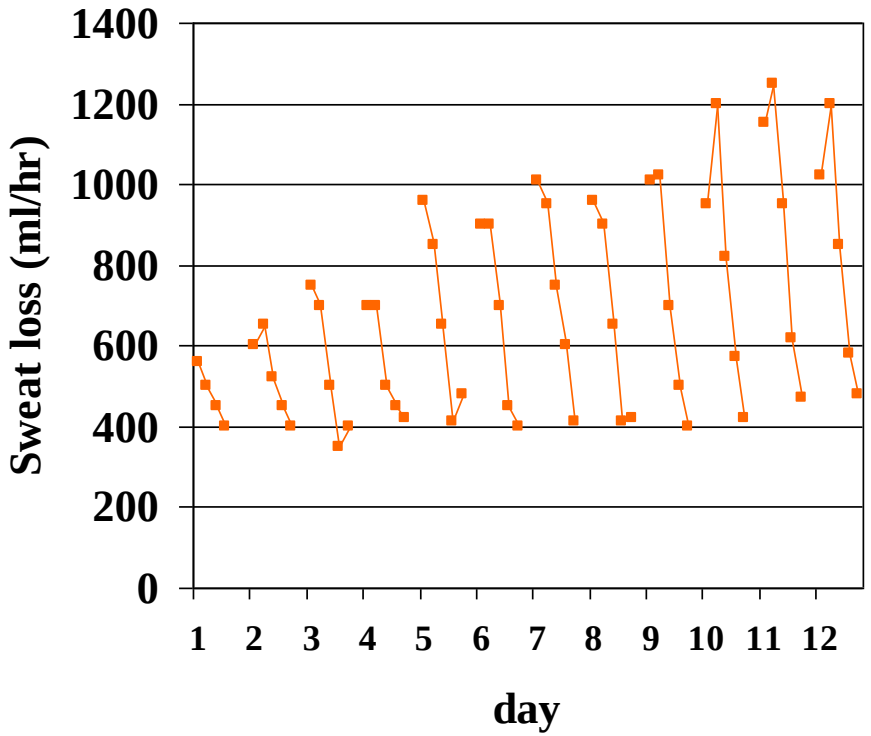
Power output during cycling

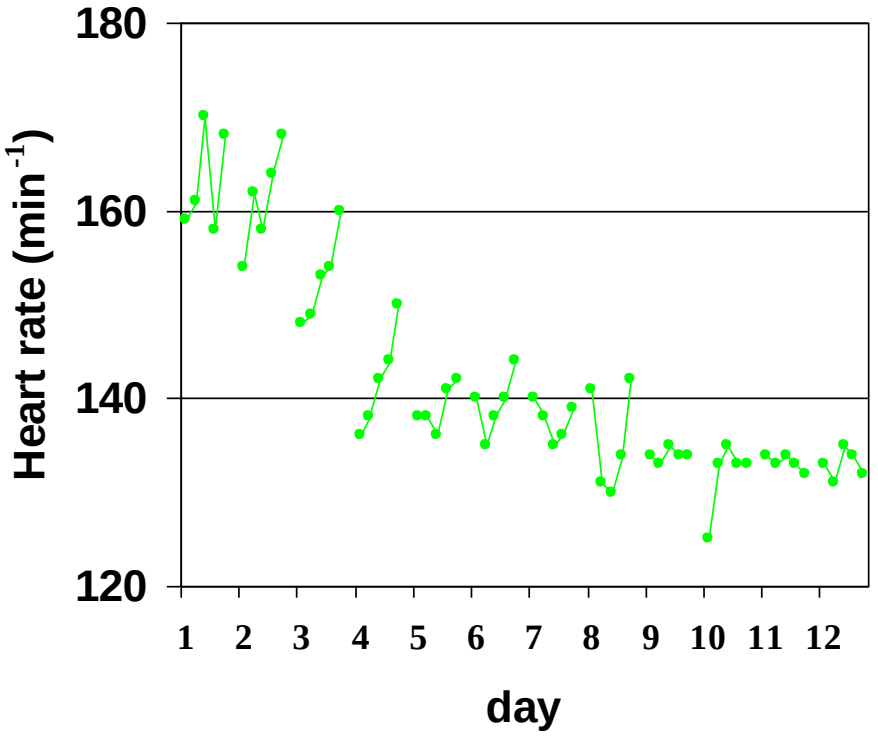
11 top cyclists – End lactate was lower in the heat => no metabolic limitation



Tatterson et al., JSMS, 2000

Acclimation to heat

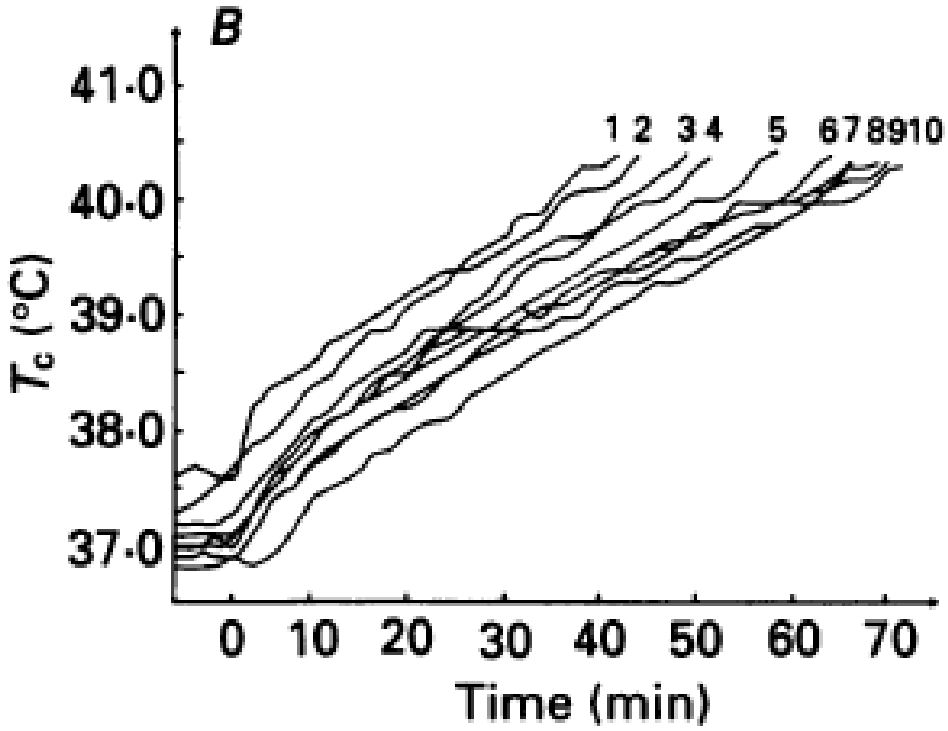




(Strydom et al., JAP 21(2): 636-642, 1966)

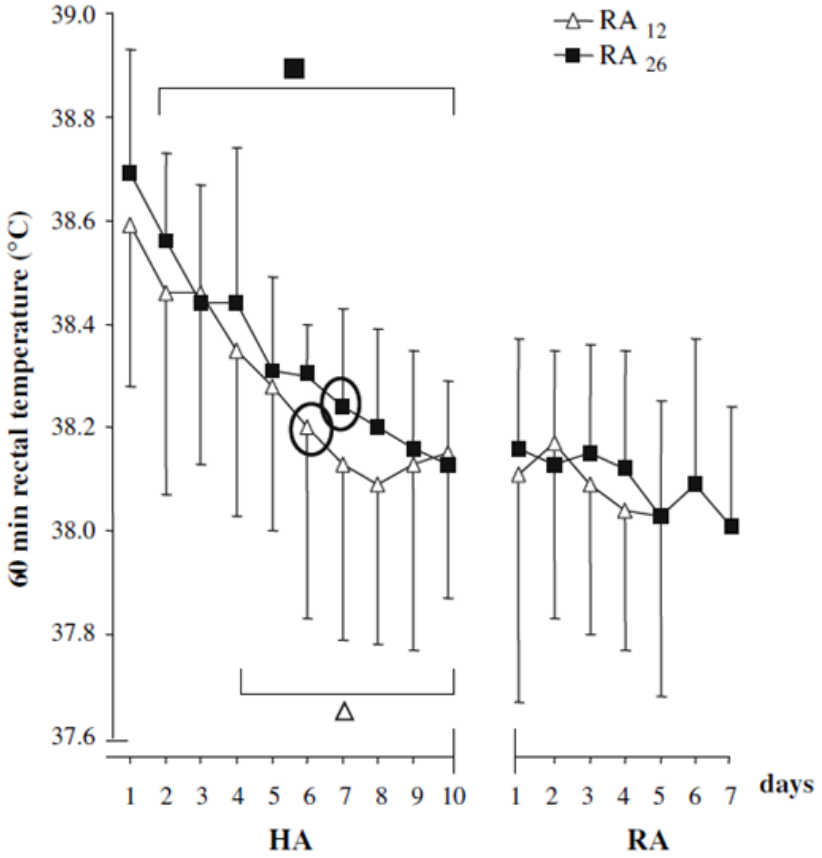
Physiological adaptations to HA

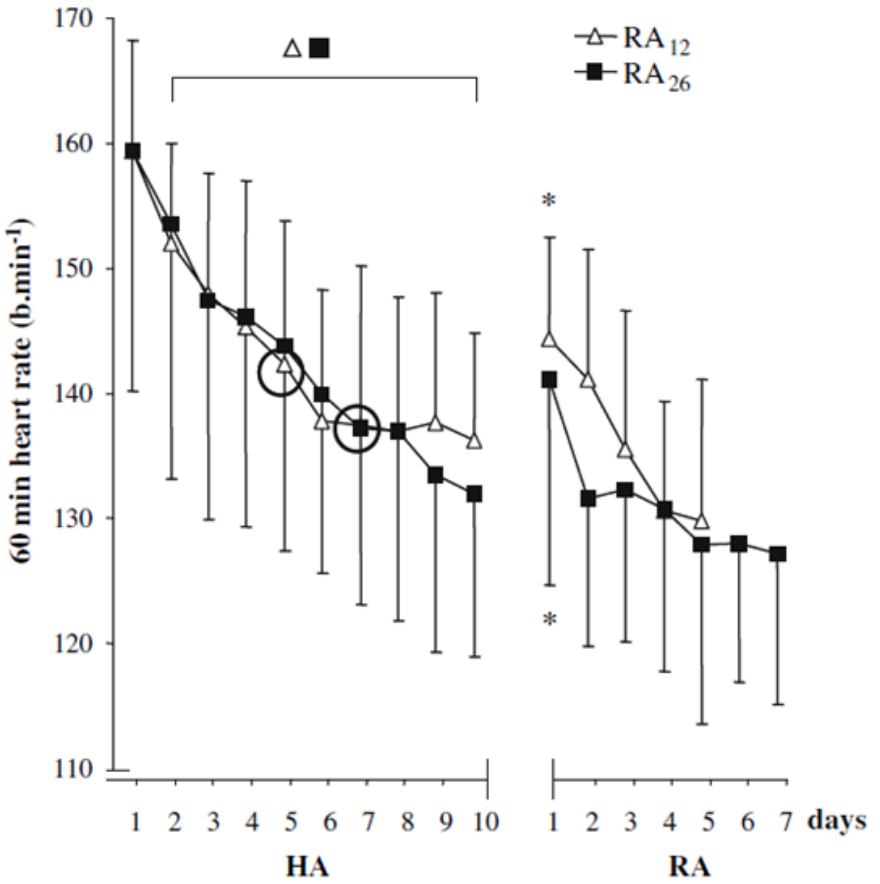
* decreased core temperature ($T_{c)}$
* decreased heart rate (HR)
* increased plasma volume
* Increased production of sweat
* Lower threshold for sweat production
* decreased RPE
* increased thermal and exercise tolerance (and thus performance)



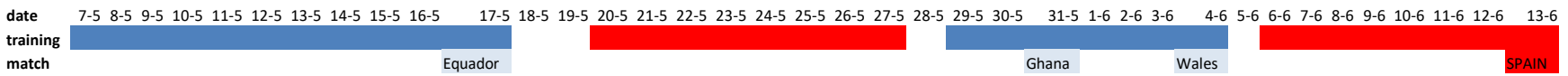
Core temperature during 10 day HA. Exercise to exhaustion (40˚C) Nielsen et al. 1993

De- and Re-acclimation





Dutch Soccer team 2014 WC



Dutch Soccer Team preparations for World Championships Rio 2014 (3th place)

Plan:

HA in Portugal

RA in Brasil

Training in Portugal

When to cool?

Pre-cooling

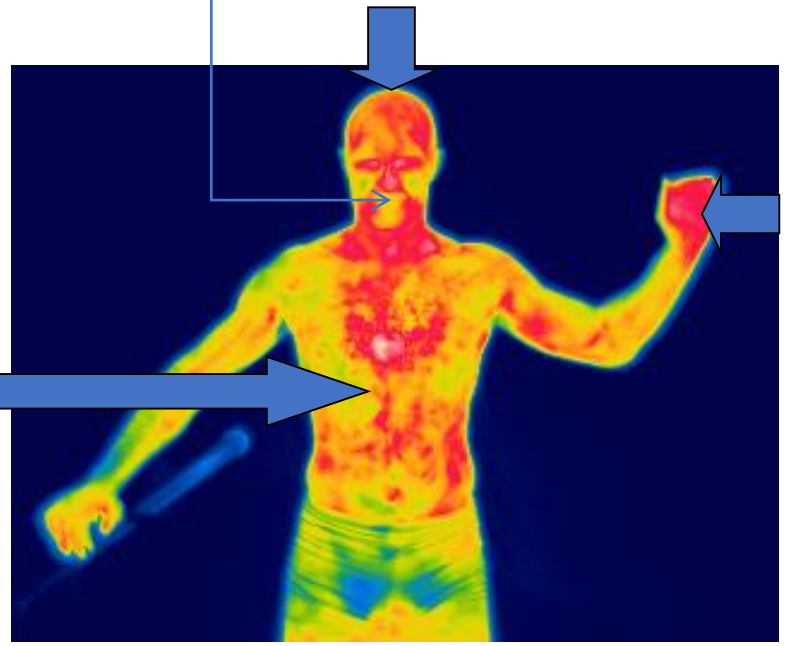
Per-cooling

After-cooling

Where to cool?

Drink /
ice slurry

Head?



Hands?

Torso?

How to cool?

- **Liquid**

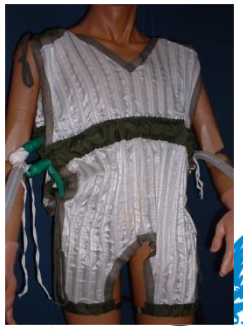
Concept: Let cold water in small tubes flow over the skin, the water takes up heat from the skin and thus from the body

- **Air**

Concept: Let outside air flow over the skin so that the sweat present can evaporate and thus cool the body through its natural method

- **Phase change**

Concept: Put a solid material on the skin with an appropriate melting temperature. The melting process removes heat from the skin, during the melting process the temperature is constant



Conclusions

Human performance is compromised in the heat (Tokyo 2020!)

This is even more so for SCI athletes

Heavy subjects have a disadvantage in the heat

Enforcing an even pacing strategy may help

Humans have great potential for heat acclimation

There is some evidence that re-acclimation is faster than HA

Dedicated (pre)cooling systems may help endurance athletes

Thank you!

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