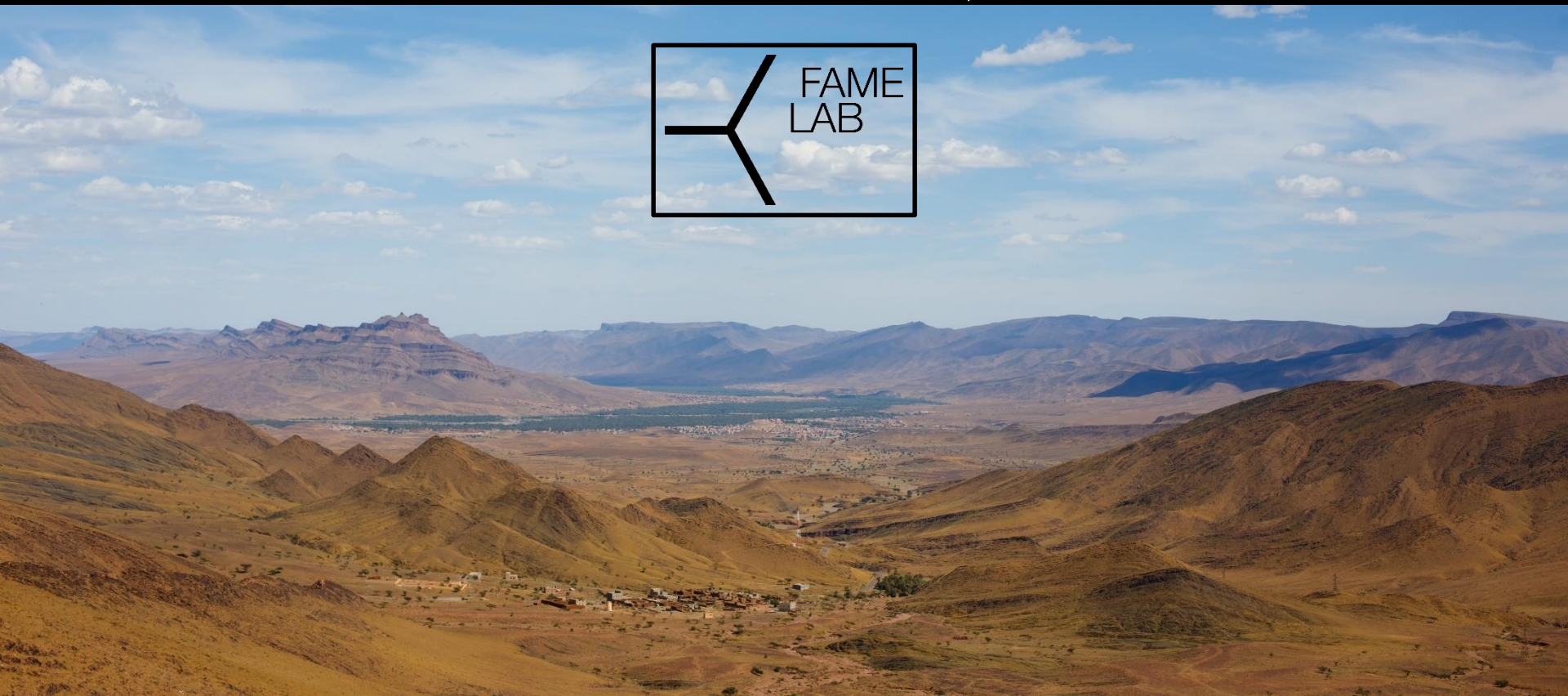
SCIENCE SUPPORT AND PREPARATION FOR ATHLETIC EVENTS IN EXTREME ENVIRONMENTAL TEMPERATURES

Andreas D. Flouris, PhD

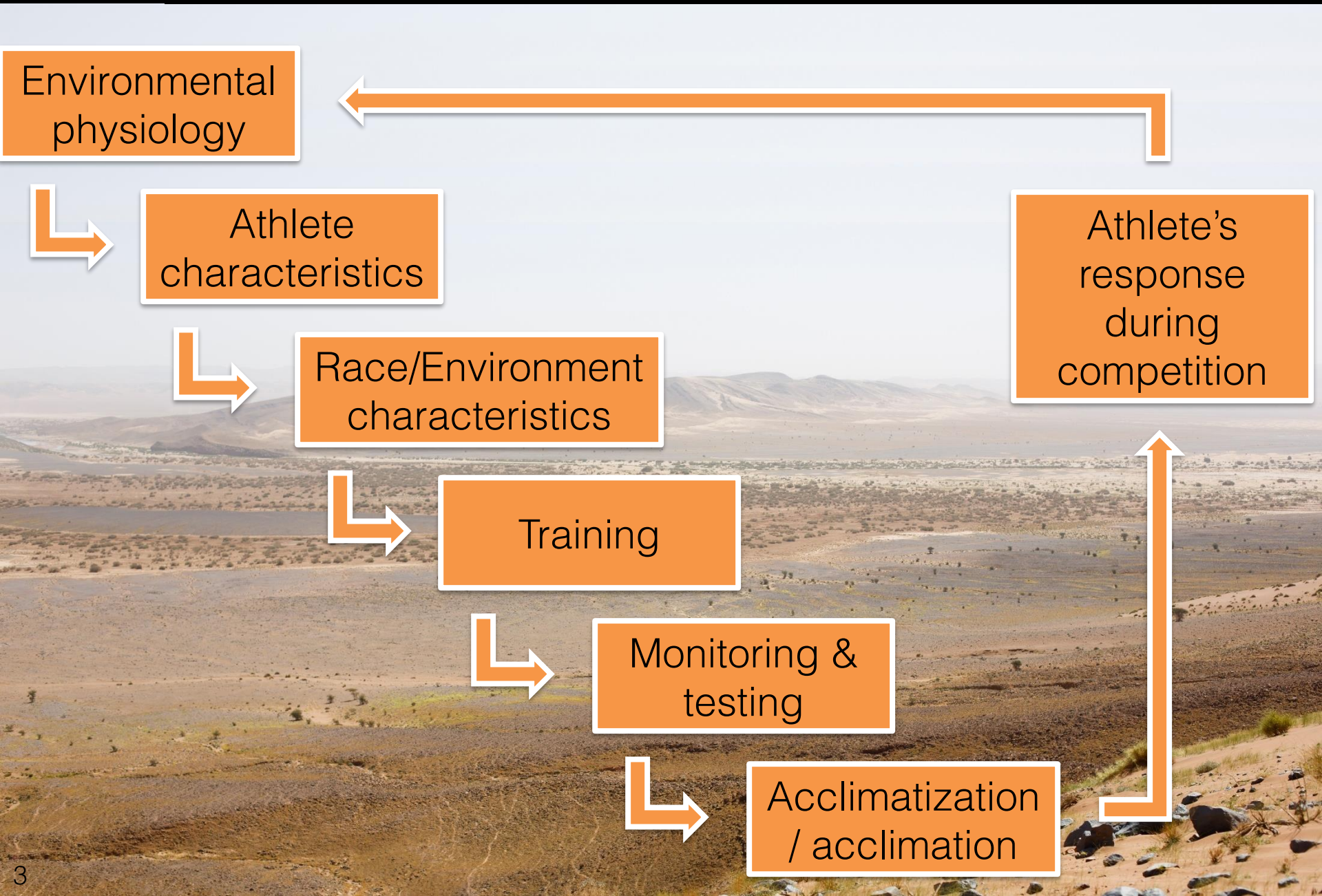


THE ATHLETE IN EXTREME HEAT

…"But sunstroke gives no such warning. It strikes down its victim with his full armor on. Youth, health, and strength oppose no obstacle to its power; nay, it would seem, in some instances, to seek out such as these, as if boldly to flaunt its power, and in the very glare of day to deal its final blow.“

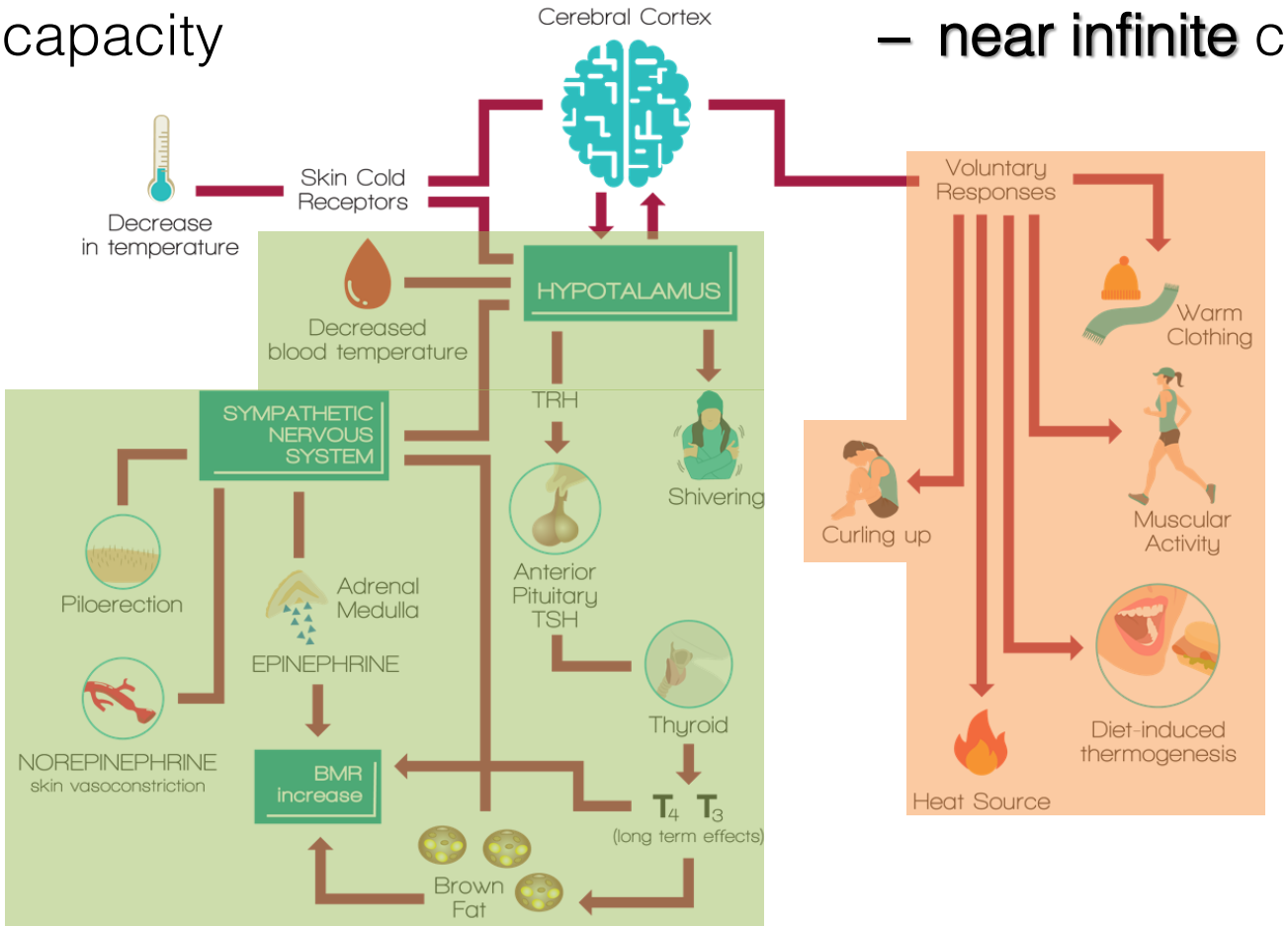
Levick J.J., Remarks on sunstroke, Am J Med, 1859

ATHLETE SUPPORT FOR EVENTS IN HEAT



THERMOREGULATION

- **Autonomic** thermoregulation
  - **finite** capacity
- **Behavioural** thermoregulation
  - **near infinite** capacity



HUMAN RESPONSES TO HEAT

Increases in skin/core temperature (heat/work)

- Heat dissipation
  - peripheral vasodilation
  - sweating

HUMAN RESPONSES TO HEAT

Increases in skin/core temperature (heat/work)

- Heat dissipation
  - peripheral vasodilation

  - sweating

- **Behavioural responses**

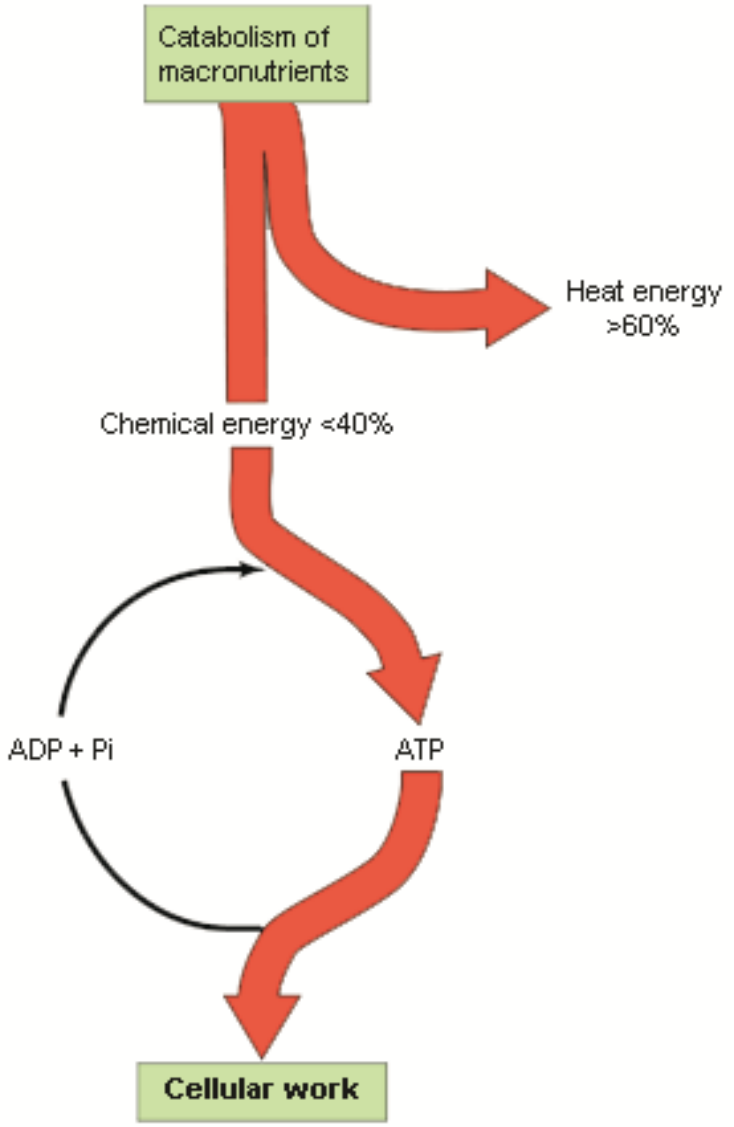
insulation/clothing

shade/breeze

relaxation

THERMOREGULATION

- The human body is quite inefficient at using the energy derived from metabolic processes to generate external work
  - ~60-95% of the available energy (depending upon the physical task) is wasted and subsequently released as heat energy

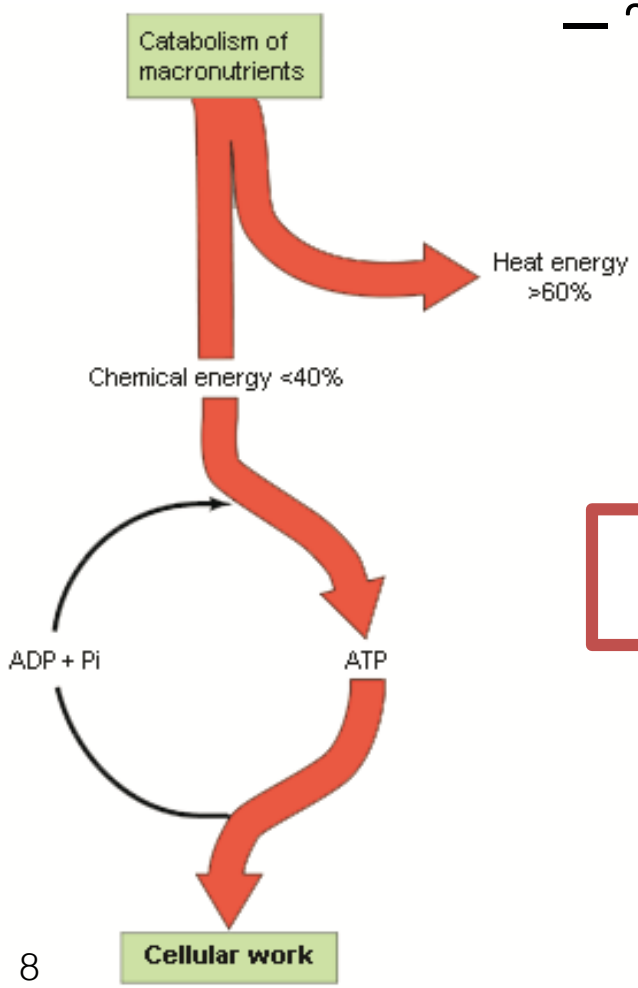


- The body must dissipate this excessive amount of heat to the environment to maintain its thermal homeostasis

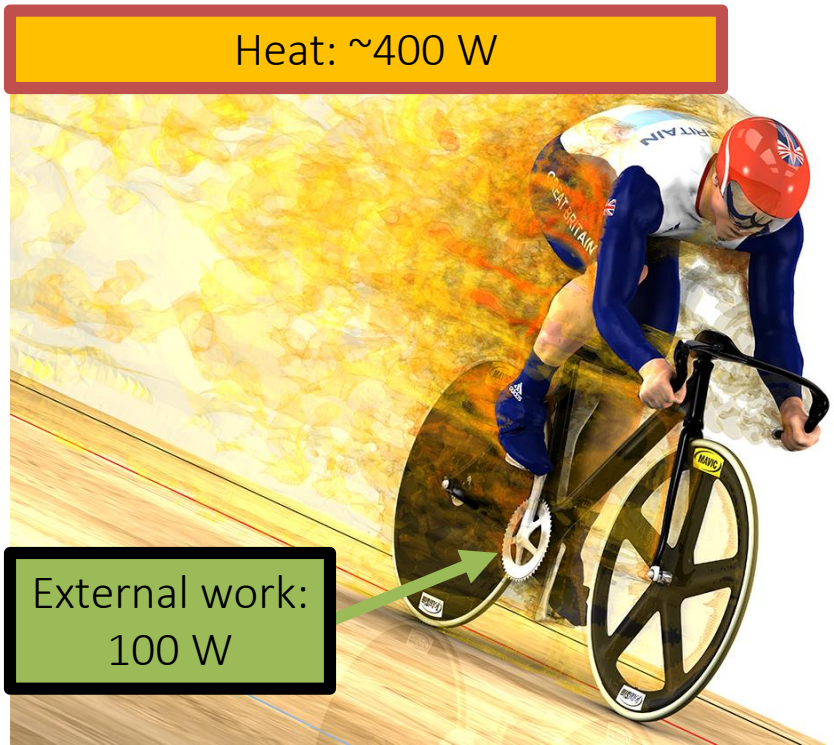
THERMOREGULATION DURING EXERCISE

- Cycling (most efficient physical task)
  - ~20% of energy used for work

Whipp & Wasserman, JAP, 1972



Catabolism: 500 W



THERMOREGULATION DURING EXERCISE

↓ performance

Flouris & Schlader, SJSMS, 2015

Schlader et al., J Therm Biol, 2011

Flouris, Eur J Appl Physiol, 2011

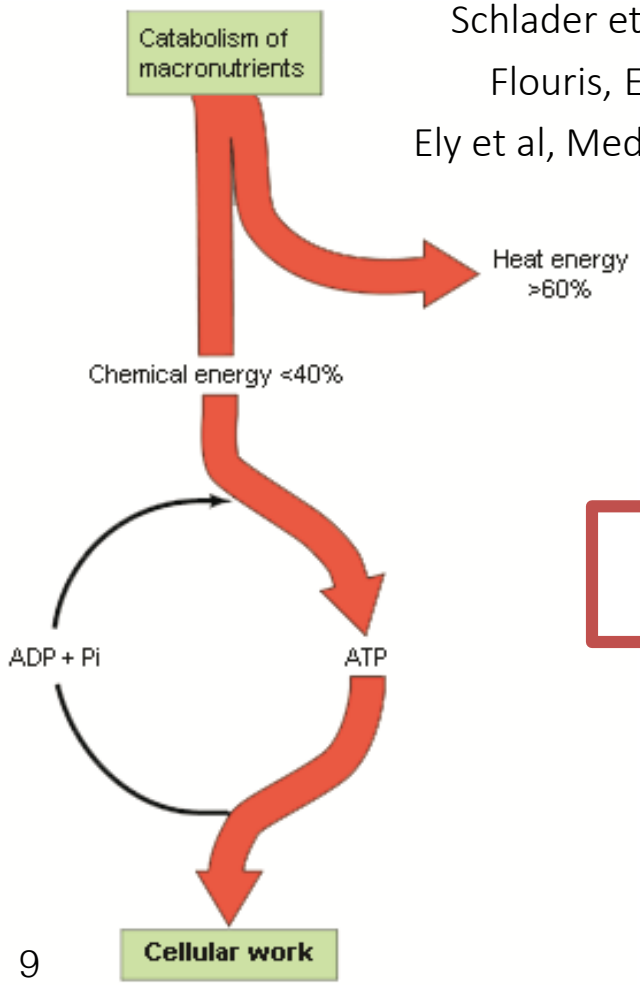
Ely et al, Med Sci Sports Exerc, 2010

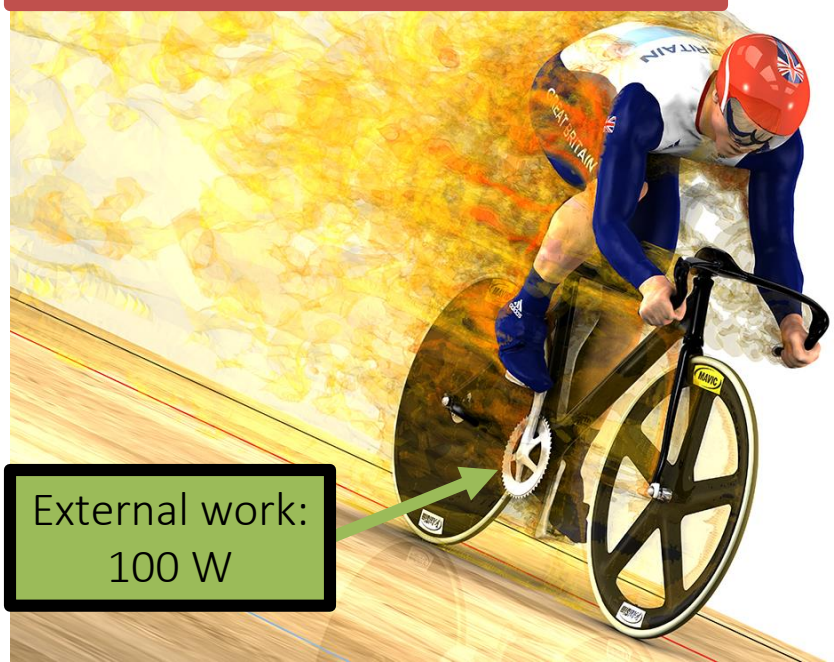
↑ body temperature

Heat: ~400 W

Catabolism: 500 W

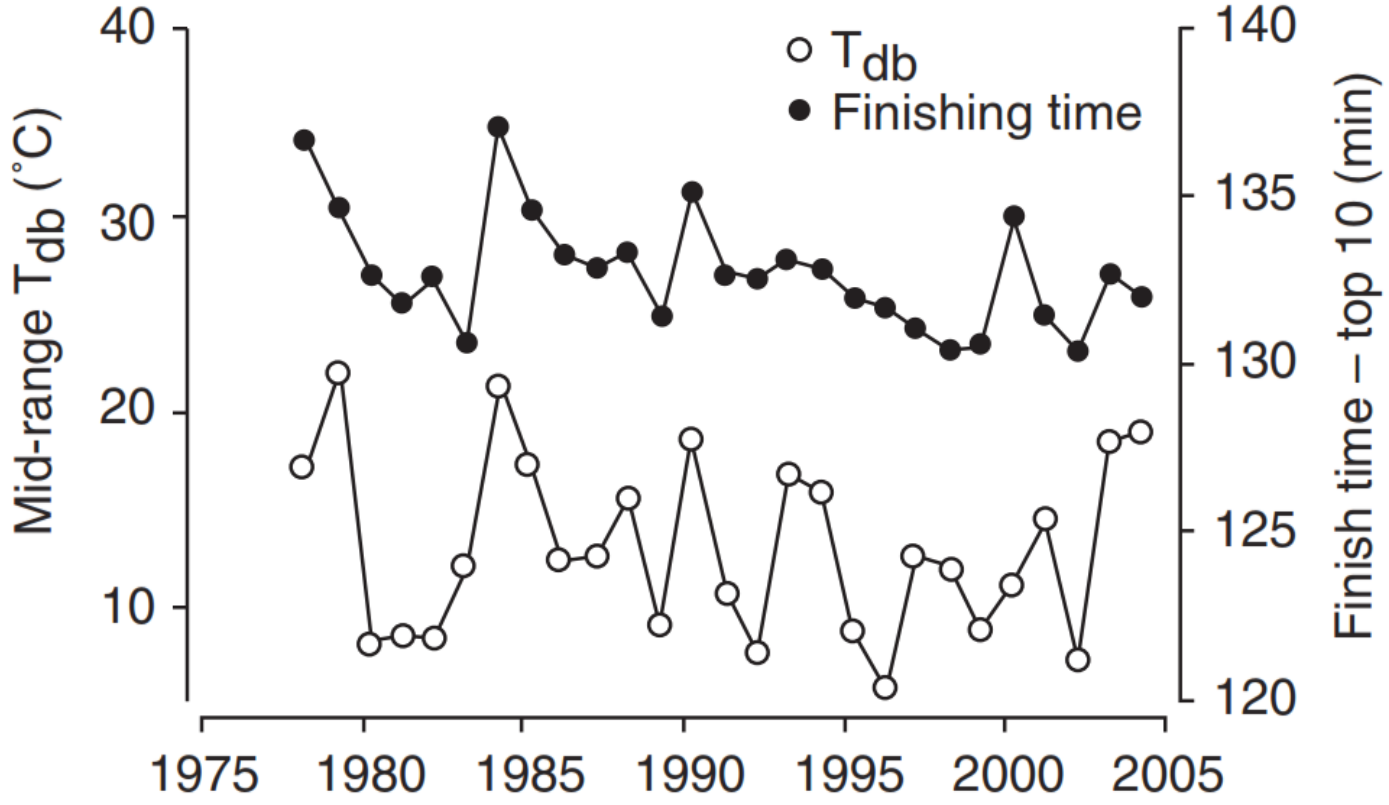
External work: 100 W



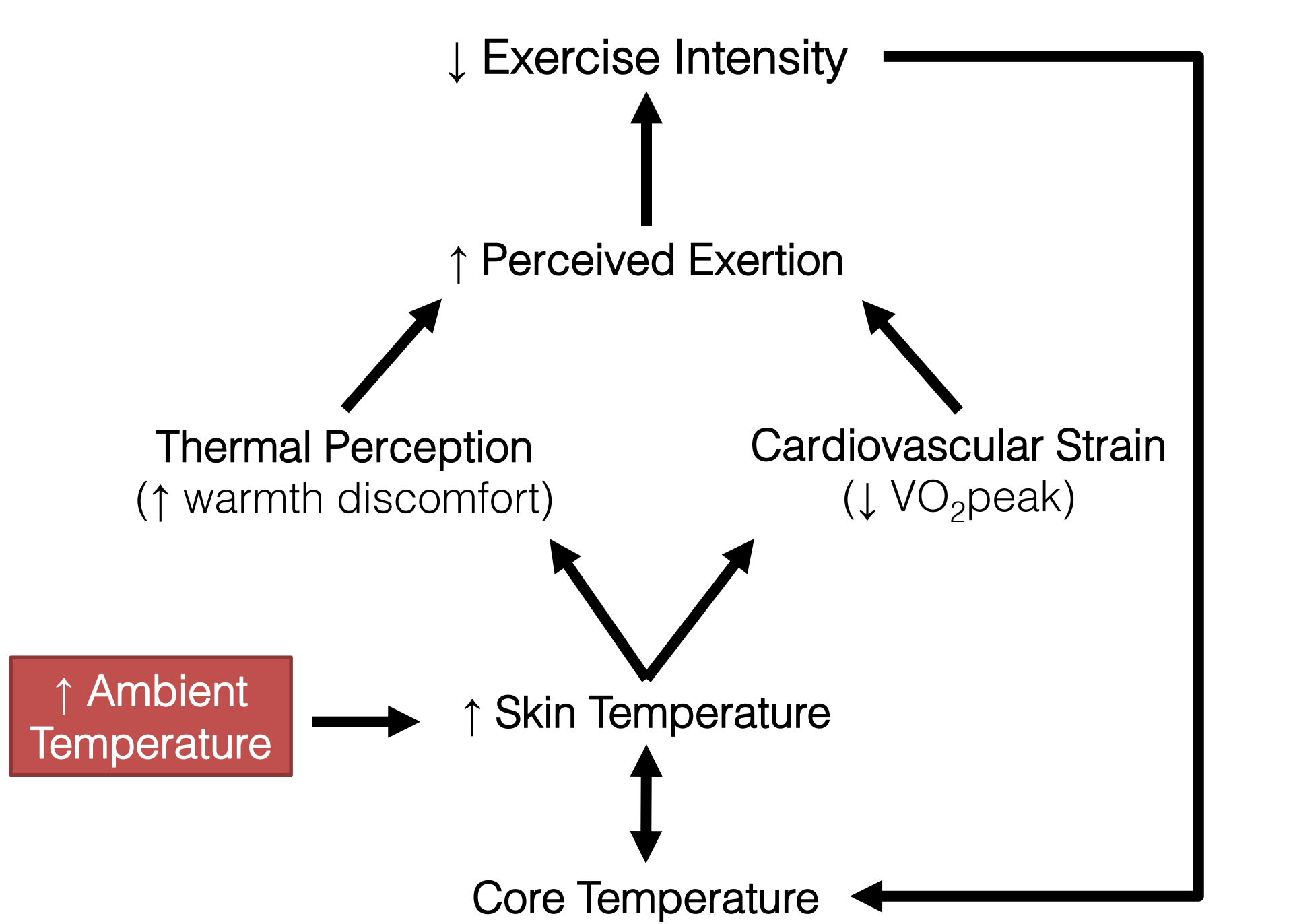


HEAT AND MARATHON PERFORMANCE

Dry bulb temperatures and mean finishing times of top 10 male finishers of New York City Marathon from 1978 to 2004



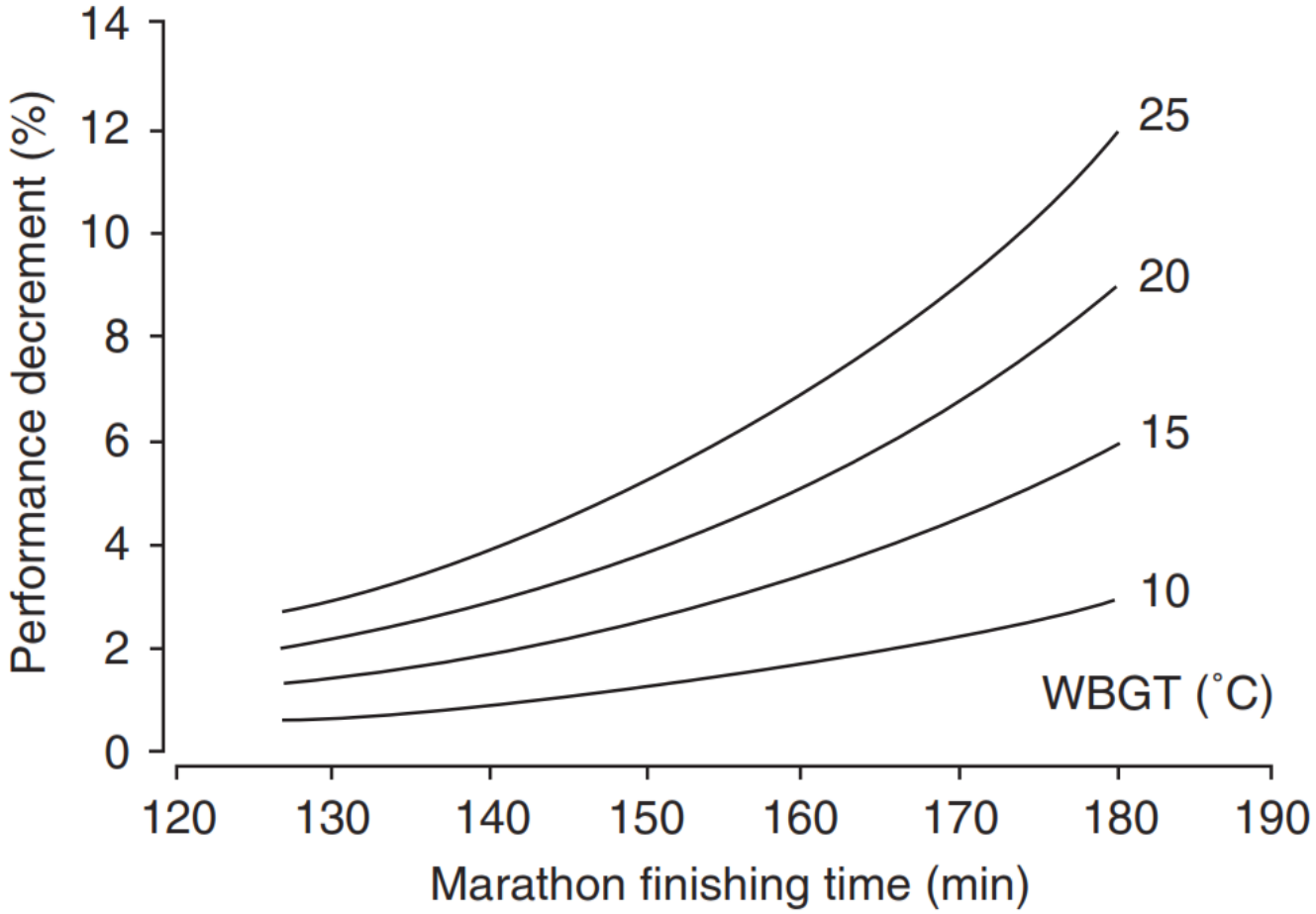
Montain et al., Sports Med, 2007



Flouris & Schlader, SJSMS, 2015

HEAT AND MARATHON PERFORMANCE

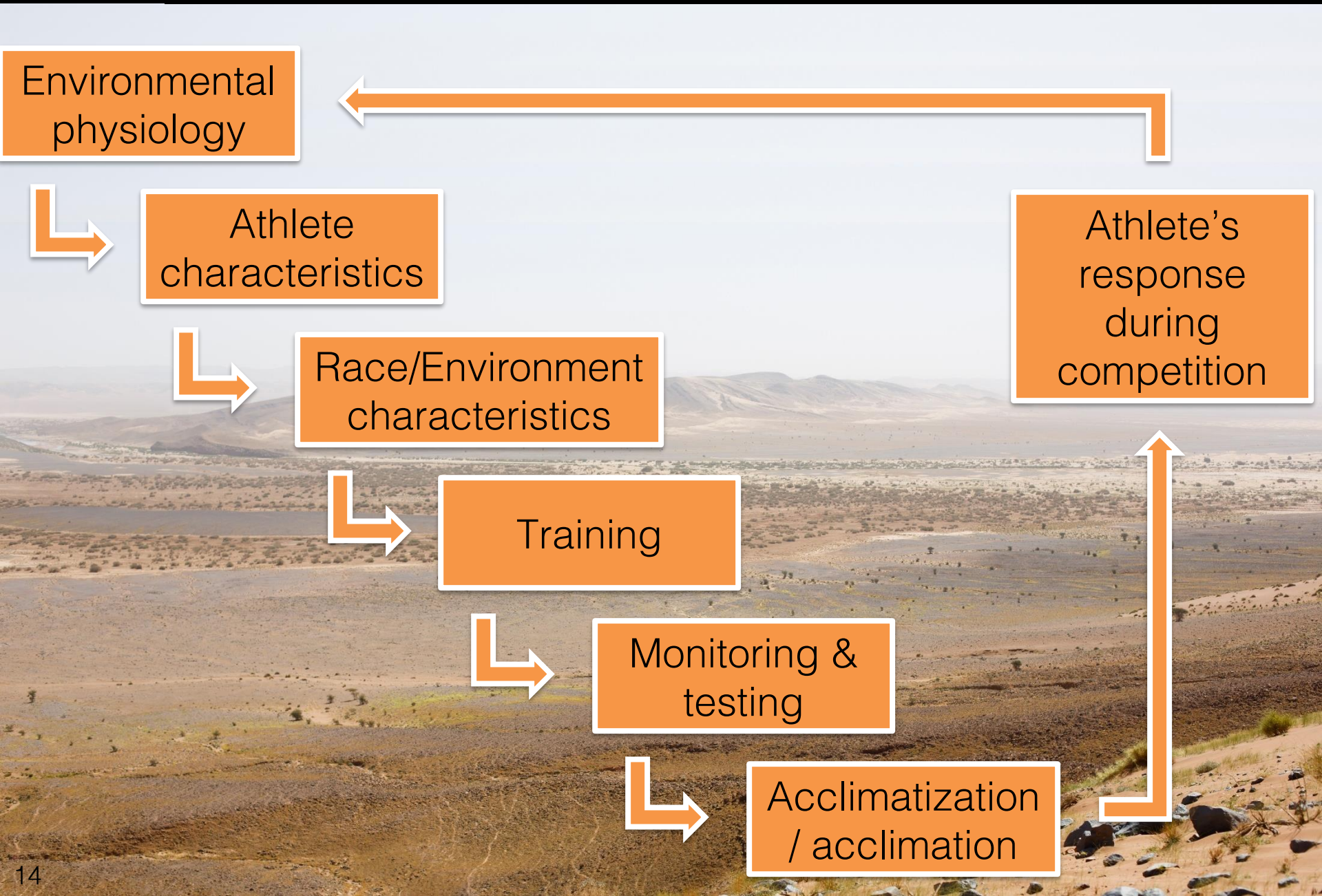
- Performance decrements and projected marathon finishing time with increasing WBGT from the New York City Marathon between 1978 and 2004



Ely et al., MSSE, 2007

2015 MARATHON DES SABLES

ATHLETE SUPPORT FOR EVENTS IN HEAT



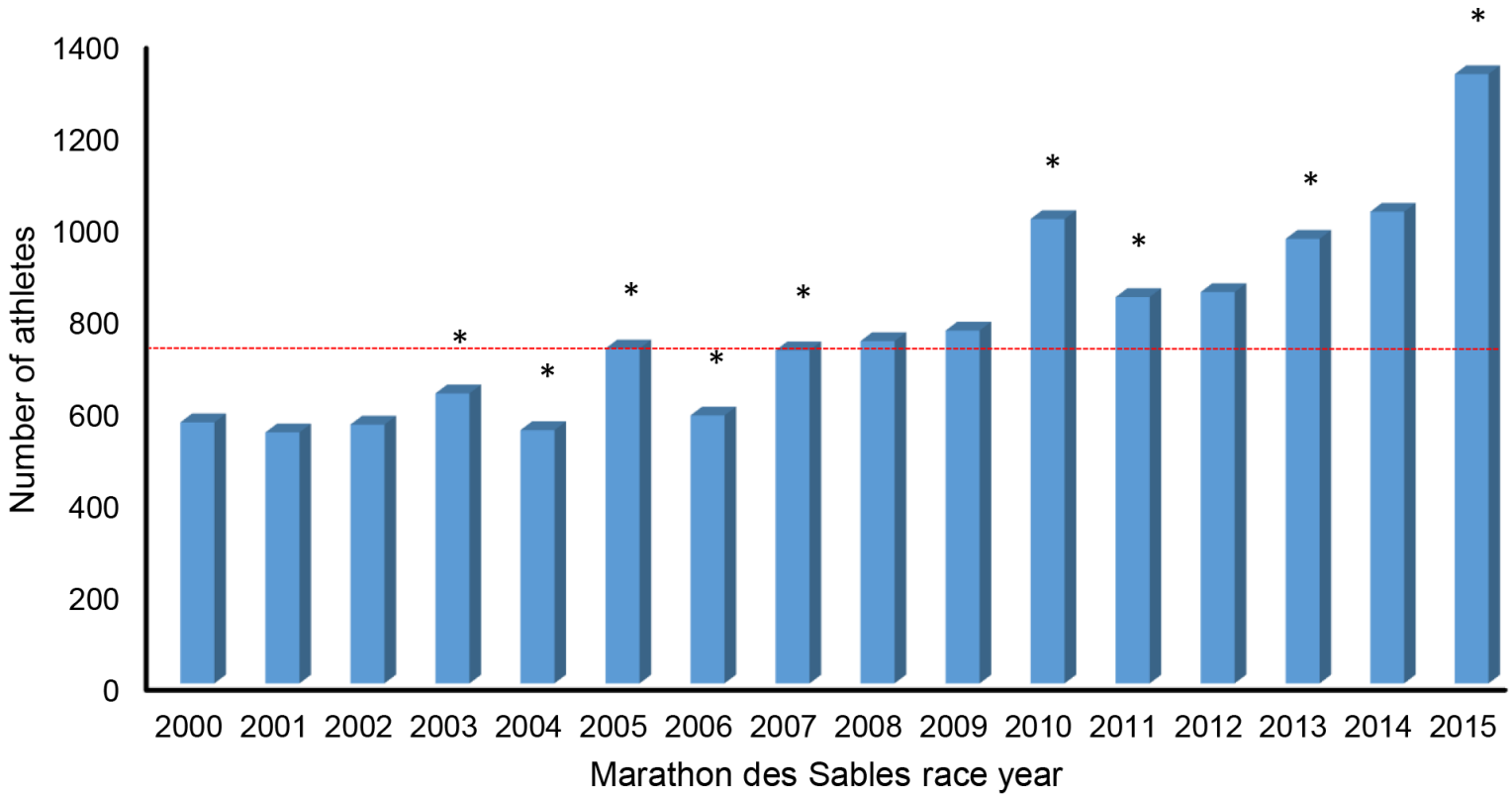
ATHLETE CHARACTERISTICS

- Sex: male
- Age: 39
- Weight: 86 kg
- Height: 1.83 m
- BMI: 25.7
- Body fat: 16.4%
- VO_2peak: 69 ml/kg/min
- Medical history: no serious and/or chronic conditions

RACE CHARACTERISTICS

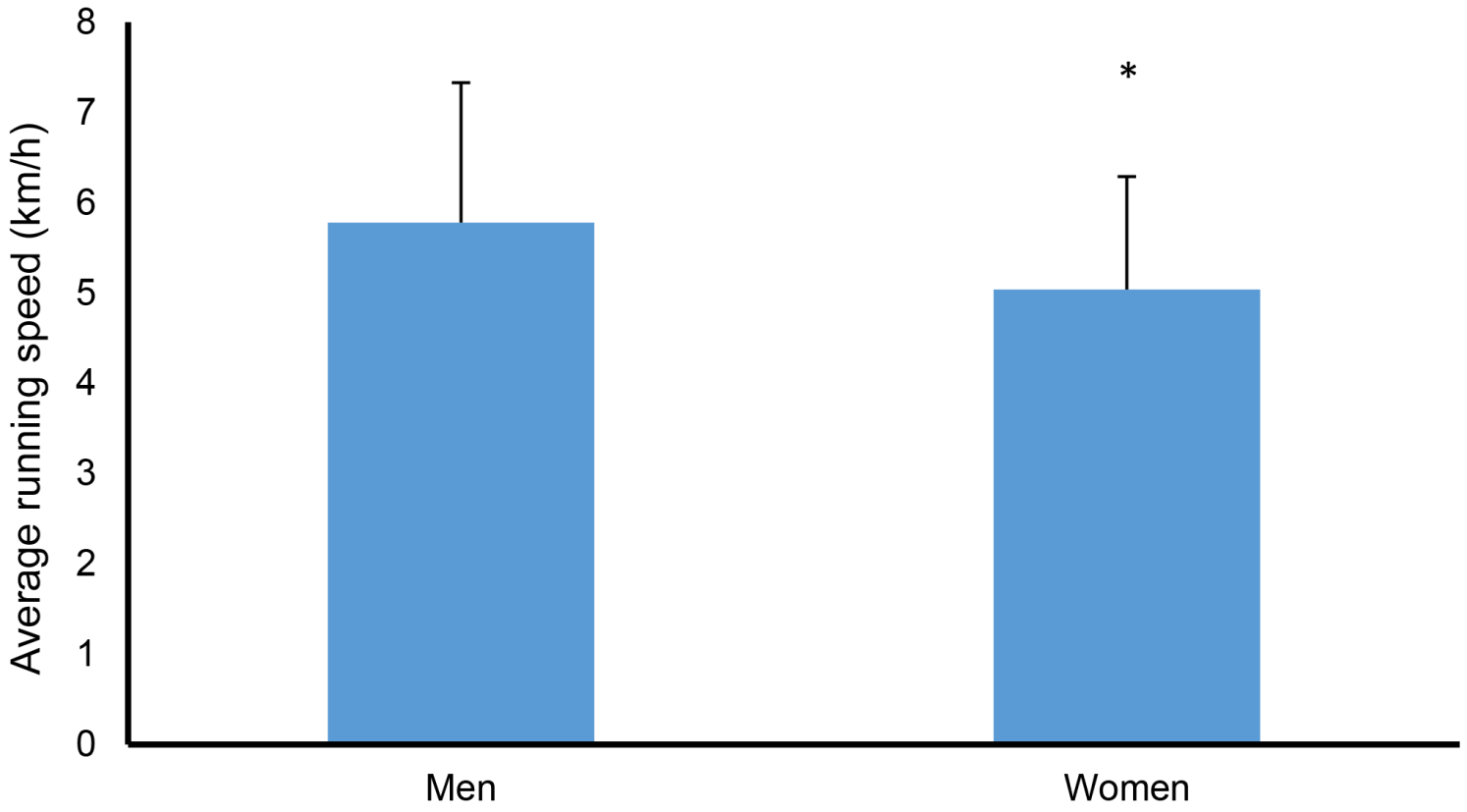
- Venue: Moroccan desert
- Duration: 7 days (5th day rest)
- Distance: >250 km
- Carrying food and equipment
- Water: 4½ L daily to be carried by the athlete

RACE CHARACTERISTICS



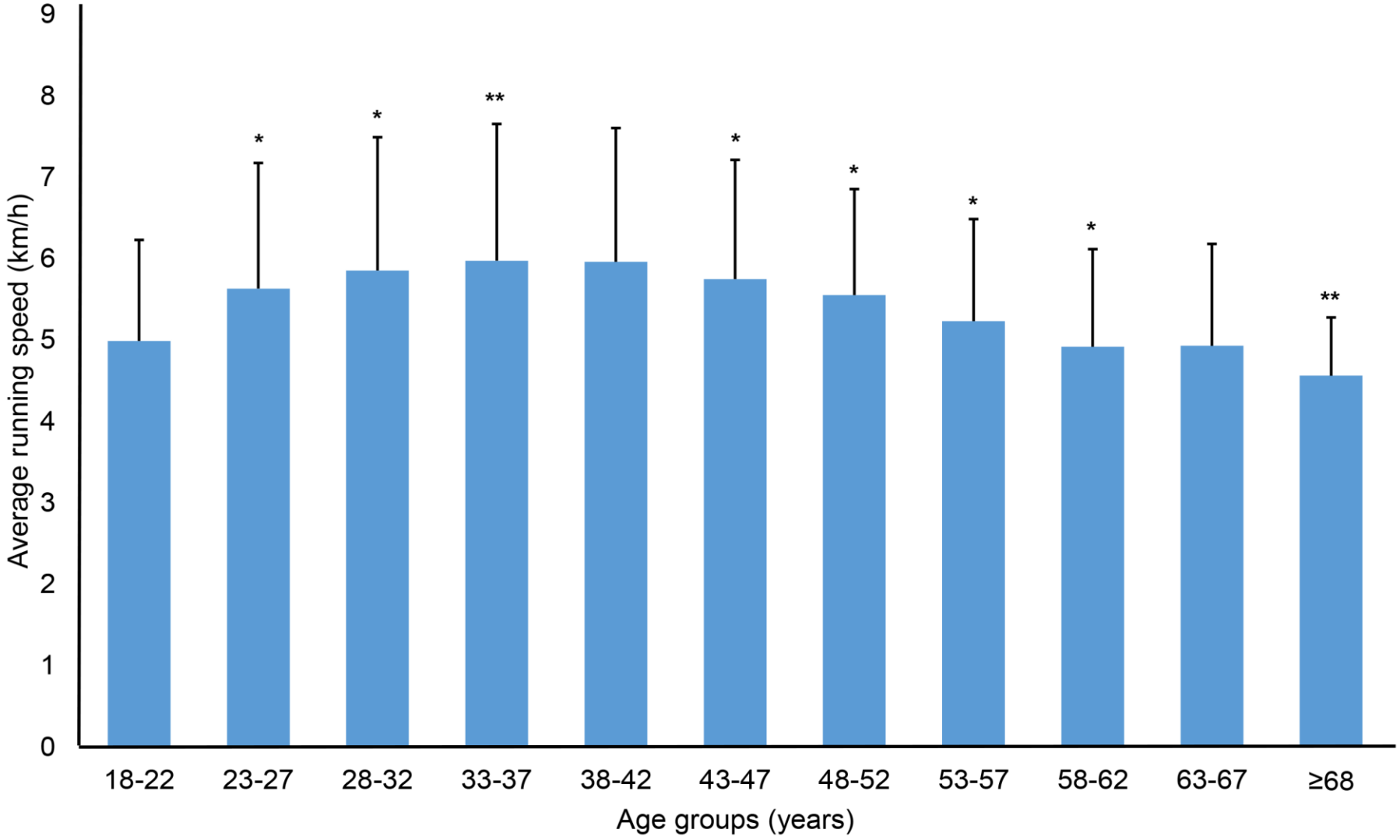
Tsoutsoumbi et al., JGMG, Under Review

RACE CHARACTERISTICS



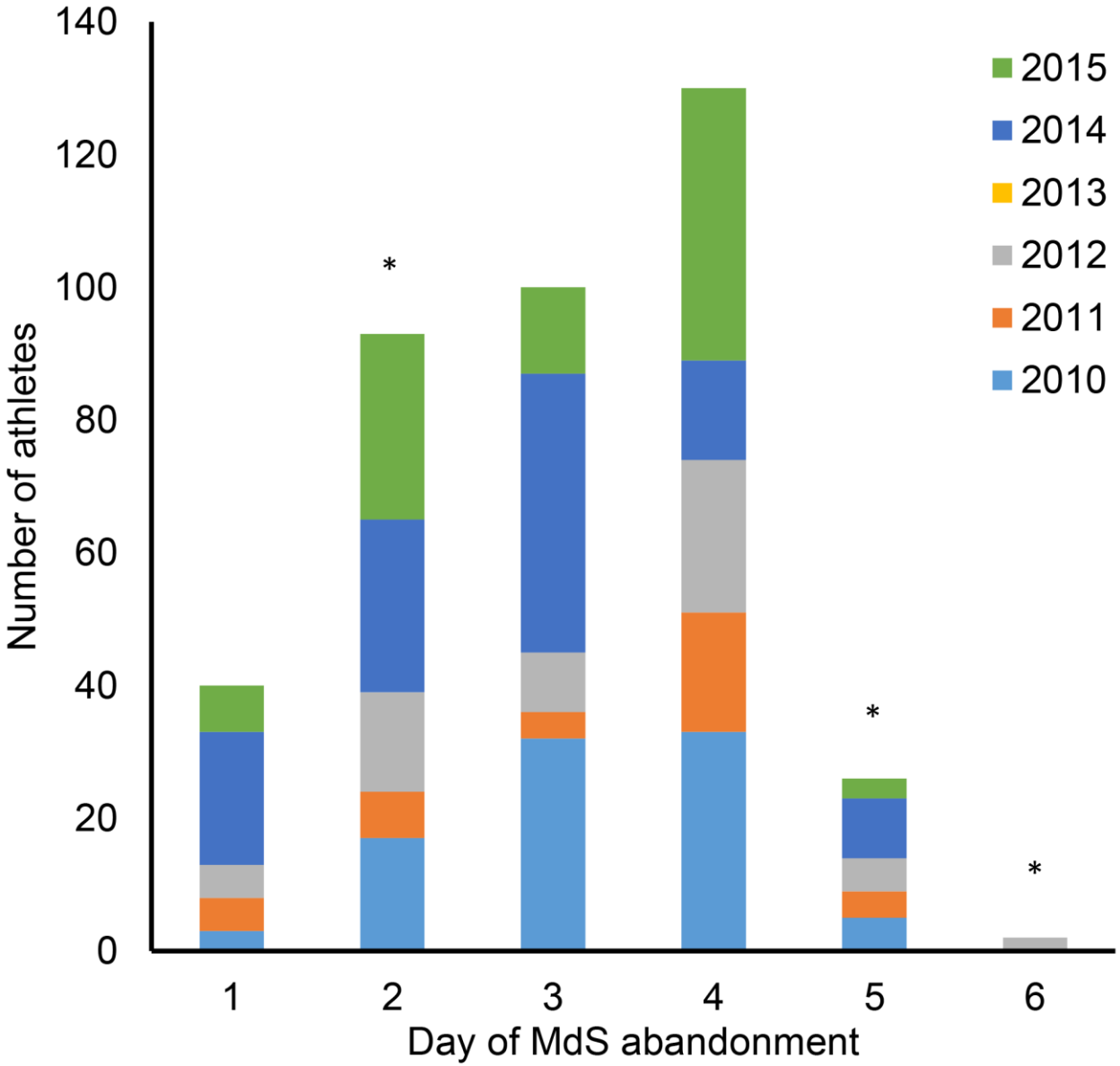
Tsoutsoumbi et al., JGMG, Under Review

RACE CHARACTERISTICS



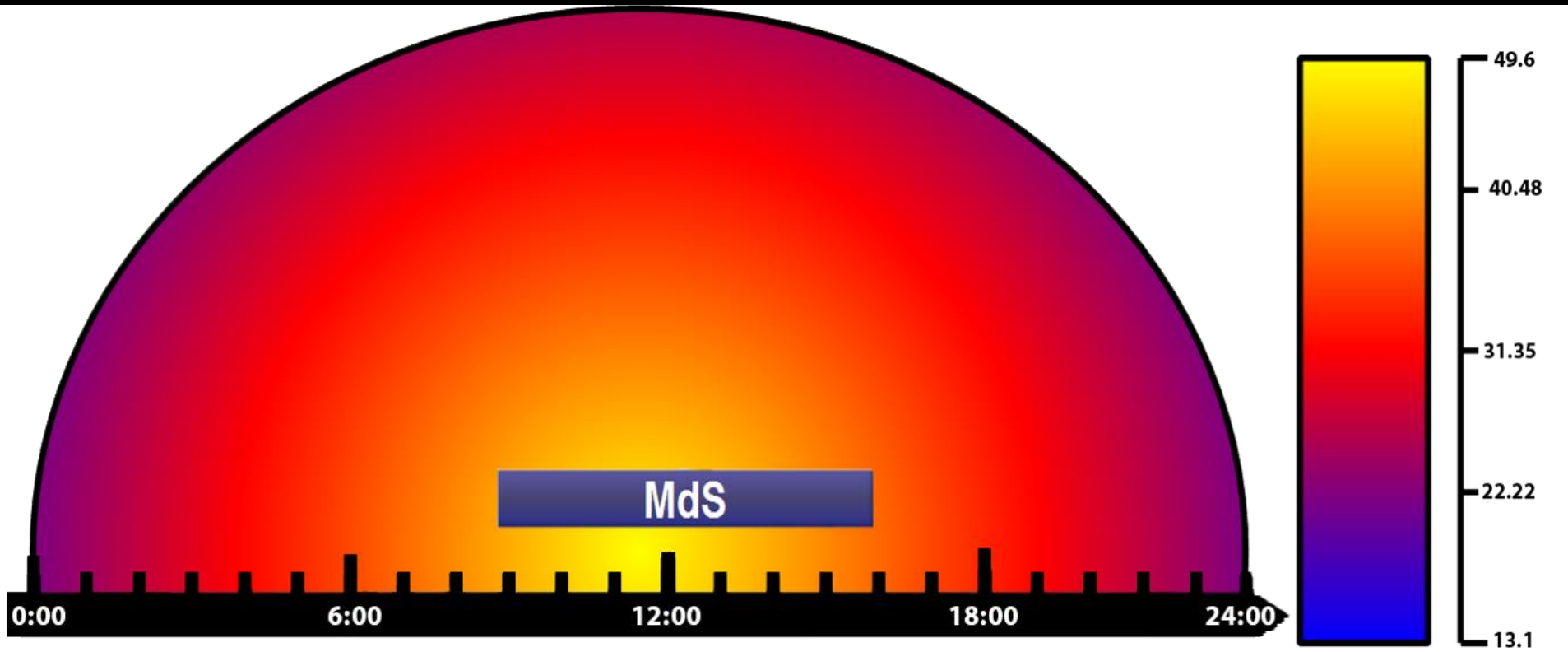
Tsoutsoumbi et al., JGMG, Under Review

RACE CHARACTERISTICS



Tsoutsoumbi et al., JGMG, Under Review

ENVIRONMENT CHARACTERISTICS



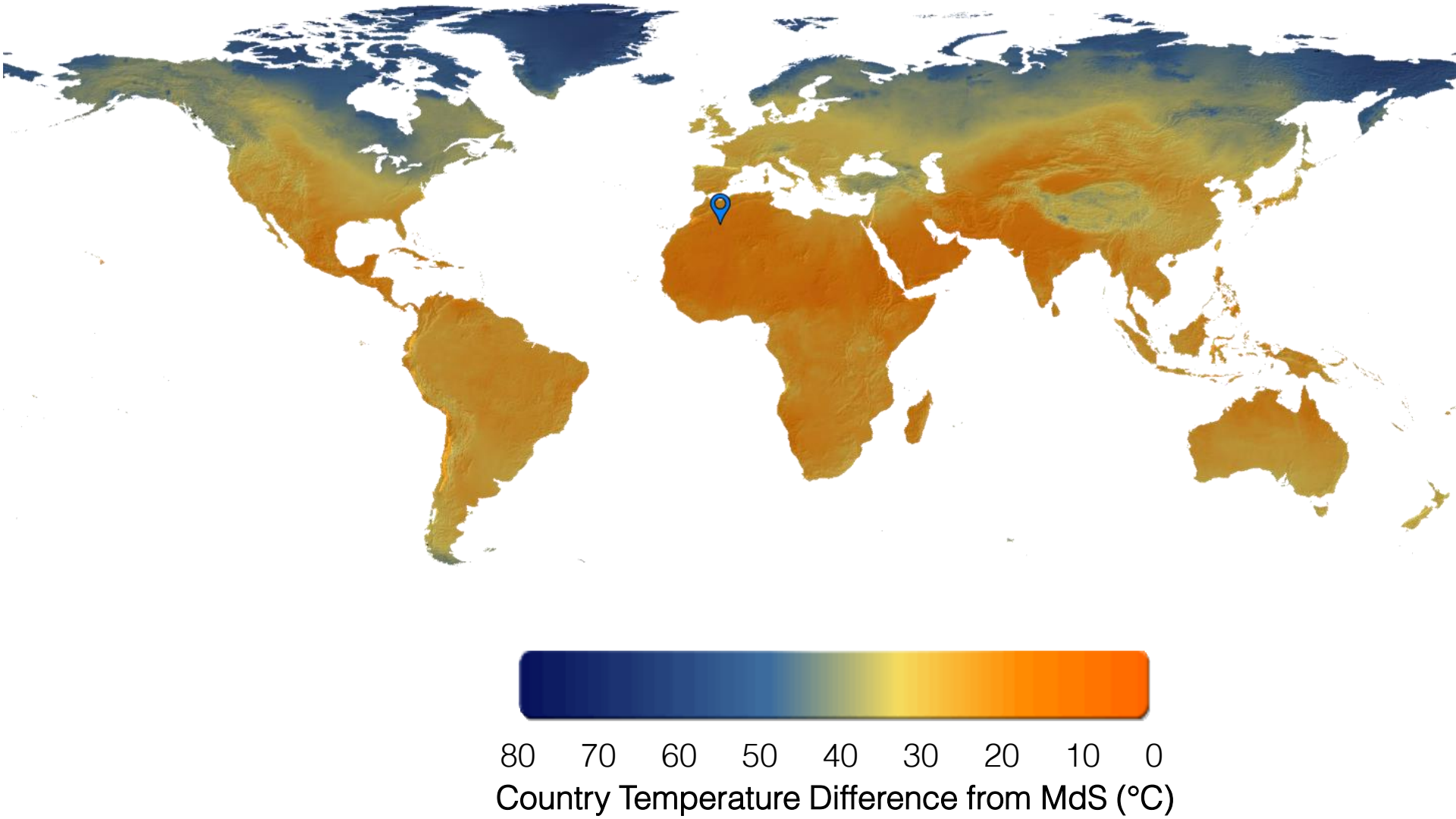
- WBGT
  - start: 22°C
  - middle: 35°C
  - finish: 29°C

WBGT °C heat exposure

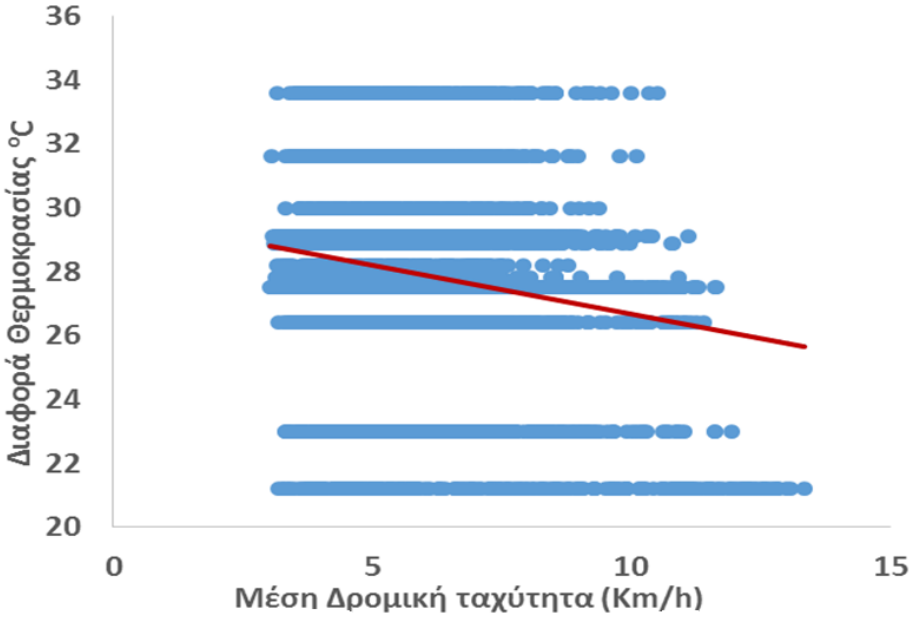
<28.6	29.3	30.6	31.8	>38
60 min/hr	45 min/hr	30 min/hr	15 min/hr	0 min/hr

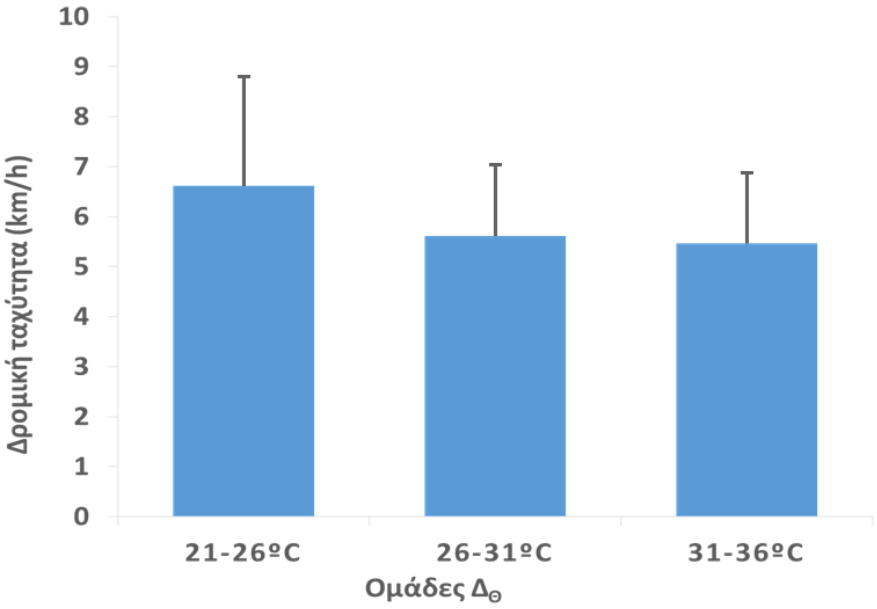
Hourly work capacity for an acclimatised worker, carrying out moderate activity (300W)

ENVIRONMENT CHARACTERISTICS

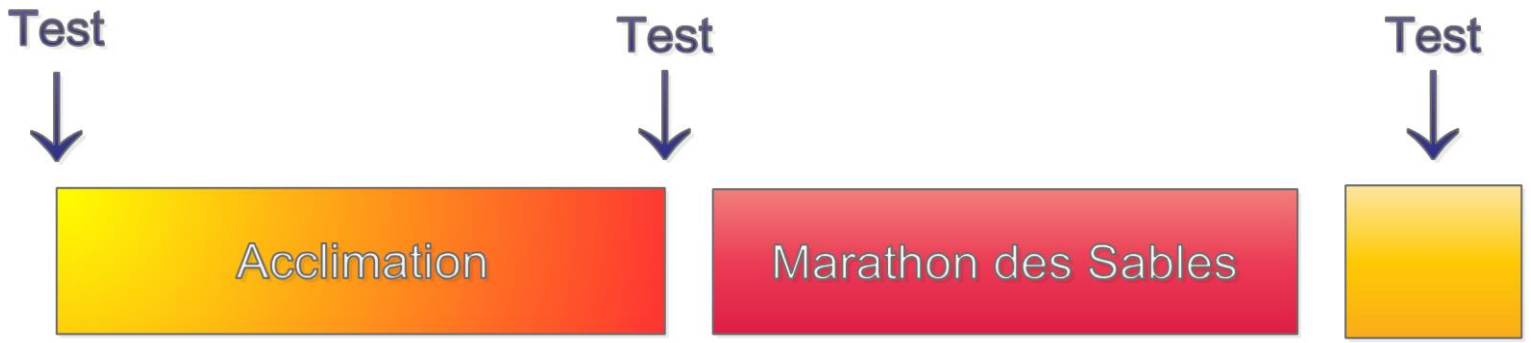


ENVIRONMENT CHARACTERISTICS



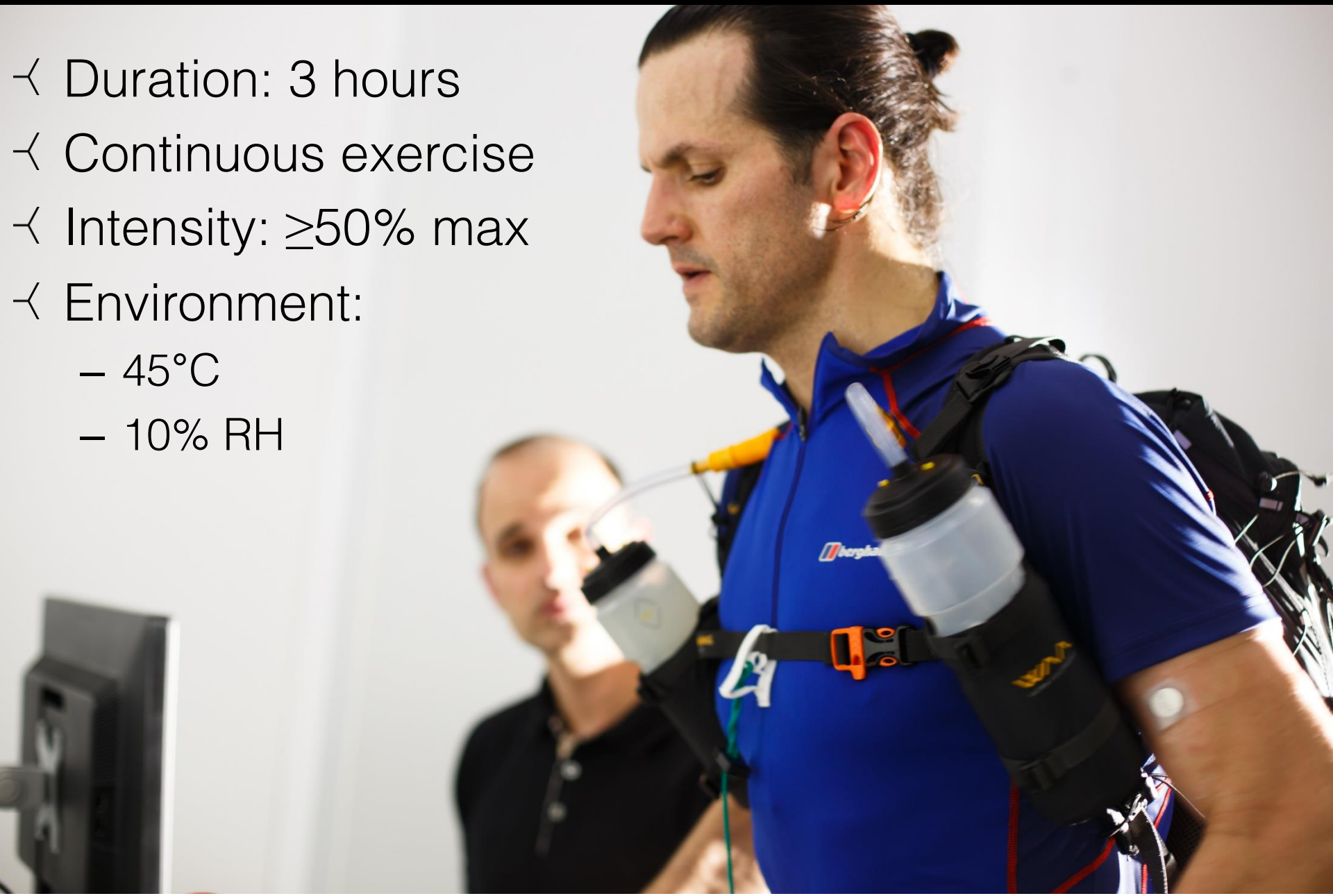


MONITORING AND TESTING



MONITORING AND TESTING

- Duration: 3 hours
- Continuous exercise
- Intensity: ≥50% max
- Environment:
  - 45°C
  - 10% RH

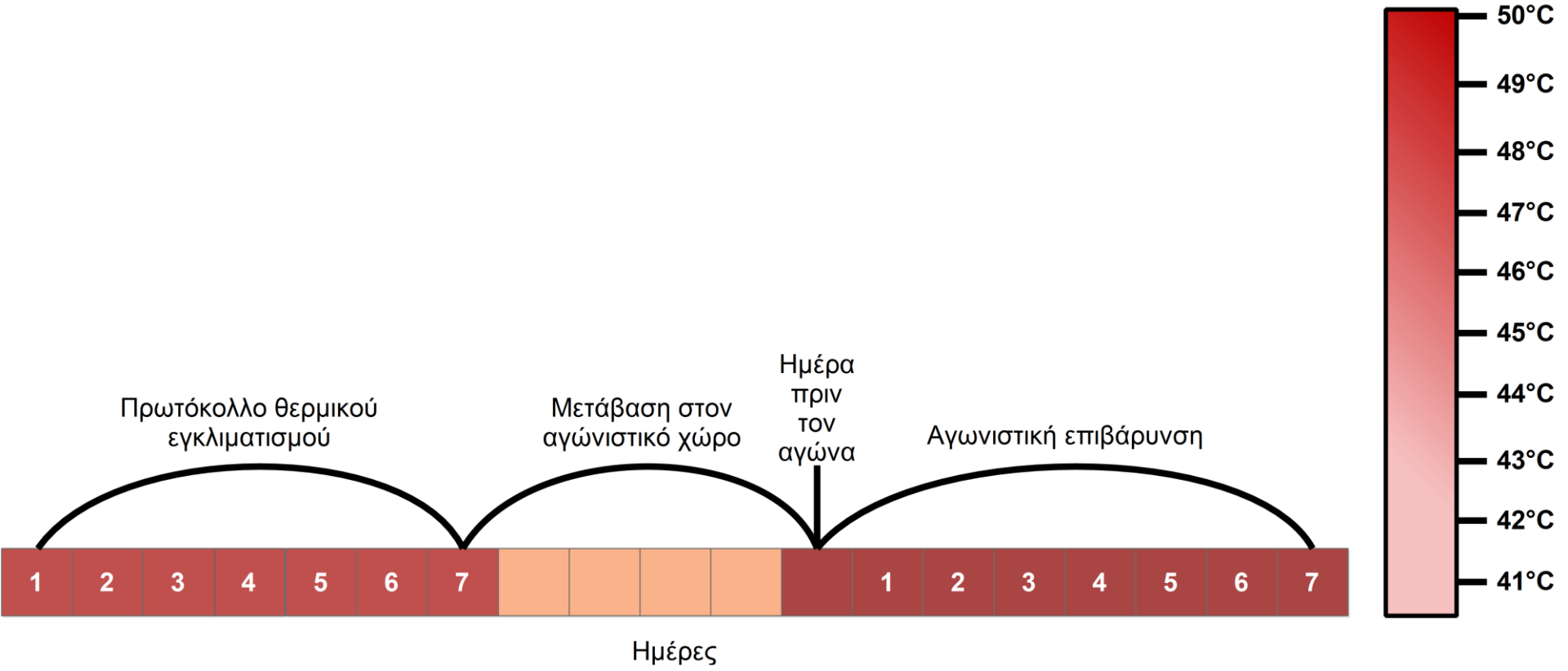


RECOMMENDED ACCLIMATION PROTOCOL

- Duration: 7-14 days
- Continuous exercise
- Duration: ~100 min/day
- Intensity: ≥50% maximum
- Environment: ≥35°C
  - clothing
- Duration of effects: 2-3 weeks

Racinais et al., BJSM / SJSMS / Sports Med / Chin J Sports Med, 2015

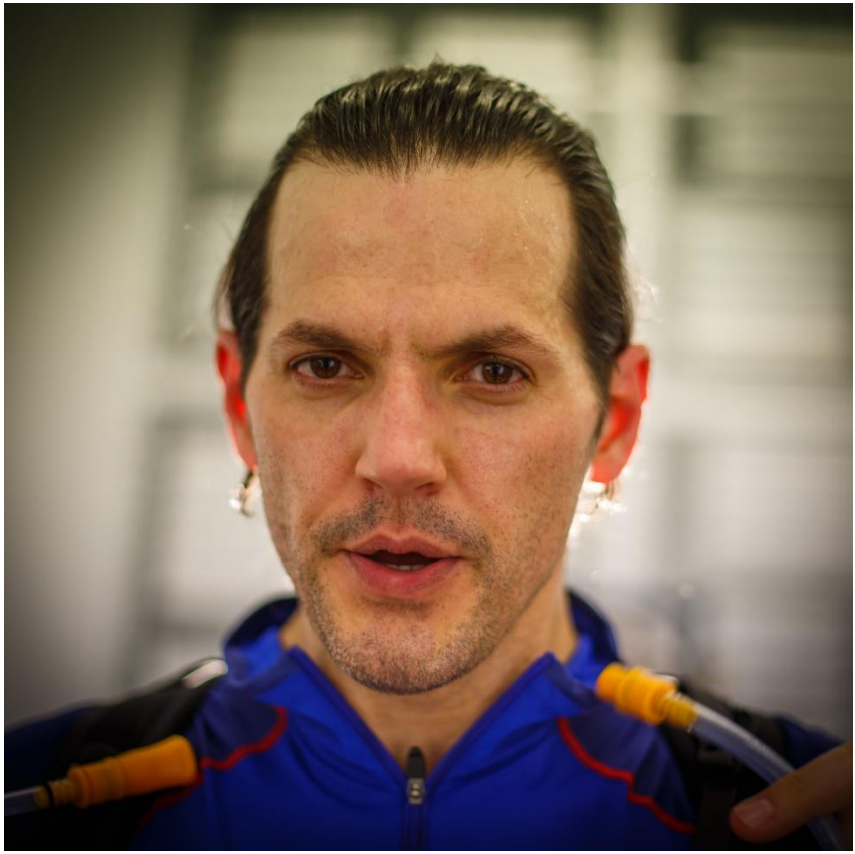
APPLIED ACCLIMATION PROTOCOL



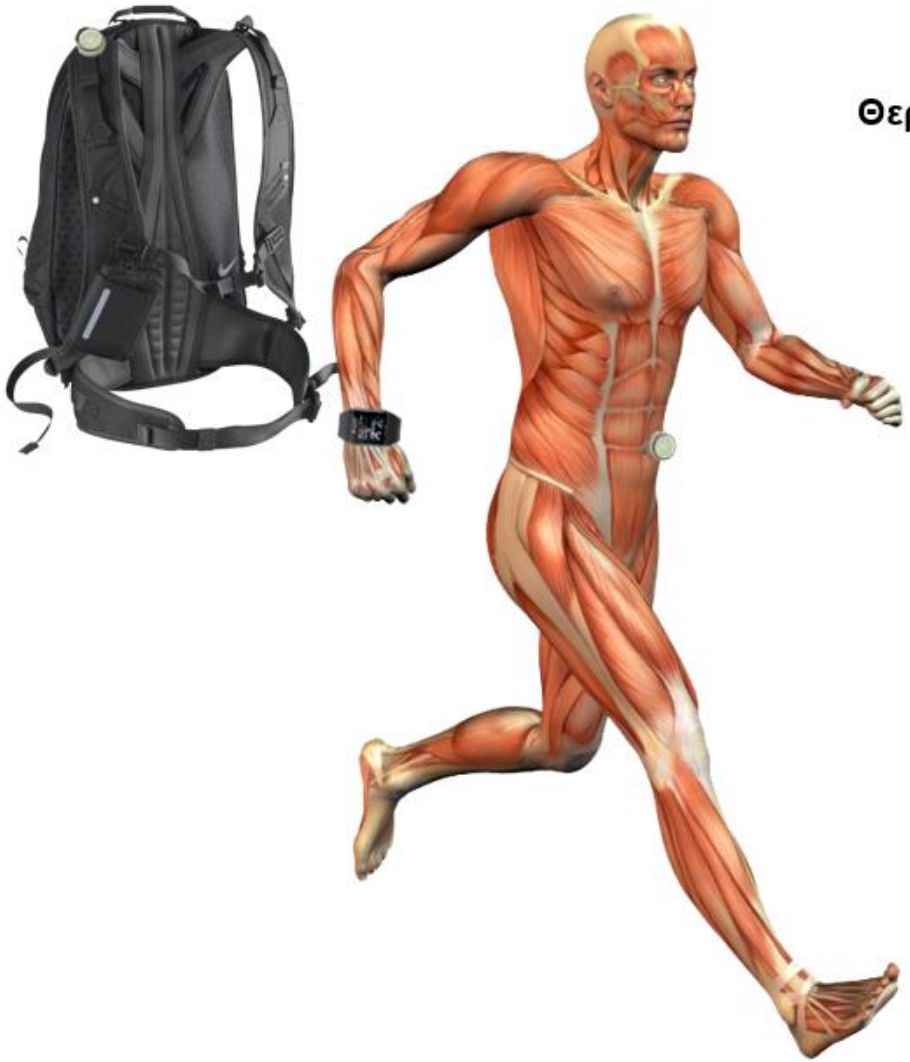
(initial plan for a 2-week acclimation protocol was not possible)

APPLIED ACCLIMATION PROTOCOL

- Duration: 7 days
- Continuous exercise
- Duration: 90 min/day
- Intensity: ≥50% maximum
  - race simulation
    - treadmill speed
    - treadmill inclination
    - bag weight (13.7 kg)
- Environment: 44°C / 10% RH
  - race simulation
    - clothing



MONITORING DURING COMPETITION



Θερμοκρασία Περιβάλλοντος
Θερμοκρασία Σώματος

Χιλιομετρική απόσταση
Δρομική ταχύτητα
Υψόμετρο

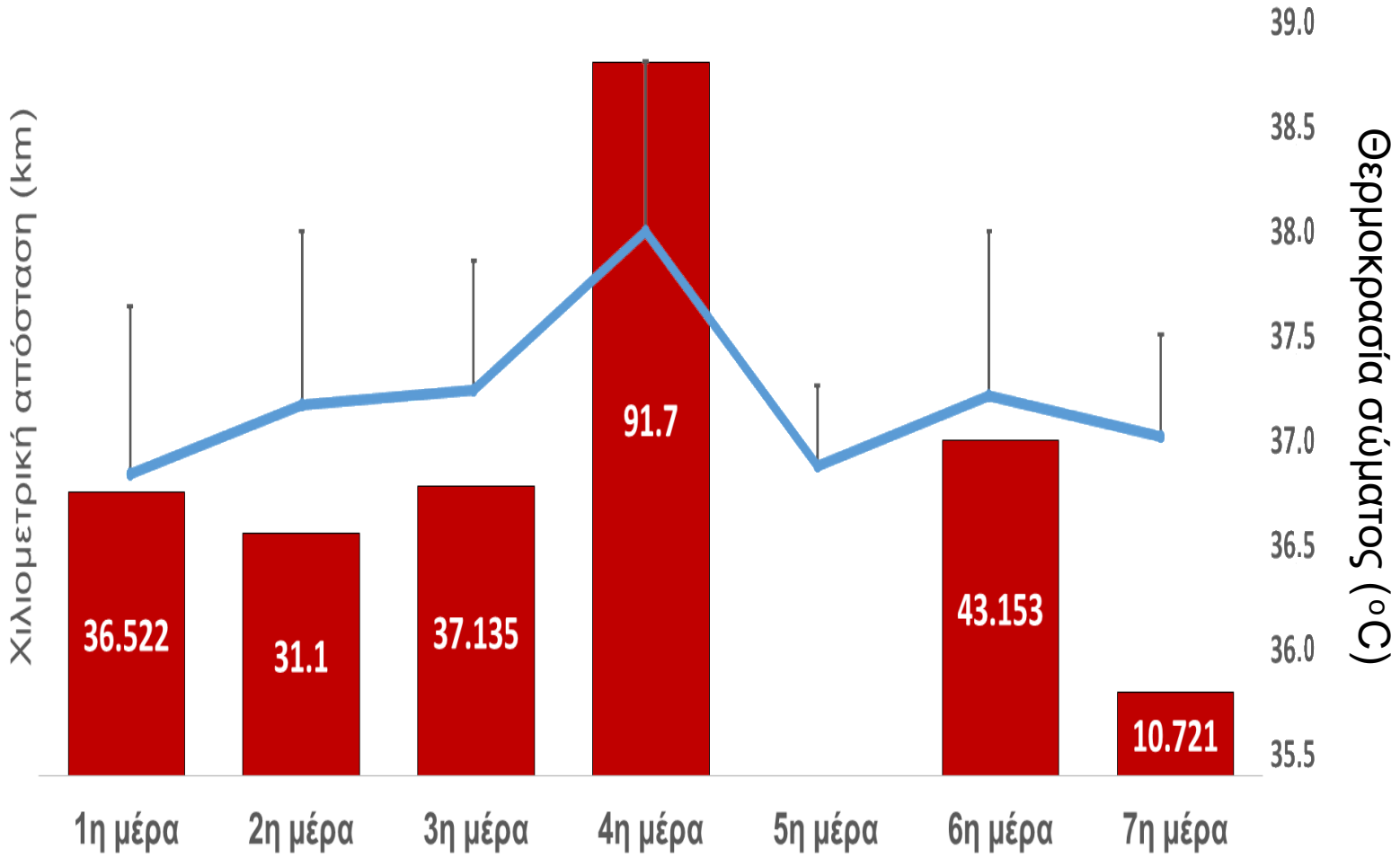
Καρδιακή συχνότητα

MONITORING DURING COMPETITION

Πριν και μετά τη δρομική επιβάρυνση	Κατά τη δρομική επιβάρυνση
Αντιλαμβανόμενη κόπωση	Αντιλαμβανόμενη κόπωση
Γνωστική ικανότητα	Γαλακτικό οξύ αίματος
Δίψα	Γλυκόζη αίματος
Δυσκολία στην αναπνοή	Δίψα
Ειδικό βάρος ούρων	Δρομική ταχύτητα
Θερμική αίσθηση του περιβάλλοντος	Δυσκολία στην αναπνοή
Θερμική άνεση του περιβάλλοντος	Ενεργειακή διαθεσιμότητα
Θερμοκρασία περιβάλλοντος	Θερμική αίσθηση του περιβάλλοντος
Θερμοκρασία σώματος	Θερμική άνεση του περιβάλλοντος
Ισχύς χειρολαβής	Θερμοκρασία περιβάλλοντος
Μάζα σώματος	Θερμοκρασία σώματος
Ολική κόπωση	Καλυπτόμενη χιλιομετρική απόσταση
Περίμετρος κάτω άκρων	Καρδιακή συχνότητα
Προσλαμβανόμενα θρεπτικά συστατικά	Ολική κόπωση
Σύσταση σώματος	Προσλαμβανόμενα θρεπτικά συστατικά
Χρόνος αντίδρασης	
Ψυχολογικές παράμετροι	

MONITORING DURING COMPETITION

Tb & distance covered: r = 0.62, p<0.001
Tb & running speed: r = -0.32, p<0.001



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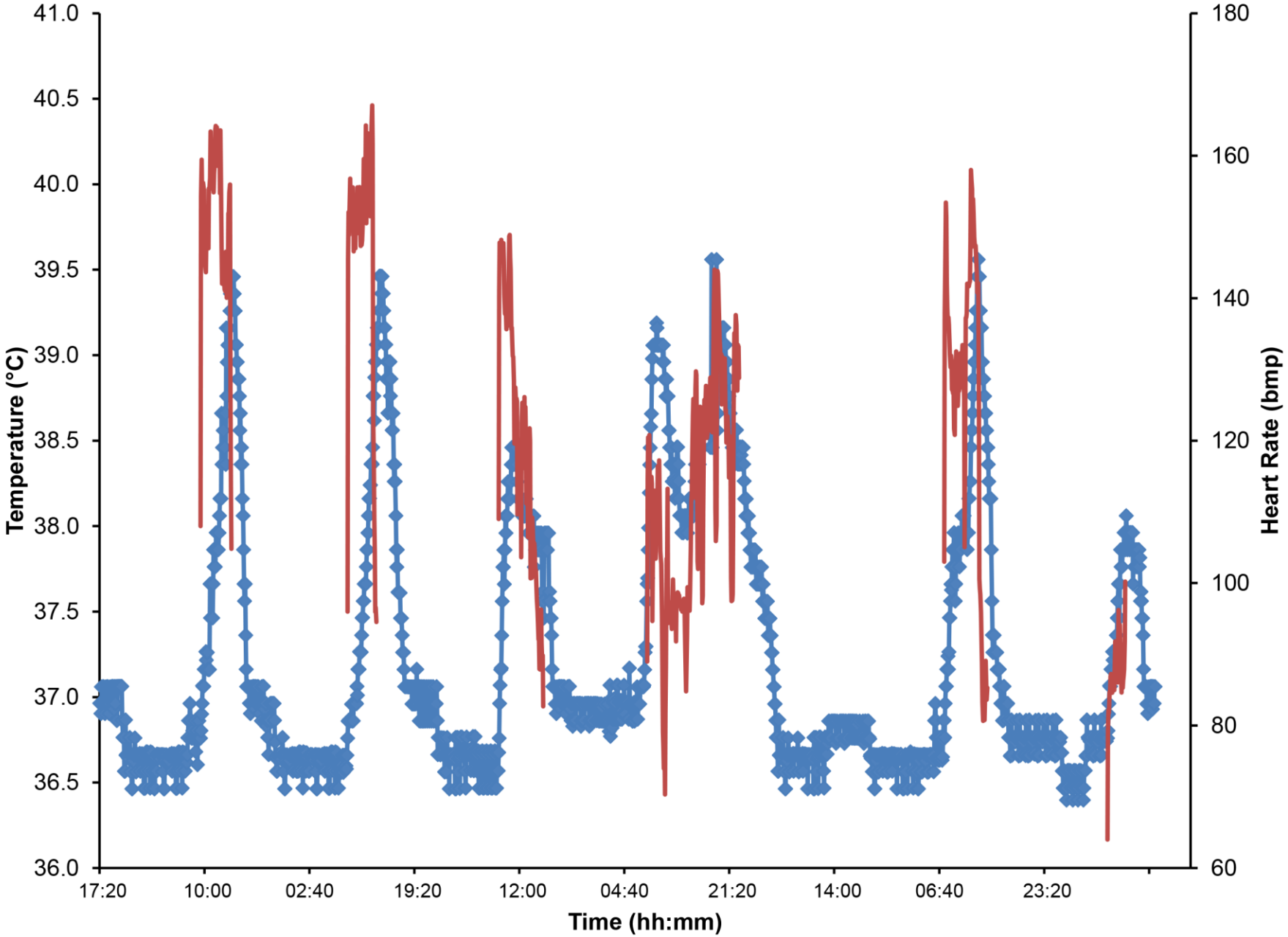

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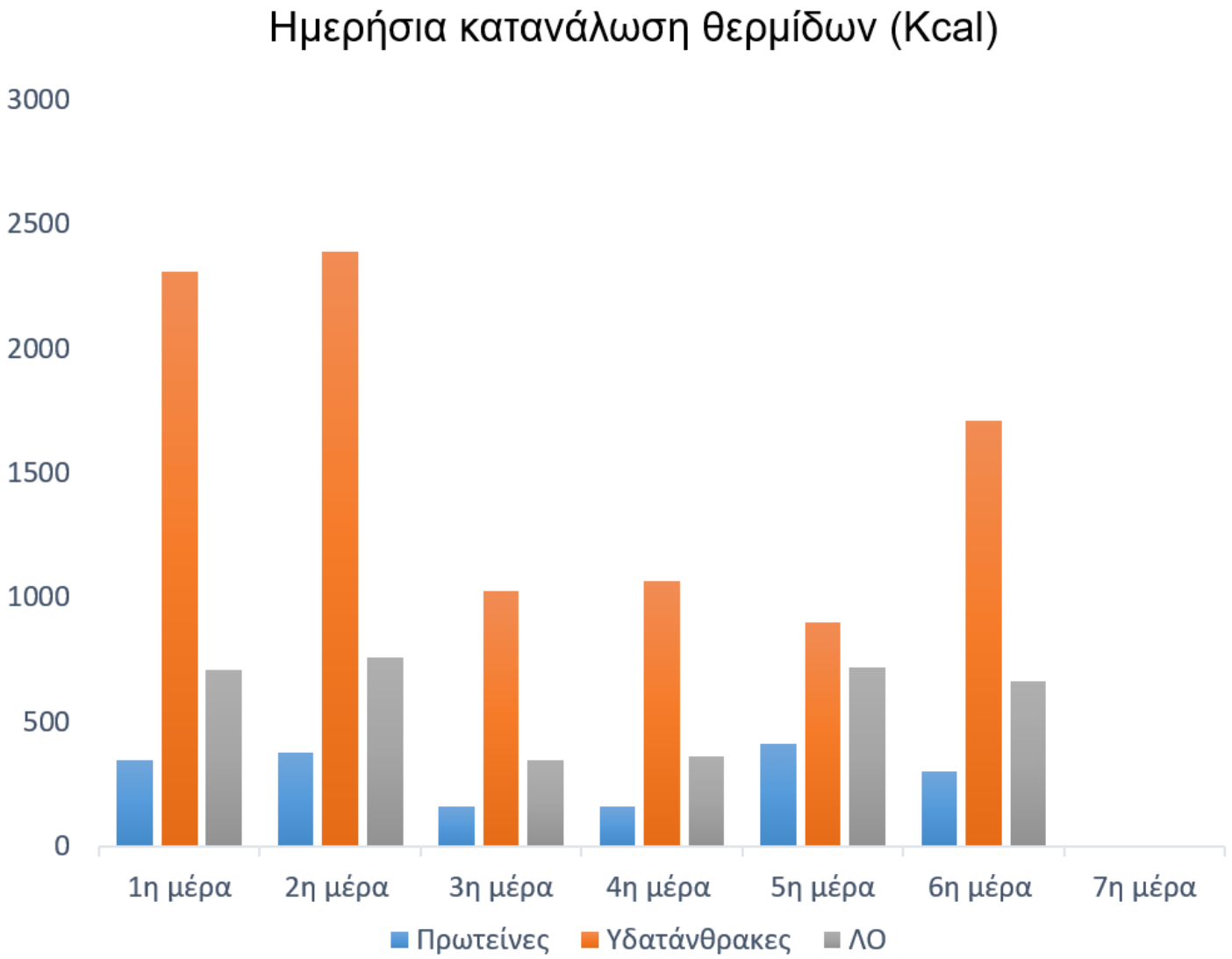


MONITORING DURING COMPETITION

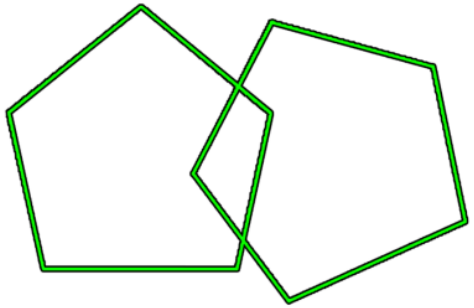
Γλυκόζη αίματος → Λάθη στο σχήμα

Παρακαλώ αντίγραψε το σχήμα

Σχέση μεταξύ της γλυκόζης αίματος και του σχήματος

SMMSE

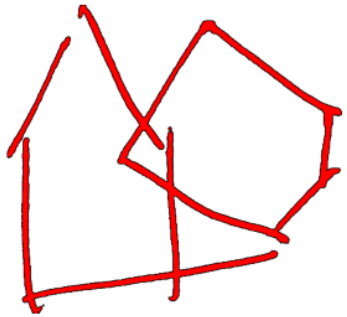
	p	r
Συνολική περίμετρος	0.028	-.72
Συνολικό εμβαδόν	0.024	-.74
Περ. αριστερού σχήματος	0.032	-.71
Εμβ. αριστερού σχήματος	0.019	-.75
Περ. δεξιού σχήματος	0.039	-.69
Εμβ. δεξιού σχήματος	0.033	-.71



Πρότυπο σχήμα

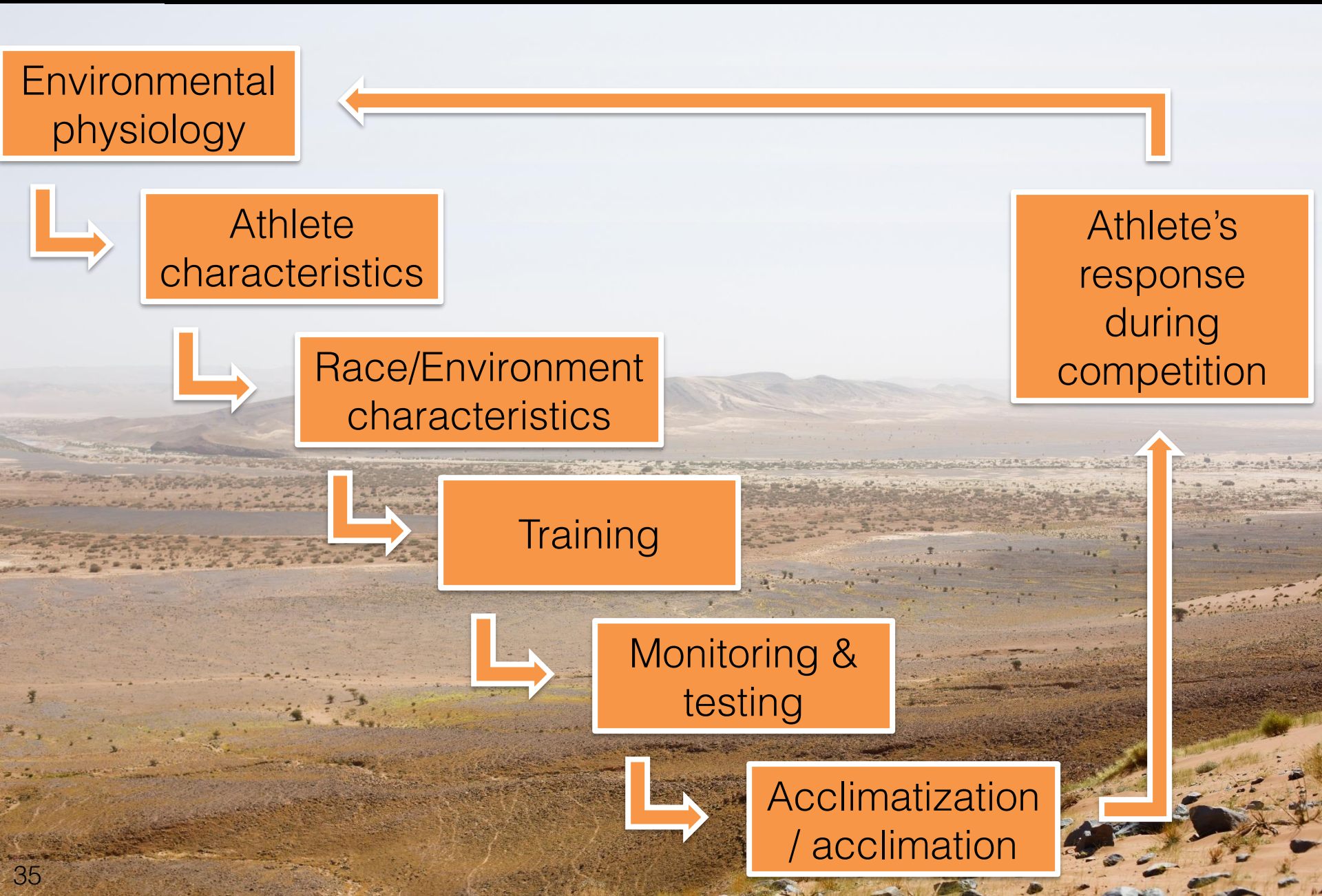
Σχήματα αθλητή

(148 mg/dl)



(81 mg/dl)

ATHLETE SUPPORT FOR EVENTS IN HEAT



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Environmental Ergonomics Research Centre
Loughborough University

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