



HIGH PERFORMANCE TRAINING IN HOT AND HUMID ENVIRONMENTS



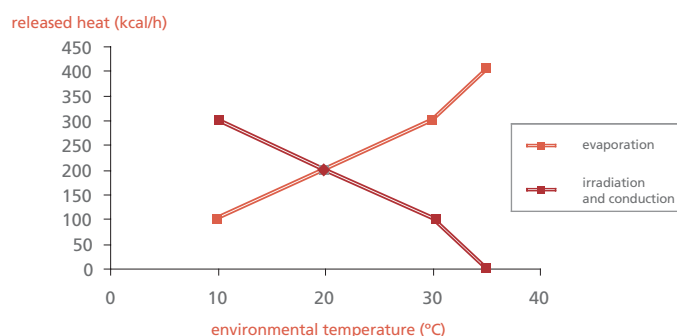
MAURÍCIO MELLO MARTINHO, MSC
Biomedical Sciences, Federal University of São Paulo (UNIFESP)

Production of heat during exercise is about 15-20 times higher than at rest, which would be enough to increase human body temperature by 5°C at every minute of physical activity¹. At 37°C central temperature is kept practically constant thanks to the action of an efficient heat regulating system, which through physiological responses, manages to establish a balance between heat production and dissipation. This balance could be negatively impacted by factors such as adverse environmental conditions, high intensity exercise and hydration levels. In such situations, the body is unable to keep central temperature constant, thus increasing the risk of heat related diseases and entailing serious performance losses.

Every time a body is exposed to an environment that differs from its own, heat transfer between that body and the environment takes place proportionally to temperature gradient. Heat transfer happens naturally from the body or from a higher temperature region to the body or lower temperature region. Just like any other body, human body exchanges heat with the environment by conduction, convection or irradiation.

In the so-called thermo neutral environments (20-25°C) our body loses heat, once body temperature is higher than the environment temperature. As the environment temperature gets closer to body temperature, heat transfer is reduced (lower temperature gradient), which would render maintaining central temperature in environments with temperature above 37°C impossible. To enable this to happen there is a fourth means of dissipating heat, which is evaporation, the most important way of losing heat, as shown in the figure below².

Heat Mecanisms Related To Environmental Temperature



Evaporation is heat transfer from the body to the water molecules; when water molecules acquire a sufficient amount of heat evaporation takes place, carrying heat away from the body. Evaporation occurs because of the difference of water vapor pressure on the skin and environment vapor pressure. In dry environments (low vapor pressure) evaporation happens more easily, while in humid environments (high vapor pressure) evaporation is impaired. In this type of environment sweat fails to evaporate and just runs along the body, hindering heat transfer to the environment.

Hot and humid environments result in harder to achieve thermal homeostasis, once all heat dissipation mechanisms are impaired. When associated to high intensity exercise, this picture is aggravated, once higher heat production requires higher dissipation in order to enable keeping central temperature constant.

When its central temperature increases above normal levels, the body responds by sending more blood

“*Exercise in a hot and humid environment is a stress agent and, above all, a stress agent to the cardiovascular system, once blood flow to the skin must be increased.*”



Scientific researches also evidence a central body temperature increase associated to loss of performance.



to peripheral areas (vasodilation) in an attempt to increase the temperature gradient between the skin and the environment, facilitating heat transfer by conduction, convection and irradiation. Production of sweat (transpiration) also increases to facilitate heat transfer by evaporation. The higher is central temperature increase the higher will be the magnitude of these responses. In extreme situations these physiological responses are incapable of reestablishing normal central temperature level.

Exercise in a hot and humid environment is a stress agent and, above all, a stress agent to the cardiovascular system, once blood flow to the skin must be increased, at the risk of adversely affecting other tissues, including the active muscles. Heart effort increases in an attempt to compensate for the smaller blood volume that gets to it as a result of marked dehydration resulting from increased sweat production

in such an environment. For several reasons loss of an adequate blood flow to meet muscle demand impairs performance. Some of these reasons are higher muscle glycogen degradation together with higher anaerobic metabolism demand, which reduce tolerance to exertion³.

Scientific researches also evidence a central temperature increase associated to loss of performance. In an attempt to protect the body against damages caused by temperature increase, the Central Nervous System reduces nerve stimuli to active muscles, and this results in early fatigue^{4,5}.

The adverse effects of exercises in this type of environment may be minimized or even eliminated by adequate preparation. Among enforced actions are adequate hydration as shown in the table below⁶ and the process of climatization, generating adaptive responses such lower central temperature at rest, heart efficiency and larger plasmatic volume. Together these responses lead an improvement of physical performance in this type of environment.

Hot and humid environments represent a major cause of performance degradation, but well prepared athletes may use this type of situation to defeat more talented athletes but unprepared for this type of environment.

RECOMMENDATIONS

BEFORE COMPETITION

5-7ml of H₂O/kg of body mass 4h before.

Additional replenishment of de 3-5m/ kg in case of failure to produce urine or very dark urine.

Avoid hyperhydration with H₂O or glycerol solutions (risk of hyponatremia).

Intake of Na⁺ (20-50mEq/l) solution encourages thirst and retains ingested liquids.

DURING COMPETITION

Evaluate body mass differences in training sessions and/or competitions (customized water replacement).

Replace the quantity of water required to avoid any decrease exceeding 2% of body mass.

Sodium (20-30mEq/l) and potassium (2-5mEq/l) solution.

For long competitions (>1h), 500ml/h of solution with carbohydrates (6-8%).

AFTER COMPETITION

If possible, normal meal and H₂O.

Otherwise, immediate replacement – 1.5l per kg of mass lost (electrolyte solution).

REFERENCES

1. Nadel ER, Wender CB, Roberts MF et al. *Physiological defenses against hyperthermia of exercise. Ann NY Acad Sci* 1977; 301:98-109
2. Gisolfi CV, Wenger CB. *Temperature regulation during exercise: old concepts, new ideas. Exerc Sport Sci Rev.* 1984;12:339-72.
3. Febraio MA. *Does muscle function and metabolism affect exercise performance in the heat? Exerc Sport Sci Rev* 2000;28:171-6
4. Nielsen, B., and L. Nybo. *Cerebral changes during exercise in the heat. Sports Med. (New Zealand)* 33:1–11, 2003.
5. Nybo, L., and N. H. Secher. *Cerebral perturbations provoked by prolonged exercise. Progr. Neurobiol.* 72(4):223–261, 2004.
6. American College of Sports Medicine, Sawka MN, Burke LM, Eichner ER, Maughan RJ, Montain SJ, Stachenfeld NS. *American College of Sports Medicine position stand. Exercise and fluid replacement. Med Sci Sports Exerc.* 2007 Feb;39(2):377-90.i

OFFICE HOURS

Chief Editor: Technical Department – COB
Executive Superintendent of Sports: Marcus Vinícius Freire
General Manager: José Roberto Perillier
Sport Science Area: Luis Eduardo Viveiros de Castro
Isadora Toscano de Britto
Edition: Isadora Toscano de Britto

Contributor: Luciano Espíndula Pinto
Address: Comitê Olímpico Brasileiro (COB)
Avenida das Américas, 899 - Barra da Tijuca
Rio de Janeiro - RJ - CEP: 22631-000 - Brazil
Contacts: laboratorioolimpico@cob.org.br
Fax: +55 (21) 3433.5858

OFFICIAL SPONSORS



CAIXA



Sadia

MEDICAL ASSISTANCE



DENTAL PLAN

