Chapter 43
Thermal Imaging in Evaluation of the Physical Fitness Level

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ABSTRACT

The thermoregulation mechanisms during the physical effort can be easily study by using the thermovision. The thermoregulation mechanisms in human body keep the body core temperature on basic level 37 ± 2 °C. However, the question is if there are any differences in skin surface temperature distribution between trainee sportsmen and amateur. Is there any possibility to show the sportsman level of practise using the thermal imaging? Would it be possible to evaluate the efficiency of athlete or evaluate the level of sports possibilities in average amateur who just wants to start cycle training. To find how the thermoregulation mechanisms work the different measurements were done i.e. during the cyclist endurance test for group of male cyclist (intermediate level of cycling skill) and during the Aerobic Circuit Training (ACT) for trainee and amateur group of women.

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INTRODUCTION

The Mechanisms of Organism Thermoregulation

It is known that body core temperature is kept on basic level 37,0 ± 2,0 °C due to the thermoregulation mechanisms in human body. All living processes are dependent upon the temperature. The optimal core temperature is maintaining the normal heart beating, muscles working and nervous system functioning. The correct living organism functioning due to normal metabolism and organs functioning is possible thanks to optimal temperature conditions called thermal homeostasis (Górski, 2010). However, the temperature of human body (core as well as the surface) can change due to diseases, fever, stress and physical effort (Wendt, 2007; Pilawski, 1983).

The human body raises the energy needed for living from nutrition (oxygen and food metabolism). Part of this energy is used for work and the rest is radiated as a thermal energy (heat) (Herman, 2007). To keep the thermal homeostasis the overcapacity of energy has to be removed from the organism. Heat transfer between human body and environment can be done by mechanisms like: conducting, convection, radiation and evaporation. It can be noticed that the fragmented streams from convection Φ_K, radiation Φ_R and evaporation Φ_E have contribution to the total heat flow Φ (Equation 1):

$$\Phi = \Phi_k + \Phi_r + \Phi_p \tag{1}$$

However the heat transfer due to the conducting is observed only in the thermal energy transport between the tissues and skin (Pilawski, 1983; Herman, 2007).

Human body as a subject with temperature higher than absolute zero (0°K) transfers heat also by radiation (Usamentiaga, 2014). The power of radiation loss can be estimated from the surface of the body using the Stefan-Boltzmann law for biological object (Pilawski, 1983; Cholewka, 2004; Cholewka, 2005; Tuszynski, 2002; Wiśniewski, 2009):

$$\Phi_R = \sigma \cdot a \cdot A \cdot (T_S^4 - T_0^4) \tag{2}$$

where:

σ – black body radiation constant,

$$\sigma = 5{,}67 \cdot 10^{-8} \frac{W}{m^2 K^4},$$

a – radiation surface emissivity,
A – body surface.

Another way of heat transfer occurring in the human organism is sweating and evaporation, which should be taken into consideration from the thermal imaging point of view. It is known that the human body excretes the water due to sweating. In normal conditions the 50 ml of water is lost per hour in

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