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FLUCTUATIONS IN SKIN SURFACE TEMPERATURE WHEN SIMULATING AN EFFECT THAT INTERRUPTS THERMOREGULATION IN PEOPLE INVOLVED IN CYCLIC SPORTS

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Key words: thermoregulation, homeostasis, temperature rhythmological fluctuations, female students.

Annotation. The aim of this study was to assess the influence of moderate cooling on the preservation of temperature rhythmological fluctuations of the skin surface in female students with different fat state, who engage in cyclic sports, before and after warm-up. The experiment was carried out at an ambient temperature of 20-21 ºC. The analysis of temperature fluctuations confirmed the hypothesis of the study, based on the fact that each individual has his own personal biorhythm of fluctuations in the temperature of the body’s skin surface. Due to the genetically determined temperature biorhythm, adaptive changes at an ambient temperature of 20-21 ºC are the one of the mechanisms contributing to the efficiency of muscular activity.

Introduction. Rhythmological fluctuations are the fundamental property of living matter, which is shown in form of continuously created interrelated fluctuations of all biochemical and functional processes. It is known, that the organism’s adaptation processes to environmental conditions are made much easier due to biological rhythms, which supports the work of mechanisms of vital functions’ regulation. The research activity of scientists allows forming a data bank on models of biorhythms’ generation (genetic, cellular and multi-oscillatory), their nature and mechanisms of functioning, although many aspects of biorhytmology are still unknown. The rhythm structure in the time continuum also remains insufficiently studied [1]. Some researchers [2-3] are convinced that the basic stem of biological hours of the organism (the so-called central oscillator) is located in the hypothalamus, in its suprachiasmatic nuclei (SCN). On the genetic level, an independent programming of SCN, which serve as an oscillator triggered by biochemical reactions in a cell and dependent on their speed, takes place. The protein synthesis inside the cell includes biorhythm mechanism in SCN, the synthesis is repressed due to the feedback node, and then proteins decompose and synthesize again [4-6]. One of the most significant biomarkers of preserving life-support systems is the thermal state indicator, i.e. the skin temperature, which possesses high informational capacity. In recent studies related to biorhythmology, rhythms of changes of the average body temperature in 24 hours are examined more often; its changes are also attributed to the performance level. There are practically no studies concerned with dynamic changes in the skin temperature in time micro intervals, despite the fact that the time structure of temperature rhythms is difficult. Moreover, issues related to rhythmical organization of functions are still not examined [7-9]. There is a possibility of checking experimentally the integrity of temperature rhythmological fluctuations in the skin, despite different hindering factors, which appear due to physical warm-up exercises, the metabolism increase, the nonshivering thermogenesis effect, the active inclusion of the thermoregulation system. Physiological processes that occur in the organism cause unevenness of examined time intervals of biorhythms due to regular adjustment between multi-stage hierarchic levels of biological systems, which supports its integrity [10-11]. The purpose of this study was to assess the influence of moderate cooling on the preservation of temperature rhythmological fluctuations of the skin surface in female students with different fat state, who engage in cyclic sports, before and after warm-up. The experiment was carried out at an ambient temperature of 20-21 oC.

Methods and organization. The study included 30 female students aged 17-21 years. The first stage of the evaluation included defining body length, as well as a percentage of fat tissues and water using the Tanita BC–418 MA analyzer made in Japan. In order to conduct the ascertaining experiment, a group of 6 female students, actively engaged in cyclic sports, with different fat state, was formed from 30 examined female students. In our previous studies [12] we obtained results showing the present correlation of skin temperature to fat tissue percentage values, which gave us a handle to study the temperature balance of female students with different fat tissue percentage (Table 1).

Table

Morphofunctional characteristics of female students

№ of the examined student	Age, years	Body mass, kg	Body length, cm	Fat, %	Water, %
1	21	46,12	155	7,4	67,3
2	20	48,85	168	12,1	64,5
3	20	52,63	166	17,1	60,2
4	19	51,16	155	19,3	59,1
5	19	56,09	158	22,0	57,7
6	18	53,73	155	24,8	55,1

The second stage of the evaluation included two parts and consisted of non-contact infrared skin thermography of six selected female students using the BALTECH TR-01500 thermal camera and the special Baltech Expert software for the following process of exposures. The first part of the experiment included series of exposures of students facing the thermal camera. After the 15-minute adaptation period to laboratory conditions, female students took off their outdoor clothing, leaving two-peace bathing suits. Thermography began 15 seconds after (15 seconds are needed to prepare and point the thermal camera at the target) and consisted of series of 20 exposures (every 30 seconds) 10 minutes long. Then, female students performed 15-minute standard warm-up of average intensity in a sports costume, which caused moderate sweat production. In the second part of the experiment, 15 seconds after warm-up and taking off the costume, the second series of thermography of 20 exposures took place (every 30 seconds) 10 minutes long (also with a front view). Considering data presented in the form of mean values of temperature of the skin located above the quadriceps of the left leg, we created graphs of temperature changes of skin of six examined students before and after warm-up using Microsoft Excel.

Results and discussion. We obtained average temperature data from the frontal surface of the left leg's hip (skin area above the quadriceps) of each exposure, corresponded with a certain time of recording, on the basis of which temperature balance graphs of the first and the second part of the ascertaining experiment were created for each student of the experimental group. One graph included temperature curves (Fig. 1, 2) for two physiological states of the organism of female students, who engage in cyclic sports (without warm-up and immediately after warm-up). As an example, we present graphs of temperature fluctuations of two examined students, whose values confirmed the hypothesis that was presented at the beginning of the article (Fig 1, 2).

For example, temperature fluctuation graphs of the female student № 2 almost became one starting from 3,75 minutes, regardless of powerful temperature fluctuations immediately after warm-up.

Vector of changes in temperature fluctuations in the female student № 3 was recorded from 1,75 minutes, although it fluctuated a bit higher on the temperature axis due to increased metabolism because of 15-minute warm-up. It is obvious, that these two female students were different by a character of urgent adaptation of muscular activity in terms of interaction between mechanisms of heat production and heat loss and had different speed of metabolic responses.

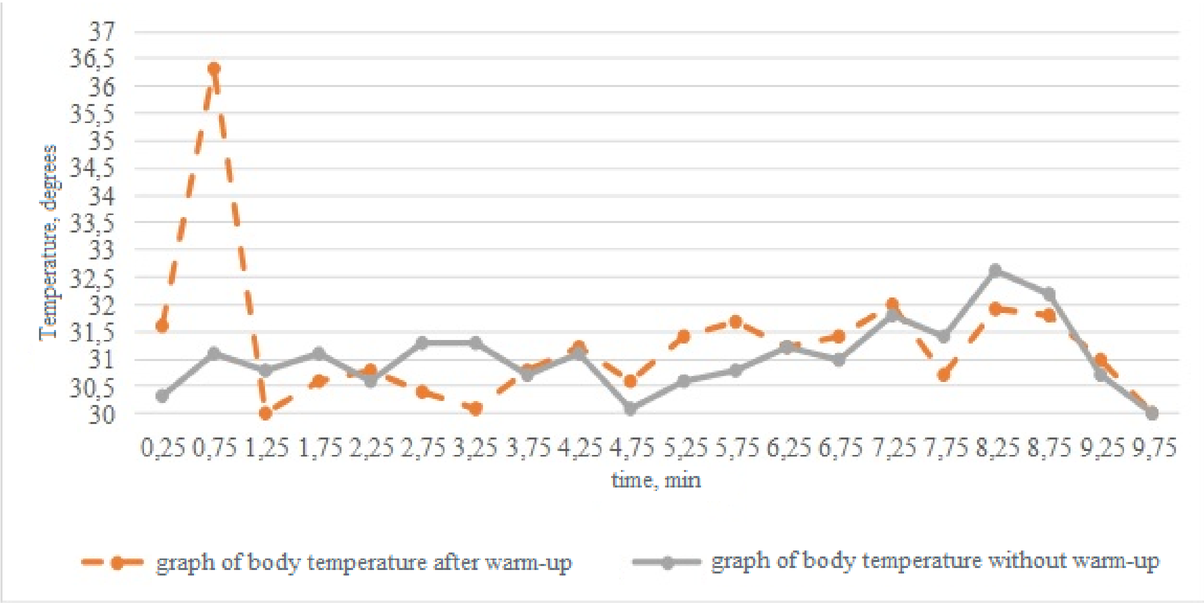

Fig. 1. Changes in the average temperature of skin located above the quadriceps of the left leg, before and after warm-up in female student № 2 when exposed to cold with an environment temperature of 20-21°C in the state of muscle rest for 10 minutes

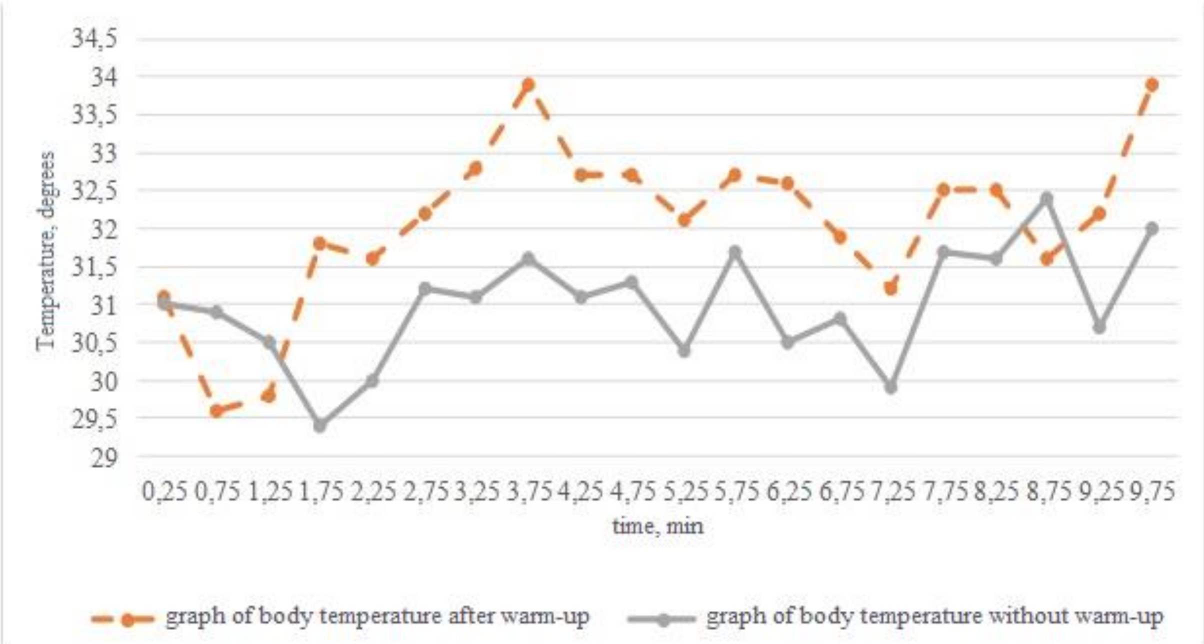

Fig. 2. Changes in the average temperature of skin located above the quadriceps of the left leg, before and after warm-up in female student № 3 when exposed to cold with an environment temperature of 20-21°C in the state of muscle rest for 10 minutes

It is known that any precise measurements of almost all physiological parameters do not lead to the time sequence, which would be stationary or periodical. Fluctuations always appear around a certain fixed level or period of oscillations. Despite the possibility of random fluctuations to exist (noise or chaos), the experiment gave an opportunity to check a hypothesis that is based on the fact that functional systems of the human's organism are aimed at preserving temperature homeostasis through the possibility to support the integrity of temperature fluctuations on the skin surface of each individual, which are manifested through a certain thermoregulatory biorhythm, despite consistent external and internal oscillatory and hindering effects [13]. Doing warm-up in sports is usually directed towards increasing temperature of muscle structures that leads to warming-up the preoptic area of the hypothalamus, contributing to sweat production with simultaneous vasodilation of skin vessels, increase of the skin blood flow with the transfer of excessive heat from the core to upper layers of the body [14-17], decrease in thermogenesis. The skin temperature in female students, who performed 15-minute warm-up typical for cyclic sports, increased to 36-28 °C (all female students had a special warm-up costume). After taking out the costume, regardless of the fact whether there was warm-up or not, due to lower air temperature in the laboratory (with a humidity of 40 % and air temperature of 20-21 °C, which is 10-13 °C lower than temperatures of the thermoneutral zones), stimulation of sympathetic centers of the hypothalamus took place [3, 18-19]. It led to spasms in skin vessels and the increase of heat production due to chemical thermogenesis in terms of uncoupling of the oxidative phosphorylation [20-21]. The thermogenesis, as a generation of heat to support temperature homeostasis of the homoiothermal organism, happens almost constantly, differing at certain moments by its intensity depending on environmental temperature and the organism's metabolic state [22-23]. The infrared radiation with a wavelength of 5-20 μm, convection led to heat loss from the skin of female students to the environment. Two differently directed processes related to temperature increase and its simultaneous decrease, made correcting influences on the rhythmicity of changes in the skin temperature, mostly increasing the amplitude of temperature fluctuations. Temperature oscillations of the skin of female students are observed also in case when they do not perform warm-up. The main difference is that there is no metabolism increase, no cooling response due to sweat production. Depending on which process is dominating at this moment of time, increase or decrease of the skin temperature takes place. When evaluating graphs of temperature curves of the skin above the frontal surface of the hip of female students, we registered its recurrent decrease and increase that appear because of the equality of the heat's "income" and its emission from the skin surface, which is a certain fluctuating rhythmical system.

The obtained data that approve the hypothesis of preserving the individual temperature rhythm of the skin surface of female students, who engage in cyclic sports, have not yet received appropriate estimation as a certain value for sports physiology, although there are possibly interesting science prospects related to deeper fundamental acknowledgement of obtained results.

Conclusion. Despite warm-up that was carried out as a factor, which hinders the work of the thermoregulation system, we revealed a return of temperature fluctuations to the initial biorhythm, observed before the beginning of warm-up and triggered in both cases of moderate cooling in an ambient temperature of 20-21°C even when the so-called noise and chaos were present. It can indicate the fact that the strategy of maintaining the thermal balance allowed the thermoregulation system of examined female students to control effectively the temperature homeostasis of the skin above muscles that are actively engaged in sports movements. That would happen due to the genetically determined and triggered by the environment temperature biorhythm, as well as the formed adaptation to moderate cooling, which is the one of conditions of the muscular activity's effectiveness. It is also important to note, that preservation of temperature rhythmological fluctuation on the skin located on the frontal surface of the left leg's hip was observed in all female students, despite different fat state.

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