Journal of Human Kinetics volume 13, 2005, 107-116

The Influence of Sauna Overheating on chosen Physiological Variables in Male Swimmers

by

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The main aim of this study was the comparison of physiological changes to sauna overheating stress in male swimmers. The research was conducted on 10 swimmers, students of Academy of Physical Education (group I) and 10 non-training students of other universities (group II) aged 20-23. Both groups were exposed to 15 min. sauna sessions with two 2 min. rest intervals under shower at temperature equal to 20-22°C. The sauna temperature was 92.3°C and the humidity at 27.4%. The following variables were evaluated in both groups: HR, Tre, BWT, Hct and Hb and subjective sensations measured with the Bredford scale. A smaller decrease in body mass was observed in group I in comparison to group II. The average increase in internal temperature after sauna session was registered in male swimmers. The average heart rate increase was smaller in the group of swimmers, while dehydration was higher in untrained subjects. During the experiment swimmers better tolerated higher external temperature, what suggests better tolerance to temperature stress.

Keywords: *thermoregulation, swimming, temperature stress*

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Introduction

Sauna as a thermal manipulation has a positive influence on most organs and systems in the human body. First of all it improves adaptation, increases body immunology and physical fitness. In healthy subjects it positively influences the cardio-vascular system, regulates hemodynamic processes, improves coronary circulation and leads to arterial blood pressure stabilization (Kubica 1995).

Nowadays sauna session focus mainly on a wide range of biological restoration in professional sport. Swimmers use this method very rarely in biological renovation. Practicing in water causes greater adaptations of swimmers other environments. Because of this swimmers are exposed to higher body heat lose than subjects not-practicing in water environment what causes higher under skin body fat content and total percentage of body fat (McMurray 1979, Flynn 1990). There is a small number of research papers on the influence of thermal factors, such as sauna, to swimmers organism. In that case the main aim of this research the comparison of physiological variables changes and the sauna overheating stress in male swimmers.

Material and methods

The research was conducted on 10 swimmers, students of Academy of Physical Education (group I) and 10 untrained students of other universities (group II) aged 20-23. Swimmers practiced four times per week swimming approximately 3000 m with average heart rate equal to 140 beats per minute. Both groups were exposed to 15 min. sauna sessions with two 2 min. rest intervals under shower in temperature equal to 20-22°C. The sauna temperature was equal in to 92.3°C and the humidity to 27.4%. The evaluations were always performed in the morning and the subjects did not eat before these sessions. In both groups, before and in the 5th, 10th and 15th minute of thermal exposures the following variables were measured: rectal temperature (Tre) with the use of Ellab electro thermometer, heart rate (HR) and thermal sensations with the Bredford scale (7 grades). Before sauna and immediately after, body mass was measured with the use of an electronic scale (Sartorius). Blood to analysis was taken from the fingertip before and after sauna sessions. The hematocrit (Hct) was determined with the microhematocrit method and hemoglobin concentration (Hb) was evaluated with the Drabkin method. The acquired results of Hct and Hb allowed to calculate the plasma volume (?%pV) according to Dill and Costill formula (1974) modified by Harison (1982):

$$?\%pV = 100*\{(Hb_1/Hb_2)(100-Hct_2*0.874)/(100-Hct_1*0.878)\}-1$$

Four skin-folds (triceps, biceps, abdominal and scapula) were measured before sauna sessions to calculate:

a) body density – D [g/mm^3],
b) body fat – F [%],
c) body surface – [m^2],
d) body mass index – BMI [kg/m^2],
e) total fat mass – FM [kg],
f) lean body mass – LBM [kg].

Measured variables were calculated as mean values and standard deviations. Statistical significance in same group was calculated with the use of Wilcoxon test for dependent variables, while between groups with one-factor analysis of variance (ANOVA).

Results

The general characteristic of tested subjects is presented in table 1. The average age was similar, while subjects differed significantly in other variables, which were higher in swimmers.

Table 1

Anthropometric characteristics of tested subjects

Variable	Swimmers		Untrained	
	x	SD	x	SD
Age [years]	22,6	0,52	21,6	1,26
Body height [cm]	178,6	6,26	178,8	5,61
Body mass [kg]	71,82	12,52	69,26	8,08
BMI [kg/m^2]	22,48	3,24	21,7	2,34
Body surface [m^2]	1,88	0,18	1,86	0,12
Body density [g/mm^3]	1,05	0,007	1,06	0,01
Fat [%]	18,09	3,51	16,91	3,35
Fat mass [kg]	13,22	4,41	11,86	3,38
LBM [kg]	58,6	8,86	57,4	5,42

Hypothermia caused higher body mass losses in untrained subjects. They were equal to -0.43 in swimmers and -0.82 kg in untrained subjects (p=0.001).

The increase on rectal temperature caused by the sauna session was higher in swimmers what is presented in figure 1. A lower body temperature before entering sauna was registered in swimmers what was also true after the sauna session (fig. 1 and 2).

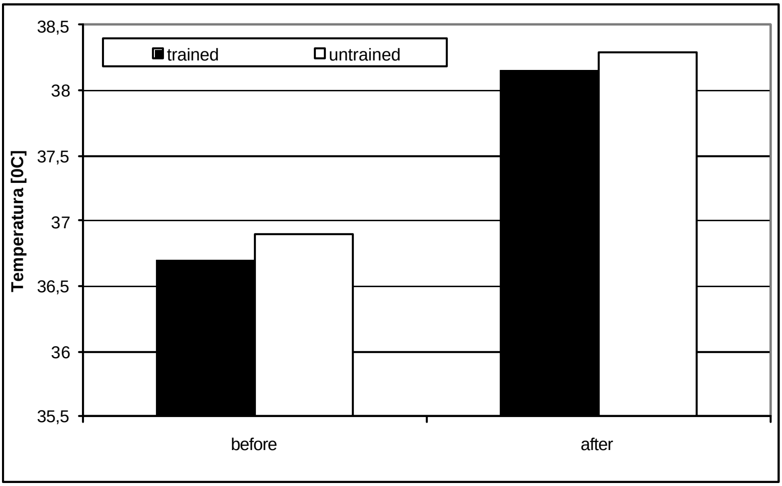

Fig. 1.

Comparison of changes in rectal temperature in both groups

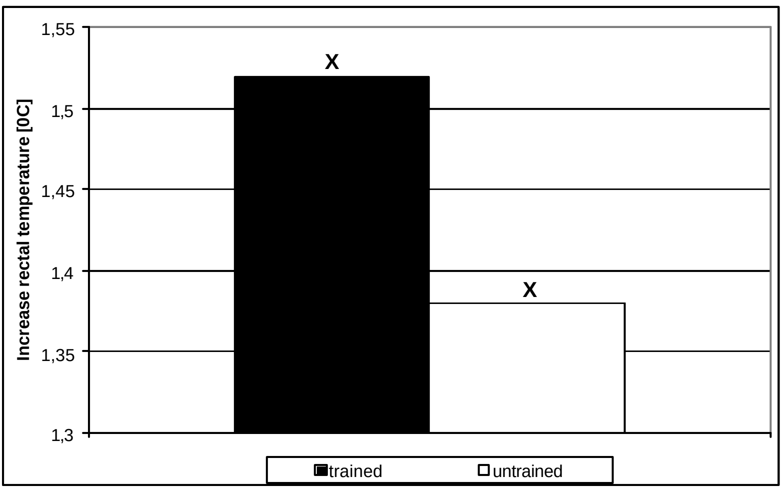

Fig. 2.

Comparison of changes in rectal temperatures after sauna sessio n

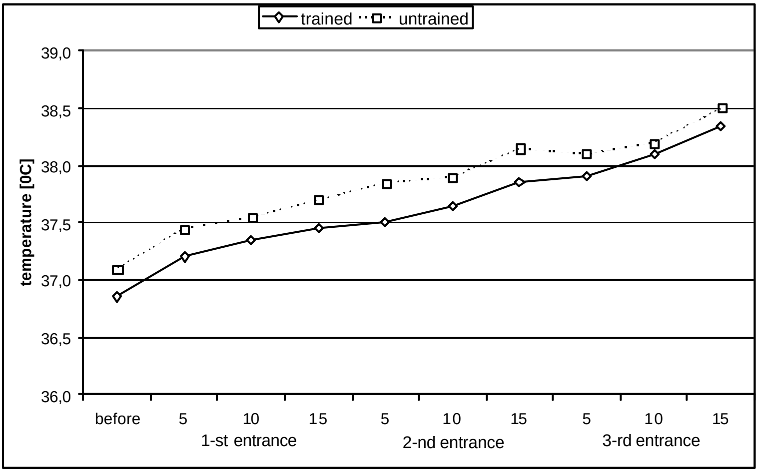

Fig. 3.

Average increase in rectal temperature in both groups during consecutive sauna sessions

Heart rate increased after sauna exposure in both groups by 61.8 beats/min. in swimmers (p=0.01) and 62.7 beats/min. in untrained subjects, what is presented in fig. 4.

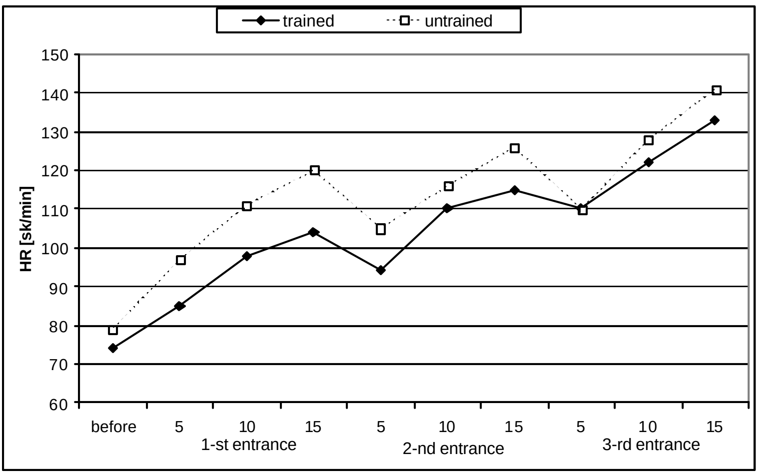

Fig. 4.

Comparison of heart rates

Higher plasma volume loss was registered in untrained subjects (fig. 5).

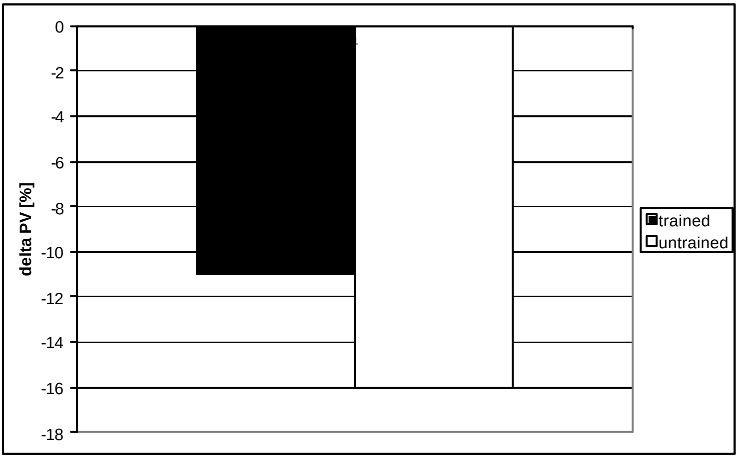

Fig. 5.

Comparison of plasma volume loss

Significantly intensified, subjective thermal sensations were observed in the group of swimmers (fig. 6).

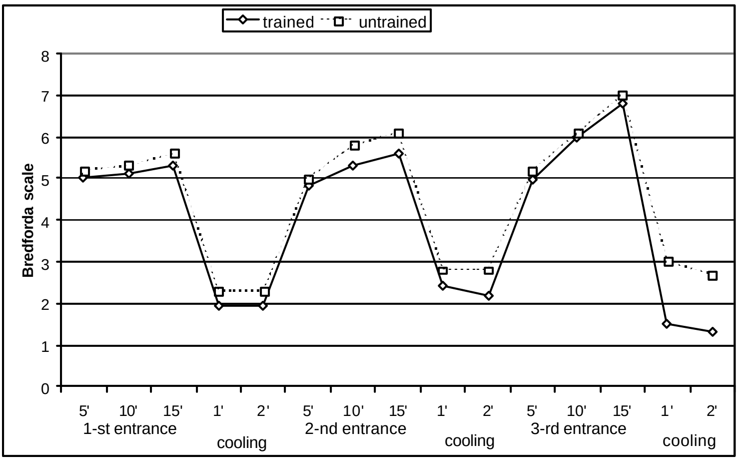

Fig. 6.

Comparison of thermal sensation changes

There were no statistically significant differences between groups in any of the above described variables.

Discussion

On the basis of performed measurements it is possible to state, that average values of anthropometric coefficients in both tested groups are characteristic for male subjects of this age (Szopa 1985). The higher percentage of body fat in swimmers confirms that practicing in low temperatures leads to increased production of body fat (McMurray 1979, Flynn 1990).

It is well known, that human body radiates heat with sweat as a consequence of increased environmental temperature. The temperature increase above the “biological thermostat” causes the hypothalamus reaction activity in order to compensate thermal balance. During a routine sauna session the average body water loss with sweat equals approximately 400-600 g (20 g/min. on average). Generally less than 60% evaporates giving a cooling effect. The rest evaporates through the skin surface (Haninen 1986, Hawkins 1987, Kaupinen 1986, Szygula 1995).

Intensified sweating causes extracellular fluid loss, plasma volume decrease, body mass loss and a decrease of circulated blood. The average body mass losses during sauna exposure in untrained subjects equaled to 0.82 kg, while in swimmers 0.43 kg. The higher body mass loss observed in non-training subject was affected by earlier activated thermoregulation processes (lower threshold for heat tolerance). It manifests in premature sweating and in consequence causes a relatively higher body mass loss in comparison to sportsmen (Kubica 1995).

During the first 4 min. of sauna exposure, the skin temperature increases urgently to 40°C. If the exposure to high temperature prolongs, despite very effective thermoregulatory mechanisms, heat accumulation follows. The temperature recordings showed progressive increase of body temperature. During the 20th min. of sauna exposure the internal temperature may increase by 4°C, however it never reaches 40°C (Szygula 1995, Pilch 1998).

In the presented experiment body temperature increased significantly in both groups. The internal temperature, measured as rectal one, was lower before sauna exposure in swimmers what suggests that trained subjects have organisms “switched” to lower metabolism caused by practicing in lower temperature than air (Buono et al. 1998).

Higher rectal temperature increases were observed in swimmers, what suggests less effective thermoregulatory mechanisms. Similar observations were acquired when swimmers performed physical activity in 20°C water. The internal temperature of swimmers increased mores significantly than runners (McMurray 1979). The maintenance of increased systolic blood circulation causes a more intensive heart work. During typical sauna sessions in the Finnish sauna heart rate increases to 160 beats/min. This acceleration is caused by sympathetic system activation and noradrenalin release in greater amount under thermal stress conditions, as well as increased internal temperature (Kaupinen and Vuori 1986).

The comparison of both groups in this respect allows to conclude that a higher increase of heart rate in untrained group gives evidence of higher workload to their organism and higher metabolism economy in swimmers.

Intensive sweating causes water loss i.e. the main component of body plasma which decreased in swimmers and untrained subjects by 9.5% and 14.5% respectively. It may suggest that swimmers dehydrate slower and their body fat hinders sweating and water loss.

In this experiment the subjective thermal sensations were also evaluated with the use of Bredford scale. It showed that swimmers despite higher overheating tolerate stress better.

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