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Behavioral Comfort and Nutritional Problems of the Hungarian Soldiers in World War II

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Abstract: Exercising in the cold weather brings some unique challenges for soldiers who participate in cold environment. Anyone who exercises in cold weather needs to take a few precautions in order to stay comfortable, safe and still perform at an optimal level when temperatures drop. Suitable clothing and proper nutrition helps regulate the core temperature, keeps the body warm and provides enough fuel for the working muscles. This paper describes the behavioral comfort and nutritional problems of the Hungarian soldiers in WWII and shows our results with thermal manikin.

Key words: 2nd Royal Hungarian Army, behavioral comfort, suitable clothing, nutritional problems, thermal manikin

INTRODUCTION

In January 1943 a lot of soldiers of 2nd Royal Hungarian Army died in Russia, at the River Don, because of the lack of food supply and suitable clothing. One of the main explanations for these causes were the not proper thermal insulation of the uniforms. Nowadays this opened question can be answered with the use of the thermal manikin. The comfort behaviour of the soldiers is based on the thermal insulation of the clothing and on the thermal insulation of the clothing. Proper nutrition helps regulate the core temperature, keeps the body warm and provides enough fuel for the working muscles. In warm weather it's easy to sweat to regulate the temperature and remove excess heat, but in cold weather there is need to generate more heat to stay warm. When it comes to eating during cold weather exercise, warm foods are ideal, but not very practical. The problem with cold foods and fluids is that they can chill the body. In summer, this cooling effect is helpful during exercise, but in winter hot foods are the better choice.

"Metabolic adaptation in military service to heat, cold and high-altitude exposure may be accompanied by changes in nutrient requirements. Energy expenditures in increased in all three environments. Increased B-vitamin nutrient requirements are met by an increased consumption of the diet to meet energy requirements. Vitamin and minerals may reduce the increased oxidative stress in cold, heat or high altitude outdoor environments (Revai, 2009)".

"The diet of soldiers in different geographic and climatic regions of earth varies in both quantity and composition of foods in the diet. The relationships between diet and tolerance to cold, heat and hypoxia have been studied for many years, with interest peaking during periods of national focus on war efforts (Holmes, 1942; Mitchell and Edman, 1949). Global war efforts such as World War I and II have trust large numbers of unacclimated soldiers into geographical climates (Revai, 2007)".

"Soldiers of the Royal Hungarian Army ate only potato and carrots in Russia in 1943. Whenever people are largely dependent on a single crop or carrot for their main source of food, there is always the risk that the crop and carrot may be destroyed by disease, and famine conditions follow. Wars have been directly responsible for many famines throughout history. Food shortages are inevitable result of all wars and these can readily lead to famine conditions (Revai, 2007)".

The physiological function of the clothing and the role in forming the comfort has fundamental importance. The worn dresses influence the people nation comfort feeling, their safety, their working, their health. The aim of the physiological researches of the clothing is to let to make the planning of clothing to provide for people nation daily activity the most proper microclimate, wearing comfort and let to create optimal circumstances in the course of the given activities.

The reason for the Hungarian catastrophe at the bend of the River Don-the modern science-than we may have seen provides an opportunity. On the base of the measurement we defined the heat submission of the thermal manikin dressed in the uniform of the soldier serving at he River Don. We defined it the single body parts and the whole man's heat submission beside air velocity changing in case of a different operative temperature. We compared the measured values the reference with a value, the heat submission of the naked human body. We proved that the heat insulating ability of

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clothings weared at the bend of River Don can be measured and the worn clothing did not meet the requirements.

The federal expectations request it in order for the soldiers to be equal to the vocational requirements made on them independently of the environment surrounding them.

The data of temperature sensation measurements made on the thermal manikin wearing the uniform of the soldier serving at the bend of the River Don may serve as a sample, well utilizable the unsettled one and often in the course of extreme present and future missionary activities between weather conditions.

The outlined thermal manikin examinations are suitable all kinds of clothing-for example the cheque of the heat insulating ability of the present or planned military clothing in winter and summer states and at the time of the additional developments this opportunity into attention this purchase. It was the main question, whether in -19°C cold, wind the army's given clothing was suitable.

The measurement series proved that the thermal manikin is fundamentally fit for the examination of this. We initiated the examination in the comfort zone (20-24°C) and our opportunity was to reduce the temperature till -4°C, but we could get successful answer for the questions to be cleared.

The presentation of the thermal manikin: We made the measurements in the of heat comfort laboratory of the University of Pecs. The thermal manikin is a gauge system with big complexity, which was made of an average adult plastic puppet tallying with a man's body sizes.

The surface of the body consists from 18 parts and the surface temperature of each segments of the body can be separately set. During the measurement we measured the body heat loss each parts of the manikin in the clothing under various ambient temperatures (Banhidi *et al*., 2010).

Clothing of soldiers of the 2nd Royal Hungarian Army: The military service in cold and hot environments is generally more difficult than in an inert environment. The physical exertion, which occur in cold and hot climatic conditions, has also greatly affected the safety and health. The physiological effects of wearing apparel can be traced back to complex physical processes, and this is the topic of the clothing physiology (Revai *et al*., 2011). The physiological shortcoming of the clothing of 2nd Hungarian Army is mentioned during the activity at the river Don. The installation of a system of clothing were 2 pieces of upper and lower underwear, 4 pairs footcloth, an outgoing and practicing clothing, cap, jacket, pants, jacket, a pair of shoes and flax, cotton cloth sites. Footcloth for winter, warm underwear top and bottom for winter gloves were off. The clothing buttoned up to his neck in summer heat, in winter was cold. This clothing is not provided with the comfort of soldiers (Revai, 2010).

Fig. 1: Thermal manikin

Fig. 2: One of the sensor in the hand

Fig. 3: Data transmitter

The clothing's main physiological function is to help the human body temperature keep constant. Primarily the stability of the trunk and the head is very important (about 37°C) and the daily fluctuations do not exceed 0.7-1.5°C. This requires that the heat production and heat loss should be balanced. The man in the clothes feel comfortable if at the skin surface 30-35°C air temperature and relative humidity below 80 % prevails. In the heat household of the body, dressed in the clothes the insulating and the ability moisture permeability of the clothing covered with body surface area plays a role.
During the measurement we determined the ability of the clothing insulation according to (ISO/FDIS, 9920:2007):

$$I_T = \frac{\bar{t}_{sk} - t_o}{h} = \frac{\bar{t}_{sk} - t_a}{h} = \frac{\sum f_i \cdot t_i - t_a}{\sum (f_i \cdot h_i)} = \frac{\sum f_i \cdot (t_i - t_a)}{\sum (f_i \cdot h_i)}$$

Where:

f_i = Surface area of segment i./Total surface area of manikin
$\bar{t}_{sk}$ = The mean skin surface temperature in degrees Celcius
t_o = The operative temperature in °C
t_a = The air temperature in °C
t_i = The surface temperature of segment i in °C
h_i = The dry heat loss of segment i. per square metre of segment i., in watts per square metre ($W*m^{-2}$)
h = The dry heat loss per square metre of skin area, in watts per square metre ($W*m^{-2}$)

Measurement in the thermal manikin dressed in military clothing wearing at the bend of the River Don:
During the measurement of the part of the body heat loss was measured every five seconds. Duration of one measurement was approx. 4 h in length. Series received during the measurement we trained average and this was used for further analysis.
The examination extended to the military clothing wearing at the bend of River Don in full gear and without a jacket, assuming the windless and windy situations.
The insulation ability of the clothing was determined by internationally used clo value (1 clo = 0.155 m^2K/W). The benchmark was the man without a dress, which is 0 clo. Based under the calculation thermal insulation of the military clothing with the jacket was 1.5 clo, while the thermal insulation of the soldier's clothing without the jacket was 1.3 clo, respectively.
We determined the heat dissipation of the thermal manikin in different attire. Figure 5 shows the heat loss of a naked (0 clo), of a military clothing without jacket (1.3 clo) and the thermal manikin in jacket in addition to various operational temperatures. From the chart can be seen that already -3°C - 200 W was the heat dissipation of the thermal manikin in jacket, which caused thermal discomfort sensation.

Fig. 4: Thermal manikin dressed in military clothing weared at the bend of River Don

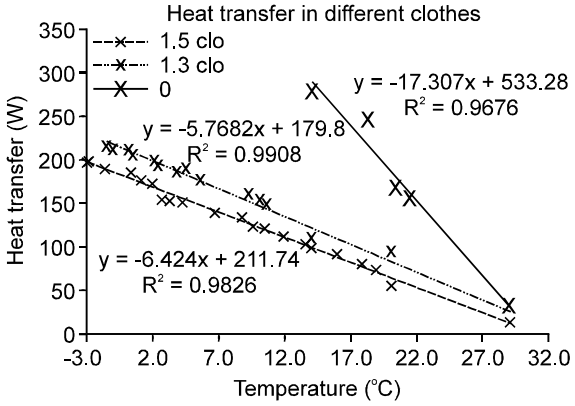

Fig. 5: Specific heat transfer of the different part of the body from the nude thermal manikin

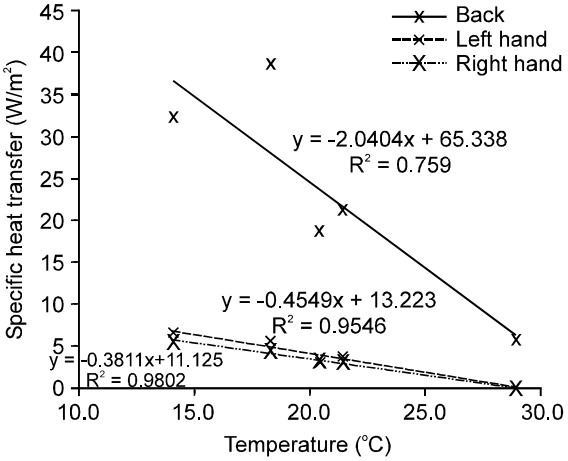

Fig. 6: Specific heat transfer of the different part of the body from the nude thermal manikin

We tested also heat loss the individual parts of the body. As an example we show the heat loss of the back, left

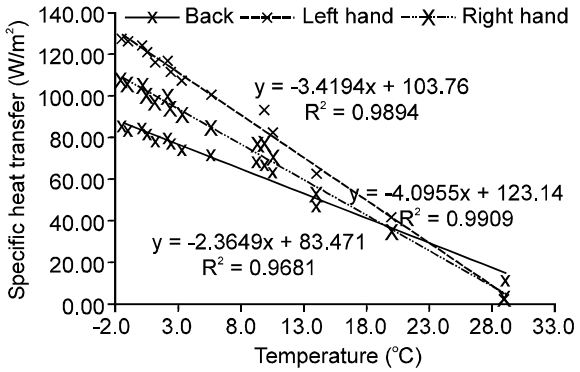

Fig. 7: Specific heat transfer of the different part of the body from the thermal manikin in the original clothes

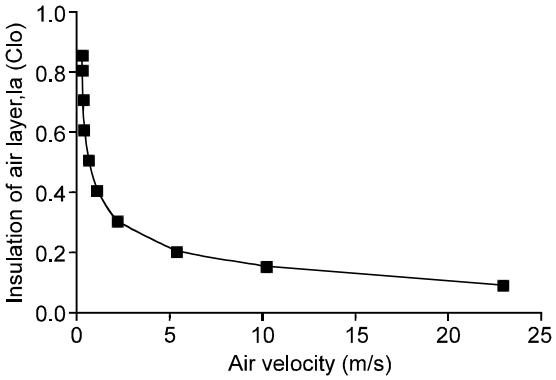

Fig. 8: Heat insulation capacity change in the dependence of the velocity function (Burton and Edholm, 1955)

and right arm at as a reference used at naked over matter (Fig. 6) and at the case of thermal manikin dressed in military clothing case (Fig. 7).

The clothing insulation capability, thus the man sensation greatly influenced the wind speed. During the measurement the heat loss of the thermal manikin was determined at 15 km/h wind speed. Figure 8 shows the change of the insulation air layer in the dependence of the velocity function.

Summary: In determining and maintaining the behavioral comfort of the soldiers plays a very important role of the proper clothing and proper nutrition. It is well known that the 2nd Hungarian Army soldiers fought under extreme weather conditions, performed military service, and that the Army lost in 2 weeks hundred and fifty thousand people in Russia at the bend of River Don. Our research confirmed that the clothing of Hungarian soldiers was really not appropriate to the bad weather, and also together with the inappropriate, inadequate nutrition contributed significantly to a reduction in the behavioral comfort, and conducted to the emergence of a large number of freeze damage. The aim of our examination was to call the attention to the proper clothing and nutrition in extreme and changeable weather conditions.

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