THE HEAT TOLERANCE AFTER AN ACUTE HEAT ILLNESS - A FOLLOW UP STUDY AMONG MILITARY CONSCRIPTS

Ham Lindholm 1), Raija Ilmarinen 2), Antti Viljanen 1), Aarne Laakkonen 1), Tuula Lindholm 1) and Risto Kemppainen 3)

1) Institute of Military Medicine, Mannerheimintie 164, SF- 00300 Helsinki, Finland
2) Institute of Occupational Health, Topeliuksenkatu 41aA, SF- 00250 Helsinki, Finland
3) General Headquarters, Medical Department, Laivanvarustajankatu 6, SF- 00130 Helsinki, Finland

INTRODUCTION

Heat illnesses are a typical problem in military service. Even fatal heat strokes occur (1). The determination of the heat tolerance of a former heat illness patient has been recommended (2). The *training* program of every Finnish soldier includes instructions in the prevention and first aid of an acute heat illness (3). In order to evaluate the frequency of heat illnesses in the Finnish Army the troops are told to report every possible case. The report includes the description of the event, first symptoms of the patient and facts concerning the clinical state and first aid given.

The aim of this study was to evaluate the frequency of exertion induced heat illnesses in the Finnish Army. The other purpose was to examine the heat tolerance of the conscripts after an acute heat illness. We have also started a study concerning normal subjects without heat illness.

METHOD

The subjects (Table 1) were selected from the reported heat illness casts. The criteria were 1) the military service had begun in June 1991 2) the heat illness occured during physical training 3) the rectal temperature was over 38.5" C and/or 4) the patient had typical symptoms of an acute heat illness. Before the heat tolerance test the subjects had a thorough medical examination to exdude other diseases and their maximal working capacity was determined by the spiroergometer test.

Table 1. The physical characteristics of the conscripts (N = 17)

	Age a	Height cm	Weight kg	Body fat %	VO_2max $ml \cdot kg^{-1} \cdot min^{-1}$	EF %
mean	20	179	73	14.4	43.5	60
SD±	1.2	5	9.5	3.4	6.3	6

EF= ejection fraction in echocardiography

The heat tolerance test modified from the previous tests (4) was conducted in a climatic chamber under carefully controlled conditions (T_a 35°C = T_g, RH 60 %, v_a 0.3 ms^{-1}). The Subjects, clothed in shorts and sport shoes and provided with drinking water *ad libitum*, performed a 60 min work bout on a treadmill (4 kmh^{-1}, incline 3.5") after a 30 min bedrest under neutral climatic conditions. ECG (OLLI 323 monitor) and heart rate were continuously monitored and HR was recorded once a minute with Sport Tester PM 3000 system. Rectal temperature (T_r) at a depth of 10 cm (YSI 427) and skin temperatures (T_{sk}) at 9 sites (YSI 401) were registered every 10 sec (Grant Squirrel 1200 meter/logger). Blood pressure (conventional auscultatory technique) and skin blood flow with laser Doppler flowmetry (Periflux PF 2B) were measured every 10 minutes and oxygen consumption was measured (Mijnhardt Oxycon 4) at the beginning, in the middle and at the end of test period. The evaporative sweat loss was determined by weight changes of nude subjects recorded (Sauter E 1200, ± 5g) before and after the test and corrected for water intake. The autonomic nervous system function was evaluated by short orthostatic and deep breathing tests immediately before and after the heat exposure.

RESULTS

The frequency of exertion-induced heat illnesses was about 1/1000 men during the summer 1991. Most of the casts were considered heat exhaustion due to water depletion. Three cases were nearly heat strokes. In about two thirds of the cases the first aid was given immediately by another conscript.

The preliminary results are focused on T_r, HR and sweating responses in the heat tolerance test; the other physiological data as well as the results of the control group will be reported elsewhere. One of the 18 conscripts could not complete the test; the reason for termination after about 15 min was a typical heat syncope. Table 2 shows the mean values (M ± SD) for T_r at the end of heat exposure, for T_r, HR and pulse pressure changes during the exposure, for sweat production and for water intake. The T_r of seven conscripts was ≥ 38.5°C at the end of the heat exposure. In five cases the increase was more than 1.5°C.

Table 2. The preliminary results of heat tolerance test of the conscripts.

	$T_r$end °C	$T_r$change °C	HR change bpm	Sweat production e	Water intake g	Pulse pressure change mmHg
Group A (N=10)						
mean	37.9	1.0	52	730	514	37
SD±	0.2	0.3	14	235	327	22
Group B (N=7)						
mean	38.7	1.5	49	704	542	32
SD±	0.1	0.2	13	165	310	17
All						
mean	38.2	1.3	50	719	525	35
SD±	0.4	0.3	13	204	310	20

Group A = T_r < 38.5°C at the end of the test
Group B = T_r ≥ 38.5°C at the end of the test

There were no significant differences in physical condition, cardiovascular function or water intake between the high and low temperature groups. Two of the high temperature group subjects had a renewed heat illness during the service. The preliminary results of this study support the results of present study.

CONCLUSIONS

We conclude that there might be individual differences in heat tolerance which are not connected With for example overweight and physical condition. We recommend a simple heat tolerance test after a serious heat illness of a conscript. The test may also be useful in selecting men ,who could be exposed to heavy heat stress in their service. In field conditions ineffective drinking is one of the most important risk factors. We have had promising results in the Finnish Army from first aid training of conscripts with regard to managing heat illnesses.

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