

THE EFFECTS OF HEAT ACCLIMATION ON SWEAT GLAND SENSITIVITY

Jay H. Heaney, Michael J. Buono*, Katherine M. Canine,
Michael P. Shannon, and Robert S. Pozos.
Naval Health Research Center and San Diego State University*
San Diego, California, 92186-5122, USA

INTRODUCTION

Improvements in the sweating response have been reported to occur via central adaptations with heat acclimation and via peripheral adaptations with physical training (1). Other investigators have suggested that improved sweat production following heat acclimation is due primarily to peripheral adaptations in the sensitivity of the sweat gland or that heat acclimation must stimulate both central and peripheral adaptations (2,3). The purpose of this study was to investigate the effects of heat acclimation on peripheral sweat gland sensitivity.

METHODS

After providing informed consent, ten male active duty U.S. Navy sailors completed an 8 day heat acclimation protocol. The mean (\pm SD) age, height, weight and body fat for the group were 22 ± 2 yr, 178 ± 8 cm, 78 ± 8 kg, and $16 \pm 5\%$, respectively. Each day the subjects performed four 25-minute intervals of exercise separated by 5 min of seated rest alternating cycle ergometry and treadmill walking (oxygen uptake = $1.2 \text{ L}\cdot\text{min}^{-1}$) during a 2 hour exposure to a thermal environment of 35°C and 74% relative humidity. Heart rate (HR), and rectal temperature (Tre) were monitored throughout each heat exposure. For the purposes of this investigation, the subjects were considered to be acclimated when final Tre and final HR values were not statistically significant from the final Tre and final HR values recorded from the the previous day. Metabolic rates were measured during the first treadmill walk, using a standard Douglas Bag technique. Whole-body sweat rate (WBSR) was determined from nude, dry body weight differences obtained pre and post each heat exposure and corrected for fluid exchanges. Sweat sensitivity was measured in a thermal neutral environment at three different time intervals; prior to testing on day 1, prior to testing on day 4 and on the day after the final heat exposure. Forearm sweat glands on both arms were stimulated via pilocarpine (a cholinergic agonist) iontophoresis and applied using a Wescor (Logan, Utah) model 3700 inducer with the iontophoresis current was fixed at 1.5 mA for 10 min. Pilocarpine was delivered via reagent-impregnated (0.5% pilocarpine) solid agar gel discs and the sweat was collected using Macroduct sweat collectors. Mean forearm sweat (MFS) values, derived from averaging the sweat collected on both arms, were compared with HR, Tre and WBSR responses observed on days 1, 3 and 8 of acclimation. A different forearm site was used on each of the three sweat measurement days to control for any potential effects of repeated pharmacologic stimulation. Statistical significance which was set at the .05 level and determined using a repeated measures ANOVA.

RESULTS AND DISCUSSION

Mean values for HR, Tre, WBSR and MFS are displayed below in Table 1. During acclimation, final HR and Tre values on day 8 were significantly decreased from day 1 by 19 bpm and 0.5°C respectively. Although mean WBSR values increased 11% throughout acclimation, this was not a significant increase. The small increase in WBSR was most likely the result of using a constant work load protocol. Since the physiological stimulus was not as great on day 8 vs. day 1 (i.e., ending Tre was 38.3 vs. 38.8 , respectively) the stimulus for sweating may have been reduced as well (3). MFS values significantly increased 27% and 41% by day 3 and day 8 respectively. Pharmacologic induced forearm sweating increases observed in the present study are in agreement with those of 40% reported in a similar study (4). Metabolic rates, which remained unchanged throughout acclimation, averaged $16 \pm 8 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$. This metabolic rate represents an exercise intensity level of 33% aerobic power for this population. Since the exercise intensity level was less than 50% of maximal aerobic power, it is unlikely that the low exercise work rate used in this study generated much of a physical training effect (5).

Table 1. Mean (\pm SD) Group Physiological Responses

N=10	HR (bpm)	Tre ($^{\circ}$ C)	WBSR (L/hr)	MFS ($\text{mg}\cdot\text{cm}^{-2}\cdot\text{min}^{-1}$)
Day 1	154 \pm 20	38.8 \pm .5	1.04 \pm .3	.663 \pm .21
Day 3	139 \pm 24*	38.5 \pm .6	1.06 \pm .3	.839 \pm .31*
Day 8	135 \pm 20*	38.3 \pm .4*	1.24 \pm .2	.937 \pm .36*

*=significantly different from Day 1

CONCLUSIONS

These results indicate that peripheral adaptations occur in the human sweat gland with heat acclimation. Additionally, heat acclimation significantly improved sweat gland sensitivity, as evidenced by a 27% increase in forearm sweat production within three days and a 41% increase upon completing 8 days of heat acclimation.

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