Inter-Laboratory and Inter-Subject Group Differences in Heat Stress Data

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INTRODUCTION

It is often useful for investigators to compare results from other research studies. These data may have been collected in the same laboratory on different subject groups, or in different laboratories. In previous studies conducted by two different U.S. Navy research laboratories using the same research protocol, the relative effectiveness of a cooling system in increasing tolerance time to work in the heat was comparable (1, 2). There were differences, however, in absolute measures of heat strain and endurance time. Other studies have demonstrated difficulty in reproducing heat stress results (3). The present study was designed to attempt to quantify inter-laboratory as well as inter-subject group differences in heat stress data.

METHODS

Heat stress testing was conducted using the same research protocol in two different U.S. Navy research laboratories. Prior to testing, investigators at both laboratories compared and standardized test equipment, instrumentation, and measurement and calibration techniques to the extent possible.

In the first phase of testing, one group of male subjects (n=7) underwent heat stress exposures in both laboratories (IA and IB). In the second phase of testing, a different group of male subjects (n=6) underwent heat exposures in one of the laboratories (IIB). The subject groups were similar in age, height, weight and physical fitness. The protocol included 8 days of initial heat acclimation, followed by heat stress tests in three environments: 35°C db, 31°C wb (WBGT 32°C); 43°C db, 33°C wb (WBGT 36°C); and 52°C db, 34°C wb (WBGT 39°C). During the heat exposures, subjects wore a military work uniform (clo=1.0; i_m=0.4) and walked on a treadmill (1.3 m/s; 3% grade) to elicit a metabolic rate of 470 watts for a maximum of 180 minutes.

The data were analyzed using repeated measures analyses of variance (separate analyses for each environment).

RESULTS

Table 1 includes data from all tests (IA, IB and IIB), in each of the three environments. Comparing tests, there were no statistically significant differences in tolerance time, heart rate, or total body sweating rate in any of the environments ($p>0.05$).

There were several statistically significant differences ($p<0.05$) in the rectal temperature responses. In WBGT32, the increase in rectal temperature (°C/h) was significantly higher for IIB than IA or IB. In WBGT36, the increase was significantly lower for IIB than IA or IB.

Table 1. Tolerance time and physiological responses (mean ± S.D.)

	WBGT32			WBGT36			WBGT39		
	IA	IB	IIB	IA	IB	IIB	IA	IB	IIB
Time (min)	175 ±14	172 ±23	175 ±11	93 ±35	103 ±18	95 ±32	59 ±8	53 ±7	62 ±24
Tre * (°C/h)	0.68 ±0.09	0.60 ±0.14	0.84 ±0.11	1.90 ±0.28	1.77 ±0.30	1.53 ±0.35	2.49 ±0.25	2.52 ±0.39	2.43 ±0.45
HR[1]	145 ±12	142 ±9	140 ±14	152 ±9	150 ±12	140 ±19	149 ±9	153 ±8	151 ±16
SR[2]	650 ±180	750 ±120	650 ±120	1060 ±250	920 ±220	940 ±160	1340 ±260	1060 ±340	1110 ±290

* Statistically significant differences among tests (see Results).
1 HR = Heart Rate (b/min); Measured after 150 minutes of exposure in WBGT32, 60 minutes in WBGT36, and 40 minutes in WBGT39.
2 SR = Total body sweating rate ($g/m^2/h$).

CONCLUSIONS

Under carefully controlled conditions, inter-laboratory differences in heat stress data measured on the same group of subjects are negligible. Some differences between subject groups, however, may be expected in some of the physiological responses. The magnitude of those differences varies depending on the severity of the heat stress.

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