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The USARIEM Heat Strain Decision Aid (HSDA) is an empirically developed tool for mission planning and prevention of heat injury. HSDA uses information about the individual, their environment, clothing, and activity to estimate core temperature (Tc) and calculate recommended safe work times. Data from a recent series of experiments was used to validate the performance of HSDA for the conditions studied.

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COMPARISON OF MODEL PREDICTIONS TO CORE TEMPERATURE RESPONSES DURING PROLONGED INTERMITTENT EXERCISE

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INTRODUCTION

The USARIEM Heat Strain Decision Aid (HSDA) is an empirically developed tool for mission planning and prevention of heat injury. HSDA uses information about the individual, their environment, clothing, and activity to estimate core temperature (T_c) and calculate recommended safe work times. Data from a recent series of experiments was used to validate the performance of HSDA for the conditions studied.

METHODS

Sixteen volunteers (1 woman and 15 men) participated in a series of experiments consisting of six 60 min walking bouts alternating with 20 min rest periods. The subjects' characteristics (mean ± SD) were age 22 ± 4 yr, height 177 ± 4 cm, mass 80 ± 13 kg, BSA 2.0 ± 0.2 m^2. Experiments were conducted in 4 different environments: T_{db} = 40°C and RH = 40%, T_{db} = 35°C and RH = 30%, T_{db} = 27°C and RH = 40%, and T_{db} = 20°C and RH = 50%. Wind speed was 1m/s for all experiments. Two moderate work rates were used: ~350W for the experiments at T_{db} = 27°C, 35°C, and 40°C and ~450W for the experiments at T_{db} = 20°C, 27°C, and 35°C. Volunteers wore standard army battledress uniforms for all tests. T_c was measured continuously with a temperature telemetry pill.

Experimental conditions were used as inputs to HSDA and its outputs were compared to measured T_c and endurance times. Since HSDA predicts for a 5 hour window, 2 episodes of each test bout were considered for comparison; minutes 0-300 and minutes 160-460. Not all volunteers completed every experiment and some volunteers ingested T_c pills < 4 hours before testing, which resulted in measurement interference from ingested fluids. Thus, a total of 131 model runs were available for comparison with test data.

RESULTS AND DISCUSSION

The overall root mean square deviation (RMSD) for all 131 comparisons was 0.43°C which is less than the SD of the actual T_c data (0.46°C). Predictions by HSDA were slightly better for experiments at the lower work rate (RMSD = 0.39°C, SD = 0.53°C) than the higher work rate (RMSD = 0.46°C, SD = 0.39°C) and slightly better for first 300 minutes of exercise (RMSD = 0.39°C, SD = 0.46°C) than the last 300 minutes of exercise (RMSD = 0.48°C, SD = 0.47°C).

Since HSDA predictions are the basis for much of Army doctrine for prevention of heat injury[1], it is important to regularly validate its performance. This comparison of HSDA predictions to actual outcomes during exercise in the heat indicates that it is reasonable to use in guidance for prevention of heat injury for the conditions studied here. A similar level of robustness has been observed during comparisons to other data sets[2]. Model refinement may be possible to improve its performance to account for individual variability. Further research is required to examine the performance of HSDA for other environments, uniforms, and activities.

REFERENCES

1. U.S. Department of Defense. Heat Stress Control and Heat Casualty Management. Washington, D.C.: Departments of the Army and Air Force. TB MED 507, AFP 48-152 (I), 2003.
2. Gonzalez, McLellan, Withey, Chang, and Pandolf. Heat strain models applicable for protective clothing systems: comparison of core temperature response. JAP 83:3, 1997.

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The investigators have adhered to the policies for protection of human subjects as prescribed in Army Regulation 70-25, and the research was conducted in adherence with the provisions of 32 CFR Part 219.

Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRMC Regulation 70-25 on the use of volunteers in research.

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