The Predicted Heat Strain Model (ISO7933) Severely Over- or Underestimated Core and Skin Temperature in Protective and Light Summer Clothing

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Published in:
Arbete och hälsa

2011

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Introduction: Heat stress is a person's net heat load that exposed to combined factors such as air temperature, relative humidity, air velocity, radiation, metabolism and clothing factors. A mild or moderate heat stress may cause discomfort and a deterioration of performances. If the heat stress level reaches human tolerance limits, heat-related illnesses such as heat syncope, heat cramp, heat exhaustion and heat stroke may occur. It is thus meaningful to have predictive measures to supervise those people who may suffer great heat strain. A feasible approach is using heat strain models. The aim of this study was to examine the reliability of the Predicted Heat Strain (PHS) Model in predicting physiological responses under various scenarios.

Methods: Eight male subjects participated in the study. Three levels of air temperature were selected: 20.0, 30.0 and 40.0 °C. The water vapor pressure in the chamber was kept at either 2.0 or 3.0 kPa. Five sets of different vocational clothing ensembles (light summer clothing & heavy protective clothing) were involved. The subjects walked on a treadmill at a speed of 4.5 km/h inside a climatic chamber for totally 70 minutes. The heart rate, skin and core body temperatures were recorded throughout the experiment. The metabolism, sweat rate and evaporative rate were also acquired using relevant instruments.

Results: It can be deduced from RMSD (root mean standard deviation) values that the PHS model performed well in clothing CLM at 20.0 °C, and clothing L, HV and MIL at 30.0 °C. However, for other 7 test scenarios, the PHS model generated either unreasonable rectal temperature or unreasonable skin temperature. In particular, the PHS model had both unreasonable rectal temperature and skin temperature for test scenarios of clothing FIRE at 30.0 and 40.0 °C.

Conclusions: The PHS model severely overestimated core body temperature during high insulation protective clothing such as FIRE. For summer light clothing such as L and MIL, the predicted skin temperature was underestimated. Thus, the model should be further revised to enhance its applicability.

NR 2011;45(5)

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ARBETE OCH HÄLSA | VETENSKAPLIG SKRIFTSERIE
ISBN 978-91-85971-32-9 ISSN 0346-7821