

VARIABILITY OF BODY TEMPERATURE RESPONSE TO STANDARDIZED STRESS CONDITIONS

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INTRODUCTION

It is common practice to measure changes in body temperatures of subjects working under standardized controlled conditions to assess the heat stress imposed when wearing various clothing systems (1,2,3). Recently, however, difficulties were experienced when trying to obtain reproducible results from similar experiments. As a result, the following controlled experiments were conducted to determine the extent of reproducibility which might be expected.

METHODS

Four young, active, male members of the Canadian Forces (CF) gave their informed consent to participate in the experiment. Each subject (dressed in shorts, T-shirt and footwear) sat quietly in an environmental chamber at 35°C and 50% humidity for one hour. After being instrumented with skin and rectal thermistors, he donned a CF chemical protective overgarment. He then walked on a treadmill at 5 km hr⁻¹ and 2.5% grade while his temperatures were measured and recorded every minute using an automated data acquisition system. The tests were concluded when rectal temperature reached 38.5°C or had risen 1.5°C, or 120 min had passed or the subject requested that he be allowed to stop. Each subject repeated the experiment at the same time of day 11 additional times with at least 72 hours between exposures.

RESULTS

Variation in rectal temperatures with time during the 12 experiments for each of two subjects is shown in Figure 1. The repetition number is shown at the end of each line. It can be seen that reproducibility between experiments was not obtained. Although the subjects rested in the warm chamber for an hour before each test and successive tests were done at the same time of day, it is readily apparent that rectal temperature in the different experiments did not vary in a consistent manner. Even the initial rectal temperatures (T_{ri}) were different. The time required to reach the endpoint appears to be influenced by T_{ri} but the correlation between these two variables was significant for only one subject (A in Figure 1). It is also seen that acclimatization, if any, played no part in the variability since the changes were random and did not seem to be dependent on previous exposure.

DISCUSSION

The method most commonly used to detect differences in heat stress caused by different types of clothing is that of determining the length of time required for a subject's rectal temperature to increase to a predetermined level while working at a given rate. In the current experiment we have substantiated the finding that even when a subject wears the same garment, it is difficult to obtain repeatable results. It is unlikely that accurate results would be attained even with the subject with the least variability because the lack of reproducibility would likely mask differences caused by dissimilar garments. It may be conjectured that if steps were taken to ensure that T_{ri} was the same value at the beginning of each test, more consistent results would be obtained. However, even though the subjects sat under controlled conditions for one hour before testing and were tested at the same time of day it was difficult to standardize T_{ri} . Even this may not have improved reproducibility since the correlation between T_{ri} and time to reach endpoint was small.

To date no solution to this problem has been found. As a result, using this method to compare clothing ensembles meaningfully is difficult unless the difference between ensembles is so great that one can easily estimate the end result before testing.

REFERENCES

1. Shelley W.B., Eichna L.W. and Horvath S.M. 1946, The effect of clothing on the ability of man to work in extreme heat, J. Clin. Invest. 25, 437-446.
2. Givoni B. and Goldman R.F. 1972, Predicting rectal temperature response to work, environment, and clothing, J. Appl. Physiol. 32, 812-822.
3. McLellan T.M., Meunier P. and Livingstone S.D. 1992, Influence of a new vapour protective clothing layer on physical work tolerance times at 40° C ambient temperature, Aviat. Space Environ. Med. 63, 107-13.

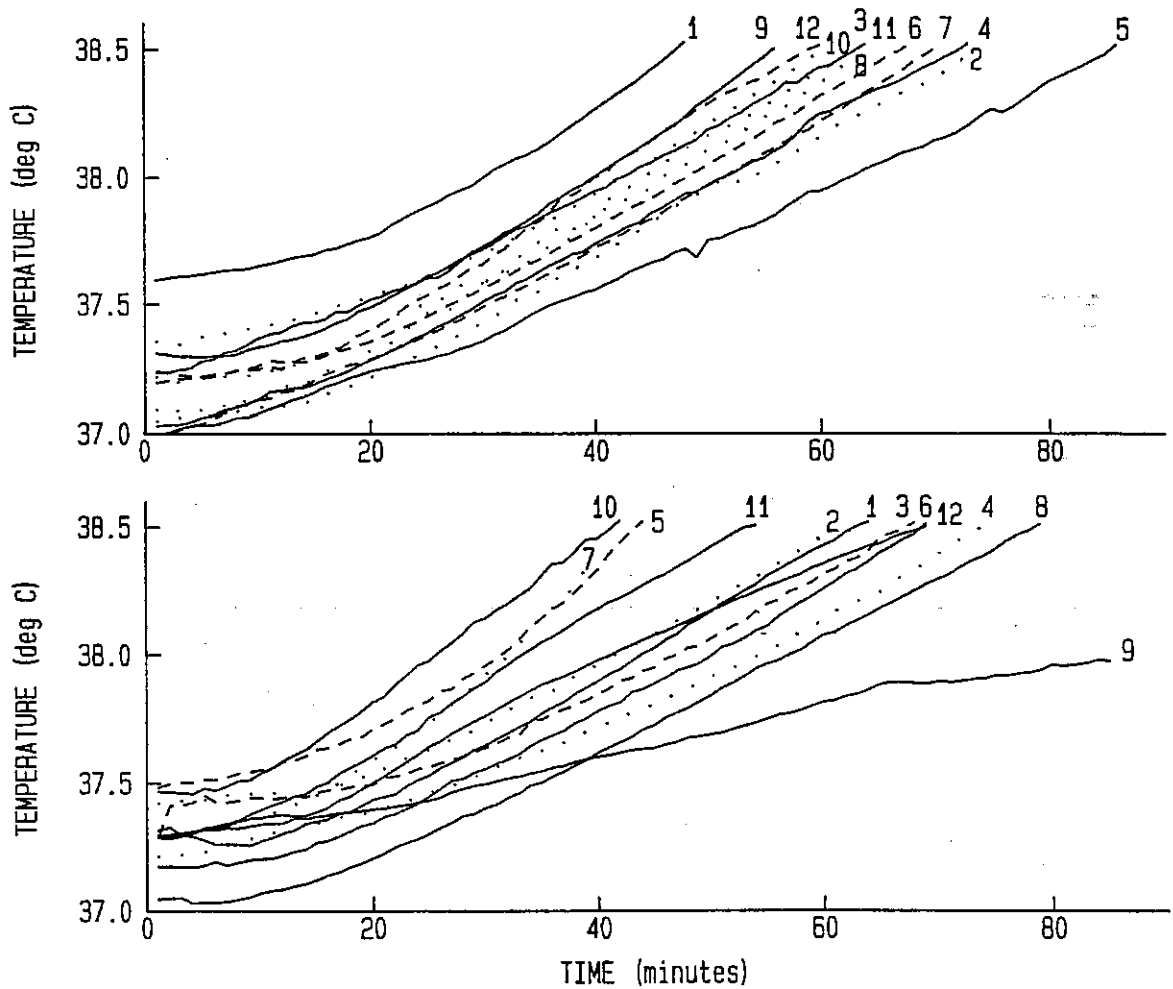


Figure 1 - Variation in rectal temperature with time as subjects work at 35° C. Numbers at the end of each line indicate successive experiments. Subject A showed the least variation while Subject B is more typical of our results.