

IS CORE TEMPERATURE DURING EXERCISE IN THE "PRESCRIPTIVE ZONE" DETERMINED BY WORK INTENSITY ALONE?

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INTRODUCTION

The "prescriptive zone" is defined by the range of external temperatures over which the deep body temperature can be stabilised during exercise (Nielsen, 1938). It is generally believed that the rise in deep body temperature and level at which it plateaus during steady state exercise within the prescriptive zone is dependent upon metabolic rate and independent of ambient temperature (Nielsen, 1938; Wyndham et al, 1952; Nielsen & Nielsen, 1962; Stolwijk et al, 1968). Furthermore, the average skin temperature is considered to be linearly related to the ambient temperature, and independent of metabolic rate (Nielsen & Nielsen, 1962; Stolwijk et al, 1968).

In the present investigation the relationship between deep body and skin temperatures were examined during mild exercise within the prescriptive zone.

METHODS

The experimental protocol was approved by a local Ethical Committee, and all subjects gave informed written consent before participating in the study. Eight subjects (7 male, 1 female) exercised at an oxygen consumption ($\dot{V}O_2$) of $1.2 \text{ l}\cdot\text{min}^{-1}$ on a non-motorised treadmill in a room at 23°C until rectal (T_{re}) and skin (\bar{T}_{sk}) temperatures plateaued for at least 15 minutes. Whilst exercising the subjects wore a suit designed to allow air to circulate over the torso and proximal regions of the upper and lower limbs at a rate of $300 \text{ l}\cdot\text{min}^{-1}$. The air was circulated after 27 minutes of exercise at a temperature of either 20°C or 30°C and a water vapour pressure gradient of 26 and 24 mmHg respectively. In the control condition the subjects exercised whilst wearing the suit without any air circulating.

Tre was measured using a rectal thermistor inserted 15 cm beyond the anal sphincter and recorded every minute on a data logger (Grants Instruments Ltd, Cambridge) with a tolerance of 0.04°C. \bar{T}_{sk} was calculated from the unweighted average of the temperatures recorded at the following 12 sites, inside and outside of the suit: right hand, chest, shoulder, lower back, thigh (inside and outside the suit), shin, calf, abdomen, shoulder, lower back and forehead.

RESULTS

During exercise the $\dot{V}O_2$ of subjects did not differ significantly between conditions averaging 1.25 l.min⁻¹ with a SD of only 0.12 l.min⁻¹ across conditions. The levels at which Tre plateaued with different air inlet temperatures and \bar{T}_{sk} were compared. When air at 20°C was blown through the suit the \bar{T}_{sk} was lower and Tre plateau higher than that seen in the control condition (no cooling) in seven of the eight subjects. The 30°C condition showed intermediate plateau levels. \bar{T}_{sk} increased above resting levels during the control condition and was either unchanged or fell in the 20°C condition. In the 30°C condition \bar{T}_{sk} rose in some subjects and fell in others in comparison with resting levels. In none of the conditions did sweat production exceed 1 l.h⁻¹ and was therefore considered to be submaximal at all times.

Using the least squares method of linear regression, an inverse relationship was identified between Tre and \bar{T}_{sk} for six of the eight subjects ($R^2=0.8$). This relationship produced a relatively stable mean body temperature (\bar{T}_b) within these subjects, across conditions (Figure 1). The proportional input from Tre and \bar{T}_{sk} to \bar{T}_b varied slightly between these subjects, in all cases Tre was the greater factor accounting for 93% of \bar{T}_b on average.

DISCUSSION

The results of the present study do not support the conclusion that the deep body temperature during mild exercise within the prescriptive zone is dependent on work rate only, and independent of ambient or skin temperature.

The higher \bar{T}_{re} plateau seen in the 20°C compared to 30°C condition cannot be attributed to physical factors as gradient for convective, conductive and evaporative heat loss was greater in the cooler condition. The consistency of mean body temperature across the conditions suggest that it is this variable which most closely reflected the "regulated" temperature during exercise. The same relationship between deep body and skin temperature can be found in the literature pertaining to both the thermoregulatory control of skin blood flow (Savage & Brengleman, 1996) and microclimate cooling (Teal & Pimental, 1995) but has not been commented upon in the present context.

The implication for microclimate cooling is that once an individual has been returned to his or her prescriptive zone, additional cooling (and greater consumption of the limited power supply which may be driving the system) is of little benefit.

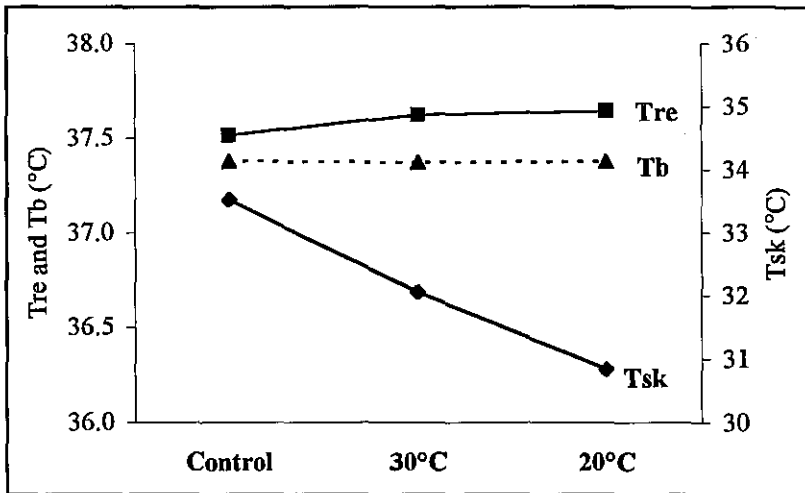


Figure 1. Mean \bar{T}_{re} , \bar{T}_b and \bar{T}_{sk} during the plateau period for each condition. Each point represents the mean value for the 8 subjects.

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