

PHYSIOLOGICAL RESPONSES OF MEN IN SLEEPING BAGS AT  $-20^{\circ}\text{C}$ 

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## INTRODUCTION

This set of experiments was designed to determine if we could differentiate between sleeping bags of different known insulative values by measuring body temperatures and metabolic rates of subjects exposed to  $-20^{\circ}\text{C}$  while in the bags.

## METHODS

Four male volunteers gave their informed consent to participate in these experiments. Each subject, wearing only shorts and instrumented with a rectal and 14 skin thermistors, lay on top of a Canadian Forces (CF) sleeping bag which was placed on a foam mattress on a rope mesh cot. A blanket was provided to keep him comfortable in the laboratory ( $20^{\circ}\text{C}$ ). After 60 min he got into the bag and donned the CF sleeping hood. The cot was then wheeled into the cold room ( $-20^{\circ}\text{C}$ ) where he remained for 120 min. Metabolic rate and body temperatures were measured continuously over the 180 min period. Experiments were performed using the CF sleeping bag, in either the single or double configuration. The insulation of the single bag was approximately  $1.2\text{m}^2\text{K/W}$  over the subject and  $0.2\text{m}^2\text{K/W}$  under the subject and that of the double bag, was twice those values (1). The insulation of the foam pad was  $0.2\text{m}^2\text{K/W}$ . Subjects were tested twice in each condition with the order of conditions randomly determined. Mean skin ( $T_s$ ) and mean body ( $T_b$ ) temperatures and changes in body heat content were calculated (2).

## RESULTS

From figures 1, 2 and 4 it is evident that there is little difference in the course of changes in rectal and mean skin temperatures or in metabolic rates in the subjects exposed to  $-20^{\circ}\text{C}$  in either the single or double sleeping bag. The only difference observed is that the toe temperature fell significantly lower ( $p < 0.05$ ) in the single sleeping bag (fig 3). Nonetheless, the total response of the other skin temperatures is not represented by the toe temperature. Although the skin is cooler in the single bag it is not significantly lower (fig 2). There was no increase in metabolic heat production (fig 4) as would be expected when subjects are exposed to cold (3). This would indicate that, although the subjects felt cold in the single bags, there was not enough cold stress to promote an increase in metabolism. Because there is a lack of metabolic response from the subjects this would support the argument that there is insufficient cooling to elicit this response and a longer exposure is needed to differentiate the insulative properties of the bags. It is also interesting to note that there was as much or more variation between the repeated exposures (Table 1) as there was between the single and double bag measurements in individual subjects. This was also true for the calculations of  $T_b$  and heat loss ( $H_{\text{loss}}$ ) through the sleeping bags (Table 1). It may be that the results are being masked by the heat content of the sleeping bags and a period of exposure, longer than 120 min is required to indicate the differences in the bags.

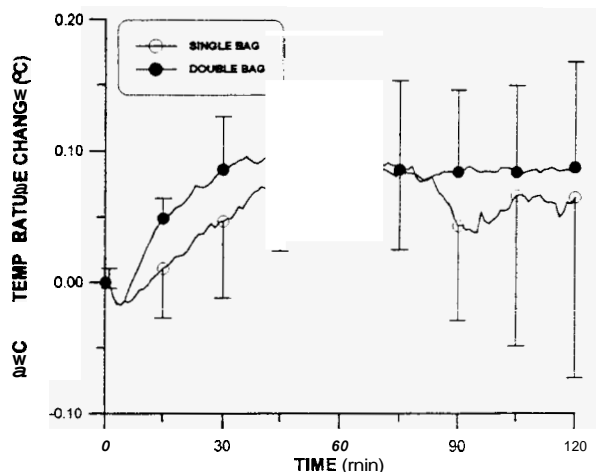


Fig. 1 Changes in rectal temperature from the initial temperature measured on entering the cold room. Values are mean  $\pm$  S.D.

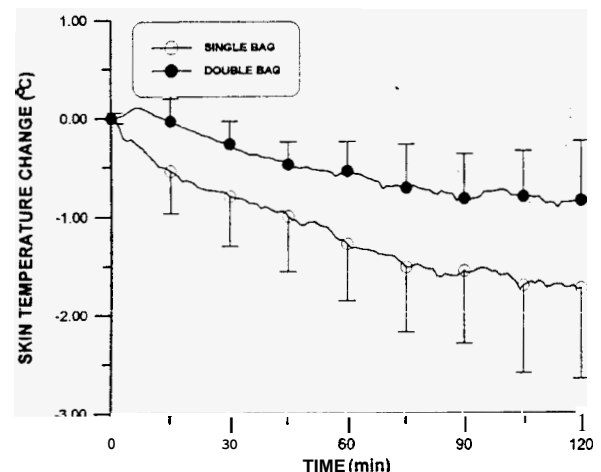


Fig. 2 Changes in mean skin temperature from the initial temperature measured on entering the cold room. Values are mean  $\pm$  S.D.

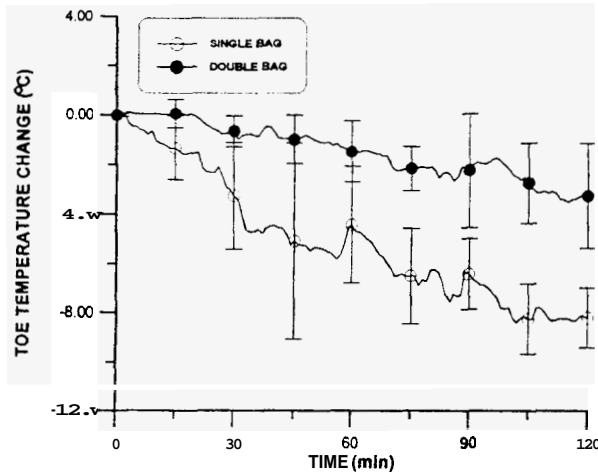


Fig. 3 Changes in toe temperature from initial values measured on entering the cold room. Values are mean  $\pm$  S.D.

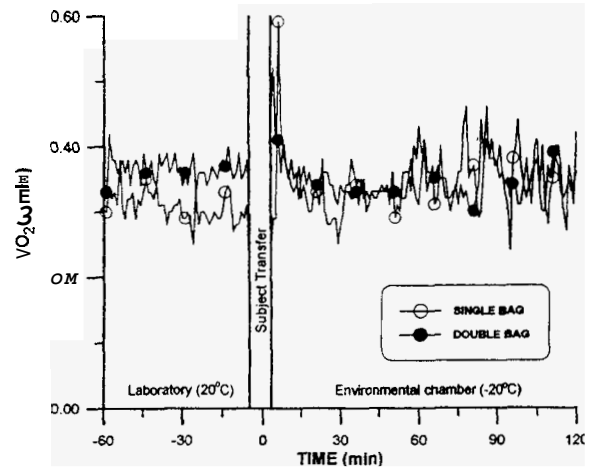


Fig. 4 Oxygen consumption measured during the tests. The break in the results is caused by moving the subjects to the cold room.

Table 1  
Comparison of measured changes in body temperature in the sleeping bags

Subj.	Bag Trial	Metabolic Rate		Exposure $\Delta T_b$		$H_{loss}$	
		1	2	1	2	1	2
A	single	214	208	0.85	0.79	273	263
	double	184	178	0.40	0.40	213	206
B	single	202	160	0.20	-0.23	216	144
	double	160	188	-0.05	-0.11	157	180
C	single	184	206	0.67	0.90	236	277
	double	180	224	0.38	0.24	210	243
D	single	146	160	0.56	0.29	184	180
	double	174	168	0.00	0.47	174	200

$\Delta T_b$  (decrease in body temperature during cold exposure) is expressed in  $^{\circ}\text{C}$  and metabolic rate and heat loss are expressed in total Kcals over the 120 min experimental period. Repeated exposures are indicated by 1 and 2. Negative signs shown for  $\Delta T_b$  are indicative of increases in body temperature.

## CONCLUSIONS

In the outlined experiments, both the single and double layer sleeping bags provided sufficient insulation to prevent any cooling of the core. It is likely that for exposures longer than the one simulated, the additional thermal protection by the double layer bag compared to a single may be reflected in a reduced thermal strain (i.e. higher rectal and skin temperatures).

## REFERENCES

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