

AMOUNT OF SUBCUTANEOUS FAT MODIFIES THE COOLING INDUCED CHANGES IN MUSCULAR PERFORMANCE

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INTRODUCTION

Cooling impairs force production and contraction velocity of a muscle (1,2). The decrement is related to the degree of cooling. However, the degree of cooling is dependent on the amount of subcutaneous fat, which provides thermal insulation against cool environment. The aim of this study was to quantify the effects of cooling on muscular performance with subjects having different amount of subcutaneous fat.

METHODS

Eleven healthy men served as test subjects. The amount of subcutaneous fat was estimated by skinfold thickness measurements described by Durnin & Rahaman (3). According to the measurements two groups were formed: lean subjects with body fat less than 10% and normal subjects with body fat more than 10% (Table 1).

Table 1. Physical characteristics of the test subjects. The values are mean \pm SD.

| | n | Age (yrs) | Height (cm) | Weight (kg) | Fat % |
|--------|---|------------|---------------|----------------|----------------|
| Lean | 6 | 24 \pm 4 | 173 \pm 7.8 | 66.4 \pm 4.1 | 8.9 \pm 0.2 |
| Normal | 5 | 25 \pm 3 | 174 \pm 7.8 | 74.9 \pm 7.5 | 14.0 \pm 1.2 |

Before the tests, the subjects were allowed to sit motionless for 60 min in a climatic chamber either at 10°C or 27°C, dressed in shorts and jogging shoes. During the exposures eight skin temperatures (YSI 400-series thermistors and Squirrel 1200, Grant, UK) were measured. The temperature of m. triceps from four subjects at a depth of 3 cm was measured after exposure to 10°C on a separate occasion, in order to avoid disturbances in performance and measurements.

The subjects performed an overhead throwing test with both arms. Five balls, weighing from 0.271 to 3.0 kg were thrown. The time the ball traveled 2.5 m distance was measured (Digitest 1500, Finland). The test was performed after exposures to 27°C and 10°C in a random order. The subjects were familiarized to the test before experiments.

The difference in muscular performance between 27°C and 10°C was tested among groups with one way analysis of variance (ANOVA). Significance was accepted at the 0.05 level.

RESULTS

Mean skin and muscle temperature values after exposure to 10°C are seen in table 2.

Table 2. Mean skin and muscle temperatures at the end of exposure to 10°C in lean and normal subjects. The values are mean \pm SE.

| | mean skin T | muscle T |
|--------|----------------|----------------|
| Lean | 24.7 \pm 1.2 | 29.6 \pm 0.1 |
| Normal | 25.4 \pm 0.5 | 31.0 \pm 0.5 |

The cooling induced decrement in muscular performance was more pronounced in lean subjects (Fig 1).

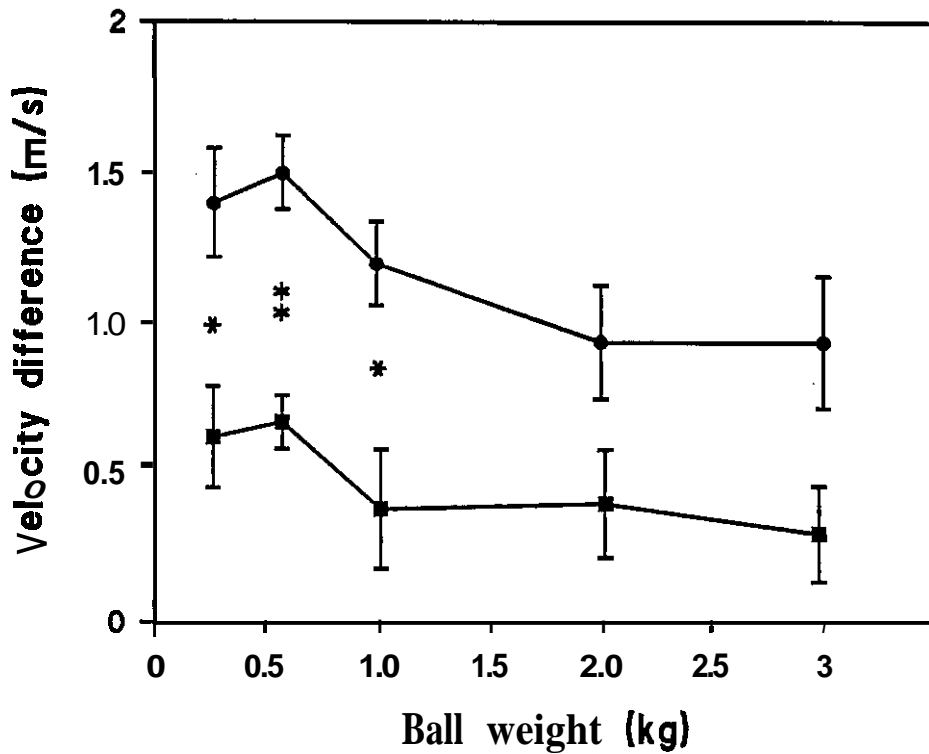


Fig 1. Ball velocity difference (27°C-10°C) in lean (solid circles) and normal (solid squares) subjects. Significant differences are denoted by one ($p < 0.05$) or two symbols ($p < 0.01$).

CONCLUSIONS

Exposure to 10°C did not markedly alter mean skin temperature between groups. However, the degree of cooling in the working muscles in lean subjects was more severe which was seen as a pronounced decrement in muscular performance.

Even with subjects who can not be considered as obese, body fat seems to be an effective insulator in cool environments, therefore slowing the decrease in performance capacity.

REFERENCES

1. Sargeant A.J. 1987, Effect of muscle temperature on leg extension force and short-term power output in humans, *Eur. J. Appl. Physiol.* **56**, 693-698.
2. Oksa J., Rintamäki H. and Mäkinen T. 1991, Cooling alters force-velocity relationship of upper body and arms, *Proceedings of I Int. Conf. on Human-Environ. Syst. Tokyo*, 587-590.
3. Durnin J.V.G.A. and Rahaman M.M. 1967, The assesment on the amount of fat in the human body from measurements of skinfold thickness, *Br. J. Nutr.* **21**,544-550.