

## MUSCULAR PERFORMANCE OF LOWER LEG AFTER COOLING

Juha Oksa, Hannu Rintamäki, Tero Mäkinen and Vesa Martikkala\*

Oulu Regional Institute of Occupational Health

Aapistie 1, Fin-90220 Oulu, FINLAND

\*Oulu Deaconess Institute, Department of Sports Medicine, Oulu, FINLAND

### INTRODUCTION

The earlier research of the effects of cooling on muscular performance of the leg has been mainly done during jumping or bicycling exercise (1, 2). In these exercises the elastic properties of the muscles may not be fully utilized. Hence, in this study we examined how cooling affects muscular performance during drop-jump exercise, which effectively utilizes elastic properties of the working muscles.

### METHODS

Twelve slightly clothed male subjects were exposed to 10°C and 27°C for 60 min. Rectal temperature (Tre) and skin temperatures from 7 sites were measured and registered every minute by a portable data logger (Squirrel 1200, Grant Instruments Ltd, England). Muscle temperature of *in. gastrocnemius medialis* was measured (n=6) at the end of similar exposures from the depth of 30 mm. After the exposures the subjects dropped from a bench (six different heights 10, 20, 30, 40, 50 and 60 cm) onto a force plate (Newtest, Finland) and performed a maximal instantaneous jump upwards. The subjects were asked to perform the jump with a minimum knee angle to maximally utilize the muscles of the calf. From the force plate data the mean force (meanF) produced during upward movement and the rise of body center of gravity (BCOG) during the jump was calculated. The take-off velocity of the jump was measured using an optoelectronic motion analysis system (MacReflex, Sweden).

### RESULTS

The exposure to 10°C decreased mean skin temperature 5.8°C (p<0.001). Rectal temperature was virtually unaffected. Muscle temperature of *in. gastrocnemius medialis* decreased 4.1°C (p<0.01).

The rise in BCOG was significantly lower after cooling in every drop height (Fig. 1). The average decrease was 21%.

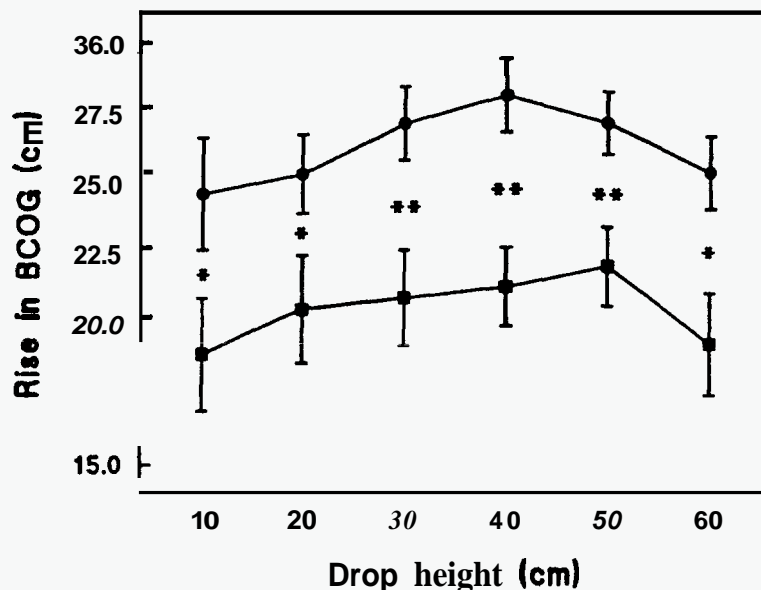


Figure 1. The rise in BCOG after exposure to 27°C (circles) and 10°C (squares). \* = p<0.05, \*\* = p<0.01

Cooling decreased force production of the lower leg and hence also the take-off velocity tended to be slower (average decrease 10%, Table 1).

Table 1. The effect of cooling on force production (meanF) and take-off velocity (Take-off) during the shortening phase. \* =  $p < 0.05$ , \*\* =  $p < 0.01$  and NS = not significant.

Drop height	10 cm	20 cm	30 cm	40 cm	50 cm	60 cm
meanF (N)						
27°C	1980±205	1970±208	1812±170	1818±121	1802±234	1663±217
10°C	‡389±82	‡418±75	‡436±73	‡350±67	‡275±106	1219±94 NS
Take-off (m s <sup>-1</sup> )						
27°C	2.57±0.2	2.54±0.2	2.67±0.2	2.65±0.1	2.56±0.1	2.50±0.1
10°C	2.28±0.2	2.34±0.1	2.41±0.2	2.31±0.2	2.32±0.2	2.30±0.3
	NS	NS	NS	NS	NS	NS

### CONCLUSIONS

After cooling a decreased level of force production was observed. This caused a smaller rise in BCOG after the exposure to 10°C.

The average decrement in muscular performance was 21% during lower leg exercise where elastic properties of the muscles were effectively utilized. In our previous studies after similar thermal exposures and exercise modes where elasticity of the muscles were not so efficiently utilized, like rebound jumping (3) or throwing (4), the decrement in performance varied between 7 - 11%. This implies that exercise mode where elasticity of the muscles are effectively utilized may be more susceptible to cooling.

### REFERENCES

- Bergh, U. 1980, Human power at subnormal body temperatures. *Acta Physiol. Scand.* 478, 1-39.
- Sargeant, A.J. 1987, Effect of muscle temperature on leg extension force and short-term power output in humans. *Eur. J. Appl. Physiol.* 63, 345-348.
- Rintamäki, H. Oksa, J. Rissanen, S. and Hassi, J. 1991, Cooling decreases maximal anaerobic power and oxygen debt in 60 s jumping test. In: *Int. Conf. on Human-Env System, Tokyo*, 547-550.
- Oksa, J. Rintamäki, H. Mäkinen, T. Hassi, J. and Rusko, H. 1994, Cooling-induced changes in muscular performance and EMG-activity of agonist and antagonist muscles. *Aviat. Space Environ. Med.* In press.