EVEN MILD COOLING DECREASES MUSCULAR PERFORMANCE

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INTRODUCTION

Several studies have shown that cooling decreases muscular performance (1, 2). In the majority of these studies the aim has been to cause such a degree of cooling that is severe enough to assure performance impairment. Therefore, knowledge about the minimal cooling necessary to impair muscular performance seems to be missing. Thus, this study was designed to evaluate the degree of cooling needed to decrease muscular performance. For that purpose drop-jump exercise which has been found to be very susceptible for cooling **(3)** was chosen for the experimental setup.

MATERIALS and METHODS

Eight voluntary subjects were exposed to 27°C (tliermoneutral reference), 20°C, 15°C and 10°C for 60 min, dressed in shorts and jogging shoes. Their mean (±SD) age was 26±4 years, height 175±8 cm, weight 72±6 kg and body fat 15±3 %. During the exposures skin **(8** sites), rectal (T_r, 10 cm depth) (Yellow Springs Instruments, YSI 400 series) and muscle (T_m, *m. gastrocnemius medialis,* 3 cm depth, YSI 511) temperatures were recorded in a data logger (Squirrel 1200, Grant, UK). Mean skin temperature (T_{sk}) was calculated by weighing the **8** local skin temperatures by representative areas (4).

After the exposures the subjects were allowed to drop from a 40 cm bench onto a force plate (Kistler 9287A) and perform a maximal instantaneous rebound jump with as straight legs as possible (knee angle was between 150 - 170°). From the force plate data, average force production during shortening phase (F_{conc}, upward movement during contact) and flight time (T_f) were analysed.

During the jump the EMG activity of *m. triceps surae* (agonist) and *m. tibialis anterior* (antagonist) were measured with a sample rate of 1250 Hz (Mespec 4001, Mega Electronics, Finland). The measured EMG signal was amplified 2000 times (preamplifier situated ***6*** cm after the measuring electrodes) and signal band between 20 and 500 Hz was full wave rectified and integrated (IEMG) with 13 ms time constant.

RESULTS

The exposures to ambient temperatures of 20°C, 15°C and 10°C significantly decreased all measured skin and muscle temperatures. Rectal temperature was unaffected by the exposures (Table 1).

The average force production during the shortening phase and consequently the flight times decreased already after the exposure to 20°C (Fig 1).

Along with decreasing ambient exposure temperature the IEMG of the agonist muscle decreased during the shortening phase. However, opposite changes were found in the antagonist muscle: the IEMG increased along with decreasing ambient exposure temperature (Table 2).

Table 1. Rectal (T_r), mean skin (T_{sk}), calf (T_c), shin (T_s) and *m. gastrocnemius medialis* temperature (T_m) at the end of exposures to 27°C, 20°C, 15°C and 10°C. The values are mean±SE of 8 subjects, except muscle temperature (n=6). The significance in relation to 27°C is denoted by * = $p<0.05$, ** = $p<0.01$ and *** = $p<0.001$.

	T_r (°C)	T_{sk} ("C)	T_c (°C)	T_s ("C)	T_m (°C)
27°C	37.0±0.1	32.6±0.3	31.6±0.2	31.8±0.3	32.9±0.5
20°C	37.0±0.1	28.1±0.5***	28.9±0.1***	28.8±0.3***	32.0±0.8
15°C	37.0±0.1	27.5±0.4***	27.1±0.5***	26.5±0.4***	31.0±0.4*
10°C	37.0±0.1	25.8±0.6***	24.0±0.3***	24.1±0.4***	29.5±0.7**

Table 2. **IEMG** of the agonist *(m. triceps surae)* and antagonist *(m. tibialis anterior)* muscles during the shortening phase after the exposures to 27°C, 20°C, 15°C and 10°C. Explanations as in Table 1.

	m. triceps surae (μV)	*m. tibialis anterior* (μV)
27°C	409±21	96±9
20°C	360±38	102±19
15°C	333±27*	160±16**
10°C	331±23*	197±20***

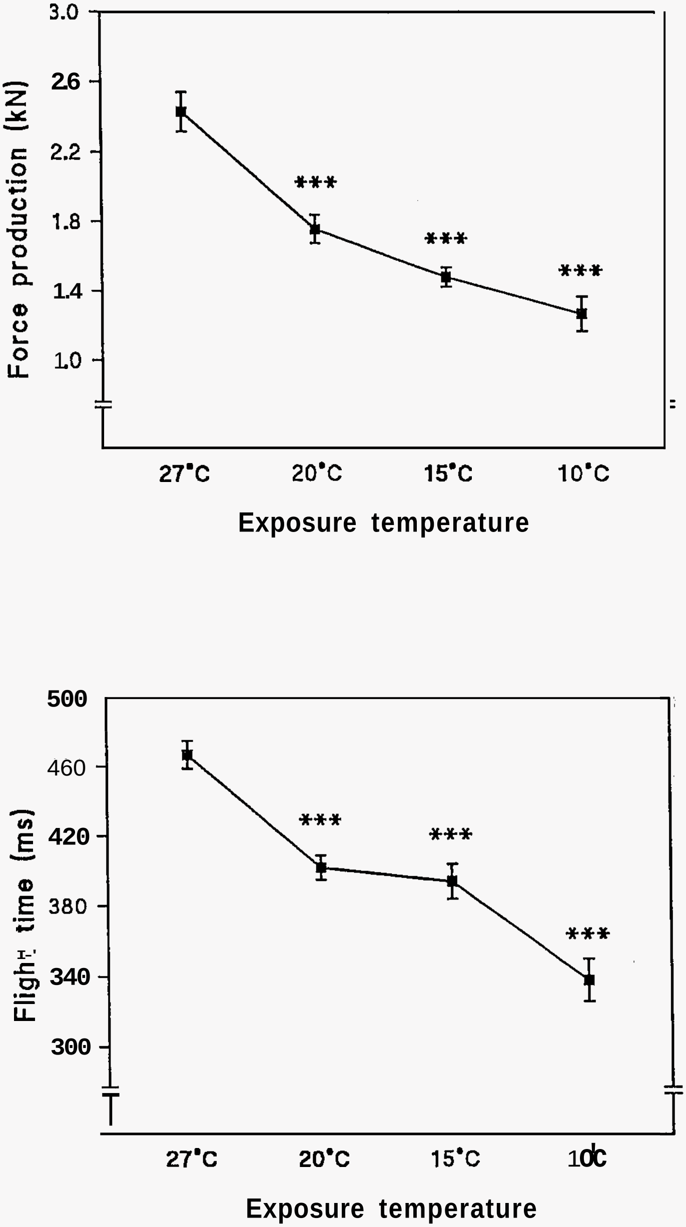

Fig 1. Average force production (upper panel) and flight time (lower panel) after the exposures to 27°C, 20°C, 15°C and 10°C. The significance in relation to 27°C is denoted by *** = $p<0.001$.

CONCLUSIONS

It is concluded that the level of cooling which is needed to substantially decrease muscular performance is very low and most probably occurs more often than expected. This is important when considering that frequent cooling may be a risk factor for musculoskeletal disorders. Cooling may also enhance the risk for accidents and very easily impair athletic performance.

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