

## COMBINED EFFECTS OF COLD AND WIND ON MUSCLE TEMPERATURE IN SUBMAXIMAL PHYSICAL ACTIVITY

E.-P. Takala, R. Ilmarinen, T. Seppälä

Institute of Occupational Health, Helsinki

Address for reprints:  
Topeliuksenkatu 41 a A  
SF-00250 Helsinki  
Finland

The knowledge about the effects of cold on physical performance is scanty. However, it seems that cold has no influence on  $\dot{V}O_2\text{max}$  in contrast to the findings for significant reduction in endurance performance. The decrement seen in performance may result directly from the muscle temperature ( $T_m$ ) drop affecting muscle performance and muscle strength. Low muscle temperature probably has a disadvantageous effect on oxidative activity in muscle and also on nervous conduction, resulting in a decrease in motor coordination.

This study aimed to assess the effect of cold and wind on temperature in the rectus femoris muscle during prolonged submaximal physical activity. Six healthy males volunteered for this study, which is part of a comprehensive project on designing functional cold protective clothing for work and leisure time. The experiments were conducted in a climatic chamber under controlled cold and windy condition ( $T_a$   $-17^\circ\text{C}$ ,  $v_a$   $10\text{ ms}^{-1}$ , Wind Chill  $-38^\circ\text{C}$ ). The subjects wore a typical cross-country ski clothing ensemble of  $I_{cl}$  0.6 clo (pants, thermal long underwear (Dunova) and a stretchable ski overall (Lycra), gloves, cap, socks, and shoes) and performed two 30-min sub-maximal work bouts on treadmill ( $10\text{ kmh}^{-1}$ , incline  $5^\circ$ ) separated by 5-min pauses for  $T_m$  measurement. The cardiovascular workload was about 80 % of the maximum approximated by the heart rate. Continuous monitoring included heart rate, rectal temperature ( $T_r$ ) and skin temperatures ( $T_{sk}$ ) at 14 sites.  $T_m$  in the rectus femoris of both legs was measured with a hypodermic probe (YSI 524) for five minutes before the exposure, after 30-min running, and at the end of the exposure. Subjective thermal and perceived exhaustion ratings were given every 10 min.

The  $T_r$  increased from the mean resting level of  $36.9^\circ\text{C}$  continuously during the exposure, even up to  $38.7^\circ\text{C}$  on average. The drop in mean skin temperature was  $5.0^\circ\text{C}$  on average. The lowest single  $T_{sk}$  values ( $7$ - $13^\circ\text{C}$ ) were registered on hand, thigh and abdomen.  $T_m$  in rectus femoris increased from the mean resting value of  $36.2^\circ\text{C}$  up to the mean working value of  $38.0^\circ\text{C}$ . During the 5-min measurement  $T_m$  decreased rapidly. The mean drop in  $T_m$  was  $0.8^\circ\text{C}$  varying from  $0.5^\circ\text{C}$  to  $1.7^\circ\text{C}$ . The lowest  $T_m$  measured was  $34.7^\circ\text{C}$ . There was no significant difference in  $T_m$  between right and left.

This study indicates that despite intense heat production and  $T_r$  increase in submaximal work at low ambient temperatures, the cooling effect of wind may decrease  $T_m$  lower than core temperature. In addition, during short breaks the muscles cool very rapidly. This may impair physical performance during prolonged physical activity in a cold and windy climate. Without satisfactory protection against cold and wind, there may be risk of hypothermia during prolonged rest periods.