2 Heat loss from the head in the cold

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The purpose of this study was to measure heat loss from the head during exercise in the cold. Three males and three females exercised on two occasions for 90 minutes on a treadmill at 4km/h in a climatic chamber controlled at -15°C, wind speed 4 km/h. The subjects were clad in arctic clothing (approximately 2 clo), with the head either fuiiy exposed or protected by three layers: a balaclava, the hood of a sweat shirt and the hood of the parka. Heat flow discs and thermistors were taped to 14 skin sites, three of which were at the head: one on the forehead and one on each cheek. Additionally, core temperature was measured using a rectal probe. All sensors were scanned continuously and averaged per minute. The difference in total body heat loss between conditions was entirely accounted for by the difference in heat loss from the head. No significant differences in heat flow and temperature for other parts of the body were found, except for the chest, which had a higher heat flow and lower temperature with the head unprotected. This is probably the result of less insulation because of removal of the balaciava. Total body heat loss stabilized within 30 minutes. The forehead was always warmer than both cheeks, as would be predicted from anatomical differences in skin blood flow between these regions. Mean head tissue insulation, calculated to be 0.045 $m^2{}^oC/W$, was independent of head protection. Although females showed higher head tissue insulation than males in both conditions, the number of subjects was too small to provide statistical significance. In this particular experiment, heat loss from the head expressed as a fraction of total body heat loss was 6% with the head protected, and 17% with the head unprotected.

A mathematical model based upon the constancy of head tissue insulation was developed and has a striking resemblance with previously reported data. The model is further extended to include the effect of a variety of independent variables like wind, temperature, exercise and head protection. Heat loss from the head, expressed as fraction of total body heat loss, is predicted to reach values anywhere between 5 and 95%.