

CHANGES OF SKIN TEMPERATURE AND BODY HEAT CONTENT IN FLUCTUATING OUTDOOR CLIMATE

Krzysztof Błażejczyk

Institute of Geography and Spatial Organization,
Krakowskie Przedmieście 30, PL-00-927 Warszawa, Poland

INTRODUCTION

Human heat balance in fluctuating outdoor climate was studied rarely. Nielsen et al. (1988) measured changes of skin temperature and body heat content as well as estimated heat exchange of subject cycling on an ergometer in the sun. de Freitas and Ryken (1989) considered heat balance of running persons. However Błażejczyk and Krawczyk (1991) studied heat exchange of standing relaxed man in different climatic zones. The paper presents results of physioclimatological investigations of the human heat balance performed outdoors in Northeast Poland.

METHOD

Skin temperature was measured every hour in steady state conditions in 10 healthy volunteers (5 male and 5 female), within the age category of 25-45 years and with a normal weight to height ratio, during 8 hours outdoor exposure (before noon or afternoon) at 5 points on the body surface. Subjects wore sport cotton wear with basic insulation of 1 clo and albedo of 30%. They stood in upright posture and after third and sixth hour of experiment they rested sitting during 15 min. Simultaneously all meteorological parameters were measured. Mean skin temperature was calculated as follows: $T_s = 0.07T_{\text{forehead}} + 0.05T_{\text{palm}} + 0.5T_{\text{chest}} + 0.18T_{\text{thigh}} + 0.2T_{\text{calf}}$. Changes of body heat content were calculated from the human heat balance equation with the use of the MENEX model (Błażejczyk 1993, 1994).

RESULTS

Skin temperature and changes of body heat content clearly depended on meteorological conditions. During cloudy, cool and windy weather (air temperature of 15-18°C, cloudiness >70%, wind speed 5 m/s) skin temperature was relatively low and very differentiated on the body surface. Net heat storage oscillated about zero. From 5:30 p.m. it had negative values and reduction of heat content was observed (Fig. 1A).

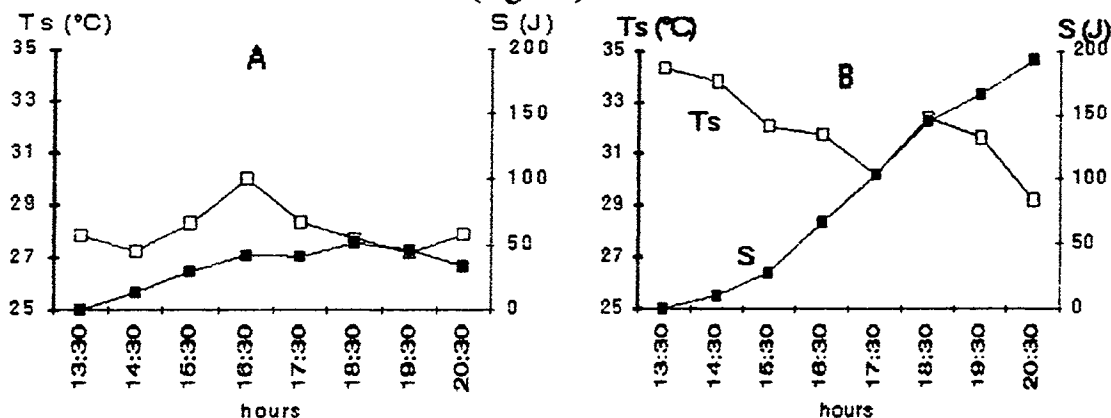


Fig. 1 Changes of mean skin temperature (T_s) and body heat content (S) in a young male during cool and cloudy (A) as well as hot and sunny (B) weather.

During hot, non windy afternoon with the clear sky, air temperature decreased slowly from 34 to 27°C. At the same time skin temperature changed from about 35 to 29°C. Low value of skin temperature at 5:30 p.m. was caused by intensive cooling of the body surface due to sweat evaporation. Net heat storage had positive values and during the period of 8 hours accumulation of heat reached up to 200 J (Fig. 1B).

Some differences between before noon and afternoon hours were observed (Fig 2). In the morning hours skin temperature increased very quick similarly to changes of air temperature. In the afternoon air and skin temperature fluctuated insensibly and only in the evening, after sunset, they fell down. The rate of heat accumulation in the afternoon was slightly greater then in the before noon period. It was caused by relatively great intensity of net heat storage. In the evening net heat storage had negative values and heat expenditure from the body began. Mean values of skin temperature, both before noon and afternoon, show cooling effect of evaporated sweat

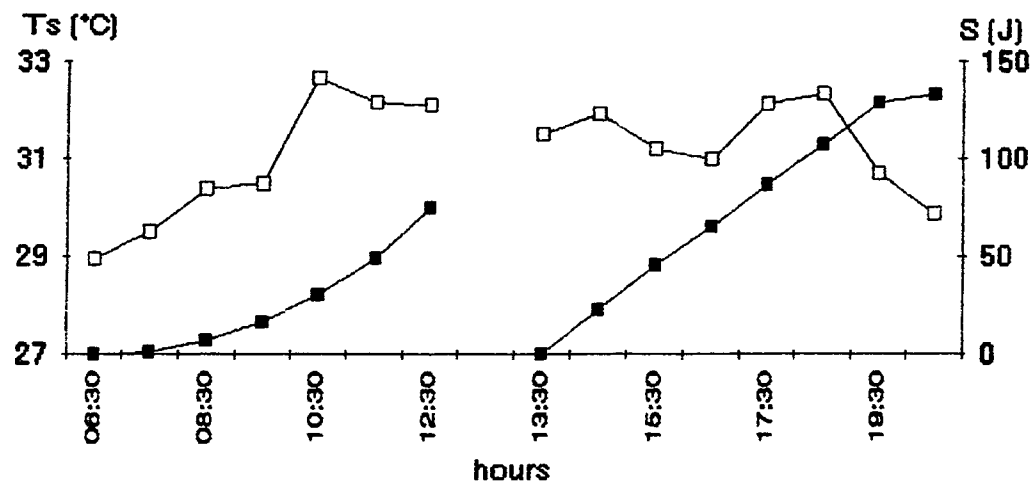


Fig. 2 Changes of mean skin temperature and body heat content during before noon and afternoon hours, mean values for 10 subjects for sunny days with small cloudiness; explanations on Fig. 1

CONCLUSIONS

During hot weather man outdoor is liable to intensive accumulation of heat; hazard of an organism overheating may be reduced by changing of clothing or by using of shading screens. In the afternoon staying outdoor loads thermoregulative system more then during before noon hours.

REFERENCES

- Nielsen B. Kassow K. Aschengreen F.E. 1988, Heat balance during exercise in the sun, *Eur.J.Appl.Physiol* 58, 189-196
- de Freitas C.R. Ryken M.G. 1989, Climate and physiological heat strain during exercise, *Int.J.Biometeorol* 33, 157-164
- Błażejczyk K. Krawczyk B. 1991, Influence of climatic conditions on the heat balance of the human body, *Int.J.Biometeorol* 35, 103-106
- Błażejczyk K. 1993, Heat exchange between man and his surroundings in different kinds of geographical environment, (in Polish), *Prace Geogr. IGiPZ PAN* 159, pp.123
- Błażejczyk K. 1994, New climatological-and-physiological model of the human heat balance outdoor (MENEX) and its applicatons for bioclimatic research in different scales. *Zeszyty IGiPZ PAN* 28, 23-36