

Inclusion of short-term adaptation to thermal stresses in a heat load warning procedure

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Abstract

It is considered to be very probable that the frequency and intensity of heat waves will increase and that heat waves, such as the one experienced in Europe in 2003, will not remain an exception. Everything goes to suggest that human beings have adapted to their local climate. Extreme events such as heat waves, for example, can, however, cause considerable stress to the thermoregulative processes in the human organism. Heat load warning systems provide a possibility for reducing heat-induced morbidity and mortality. We are presenting a method that, apart from a thermophysiological relevant evaluation of the environment, also takes into account short-term adaptation processes of human beings to the thermal environment. The forecast method differs from previously used methods in that it is based on a combination of absolute and relative thresholds and thus includes the local adaptation to the thermal conditions of the previous weeks. This is an attempt to give a quantitative description of the mainly qualitative statements in literature on acclimatisation. A further advantage of this method is that, due to the inclusion of relative, i.e. local, conditions, it can, in principle, be applied to all climates.

Zusammenfassung

Es gilt als sehr wahrscheinlich, dass die Häufigkeit und Intensität von Hitzewellen zunehmen wird und dass Hitzewellen, wie jene im Jahr 2003 in Europa kein Einzelfall bleiben. Alles deutet darauf hin, dass die Menschen an ihr Lokalklima angepasst sind. Extremereignisse wie beispielsweise Hitzewellen können jedoch erheblichen Stress auf die thermoregulativen Prozesse des menschlichen Organismus ausüben. Hitzewarnsysteme bieten eine Möglichkeit die hitzebedingte Morbidität und Mortalität zu verringern. Es wird ein Verfahren vorgestellt, dass neben einer thermophysologisch relevanten Bewertung der Umwelt auch kurzfristige Anpassungsvorgänge des Menschen an die thermische Umgebung berücksichtigt. Das Vorhersageverfahren unterscheidet sich von den bisher gängigen Methoden dahingehend, dass es auf einer Kombination aus absoluten und relativen Schwellen basiert und damit die lokale Anpassung an die thermischen Bedingungen der vergangenen Wochen einbezieht. Damit wird versucht, die überwiegend qualitativen Aussagen in der Literatur zur Akklimatisation quantitativ zu beschreiben. Ein weiterer Vorteil dieses Verfahren ist, dass es aufgrund der Einbeziehung relativer, d.h. lokaler Bedingungen grundsätzlich in allen Klimaten angewendet werden kann.

1 Introduction

The IPCC Third Assessment Report (HOUGHTON et al., 2001) stated that “there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities”. A changing climate is expected to increase average summer temperatures and the frequency and intensity of hot days and heat waves. Although heat waves are rare events, they are associated with significant mortality impacts (e.g. BASU and SAMET, 2002). In countries such as Australia and the United States, heat waves in the 20th century caused more deaths than any other weather-related hazard (EMA, 2002). Europe has also been affected by heat waves during recent years. In August 2003 a major heat wave killed about 25,000 people all over Europe, about half of them in France (LARSEN, 2003). In

Athens, a heat wave resulted in 926 directly heat-related deaths in 1987. The excess mortality, however, was estimated to be more than 2,000 (KATSOUYANNI et al., 1988). A heat wave in Portugal in June 1981 caused approximately 1,900 excess deaths (GARCIA et al., 1999). Many of the heat-related deaths may be preventable with adequate warning and an appropriate response to heat emergency measures (BASU and SAMET, 2002). Heat health warning systems consist of two parts: a meteorological component (issuing of a warning) and a public health component (action plans, intervention measures). The meteorological component is based on a heat stress indicator. Several procedures which aim at assessing the thermal environment of human beings in addition to air temperature are applied. However, procedures based on air temperatures, simple thermal indices, or weather classifications (holistic approaches) give no insight into cause-effect relationships. Fundamentally, we know the mechanism of heat exchange between the hu-

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