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Editorial

Importance of Heat Health Warnings in Heat Management

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During intense heat events, the morbidity and mortality of the population increase. Recent heat waves have highlighted the cause–effect relationship of the morbidity and mortality rates [1,2]. Due to the intensifying effects of climate change, heat waves are expected to become more frequent, more intense, and longer. These conditions are associated with their total individual duration (in terms of their defining threshold and/or attribute) and with their potential sequential overlap with each other [3]. The approach to quantifying these risk factors must be accompanied by questions that systematically establish the obligatory correlation with the future consequences of action or inaction. However, we may argue that the abandonment of efforts to mitigate climate change alone is the epitome of the latter. Although often not adequately linked, two immediate realities need to be immediately addressed: (i) the heat-related mortality that is expected to substantially increase [3] and (ii) the extent to which these mortality risks will be exacerbated for certain populations, including the chronically ill/vulnerable, older adults, very young children, and the socioeconomically disadvantaged [3]. Beyond these two intertwined realities, heat management efforts must also consider the continuing (and often unregulated) patterns of the densification and expansion of the urban fabrics in which they are to be applied. In considering such contexts, the recognition is growing of indoor/outdoor cause-and-effect relationships with respect to heat management and assessment [3]. This includes, during heat events, (i) determining the nocturnal determinants of sleep quality in residential environments [3]; (ii) cyclical diurnal heat stress monitoring in diverse indoor work environments [3]. In parallel, the term urban fabric (together with the periurban area), by its very definition, includes the construction methods and typologies that may be outdated and/or more vulnerable to regional and local heat risk events [3].

The public and public health authorities should be informed and warned about heat events through an advanced process known as a heat health warning system (HHWS) to minimize the adverse health effects associated with extreme heat events. The aim of these systems is to trigger action and enable subsequent preventive measures. The growing demand for such informed warning systems is multifaceted. Two of the catalysts for these systems are the prevention of mortality and the reduction in the margin of error of the mortality and morbidity rates. An early example of this is the underclassification of mortality due to the likely overexclusion of deaths among people with pre-existing conditions who died of heat-related causes during the 1995 Chicago heat wave [4]. Moreover, the health effects of heat waves are not limited to mortality but also include morbidity, work disability, and lowered quality of life in general. Almost a decade later, national meteorological services in many European countries have implemented heat health warning systems because of the adverse effects of the 2003 heat waves [3]. Epidemiological studies of mortality are used in most countries to determine the threshold above which a warning is issued and relevant. Usually only one threshold is set for a whole country, but regionally specific thresholds may be more appropriate [3].

In addition, HHWSs must include appropriate communication options. To ensure and protect the health and standard of living of the population, intervention measures need

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to be defined based on well-structured and comprehensive preparedness plans, such as heat-health action plans (HHAPs) [5,6].

Based on epidemiological studies of mortality data from different regions in Europe, the negative impact of different heat stress thresholds on human health is well known. Therefore, heat health warnings must reflect these impacts and be effectively communicated to the public and government authorities. However, morbidity data often fall short regarding potential applicability in warning systems and the patient use of health services [3]. The strong and extreme heat stress thresholds result in a substantial deviation of actual mortality from expected values [3]. Severe heat stress conditions are associated with a 13% increase in mortality above expected levels in all regions. Increases in mortality are observed for days with moderate heat stress [3]. Such a distinction here emphasizes the importance of recognizing that while more accentuated heat stress and/or heat events (including those of a cumulative nature) have serious implications for human health, the occurrence of subsequent heat categories with equal or higher frequency/longer duration is equally important to monitor and assess.

Short-term heat acclimatization is achieved after a few days to two weeks and is lost in the course of about a month when heat exposure has ended. The thermal conditions of the last 30 days are used to adjust the upper threshold of the comfortable category and the thresholds of the heat stress categories. In addition, climatological factors account for regional differences in the thresholds of the thermo-physiological stress categories. This is reflected in generally lower values in northern Germany than in the southern parts of the country [3]. Older people experience increased thermal stress when exposed to hot environments, which may be owing to age-related physiological changes that reduce the human body's ability to dissipate heat. In a warm environment, older people stay in the comfort zone longer, i.e., up to higher PT values. The thermoregulatory system of older adults is much more demanding. The health of older adults also crucially depends on adequate and restful sleep [3]. In HHWSs, indoor temperatures are simulated using the current weather forecast for the next few days. For each warning area, the nocturnal indoor temperature used in the HHWS is defined by the maximum of the average nocturnal temperatures in the east- and west-facing rooms. A specific approach has been developed to more comprehensively simulated nocturnal conditions in cities with more than 100,000 inhabitants. The urban heat island effect is added to the weather forecast as a function of the size of the city, the time and day of the year, and the wind speed and cloud cover in the previous 24 h. The nocturnal indoor conditions are then calculated as described above but using the modified weather forecast as input data. The nocturnal indoor temperature including the urban heat island effect can be estimated in an HHWS using this approach [3].

The HHWS is composed of several interrelated modules. In Germany, the heat warnings are based on numerical weather forecasts, but they are issued with specific adjustments and a mandatory confirmation by an experienced biometeorological forecaster. The HHWS warning is accompanied by recommendations for intervention measures to be taken [3]. Heat-health warnings are generated for German districts (counties) and are mainly addressed to the authorities and ministries of the federal states, nursing homes, and the general public. The warnings are electronically disseminated via the Internet, e-mail newsletters, or the dedicated smartphone application (e.g., WarnWetterApp or GesundheitsWetterApp).

On the DWD website (https://www.dwd.de and www.hitzewarnungen.de), heat-health warnings are displayed in maps linked to explanatory information. The text provides information on the expected intensity of heat stress, the altitude range affected, and additional information for the older adult population and warmer cities. Furthermore, if considered relevant, recommendations are provided for health-protective behavior. This information is an integral part of the daily newsletter for registered users of the health warnings. Heat trend information for days 3–6 and heat prewarning information based on perceived temperature (PT) for days 7 and 8 complete the heat warning for the specified two-day period. The warning also indicates the duration (i.e., the number of days) for which the heat warning has been active [3]. Intervention measures must be implemented on the basis of well-structured and comprehensive preparedness plans to ensure the health and standard of living of the population.

In addition, mass media (radio and television) can broadcast the warning to increase public awareness. Usually, this also prompts the conventional and electronic print media to publish further reports and advice on how to protect one's own health and that of others who may need it.

The end user can subscribe to the heat warnings either through an email newsletter, dedicated smartphone apps, or by visiting dedicated websites. In addition, a new web portal (https://www.hitzewarnungen.de) was launched in 2022, where all information related to the heat warnings, including the different forecasts, can be accessed.

The main target groups are the general public, nursing homes, state ministries, and other authorities. The HHWS, with its regional differentiation of heat stress warnings, has also become a central part of all heat health action plans in Germany.

The World Health Organization (WHO) recommends the introduction of a national heat action plan for its member states to ensure the sustainable protection against heat-related health risks. More specifically, heat warning systems and heat action plans are fundamentally different. Whereas the central task of a heat warning system is to warn of a short heat wave, a heat action plan applies an integrative approach, combining short-, medium-, and long-term health protection measures within a common framework [5,6].

The example of the German HHWS shows the feasibility of considering a routine application that considers not only air temperature but also all relevant meteorological and important nonmeteorological parameters that influence the thermal state of the human body. Heat warning thresholds can be adapted to local weather conditions as humans acclimatize during successive heat exposures. In the German HHWS, a time range of the last 30 days is included to represent the short-term acclimatization of humans. In operation since 2005, the human–biometeorological component of the German HHWS has been continuously improved to form an advanced procedure that includes additional aspects such as night-time indoor conditions, as well as the special characteristics of the older adult population and those in urban areas (especially the urban heath island (UHI) effect). Therefore, estimating long-term trends from HHWS data is not possible [3].

The vulnerable groups suffering from heat exposure are essentially known. To date, the HHWS has mainly focused on residential care for older adults. A clear need exists to extend the system to other vulnerable groups, such as babies and young children, and potentially dependent people who are also isolated, overweight, chronically ill, suffering from a heat-related disease, and/or suffering from dementia. In addition, urban and rural aspects and population density may be issues for early warning. Communication should consider not only new smartphone applications but also traditional methods of education that are targeted and tailored to groups such as those in the health sector. Any action can be implemented on the basis of existing or issued heat warnings.

In the context of climate change, the German Federal Environment Agency evaluated existing national information systems from a public health perspective. This project confirmed the acceptance and high level of awareness of the HHWS [7]. Following this line of reasoning, the implementation of warnings in heat actions, their monitoring, the methods of communication, and, finally, the evaluation of the actions, supported by such scientific know-how, will increasingly be of key importance.

In line with the growing urgency of the climate change adaptation agenda, extreme heat and heat waves will become more frequent, more intense, more continuous, and longer. These will also occur in "regular periods" (a deliberately generic term that is likely to change over time) that are already prone to notable heat risk factors. In relation to these events, the human–biometeorological component of the HHWS and its related umbrella of sub-commitments are equally important. These include preparedness plans and their associated actions as contained in the HHAPs. As a result, such instruments should no longer be solely associated with an evocative vision but with a means that encompasses effective heat management that must also remain specifically tailored to its end user—the human being.

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