

## Foreword

## A Public Health Initiative for Action on Early Warning of Heat Health Risks

Tiantian Li<sup>1,\*</sup>

Heatwaves, also known as extreme heat events, represent periods of excessively hot weather and rank among the most perilous natural hazards worldwide due to their increased mortality risk, especially among vulnerable populations. The frequency, intensity, and geographical spread of heatwaves are noticeably increasing in the setting of climate change (1). In 2019, there were a reported 475 million heatwave events worldwide, an increase of 160 million per capita days in comparison to 2016 (2). Disturbingly, in 2003 there were approximately 25,000–70,000 premature heat-related deaths in Western Europe (3), and in the summer of 2010 around 55,000 excess deaths in Russia were linked to heatwaves (4). A similar pattern was observed in 2019 with approximately 26,800 deaths in China being attributed to heatwaves (5). Furthermore, in the same year, nearly half (46.2%) of the total global heat-related deaths were elderly individuals, with the majority of these deaths occurring in Japan, Eastern China, Northern India, and Central Europe (6). Given the relentless trends in population aging and urbanization, heatwaves could pose a significantly bigger health hazard in future years. Projections from the World Health Organization (WHO) predict over 92,000 premature deaths from high temperatures globally by 2030, with over 19,000 premature deaths expected in Eastern Asia (inclusive of China and the Republic of Korea) alone (7). Hence, the development and implementation of effective strategies to combat heatwaves, as well as improving public safeguards, are and will continue to be pivotal challenges across the intersecting fields of climate change and public health.

In an effort to mitigate the health consequences of heat, the United States pioneered the establishment of the Hot Weather-Health Watch/Warning System during the 1990s. This was not only based on traditional high-temperature forecast warnings, but also focused on the premature mortality risk (8). The devastating heatwave of 2003 spurred many European countries into active research about health risks associated with such heatwaves. This resulted in the development of a more comprehensive heat health warning system (9). In 2015, to further global public health protection, the World Meteorological Organization and WHO collaboratively published the guidance document “Heatwaves and Health: Guidance on Warning-System Development”. This aimed to influence the development of similar early warning systems worldwide (10).

In China, the reaction to heatwaves primarily depends on the early heat wave warnings disseminated by the China Meteorological Administration, which consist of three classifications: yellow, orange, and red. However, this system exclusively considers temperature intensity, neglecting the correlation between heatwaves and health ramifications. Consequently, its effectiveness in safeguarding public health remains limited. Over the past two decades, Chinese researchers have endeavored to develop a more efficient heatwave health risk early warning system. Despite pieces of related research, the full-scale implementation of this system across the country has not yet materialized.

In 2001, the Shanghai Meteorological Bureau, in conjunction with the Shanghai Health Commission, launched the pioneering “Heatwave/Health Warning System” in Shanghai Municipality (11). Subsequently, in 2013, led by the National Institute of Environmental Health, Chinese Center for Disease Control and Prevention (NIEH, China CDC), a heatwave health early warning system was set up in Shenzhen, Nanjing, Chongqing, and Harbin, which are located in various climatic zones with different climatic characteristics (12–14). Researchers gathered historical data related to meteorology, air quality, mortality, and morbidity, and established models to identify the relationships between heatwaves and mortality and morbidity rates for various diseases in each city. The warning levels encompass red, orange, yellow, and blue. Depending on the risk reaching the corresponding warning level, the system generates an alert indicating the disease risk level, appropriate response measures, and recommendations for mitigation for diverse population groups. However, this system only operated on a trial basis and was not expanded nationwide.

In response to the prevailing global heatwaves and the inadequate public health protective measures in many countries, we recently proposed a comprehensive prevention and control framework. This framework incorporates a full spectrum coverage of heat health risk management into heat health early warning systems. It includes identifying warning signals based on the attributes of health issues caused by heat, and undertaking proactive and targeted measures on the basis of early warning information concerning heat-related health risks throughout the summer season (15). Under this framework, researchers from the NIEH, China CDC, developed a heat health risk early warning model that includes China's various climatic zones. The model, which relies on heat or heatwave-related mortality risks, recognizes the threshold levels for health risk surveillance, watch, and warnings (consisting of three warning levels) applicable for the entire summer season. This innovative model, which provides heat health risk alerts throughout the summer, allows for a more comprehensive public management of heat health risks compared to previous models that focused solely on warnings for extreme heat or health risks associated with extreme heat.

This innovative model has been successfully translated to local CDCs for application. For example, in collaboration with the NIEH, China CDC, the Jinan CDC leveraged this model to develop a heat health risk early warning announcement platform that issued its first cautionary message about heat or heatwave-related health risks on August 2, 2021. The platform provides a three-day forecast on potential heat or heatwave-related health risk surveillance, watch and warning information for Jinan City, which is disseminated via WeChat Official Account of the Jinan CDC. In addition to covering all local counties, the platform also provides health protection recommendations. The public can therefore access early warning information from the platform to understand their health risk from the heat or heatwaves predicted for the next three days, facilitating proactive protection against the impending high temperatures. According to the estimation, the implementation of this heatwave health risk early warning in Jinan resulted in a reduction of 10.9 deaths per million people during the 2022 warm season's warning stage. Furthermore, it helped to prevent economic losses of approximately 227 million Chinese Yuan (CNY). If this early warning system had been implemented nationally during the warm season of 2022, it could have yielded significant health benefits, potentially saving 15,115 lives and averting economic losses of approximately 62.0 billion CNY (16). In conclusion, the successful adoption of this system in Jinan represents a solid foundation for its further promotion among other local CDCs in China.

This edition centers on the subject of heat health risk early warning, incorporating two "Preplanned Studies" articles and one "Recollections" piece. An analysis by Chen et al. appraised the benefits of utilizing the heat health risk warning model in Jinan, and the potential for its nationwide promotion in the future (16). To tackle the deficiency in extended-term heatwave forecasts, Zhang et al. launched an innovative early warning system with the goal of predicting heatwave-related health hazards, within China, at sub-seasonal to seasonal intervals. The results from the evaluation indicated substantial potential for this system (17). Sun et al. conducted a review of NIEH, China CDC's experience in promoting environmental health risk early warning intervention, and suggested upcoming challenges and prospects (18). This special issue methodically encapsulates nationwide experiences of pioneering efforts in heat health risk early warning, thus providing a robust foundation for China CDC to further advance health risk early warning for environmental risk factors such as heat throughout the country.

One of the functions of the newly established National Bureau of Disease Control and Prevention is surveillance and early warning. There is an immediate need to develop early health risk warnings for environmental risk factors such as heatwaves. We propose the following steps. First, a standard technical system for early health risk warnings stemming from environmental risk factors must be designed in advance. Second, creating and publicly disseminating an information platform that can forecast and provide early warnings about health risks from environmental hazards is essential, with a focus on protecting vulnerable populations. Third, efforts should be accelerated to establish working and emergency consultation mechanisms for early health risk warnings related to heatwaves and other hazardous environmental factors. Additionally, the development of a coordinated mechanism between the national CDC and local CDCs is crucial. Finally, we recommend the gradual establishment of a collaborative working mechanism for early health risk warnings, with the China CDC serving as the primary issuer and multiple departments collaborating.

**Funding:** National High-Level Talents Special Support Plan of China for Young Talents; National Natural Science Foundation of China, 82241051.

doi: 10.46234/ccdcw2023.122

# Corresponding author: Tiantian Li, litiantian@nieh.chinacdc.cn.

<sup>1</sup> China CDC Key Laboratory of Environment and Population Health, National Institute of Environmental Health, Chinese Center for Disease Control and Prevention, Beijing, China.

Submitted: June 10, 2023; Accepted: July 10, 2023

## REFERENCES

1. Intergovernmental Panel on Climate Change. Climate change 2022: mitigation of climate change summary for policymakers. Contribution of working group III to the sixth assessment report of the intergovernmental panel on climate change. Cambridge: Cambridge University Press. 2022. [https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC\\_AR6\\_WGIII\\_SummaryForPolicymakers.pdf](https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_SummaryForPolicymakers.pdf).
2. Watts N, Amann M, Arnell N, Ayeb-Karlsson S, Beagley J, Belesova K, et al. The 2020 report of the *Lancet* countdown on health and climate change: responding to converging crises. *Lancet* 2021;397(10269):129 – 70. [http://dx.doi.org/10.1016/S0140-6736\(20\)32290-X](http://dx.doi.org/10.1016/S0140-6736(20)32290-X).
3. D'Ippoliti D, Michelozzi P, Marino C, de'Donato F, Menne B, Katsouyanni K, et al. The impact of heat waves on mortality in 9 European cities: results from the euroHEAT project. *Environ Health* 2010;9:37. <http://dx.doi.org/10.1186/1476-069X-9-37>.
4. Barriopedro D, Fischer EM, Luterbacher J, Trigo RM, García-Herrera R. The hot summer of 2010: redrawing the temperature record map of Europe. *Science* 2011;332(6026):220 – 4. <http://dx.doi.org/10.1126/science.1201224>.
5. Cai WJ, Zhang C, Suen HP, Ai SQ, Bai YQ, Bao JZ, et al. The 2020 China report of the *Lancet* countdown on health and climate change. *Lancet Public Health* 2021;6(1):e64 – 81. [http://dx.doi.org/10.1016/S2468-2667\(20\)30256-5](http://dx.doi.org/10.1016/S2468-2667(20)30256-5).
6. Institute for Health Metrics and Evaluation (IHME). GBD Compare. Seattle: IHME. 2019. <http://vizhub.healthdata.org/gbd-compare>. [2023-7-8].
7. World Health Organization. Quantitative risk assessment of the effects of climate change on selected causes of death, 2030s and 2050s. Geneva: World Health Organization. 2014. <https://www.who.int/publications/i/item/9789241507691>. [2023-6-3].
8. Kalkstein LS, Jamason PF, Greene JS, Libby J, Robinson L. The Philadelphia hot weather–health watch/warning system: development and application, summer 1995. *Bull Am Meteor Soc* 1996;77(7):1519 – 28. [http://dx.doi.org/10.1175/1520-0477\(1996\)077<1519:TPHWHW>2.0.CO;2](http://dx.doi.org/10.1175/1520-0477(1996)077<1519:TPHWHW>2.0.CO;2).
9. World Health Organization. Heat-health action plans: guidance. Geneva: World Health Organization. 2008. <https://www.who.int/publications/i/item/9789289071918>. [2023-6-3].
10. World Health Organization. Heatwaves and health: guidance on warning-system development. Geneva: World Health Organization. 2016. <https://www.who.int/publications/m/item/heatwaves-and-health--guidance-on-warning-system-development>. [2023-6-3].
11. Tan JG, Yin HB, Lin SB, Kalkstein LS, Huang JX, Shao DM. Shanghai heat wave/health warning system. *J Appl Meteor Sci* 2002;13(3):356 – 63. <http://dx.doi.org/10.3969/j.issn.1001-7313.2002.03.011>. (In Chinese).
12. Fang DK, Zhou GH, Feng JS, Ji JJ, Yu SY. Establishment and evaluation on health risk index of heat wave in Shenzhen. *J Environ Hyg* 2019;9(1):14 – 8. <http://dx.doi.org/10.13421/j.cnki.hjwxxz.2019.01.003>. (In Chinese).
13. Lan L, Lin L, Yang C, Liang W. Assessment on heat wave and health risks early warning system in Harbin. *Chin J Public Health Manage* 2016;32(4):441-3. <https://d.wanfangdata.com.cn/periodical/zgggwsgl201604005>. (In Chinese).
14. Wang QQ, Li YH, Ding Z, Zhou L, Chen XD, Jin YL. Assessment on heat-wave and health risks early warning system in Nanjing. *J Environ Health* 2014;31(5):382-4. <https://d.wanfangdata.com.cn/periodical/hjyjkzz201405002>. (In Chinese).
15. Li TT, Chen C, Cai WJ. The global need for smart heat-health warning systems. *Lancet* 2022;400(10362):1511 – 2. [http://dx.doi.org/10.1016/S0140-6736\(22\)01974-2](http://dx.doi.org/10.1016/S0140-6736(22)01974-2).
16. Chen C, Liu J, Wang MH, Cui LL, Li TT. Evaluating the applicability and health benefits of the graded heat health risk early warning model — Jinan City, Shandong Province, China, 2022. *China CDC Wkly* 2023;5(29):642 – 6. <http://dx.doi.org/10.46234/ccdcw2023.123>.
17. Zhang BC, Chen HQ, Lu B. An early warning system for heatwave-induced health risks in China: a sub-seasonal to seasonal perspective — China, 2022. *China CDC Wkly* 2023;5(29):647 – 50. <http://dx.doi.org/10.46234/ccdcw2023.124>.
18. Sun QH, Chen C, Wang Q, Li TT. Early warning interventions for environmental risk factors at China CDC. *China CDC Wkly* 2023;5(29):651 – 4. <http://dx.doi.org/10.46234/ccdcw2023.125>.