



RISK REDUCTION GUIDANCE

HEAT EARLY WARNING SYSTEMS AND ACTION PLANS

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ABSTRACT

Heat early warning and response systems and action plans are interventions that combine weather forecasts with previously-defined temperature thresholds for action with pre-planned response activities in health and other sectors; they are often combined with heat action plans that outline longer-term changes in urban planning and other areas to prepare for a hotter future. Heat early warning systems and action plans typically take several years to implement and are effective at reducing morbidity and mortality in highly vulnerable groups, although they may not reduce mortality in the general population and are unlikely to completely offset the health risks associated with extreme heat events. While cost estimates are rare, heat early warning systems and action plans are considered highly cost effective with few downsides.

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What is the intervention?

Heat early warning and response systems are a category of public health intervention that combine forecasted meteorological information with previously-defined temperature thresholds with pre-planned response activities in health and other sectors (Ebi 2007). Heat early warning systems are typically combined with heat action plans that outline



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longer-term changes in urban planning and other areas to prepare for a hotter future to reduce heat-related disease burden as the climate continues to change (Hess et al. 2022; Kotharkar and Ghosh 2022). Broadly construed, the intervention is the development and implementation of a heat early warning and response system and action plan, which necessarily includes collection and review of epidemiological data, identification of risk and protective factors in the population, identification of opportunities for additional health protection, collaboration between health and other sectors, implementation, and evaluation of activities over time (Bernard and McGeehin 2004; Knowlton et al. 2014; Hess et al. 2022).

How effective is the intervention at protecting people's health?

Heat early warning and response systems and action plans appear to be effective at reducing morbidity and mortality associated with extreme heat events, but both the diversity of programming and the variability in methods used to evaluate these interventions limits firm conclusions regarding the magnitude of the benefits (Toloo et al. 2013; Dwyer et al. 2022). Several before-and-after studies, including in middle-income settings (Hess et al. 2018), found protective effects, but these findings may be confounded (Dwyer et al. 2022). One study using quasi-experimental methods that allow for causal inference, found that heat early warning systems and action plans reduce deaths on hot days, particularly in certain populations, with an effect magnitude of approximately 2.5 deaths per day (Benmarhnia et al. 2016). Another quasi-experimental study similarly found an effect on certain vulnerable populations, estimating a reduction in mortality rates of 0.1 to 0.5 per 1,000,000 person days, but no effect on all-cause mortality in the general population (Heo et al. 2019). Overall, heat early warning systems and action plans appear to be effective at reducing mortality for high-risk populations, although they likely are not able to fully nullify the adverse health impact of extreme heat events (Fouillet et al. 2008; Rogers and Tsirkunov 2011).

How long does the intervention take to implement?

Heat early warning and response systems and action plans typically take several years to implement. The implementation of the heat early warning system and action plan in Ahmedabad, India, is perhaps the best documented in the literature. This system took approximately five years to develop, pilot, implement, and evaluate. This process included an initial epidemiological study (Azhar et al. 2014), assessment of community-level vulnerabilities (Tran et al. 2013; Kakkad et al. 2014), program development and implementation (Knowlton et al. 2014), and evaluation (Hess et al. 2018).

How much does the intervention cost?



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There are very few reports of the cost of heat early warning systems and action plans in the literature. Ebi and colleagues estimated the annual operating cost of a heat early warning system and action plan in Philadelphia, Pennsylvania to be approximately \$131,000 (in 2023 US dollars) (Ebi et al. 2004). They noted that many of the activities included in the heat early warning system and action plan were included in existing employees' work (and so were not additional costs), and that most additional costs during heat response activities were related to more labor hours recruited for response activities. In other settings without pre-existing pathways for meteorological forecasting and in which multiple new surveillance, response, and evaluation activities need to be implemented, costs would be higher. Regardless, several cost-effectiveness studies confirmed that heat early warning and response systems and action plans are cost effective, particularly for larger populations with multiple vulnerable groups in which the systems and plans prevent heat-related mortality (Ebi et al. 2004; Rogers and Tsirkunov 2011).

Are there downsides to consider?

There do not appear to be significant downsides to heat early warning systems and action plans apart, potentially, from opportunity costs. There is in theory the potential for emergency response and health care delivery systems to be overwhelmed by referrals that may result from extra vigilance on the part of caregivers, although this is likely balanced by the relative ease and cost effectiveness of treating heat-related disease exacerbations before they progress to life-threatening conditions.

What other strategies should be considered?

Heat early warning and response systems and action plans are primarily oriented toward acute heat events and associated preparedness and response. Action planning should also include longer-term risk reduction efforts (Hess et al. 2022), as these activities reduce long-term risk and have the potential to partially offset the increasing risk of heat to health as the climate changes further.

What are some good sources of additional information?

[European Union guidance on heat-health warning systems and action plans](#)

[Heat-health action plans: Guidance from the World Health Organization](#)

[Create a heat action plan guidance from One Billion Resilient](#)

[Heat preparedness through early warning systems from the Global Heat Health Information Network](#)

[Hot weather and health: Guidance from the UK](#)



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