

PUBLIC HEALTH PREPAREDNESS FOR HEATWAVE EMERGENCIES

Dr. Ananya Kapoor

Assistant Professor

Department of Public Health

School of Health Sciences

University of Global Studies, New Delhi, India

Abstract

Heatwaves have become a major public-health emergency because extreme heat can rapidly affect mortality, illness, water security, service delivery, productivity, and household wellbeing. The burden does not arise only from very high temperatures; it is shaped by humidity, duration of heat exposure, hot nights, housing conditions, urban heat islands, pre-existing disease, occupational exposure, access to cooling, and the ability of health and civic systems to respond. This study presents a literature-informed analytical framework for examining public-health preparedness for heatwave emergencies across six linked areas: early warning, risk communication, surveillance, clinical readiness, protection of high-risk groups, and continuity of essential services. The framework combines meteorological alerts, population vulnerability indicators, health-service capacity, community outreach, and infrastructure conditions to show how heat risk can move from an environmental hazard into a preventable health crisis. Particular attention is given to older adults, infants and children, pregnant women, outdoor workers, people with disabilities, people living with chronic illness, low-income households, and residents of dense urban settlements. Illustrative scenario results show that stronger preparedness can improve warning reach, access to safe cooling and hydration, early recognition of heat illness, referral capacity, and continuity of critical services. The paper identifies practical measures such as heat-health action plans, tiered alerts, multilingual communication, cooling centres, occupational safeguards, clinical protocols, community networks, and post-event review. It concludes that heatwave preparedness must be built as an all-of-government and all-of-community public-health function rather than treated as a short-term seasonal campaign.

Keywords: Heatwave Emergencies, Public Health Preparedness, Heat-Health Action Plan, Early Warning, Climate and Health, Risk Communication, Health Systems, Urban Heat, Vulnerable Populations, Disaster Risk Reduction.

1. INTRODUCTION

Heatwaves are periods of unusually hot weather that can place immediate pressure on the human body and on the systems that protect health. The public-health consequences may include dehydration, heat exhaustion, heatstroke, worsening of cardiovascular and respiratory disease, kidney stress, adverse pregnancy outcomes, mental-health strain, reduced work capacity, medication-related complications, and disruption of essential daily activities. The risk is often greater when high daytime temperatures are combined with humid conditions, stagnant air, poor night-time cooling, crowding, and limited access to water, shade, ventilation, or electrically powered cooling.

A heatwave emergency is therefore not only a meteorological event. It is also a test of health-system readiness, urban planning, social

protection, housing quality, labour safeguards, transport resilience, and the ability of public agencies to communicate clear and timely advice. In densely populated areas, heat can accumulate in built surfaces and poorly ventilated homes, while power disruptions or water shortages can remove the very resources that households need to cope. Rural and peri-urban communities may experience different but equally serious vulnerabilities through outdoor work, long travel for water, limited emergency transport, and reduced access to clinical care.

The health effects of extreme heat are unevenly distributed. Older adults living alone, infants and young children, pregnant women, people with chronic diseases, people taking certain medications, persons with disabilities, informal workers, migrant workers, homeless persons, and households with low income

often have fewer means to reduce exposure. Social isolation, language barriers, weak access to information, and lack of confidence in public services can further delay protective action. A preparedness plan that reaches only well-connected residents may therefore leave the highest-risk groups unprotected.

Effective preparedness begins before the hottest days arrive. It requires a system that can translate weather forecasts into health-relevant alerts, identify at-risk areas and groups, activate response roles, guide clinical and community workers, maintain water and electricity services, and assess whether messages and interventions are reaching people. This study develops an analytical framework for examining such readiness. It connects heat hazard indicators with population vulnerability, service capacity, and response actions so that local authorities can plan, monitor, and improve heatwave preparedness in a structured way.

2. LITERATURE REVIEW

Research on heat and health has consistently shown that elevated ambient temperature can increase mortality and illness, especially when heat exposure is intense, prolonged, or accompanied by high humidity and hot nights.

Earlier studies primarily examined temperature-mortality associations. More recent work has expanded the analysis to include exposure inequality, urban heat islands, occupational risk, health-service demand, warning-system design, and the role of climate change in increasing heat-related health burdens. This literature highlights the importance of treating heat as a cross-sector public-health issue rather than as an isolated environmental concern.

Evidence on heat-health action plans indicates that risk reduction is most plausible when multiple measures operate together: credible forecasts, graduated warning levels, targeted communication, checks on vulnerable people, clinical guidance, cooling access, worker protection, and review after each event. However, implementation quality remains uneven. Many local systems still lack neighbourhood-level vulnerability data, formal coordination arrangements, inclusive communication, surge protocols, and indicators for evaluating whether preparedness actions actually reduce avoidable exposure and illness.

2.1 SUMMARY OF PREVIOUS STUDIES

Author(s)	Method / Technique	Major Findings	Research Gap
Kovats & Hajat (2008)	Critical public-health review	Explained major pathways through which heat stress affects health and mortality.	Needs greater operational detail on local readiness and service coordination.
Basu (2009)	Epidemiological review	Summarised evidence linking high ambient temperature with mortality.	Does not specify how alerts should reach highly vulnerable groups.
WHO & WMO (2015)	Warning-system guidance	Outlined the components of heat-health warning systems and action plans.	Implementation indicators vary across cities and countries.
Toloo et al. (2013)	Systematic review	Examined the design and potential effectiveness of heat warning systems.	Few studies measured outcomes for socially excluded populations.
Gasparrini et al. (2015)	Multi-country observational analysis	Demonstrated substantial mortality risk associated with non-optimal temperatures.	Local capacity and response actions were not the central focus.
Knowlton et al. (2014)	Programme case study	Documented development of a heat-health action plan in Ahmedabad, India.	Long-term coverage and equity require continued assessment.
Mora et al. (2017)	Global exposure assessment	Showed the broad population exposure potential of dangerous heat	Does not translate exposure estimates into local health-service plans.

		conditions.	
IPCC (2022)	Global assessment	Assessed climate-related health risks, adaptation options, and limits.	Decision makers still need local trigger thresholds and response protocols.
Romanello et al. (2023)	Global health and climate monitoring	Highlighted increasing heat exposure and heat-related health concerns.	Subnational preparedness data remain incomplete in many settings.
WMO (2024)	Global climate assessment	Reported continuing climate extremes and the importance of early warning.	Public-health integration of warnings remains inconsistent.

3. OBJECTIVES OF THE STUDY

The primary objective of this research is to examine how public-health systems can prepare for heatwave emergencies through early warning, risk communication, protective services, clinical readiness, and coordinated action for vulnerable populations. The study uses a literature-informed framework to link heat hazard conditions with the operational capacity of health agencies, local governments, community organisations, and essential-service providers.

3.1 PRIMARY OBJECTIVE

The primary objective of this study is to develop and apply an analytical framework that explains how the intensity, duration, timing, and local distribution of heatwaves can influence health risk and how preparedness measures can reduce avoidable exposure, illness, and disruption.

PRIMARY OBJECTIVE POINTS

- To identify the heatwave characteristics most relevant to public-health risk and emergency activation.
- To examine how warning reach, risk communication, cooling access, hydration, and clinical readiness influence protective action.
- To connect heat exposure with population vulnerability, health-service demand, occupational risk, and continuity of essential services.
- To assess how social conditions, housing quality, urban design, and access to resources shape unequal heat-health outcomes.
- To outline preparedness and policy measures that can strengthen heat-health resilience before, during, and after heatwave events.

3.2 SECONDARY OBJECTIVES

The secondary objectives focus on practical assessment, high-risk groups, preparedness operations, and the institutional actions needed to turn weather information into timely and equitable public-health protection.

- To compare the expected health-protection outcomes of stronger preparedness and lower-preparedness response environments.
- To identify preparedness pathways for older adults, children, pregnant women, persons with chronic illness, outdoor workers, and low-income households.
- To consider the role of cool spaces, safe water, shade, ventilation, transport, and energy continuity during extreme heat.
- To examine the contribution of surveillance, clinical protocols, ambulance readiness, referral pathways, and medicine storage.
- To support local planning that integrates public health, disaster management, municipal services, labour protection, education, and community organisations.
- To recognise data limitations and distinguish illustrative scenario analysis from measured surveillance or field results.
- To provide a framework that can later be adapted for ward-level, city-level, district-level, or health-facility-based empirical studies.

4. RESEARCH METHODOLOGY

This study follows a structured literature-informed analytical methodology rather than a primary field survey. It uses a conceptual pathway approach to connect heatwave conditions with public-health outcomes and operational readiness. The framework distinguishes six heat indicators: maximum

temperature, minimum night-time temperature, apparent temperature or heat index, duration of hot conditions, humidity, and local heat accumulation in dense built environments. These indicators are considered together with demographic vulnerability, housing conditions, service capacity, and response measures.

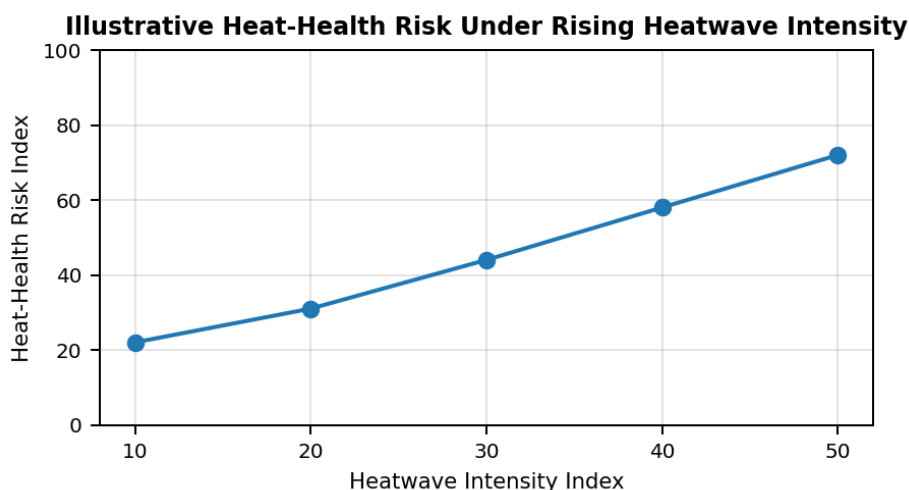
First, heatwave conditions are classified as moderate, severe, or extreme according to local climatology and public-health relevance. A moderate event may require enhanced communication and routine monitoring. A severe event may activate targeted outreach, cooling arrangements, worker-protection advisories, and health-facility readiness. An extreme event may require multi-agency coordination, extended service hours, welfare checks, ambulance preparedness, and continuity measures for water, electricity, transport, and medicines. The framework is designed to be operationalised later using weather-station records, forecast products, health surveillance data, and local administrative information.

Second, preparedness is assessed through warning reach, clarity of risk communication,

identification of vulnerable groups, availability of cooling and hydration support, capacity of primary care and emergency services, referral readiness, medicine and power continuity, occupational safeguards, and post-event review. The purpose is not to assign a single universal score to every location; it is to help planners identify where the protective chain may break. For example, a timely alert has limited value when it is not understandable, cannot be acted upon, or does not reach people who are isolated or without digital access.

Third, the framework identifies actions at household, community, service-provider, municipal, and policy levels. These include heat-health action plans, tiered alerts, multilingual messages, welfare checks, cooling centres, drinking-water points, shade and rest arrangements for workers, clinical protocols, school guidance, transport contingencies, power-outage plans, and rapid review of heat-related illness and mortality. The figure below uses an illustrative conceptual series to show the expected direction of heat-health risk as heatwave intensity rises; it is not a measured epidemiological result.

Figure 4.1: Illustrative Heat-Health Risk Under Rising Heatwave Intensity



5. DATA ANALYSIS

Data analysis evaluates how the preparedness of public-health and municipal systems can influence the ability of communities to cope with heatwave emergencies. The illustrative comparison below contrasts a stronger-preparedness setting, where forecast-based activation, outreach, cooling access, clinical readiness, and essential-service planning are

established, with a lower-preparedness setting in which response measures are fragmented or delayed. The indicators are intended to demonstrate a possible evaluation format for a future city, district, ward, or health-facility study.

For transparency, the numerical values in the following table are illustrative scenario values. They do not represent results from a survey,

routine surveillance system, experiment, or nationally representative dataset. Before empirical submission, the values should be replaced with defined heat thresholds, local weather records, health-service data,

vulnerability mapping, community observations, and a clearly stated study area and period.

5.1 ILLUSTRATIVE HEATWAVE PREPAREDNESS SCENARIO RESULTS

Evaluation Metric	Stronger-Preparedness Scenario	Lower-Preparedness Scenario
Early warning reach among priority groups	87.4%	56.1%
Availability of cooling and hydration support	81.2%	49.3%
Heat-health communication clarity	85.6%	58.7%
Timely clinical recognition and referral	79.8%	55.4%
Continuity of essential medicines and power	83.7%	64.2%
Safe-water access during peak heat	88.5%	66.3%
Outdoor-worker protection coverage	76.9%	42.8%
Post-event review and corrective action	74.6%	39.5%

Note: Values are illustrative scenario results used to show the evaluation format. They must be replaced with measured local data before the paper is presented as an empirical study.

6. DISCUSSION

The analysis shows why heatwave preparedness should be treated as a continuous public-health function rather than as a temporary response after temperatures have already become dangerous. Heat risk can escalate quickly, particularly when high daytime temperatures are followed by warm nights that reduce physiological recovery. If warning messages are delayed, unclear, or inaccessible, residents may not modify work, travel, hydration, medication management, childcare, or care-seeking behaviour until symptoms become severe. A preparedness system therefore needs clear triggers, designated responsibilities, and pre-positioned resources before the peak event.

Early warning is necessary but it is not sufficient. The warning must be translated into simple protective instructions and sent through channels that people actually use, including local health workers, schools, employers, community leaders, public transport notices, radio, mobile messages, and door-to-door support where appropriate. Messages should be adapted for language, literacy, disability, and work context. They should explain where

residents can obtain water, cooling, medical advice, or emergency assistance, and should never assume that all households can respond in the same way.

Health-service readiness is equally important. Primary care, emergency departments, ambulance services, pharmacies, and community workers need common recognition and referral protocols for heat-related illness and heat-aggravated conditions. Surveillance should include not only severe heatstroke but also dehydration, renal stress, cardiac events, medication-related complications, and disruptions in home care. Real-time information can help services identify unusual demand, adjust staffing, and direct outreach to neighbourhoods where exposure and vulnerability overlap.

Preparedness must also address the social and infrastructural conditions that create exposure. People who live in poorly ventilated dwellings, lack reliable electricity, work outdoors, travel long distances, or cannot afford cooling have limited capacity to follow standard advice. Municipal measures such as shaded public areas, water points, cooling centres, adjusted work schedules, heat-safe school practices, and heat-resilient housing policies can reduce this gap. Cross-sector planning is therefore central: public health, disaster management, housing, labour, water,

energy, transport, education, and community organisations must work from a shared heat-health action plan.

The principal limitation of this paper is that it presents a literature-informed framework and illustrative scenario values rather than original field measurements. Future studies should test the framework with neighbourhood-level heat exposure data, heat-health surveillance, household surveys, health-facility records, electricity and water reliability information, and participatory evidence from residents and frontline workers. Such research can identify the thresholds, warning channels, service gaps, and interventions that matter most in specific local contexts.

7. CONCLUSION

Public Health Preparedness for Heatwave Emergencies demonstrates that extreme heat can affect health through direct exposure and through disruption of the systems that support safe daily life. The severity of an event depends not only on temperature, duration, humidity, and night-time heat, but also on the ability of individuals, communities, and

institutions to take timely protective action. Older adults, children, outdoor workers, persons with chronic illness, low-income households, and socially isolated residents require specific attention because general alerts alone may not be enough to reduce their exposure.

The paper proposes a structured framework that connects heat indicators with warning reach, vulnerability assessment, risk communication, cooling and hydration support, clinical readiness, service continuity, and post-event learning. It emphasises that preparedness must go beyond single interventions. Effective heat-health protection requires coordinated action across health services, municipal systems, labour protection, housing, water and energy services, and community networks. Future empirical research should apply the framework to defined places and populations using measured data so that heatwave investment can be directed to the groups and settings facing the greatest preventable risk.

8. REFERENCES

1. World Health Organization and World Meteorological Organization. (2015). *Heatwaves and Health: Guidance on Warning-System Development*. Geneva: WMO.
2. World Health Organization. (2021). *COP26 Special Report on Climate Change and Health: The Health Argument for Climate Action*. Geneva: WHO.
3. World Health Organization. (2024). *Heat and Health*. Geneva: WHO.
4. Intergovernmental Panel on Climate Change. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report*. Cambridge University Press.
5. World Meteorological Organization. (2024). *State of the Global Climate 2023*. Geneva: WMO.
6. Kovats, R. S., & Hajat, S. (2008). Heat stress and public health: A critical review. *Annual Review of Public Health*, 29, 41-55. <https://doi.org/10.1146/annurev.publhealth.29.020907.090843>
7. Basu, R., & Samet, J. M. (2002). Relation between elevated ambient temperature and mortality: A review of the epidemiologic evidence. *Epidemiologic Reviews*, 24(2), 190-202.
8. Basu, R. (2009). High ambient temperature and mortality: A review of epidemiologic studies from 2001 to 2008. *Environmental Health*, 8, 40. <https://doi.org/10.1186/1476-069X-8-40>
9. Gasparrini, A., Guo, Y., Hashizume, M., et al. (2015). Mortality risk attributable to high and low ambient temperature: A multicountry observational study. *The Lancet*, 386(9991), 369-375. [https://doi.org/10.1016/S0140-6736\(14\)62114-0](https://doi.org/10.1016/S0140-6736(14)62114-0)
10. Vicedo-Cabrera, A. M., Scovronick, N., Sera, F., et al. (2021). The burden of heat-related mortality attributable to recent human-induced climate change. *Nature Climate Change*, 11, 492-500.
11. Mora, C., Dousset, B., Caldwell, I. R., et al. (2017). Global risk of deadly heat. *Nature Climate Change*, 7, 501-506. <https://doi.org/10.1038/nclimate3322>
12. Toloo, G. S., FitzGerald, G., Aitken, P., Verrall, K., & Tong, S. (2013). Are heat warning systems effective? *Environmental Health*, 12, 27. <https://doi.org/10.1186/1476-069X-12-27>
13. Knowlton, K., Kulkarni, S. P., Azhar, G. S., et al. (2014). Development and implementation of South Asia's first heat-health action plan in Ahmedabad, India. *International Journal of*

- Environmental Research and Public Health, 11(4), 3473-3492.
<https://doi.org/10.3390/ijerph110403473>
14. Fouillet, A., Rey, G., Laurent, F., et al. (2006). Excess mortality related to the August 2003 heat wave in France. *International Archives of Occupational and Environmental Health*, 80, 16-24.
 15. Ebi, K. L., Capon, A., Berry, P., et al. (2021). Hot weather and heat extremes: Health risks. *The Lancet*, 398(10301), 698-708.
 16. Romanello, M., Di Napoli, C., Drummond, P., et al. (2023). The 2023 report of the Lancet Countdown on health and climate change: The imperative for a health-centred response in a world facing irreversible harms. *The Lancet*, 402(10419), 2346-2394.
 17. World Meteorological Organization. (2023). *Global Status of Multi-Hazard Early Warning Systems 2023*. Geneva: WMO.
 18. United Nations Office for Disaster Risk Reduction. (2022). *Global Assessment Report on Disaster Risk Reduction 2022: Our World at Risk*. Geneva: UNDRR.
 19. National Disaster Management Authority. (2019). *National Guidelines for Preparation of Action Plan - Prevention and Management of Heat-Wave*. New Delhi: Government of India.
 20. Lowe, D., Ebi, K. L., & Forsberg, B. (2011). Heatwave early warning systems and adaptation advice to reduce human health consequences of heatwaves. *International Journal of Environmental Research and Public Health*, 8(12), 4623-4648.
 21. Hajat, S., O'Connor, M., & Kosatsky, T. (2010). Health effects of hot weather: From awareness of risk factors to effective health protection. *The Lancet*, 375(9717), 856-863.
 22. Bouchama, A., Dehbi, M., Mohamed, G., Matthies, F., Shoukri, M., & Menne, B. (2007). Prognostic factors in heat wave related deaths: A meta-analysis. *Archives of Internal Medicine*, 167(20), 2170-2176.
 23. Jay, O., Capon, A., Berry, P., et al. (2021). Reducing the health effects of hot weather and heat extremes: From personal cooling strategies to green cities. *The Lancet*, 398(10301), 709-724.
 24. Watts, N., Amann, M., Arnell, N., et al. (2021). The 2021 report of the Lancet Countdown on health and climate change: Code red for a healthy future. *The Lancet*, 398(10311), 1619-1662.
 25. Ebi, K. L., & Hess, J. J. (2020). Health risks due to climate change: Inequity in causes and consequences. *Health Affairs*, 39(12), 2056-2062.