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Heat-Related Health Risks and Responses of G20 and BRICS Countries

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Executive Summary

This report synthesises current evidence on heat-related health risks and policy responses across G20 and BRICS countries, highlighting the growing urgency of extreme heat as a major climate-driven public health threat. Global temperatures have now consistently exceeded 1.5°C above pre-industrial levels, with recent years ranking as the hottest on record. As a result, heatwaves are becoming more frequent, prolonged, and intense, contributing to an estimated hundreds of thousands of deaths annually and widespread impacts on health systems, labour productivity, and infrastructure.

Across G20 and BRICS countries, projections indicate substantial increases in heatwave frequency and duration by mid-century, particularly in Global South countries. Heat exposure is associated with a wide range of adverse health outcomes, including heatstroke, cardiovascular and respiratory complications, exacerbation of chronic diseases, and mental health impacts. Indirect effects include increased transmission of infectious diseases, reduced labour productivity, and strain on healthcare systems. Vulnerability is unevenly distributed, with heightened risks among older adults, children, pregnant women, individuals with chronic illnesses, outdoor and informal workers, and populations living in low-income or poorly serviced environments.

Heat Action Plans (HAPs) have emerged as the primary policy instrument to address these risks. While approaches vary, effective HAPs typically include early warning systems (EWS), public health preparedness, risk communication, urban planning interventions, and protection of vulnerable groups. Several countries, including South Africa, France, the United Kingdom, and South Korea, demonstrate strong integration of monitoring and evaluation systems, enabling more adaptive and accountable heat governance. However, many countries lack standardized indicators, limiting their ability to assess implementation and health outcomes.

Implementation of HAPs is widespread but uneven. Common measures include heat warning systems, public awareness campaigns, healthcare system preparedness, and provision of cooling centres. Successful implementation is associated with strong leadership, intersectoral coordination, community engagement, and localisation of interventions. However, significant gaps persist, including weak institutional coordination, insufficient funding, lack of legal mandates, inadequate surveillance systems, and limited focus on vulnerable populations. Urbanisation and poor planning further exacerbate heat risks, particularly in informal settlements.

The report emphasises the critical role of advancing interdisciplinary science to strengthen heat adaptation. Key research gaps include limited evaluation of HAP effectiveness in low- and middle-income countries, insufficient data on vulnerable populations, and weak integration of heat with broader climate and health risks such as air pollution. Strengthening data systems, improving monitoring frameworks, and integrating social, environmental, and physiological evidence are essential to support more effective and equitable responses.

In conclusion, while progress has been made in recognising and responding to extreme heat, current efforts remain insufficient to match the scale of the challenge. Strengthening governance, financing, data systems, and scientific evidence—alongside embedding equity and local relevance—will be essential to transform Heat Action Plans from reactive tools into proactive systems that protect health, livelihoods, and development in a rapidly warming world.

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Introduction

The World Meteorological Organization (WMO) confirmed that 2024 was the warmest year in its 175-year observational record. The annual averaged global mean near-surface temperature in 2024 was 1.55˚C ± 0.13˚C above the pre- industrial (1850 – 1900) baseline average, and the first time that the threshold goal of 1.5˚C of warming set by the Paris Agreement was exceeded.[1] Based on global mean surface temperature data, the ten most recent years now rank as the ten warmest years documented.[2]

Recent data released by the European Centre for Medium-Range Weather Forecasts (ECMWF), revealed that 2025 was the third warmest year on record. The year 2025 had minimal temperature differences as it was 0.13 ˚C cooler than 2024 and 0.01˚C cooler than 2023. As a result, the three-year period from 2023 to 2025 represents the first time that global temperatures consistently exceeded the 1.5˚C threshold, with average global temperatures remaining above 1.5˚C to pre-industrial levels[3].

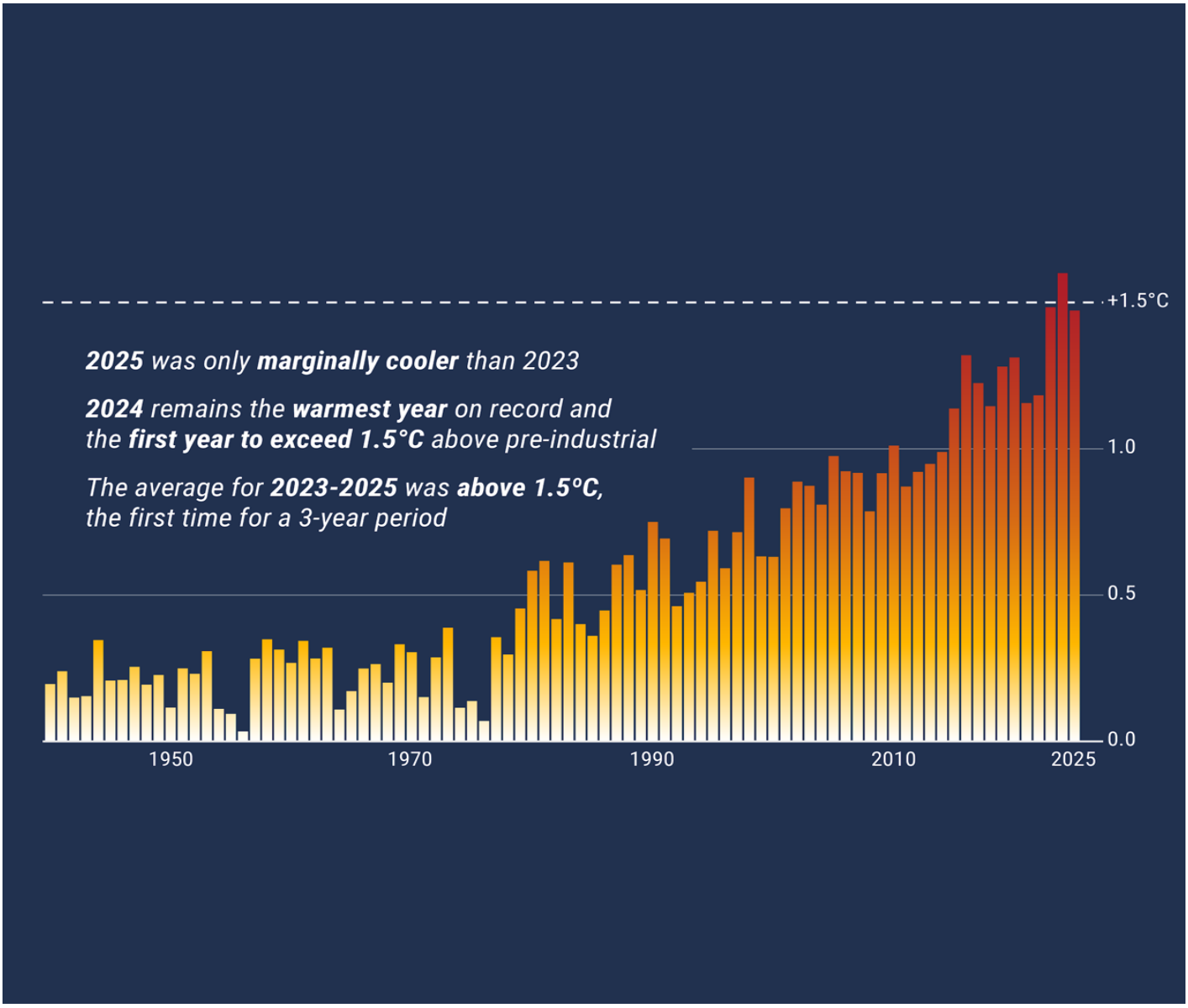


Figure 1: Global surface air temperature variations since 1940 to 2025

Moreover, data from the ECMWF, showed that worldwide, January 2025 was the warmest January on record and warmer than the historical average. In addition, 48% of the globe encountered annual temperatures above the long-term average, while half of the world experienced more days than usual with at least strong heat stress, defined as conditions in which maximum temperatures feel like 32˚C or higher.[3]

[1]WMO, 2025. State of the Global Climate. World Meteorological Organization, WMO-No. 1368, Geneva, Switzerland. https://wmo.int/sites/default/ files/2025-03/WMO-1368-2024_en.pdf.

[2]WMO, 2025. WMO confirms 2024 as warmest year on record, about 1.55˚C above pre-industrial level [Press release]. https://wmo.int/news/media- centre/wmo-confirms-2024-warmest-year-record-about-155degc- above-pre-industrial-level.

[3]ECMWF, 2026. Global Climate Highlights 2025. https://climate.copernicus.eu/global-climate-highlights-2025.

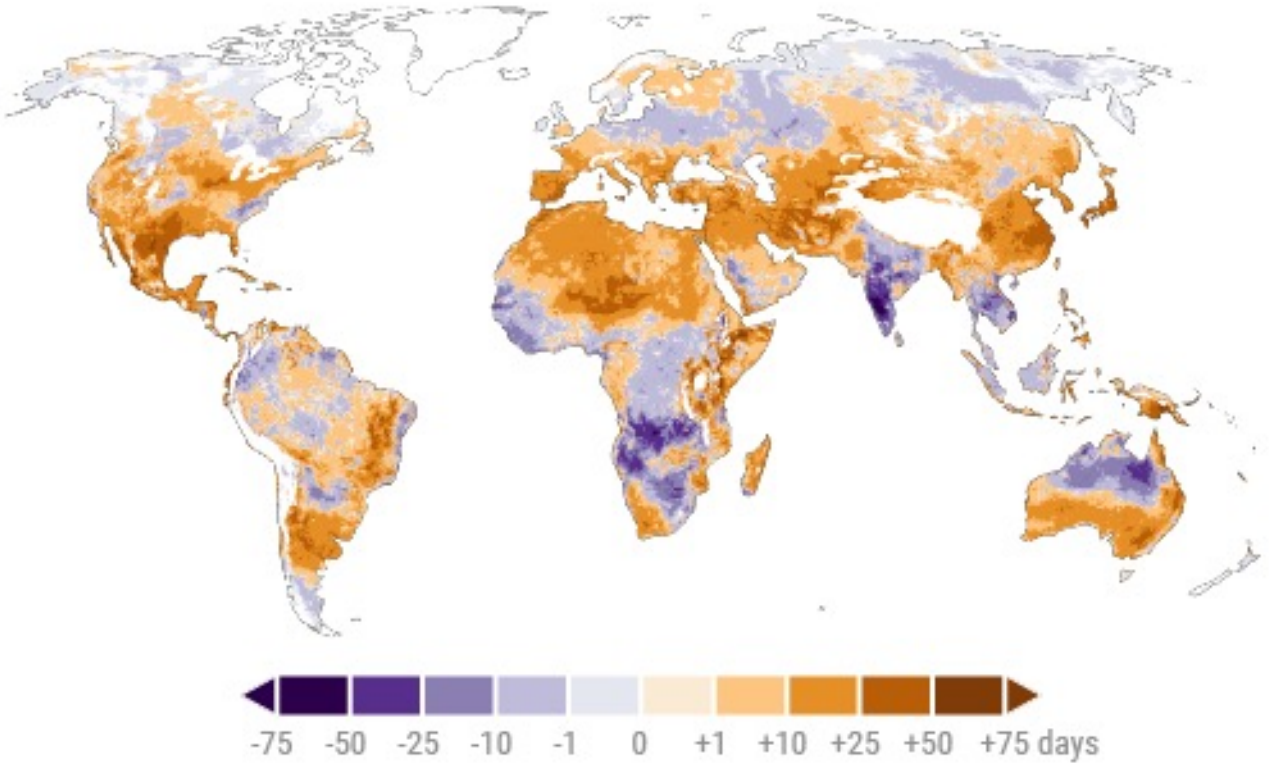


Figure 2: Abnormalities in the number of days in 2025, with at least strong heat stress

Extreme heat is a major climate change-induced risk, affecting not only public health, but also productivity, critical urban infrastructure and essential services. Heatwaves are becoming more frequent, longer and more intense; while annual mean temperatures are rising and the intensifying urban heat islands are further increasing risks to human health. Worldwide, it is estimated that over 489 000 deaths per year result from heat-related causes[4], and 2.4 billion workers are exposed to excessive heat.[5]

In May 2024, the United Nations Secretary-General issued an urgent Call to Action on Extreme Heat. Simultaneously, the WMO and the World Health Organization (WHO) published a joint report titled, Climate Change and Workplace Heat Stress, providing guidance to build resilience amongst workers.[6] In recent years, several global, regional and localised networks and clusters of researchers, policymakers and climate adaptation practitioners which focus on extreme heat have emerged. These communities of practice have contributed to establishing a solid evidence base from which global calls can be made, as well as a directive towards future research, policy and practice responses. Despite these advances, the number of workers affected by excessive heat is alarming, and occupational safety and health protections have struggled to keep up with increasing temperatures.[7]

Heat Risk Context in G20 and BRICS Countries

The urgent need for accurate estimation of heat impacts is critical for driving and informing necessary policy action at the national level. Evidence for expected increase in heat-health risk across G20 and BRICS countries is provided by the statistics that follow. Projected annual mean temperature increases (˚C) for the year 2050 for three global warming scenarios, are given in Figure 1. For a global warming scenario of 2˚C, annual mean temperatures are expected to increase by at least 1˚C, with some countries (e.g. Canada and Russia), projected to experience increases of 3.1˚C[8].

Statistical projections for the same three scenarios for the median year 2050, provide evidence of marked increases in heatwave duration (Figure 2) and heatwave frequency (Figure 3). For example, for the global warming scenario of 2˚C, the percent increase in duration is ten-fold, exceeding 1 000% for Argentina and Brazil, and is five-fold for India, Indonesia, Mexico, Saudi Arabia, South Africa and Türkiye. Percent increase in frequency is highest for Saudi Arabia (69%), and above 50% for the same set of countries in the Global South mentioned before. Increased exposure to extreme heat is closely associated with rising heat-related mortality. By 2018, heat-related deaths had already increased substantially compared to the 2000–2004 baseline, with reported increases ranging from 15% in Russia to

[4] eClinicalMedicine. The increasing burden of heat-related mortality. EClinicalMedicine. 2024 Sep 24;75:102865. doi: 10.1016/j.eclinm.2024.102865. PMID: 39763594; PMCID: PMC11701478.
[5] ILO, 2024. Ensuring safety and health at work in a changing climate, International Labour Office, Geneva, Switzerland.
[6] WHO and WMO, 2025. Climate Change and Workplace Heat Stress: Technical Report and Guidance, Geneva, Switzerland. https:iris.who.int/ bitstream/ hanle/10665/382351/9789240099814-eng.pdf?sequence=1.
[7] International Labour Organization (ILO). (2024). Heat at work: Implications for safety and health. https://www.ilo.org/publications/heat-work- implications-safety-and-health
[8] CMCC (undated). G20 Climate Risk Atlas. Centro Euro-Mediterraneo sui Cambiamenti Climatici (SMCC), Lecce, Italy. https://www.cmcc.it.

191% in Brazil[5]. The Lancet Countdown on Health and Climate Change 2025 report revealed that, between 2012 and 2021, heat-related deaths surged to on average 546 000 annually and that from the 1990s, heat related mortality per 100 000 rose by 23%[9]. Similarly, a study done on heatwaves that occurred in 67 countries across the globe in 2023, found that there were 178 000 excess deaths globally, equivalent to 23 deaths per million people[10, 11].

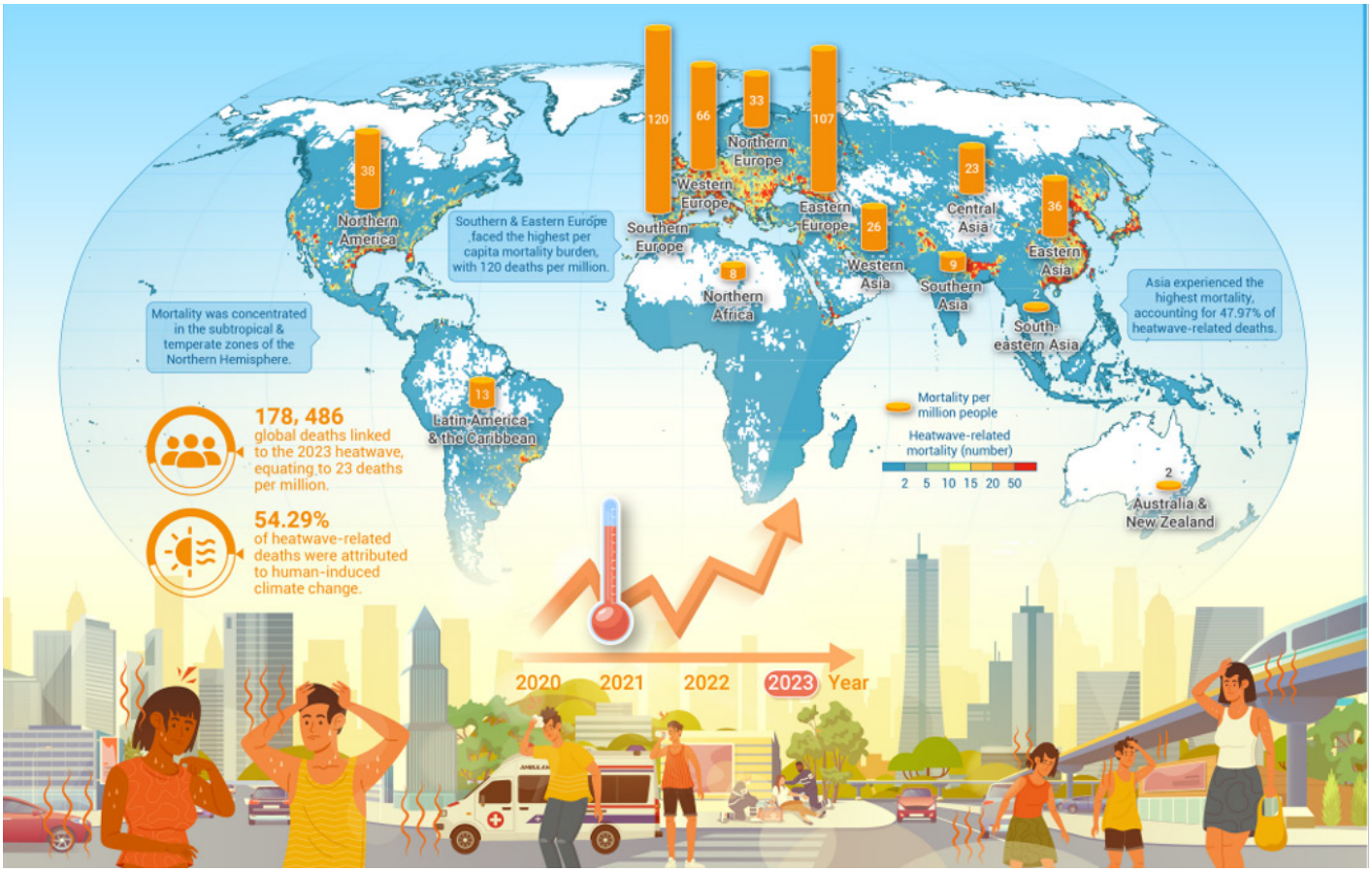


Figure 3: Excess heatwave deaths in 2025 worldwide

Currently, the temporal patterns of high heat are well understood. Most impacts are seasonal, peaking during summer months and during periods of intense heatwaves. As shown above, long-term trends indicate increasing frequency and severity of heatwave events. The identifiable patterns are significant for responding to health impacts of high heat through HAPs, since they can be temporarily directed and the timing of budget allocations for response activities is largely predictable.

Health Risks due to Excessive Heat Exposure

Exposure to excessive heat is a growing public health concern that includes direct and indirect health effects, and exacerbation of existing health conditions. All-cause and heat-specific mortality spikes during heatwaves are reported in studies from across the G20 and BRICS countries, with excess deaths ranging from dozens in smaller cities, to thousands in large urban centres during extreme events.

Direct effects include dehydration; heat-induced fainting caused by a drop in blood pressure; heatstroke, a severe life-threatening condition that can lead to death; heat-induced brain seizures; heat exhaustion, expressed as dizziness, nausea and dehydration; and hyperthermia, a condition in which the body is unable to regulate its internal temperature; causing damage to organs.

Indirect effects include an increased risk of infectious diseases, due to the expansion of vector-borne diseases such as malaria and dengue; carried by mosquitoes and Lyme disease – carried by ticks. Additional impacts include increased incidence of workplace and traffic accidents, and injuries due to heat-induced exhaustion; loss of productivity; negative economic consequences; due to workplace heat stress, and increased pressure on healthcare systems – as a result of increased heat-related hospital admissions; increased thermal discomfort of health care staff and patients, and negative effects on equipment and facilities. Extreme heat can also contribute to water shortages, which lead to increased risks of waterborne diseases and dehydration.[12]

[9] Romanello M, Walawender M, Hsu S-C, et al. The 2025 report of the Lancet Countdown on health and climate change. Lancet 2025

[10] Kjellstrom T, Freyberg C, Lemke B, Otto M, Briggs D. Estimating population heat exposure and impacts on working people in conjunction with climate change. Int J Biometeorol.2018Mar;62(3):291-306. doi: 10.1007/s00484-017-1407-0.

[11] Hundessa et al., 2025. Global excess deaths associated with heatwaves in 2023 and the contribution of human-induced climate change. The Innovation 6(10).

[12] https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health

Many chronic physical illnesses are exacerbated by heat, and mental health impacts can be significant. Even among individuals without pre-existing mental health conditions, heat can lead to cognitive impairment and an overall reduction of well-being, as it can lead to disruption of sleep patterns and compromise how one interprets information. Additional public health impacts include increased violent crimes, and accidents such as drownings and trauma injuries.

Vulnerable Populations

Certain groups are especially vulnerable to excessive heat exposure, and their needs should be addressed in (HAPs). Older adults are among the most vulnerable groups, due to factors such as chronic health conditions, impaired/ reduced physical mobility, isolation from other age groups, dependence on caregivers and less efficient thermoregulatory mechanisms. In addition, older individuals may have a reduced ability to perceive rapid temperature increases and diminished thirst sensation, which lowers the likelihood of behavioural adaptation during heat events.

Individuals with chronic physical health conditions are more sensitive to heat. These include cardiovascular disease (e.g., coronary artery disease, hypertension), respiratory disease (e.g., asthma, bronchitis, chronic obstructive pulmonary disease), kidney disease (particularly renal failure), diabetes, epilepsy, multiple sclerosis, Alzheimer's disease and Parkinson's disease. The use of certain medications namely anticholinergics, antidepressants, antiepileptics, antihistamines, antipsychotics and blood pressure regulation medicines also increase an individual's vulnerability to heat. Persons suffering from mental health conditions such as dementia, schizophrenia and depression are also vulnerable, as extreme heat either tends to worsen their conditions, as they are less aware of the heat risks, or the ability to adapt their behaviour is also diminished. Individuals with schizophrenia may be particularly susceptible, as high temperatures can increase anxiety and aggression and disrupt sleep. Evidence also indicates increased reporting of suicide, anxiety, and substance use disorders during heatwaves.

Several other population groups are vulnerable to the health impacts of extreme heat. Infants and young children are at risk as they have to depend on caregivers to provide hydration fluids and to control their environmental temperature. Pregnant women also face elevated risks such as high blood pressure, still births, pre-term births, mastitis and Group B streptococcus infections[13]. Socially isolated individuals, for example the homeless, migrants, elderly people living alone, as well as the incarcerated population may also face increased exposure and limited access to protective resources.

Indoor workers in poorly ventilated factories and facilities such as bakeries, kitchens, laundries and restaurants may experience prolonged periods of heat exposure. Outdoor workers such as agricultural, construction, drivers, delivery, emergency, miners, beach and utility workers, experience similar risks. some industrial workers and Athletes and urban residents who are exposed to the urban heat island, may also face increased heat exposure.

Socio-economic conditions further shape vulnerability. Low-income and informal communities, especially dwellers in informal settlements with poor housing conditions, and informal economy businesses are highly vulnerable, as they have limited access to resources such as potable water, cooling systems, healthcare facilities, and little regulation of building quality or occupational health. Similarly, formal, informal and emergency facilities for migrants, refugees and/or displaced people are vulnerable to the effects of excessive heat.

Components of HAPs

Typically, HAPs include early warning systems where citizens receive alerts that may be colour-coded and which trigger appropriate behavioural responses. Other common features include public health interventions related to the installation of drinking water stations, cooling centres and heat shelters, as well as medical preparedness, for example, hospital readiness. Infrastructure and urban planning measures relate to greening initiatives, such as planting of trees, creation of green corridors, green roofs etc. Also included are adjustments to building standards to promote ventilation and provide protection from the sun. Public awareness campaigns and education strategies such as the training of healthcare workers are important components of HAPs. Workplace regulations are often included in HAPs for affected sectors such as agriculture and construction to protect outdoor workers.

A well-developed HAP typically consists of nine key elements[14]:

A detailed definition of heat that is geographically specific, with identification of particular vulnerable population groups. Future projections of heat changes over time should also be included.

A robust early warning system and elaborate and practical strategies and actions for short and long-term preparation. More importantly, health outcome data should be integrated in the refinement of the system and preparation actions.

Comprehensive and pragmatic strategies for short- and long-term response. Improvement of responses must be informed by data, various sectors must be incorporated, and the allocation of resources must be guided by a vulnerability assessment.

Understandable and effectual coordination among the key government agencies. The public communication strategy (frequency and flow) must be established, and the roles and responsibilities of each agency must be defined.

An extensive implementation plan with transparent timelines, responsibilities and a robust monitoring system. Key aspects that must be included for sustainability of the HAP are a budget, feasibility assessment and a schedule for evaluation.

An extensive vulnerability assessment including risk maps to inform allocation of resources and determine interventions. Local maps of vulnerable populations and extant vulnerability studies need to be used to ensure resource efficiency.

[13] Lakhoo DP, Brink N, Radebe L, Craig MH, Pham MD, Haghighi MM, Wise A, Solarin I, Luchters S, Maimela G, Chersich MF; Heat-Health Study Group; HIGH Horizons Study Group. A systematic review and meta-analysis of heat exposure impacts on maternal, fetal and neonatal health. Nat Med. 2025 Feb;31(2):684-694. doi: 10.1038/s41591-024-03395-8.

[14] Global Heat Health Information Network, UNDRR, WMO (2025). An Assessment of Heat Action Plans: Global standards, good practices and partnerships

Stakeholder and public engagement must be robust and continuous. Systems for provision of feedback and changes to the HAP should be established.

Long-term adaptation strategies should be clearly outlined. Setting of particular goals for achievement in the long-term, aids in planning responses beyond the immediate and short-term.

Comprehensive incorporation with other existing relevant government strategies. This ensures cohesion across government levels and identification of opportunities for resource leveraging and partnership.

Heat Adaptation Governance

Some G20 and BRICS countries have made good progress in adapting to and preparing for heat risks. Responses vary across the nations but are generally captured in a (HAP). While this term is widely used, alternatives include, for example, Heat-Health Action Plan (HHAP) in the UK, Heatwave Preparedness and Response Plan in Australia and parts of the US, and a National Cooling Action Plan (NCAP) in China.

Governance arrangements differ across the various countries. Some G20 and BRICS countries have a single national HAP or equivalent that is centrally coordinated, whereas others have a national framework or national guidelines that address heat risks directly. HAPs at regional or local levels may exist in both cases. A few G20 countries have national HAPs that are in development and are classified as such. Other G20 and BRICS countries have HAPs that are embedded within a broader national framework or strategy that addresses health, planning or climate change, and not necessarily heat directly. These countries are classified as having embedded plans. A minority of G20 countries have HAPs – with decentralized coordination at the state or local government level, rather than a centrally coordinated plan. A couple of G20 and BRICS countries have no formal HAPs, but acknowledge the risks posed by extreme heat, and use weather forecasting services to provide localised warnings for high temperatures. These various governance approaches to addressing health risks of heat are summarized in Table 1.

Table 1: Summary of governance approaches to responses to heat risks across G20 and BRICS countries. Information was drawn from publicly available evidence on the Internet using Google search engine.

Country	Description
AUSTRALIA	Australia's approach to dealing with extreme heat at federal and state levels is multi-tiered, decentralized and coordinated. The decentralization ensures that the HHAPs of state and territorial governments reflect the prevailing local conditions and gain from national coordination. **National Heatwave Warning Framework 2022** The Framework streamlines the Commonwealth, state and territory governments' procedures of heatwave warnings. The Framework describes ongoing actions and actions before, during and after a heatwave emergency. The Framework is reviewed every 5 years and is mandated legislatively by: • The Sendai Framework • The National Disaster Risk Reduction Framework • The National Strategy for Disaster Resilience The Framework aligns with the Australian Warning System which has been developed to minimize the negative effects of heat on health, societal functions, ecosystems and crucial infrastructure. **National Health and Climate Strategy 2023** The Strategy includes heat and heatwaves as a focus area for a whole of government approach to aid healthy, climate resilient and sustainable communities. To realize this, one of the actions by the Australian government will be the development of a national HHAp to foster a uniform approach to reducing the impacts of heat on health. The HHAP will complement and strengthen the National Heatwave Warning Framework and leverage the local government/state/territorial HAPs. **City Level HAPs** • Greater Sydney Heat Smart City Plan 2025–2030 (2024) **State Level HAPs** • Heatwave State Hazard Plan- Western Australia, 2023 • South Australia Health Extreme Heat and Heatwave Strategy, 2023 • New South Wales State Heatwave Subplan, 2023

Country	Description
AUSTRALIA	• Victoria State Emergency Management Plan Extreme Heat Sub-Plan, 2022 • Turn Down the Heat: Strategy and action plan 2018, Western Sidney • Heatwave Ready Tasmania, 2016 • Heatwave plan for Victoria: Protecting health and reducing harm from heatwaves Plan, 2011
FRANCE	France has a well-developed system for the management of extreme heat that was established after the deadly 2003 heatwave. The system is founded on implementation of national policy and action by local governments. **Plan Nationale Canicule / National Heatwave Plan 2017** This Plan was first developed in 2004 following the deadly heatwave that struck France during the summer of 2003. Managed by the Ministry of Health, the Plan governs and coordinates actions at a national level and is centred around four major courses of action: • Prevention of the impacts of a heat wave • Protection of all people through the implementation of management measures adjusted to the weather alert levels. • Communication to raise public awareness and safeguard the public from the health impacts of extreme heat. • Assessment of lessons learnt after experiencing a heat wave The Ministry of Health manages systems for health surveillance and public campaigns for heat risks awareness. Meteo France issues weather forecasts and early warnings. The implementation of heat management plans is the responsibility of local governments. **Plan de Gestion des Vagues de Chaleur / Heatwave Management Plan 2023** This Plan complements the Plan Nationale Canicule by considering the impacts of heat waves on all aspects of society including education, transport, water supply, sports, cultural activities, animal safety and agriculture. This Plan is managed by the Ministry of Ecological Transition and Territorial Cohesion. **City Level HAPs** Paris Climate Action Plan 2024-2030 includes measures to protect its residents from heatwaves whose frequency and intensity are expected to substantially increase.
INDIA	India is one of the world's leaders in extreme heat management. Its well-established approach to management of extreme heat is composed of policies, decentralized governance, early warning systems, innovations, capacity building of health systems and collaboration. **National Action Plan on Heat Related Illnesses 2021** This is a guideline to manage the spectrum of ailments related to heat stress. **National Guidelines for Preparation of Action Plan-Prevention and Management of Heat Wave 2019** This guideline provides a framework for drafting HAPs including implementation, coordination between agencies and impact evaluation of response activities to extreme heat. These Guidelines prepared by the National Disaster Management Authority (NDMA) direct states, districts and local municipalities in the development of their formal HAPs. **City Level HAPs** • Ahmedabad Heat Action Plan 2019 • -Ahmedabad was the first city to develop and implement a HAP. • Mumbai Climate Action Plan 2022 includes approaches to tackle heat risks **Uttar Pradesh State:** • Varanasi City Heat Action Plan, 2025 • Heat Action Plan Gorakhpur District, 2019 • Uttar Pradesh State Heat Wave Action Plan 2024 **Punjab State:** • Ferozepur District Heat Wave Action Plan, 2024 • Patiala District Heat Wave Action Plan, 2022

Country	Description
INDIA	**Rajasthan State:** • Churu District Heat Action Plan, 2025 • Rajasthan (State) Draft Heat Action Plan 2017 **Odisha State:** • Bhubaneswar City Heat Wave Action Plan, 2020 • Heat Action Plan 2022 for Odisha **Gujarat State:** • Heat Wave Action Plan Rajkot City, 2020 • Climate Adaptive and Gender Integrated Heat Wave Action Plan of Surat City, 2023 • Vadodara Municipality Heat Wave Action Plan 2024 **Jammu and Kashmir territory:** • Pulwama Heatwave Action Plan 2024-2025, 2024 • Samba (District) Heat Wave Action Plan, 2024 • Doda (District) Heat Wave Action Plan 2024-2025 • Kishtwar (District) Heat Wave Action Plan 2024-2025 • Rajouri (District) Heat Wave Action Plan 2024-2025 • Srinagar District Heat Wave Action Plan 2024-2025 • Ramban District Heat Wave Action Plan 2025-2026 • Kathua District Heat Wave Action Plan, 2024 **Other States** • Delhi Heat Action Plan 2024-2025 • Heat Action Plan for Thane City 2024 – Maharashtra State • Beating the Heat: Tamil Nadu Heat Mitigation Strategy, 2024 • Karnataka State Heat Wave Action Plan, 2024 • Goa (State) Heat Wave Action Plan 2024 • Himachal Pradesh State Heat Wave Action Plan 2024 • Jodhpur Heat Action Plan 2023 – Rajasthan State • Action Plan on Heat Wave West Bengal (State), 2023 • Telangana State Heatwave Action Plan 2021 • Telangana State Heatwave Action Plan 2021 • Gujarat State Action Plan- Prevention and Mitigation of Impacts of Heat Wave 2020 • Kerala (State) Heat Action Plan, 2020 • Hazaribagh District Heat Wave Action Plan, 2016 - Jharkhand State • Andhra Pradesh (State) Heat Wave Action Plan, 2016
INDONESIA	**National Adaptation Plan 2026-2030** This Plan notes that a Climate–Health Early Warning System (CHEWS) has been developed. The CHEWS synthesizes temperature forecasts and produces communiqués in advance that activate and inform activities to prevent heat stress impacts. **Indonesia's National Cooling Action Plan (I-NCAP) 2024** The Plan was developed to support the government to meet the country's increased demand for cooling via a comprehensive strategy that spans the building, motor vehicles and food cold chain sectors.
ITALY	**Piano operativo nazionale di prevenzione degli effetti del caldo sulla salute / National Plan for the Prevention of the Effects of Heat on Health 2019** This Plan guides the activation of the heat health watch warning system (HHWWS) as one of its major elements. The Plan also defines and coordinates the distribution of information based on the magnitude of health risk predicted by the HHWWS and identifies a focal point at the local level. **National Plan of Adaptation to Climate Change 2023** Includes health as one of the areas vulnerable to climate change with extreme heat being a crucial issue.

Country	Description
ITALY	**City Level HAPs** The HHWWS started operations in 2004 and is city-specific covering 27 cities which include regional cities and cities with a population of over 250000. These cities include Ancona, Bari, Bologna, Bolzano, Brescia, Cagliari, Campobasso, Catania, Civitavecchia, Florence, Frosinone, Genoa, Latina, Messina, Milan, Naples, Palermo, Perugia, Pescara, Reggio, Calabria, Rieti, Rome, Turin, Trieste, Venice, Verona and Viterbo.
SOUTH AFRICA	**National Heat Health Action Guidelines 2020** These Guidelines provide direction to the health sector to plan for extreme heat impacts. The Guidelines were prepared by the Department of Health and are intended for use by municipalities, provincial and district health departments to develop, implement and advance their own HAPs. **City Level HAPs** • City of Cape Town High Heat Day and Heat Wave Action Plan 2023 • City of Johannesburg Climate Action Plan 2021 includes actions to protect residents from the impacts of extreme heat.
TÜRKIYE	Türkiye has no national HAP. However, its Climate Change Adaptation Strategy and Action Plan 2024-2030 identifies extreme heat as a risk and plans to conduct activities for the preparation of HAPs at a local level. **City Level HAPs** • Istanbul Climate Change Action Plan 2021 includes strategies for the city to adapt to extreme heat.
UNITED KINGDOM	**Adverse Weather and Health Plan 2025 to 2026** This a mechanism under the 2023 National Adaptation Programme and an integration and enhancement of existing guidance on weather and health including the Heatwave Plan for England to safeguard people and communities from the negative health impacts of harmful weather such as extreme heat. The Plan aims to assist local, regional and national entities to develop, improve and react to anticipated harmful weather events. Implementation of the HAP is the responsibility of both national and local governments. **Heatwave Plan for England 2018** The Plan outlines the necessary actions to be taken before and during a heatwave by national, regional and local authorities. Two early warning systems are operated. First, a Heat-Health Alert system based on weather forecasts from the England Meteorological Office and the UK Health Security Agency. This system runs from June to September every year. The second is the National Severe Weather Warning System managed by the UK Meteorological Office which issues alerts to the public for impacts across various sectors. **City Level HAPs** • The City of London has a Severe Weather and Natural Hazards Framework that is activated when extreme heat is forecast. • Manchester City is currently developing a heatwave plan as part of the actions outlined under the Climate Change Action Plan 2025-2030. • City of Glasgow Climate Adaptation Plan 2022-2030 includes various interventions for dealing with extreme heat. • Birmingham City has no formal HAP but provides advisory on the City Council's website on dealing with extreme heat. • Although Liverpool City has no HAP, the Liverpool Net Zero Carbon 2030: The Climate Challenge recognizes extreme heat as a risk to the city's residents.
UNITED STATES	The United States approach to extreme heat spans federal, state, local and tribal authorities. **National Heat Strategy 2024 – 2030** The Strategy's key objectives are to firstly, synchronize and reinforce the resources, competency and function of the federal government in responding to extreme heat through the National Integrated Heat Health Information System (NIHHS) and Extreme Heat Interagency working group. Secondly, the Strategy aims to foster collaboration across different government levels and other non-governmental partners in

Country	Description
UNITED STATES	building the country's heat resilience. The NIHHIS is an inter-agency endeavour whose key role is to provide scientific evidence-based advice on extreme heat to decision makers and to coordinate over 20 federal agencies. **County Level HAPs** • Chatham County Heat Action Plan 2024 – North Carolina State • Miami-Dade County Extreme Heat Action Plan 2022 – Florida State **State Level HAPs** • New York State Extreme Heat Action Plan 2024 • New Jersey (State) Extreme Heat Resilience Action Plan 2024 • Maryland (State) Extreme Heat Emergency Plan 2024 • Arizona's Extreme Heat Preparedness Plan 2024 • Arizona's Climate and Health Adaptation Plan 2017 provides public health guidance for hazards such as extreme heat. • Protecting Californians From Extreme Heat: A State Action Plan to Build Community Resilience 2022 • State of New Hampshire Excessive Heat Emergency Response Plan 2014 • Keeping Metro Boston Cool: A Regional Heat Preparedness and Adaptation Plan 2022 **City Level HAPs** • City of Tucson Heat Action Roadmap 2024 - Arizona State • City of Philadelphia Natural Hazard Mitigation Plan 2012 – Pennsylvania State • City of Chicago Climate Action Plan, 2012 includes heat management through reduction of urban heat islands.
BRAZIL	Brazil currently has no national HAP. However, the Climate Plan is the key guide for Brazil's climate policy until 2035 and this Plan aims to direct, advance, execute and oversee coordination of actions in adapting to climate change through strategies such as the National Adaptation Strategy to Climate Change 2016. The National Adaptation Strategy which is currently under review, is one of the two pillars of the Climate Plan and the Strategy's objective is to minimize the exposure of cities and natural environments to climate change impacts such as extreme heat. The Climate Plan includes health as one of sixteen priority sectors and acknowledges extreme heat as a climate change risk whose impact extends over all regions of the country. **City Level HAPs** • Rio de Janeiro launched an Extreme Heat Response Protocol in June 2024 that comprises an early warning system to alert the city's residents of looming danger.
GERMANY	Germany currently has no national HAP. In 2023, the German Federal Ministry for the Environment and the German Federal Environment Agency launched the National Heat Action Plan (NatHAP) project. The project aims to assess the legal and technical aspects in designing a national HAP and runs for a period of 3 years ending in 2026. **City Level HAPs** Few cities in Germany have developed a HAP these include: • Stuttgart HAP 2025 • Mannheim HAP 2021 • Offenbach am Main HAP 2020 • Erlangen HAP 2024 • Worms HAP 2022 • Würzburg HAP • Cologne HAP 2022 specifically for the elderly • Freiburg HAP • Berlin 2022 HAP for outpatient and inpatient care in hospitals and pharmacies • Hesse HAP 2023 • Other cities that are developing HAPs include Berlin, Cologne, Ludwigshafen am Rhein, Münster and Wuppertal.

Country	Description
ARGENTINA	Argentina has no formal national HAP though an early warning system for extreme heat in Buenos Aires was first introduced by the National Weather Service in 2009 and now covers 71 meteorological stations across the country. The National Adaptation Plan 2022 recognizes that extreme heat due to climate change has a significant impact on health. The plan includes actions such as strengthening and updating the early warning system for extreme heat. **City Level HAPs** • Córdoba City HAP 2025 • La Plata Plan de Contingencia Hidrometeorológica 2014 / City of La Plata Hydrometeorological Contingency Plan 2014
EUROPEAN UNION	The WHO European Region developed guidelines in 2008 for countries, regions and cities in Europe to prepare and implement heat-health action plans. The guidelines were under revision which was expected to be completed at the end of 2025.
CANADA	Canada has no formal HAP. However, the Government of Canada Adaptation Action Plan 2024 includes a section on Health and well-being which specifies strengthening a programme titled Protecting the Health of Canadians from Extreme Heat with the aim of expanding the country's capacity to minimize the risks on health from extreme heat. The Heat Alert and Response Systems to Protect Health: Best Practices Guidebook 2012 informs communities of available actions in a heat alert response system to protect themselves from extreme heat. **State / Provincial Level HAPs** • British Columbia Heat Alert and Response System, 2024 • Extreme Heat Preparedness Guide-British Columbia 2025 • Manitoba Heat Alert and Response System Guide, 2024 • Quebec Ministerial Plan for Managing Extreme Heat Events 2010 • Ontario Heat Warning and Information System 2016 **City Level HAPs** • City of Toronto Heat Relief Strategy 2024 • City of Vancouver Heat Response Plan • City of Hamilton Community Heat Response Plan, 2023– Ontario • City of Greater Sudbury Hot Weather Response Plan 2023 – Ontario • City of Surrey Extreme Heat Response Guideline 2024 - British Columbia • Montreal Heat Response Plan, 2004 • Montréal Climate Plan 2020–2030 (2020) includes actions in urban areas to reduce heat vulnerability • City of Port Moody Climate Action Plan 2020 - British Columbia includes actions to respond to extreme heat. • City of Vancouver – Climate Change Adaptation Strategy 2024-2025 (2024) recognizes extreme heat as a risk and outlines various actions to address this risk **Municipal Level HAPs** • Municipal Heat Response Planning in British Columbia 2017 • Community Climate Adaptation Plan for Regional Municipality of Waterloo, 2019 - includes action to assist vulnerable populations to reduce or avoid risks from extreme heat.
CHINA	China has no formal national HAP. However, its National Climate Change Adaptation Strategy 2035 recognizes extreme heat as a health risk. The strategy outlines special actions for adaptation of health to extreme heat including firstly, undertaking research to understand the major risks to health and subsequent development of adaptation strategies and measures to counter the impacts. Secondly, in anticipation of the risks to health, by 2035 China plans to develop risk assessment guidelines, standards and implementation plans for extreme heat adaptation. **City Level HAPs** • The City of Tianjin has established a heat health action plan in the form of a system.

Country	Description
JAPAN	**Heat Illness Prevention Action Plan 2023** The Plan outlines precise actions to be taken by national and local governments, the public, non-governmental organizations and industry to safeguard people's health from the effects of heat stress. The Plan was created as an output of the Climate Change Adaptation Plan 2021. **Municipal / City Level HAPs** Tokyo's Metropolitan Government in 2025 launched the Tokyo heat map that guides residents using a heat index to avoid heatstroke. A few cities also have heat-health prevention plans namely Kusatsu, Kumagaya, Tajimi, Obu and Machida and are all located in Tokyo. Osaka has no formal HAP though the Heatstroke Warning Alert was launched in 2021 to distribute information on preventing heat stroke to the city's residents.
MEXICO	Mexico has no formal national HAP. According to its Special Climate Change Program 2021-2024 prepared under the General Law on Climate Change, heat waves were identified as an impact of climate change. The Program proposed measures that address hydrometeorological phenomena in general, namely the improvement of early warning systems and prevention and mitigation actions. **City Level HAPs** • Programa de Acción Climática de la Ciudad de México 2021-2030 / Mexico City Climate Action Program 2021-2030 includes actions to address heat risks.
SOUTH KOREA	**National Comprehensive Heatwave Response Plan** The Plan is a whole- of -government approach to tackle heatwaves and their impact in Korea. The Korea Meteorological Administration has the critical role of providing heatwave warnings and heat wave forecasts that include information on their impacts. The Plan overseen by the Ministry of Interior and Safety is updated annually and implemented at local, regional and national level. One of the key tasks under the Plan is the development of mid to long term policies to prepare for heatwaves. **Third National Climate Change Adaptation Plan 2021 – 2025** It includes a policy direction that covers the establishment of a system to prevent impacts on health resulting from climate change with a proposed program to protect the health of vulnerable persons from climate change impacts including extreme heat. In addition, the Plan mentions that the development of a health management application addressing climate change is yet to be undertaken. **City Level HAPs** • Daegu Metropolitan City implemented the Cooling Daegu: A Comprehensive Plan to Mitigate Heat Wave Damages 2020-2024. • Seoul and Busan Metropolitan Cities annually implement a Comprehensive Heatwave Plan which encompasses various critical measures such as urban cooling initiatives. • Daegu in 2018 and Busan in 2020 legislated an Ordinance for the Prevention of Heatwave Damage and Mitigation of Urban Heat Island Phenomena which outlined actions for responding to heat waves.
RUSSIA	Russia does not have a formal national HAP. The National Action Plan for the second stage of adaptation to climate change 2023-2025 included a plan to adapt the healthcare sector to climate change effects such as heat waves. The national weather agency issues high-temperature warnings but no dedicated health response plan exists.
SAUDI ARABIA	Saudi Arabia does not have a formal national HAP. Instead, the Guideline on Preventing Effects of Working in High-Temperature 2024 is aimed at informing employers and workers regarding the health risks of working in extreme heat plus prevention and management measures for heat illness. The Saudi Meteorology Department usually issues heatwave warnings whereas the Ministry of Health issues advisories regarding exposure to extreme heat.
EGYPT	Egypt has no formal HAP. However, the Egypt National Climate Change Strategy 2050 acknowledges extreme heat as a risk to health and has identified actions to protect its citizens from the negative impact.

Country	Description
UNITED ARAB EMIRATES	The United Arab Emirates has no overarching HAP across the seven emirates. However, it has other initiatives targeted towards enhancing heat health such as the Heat Exhaustion and Disease Prevention campaign. **National Climate Change Plan of the United Arab Emirates 2017-2050** The Plan recognizes extreme heat as a hazard to public health and proposed integrating risk and adaptation assessments as an immediate action. **State Level HAPs** •Technical Guidelines for Management of Heat Stress at Work-Dubai, 2019 •Abu Dhabi has a "Safety in Heat Program" that runs for three months in the summer every year. Additionally, Abu Dhabi is currently developing a heat-stress index and a national heat health warning system.
ETHIOPIA	Ethiopia has no formal national HAP. The Health National Adaptation Plan-II identifies extreme heat as a direct impact of climate change and emphasises that heat illnesses will increase and present significant health risk to vulnerable groups. The Plan recommends utilisation of the Early Warning Alert and Response (EWARS plus) tool in the probability prediction of the outbreak of climate sensitive diseases. **City Level HAPs** Addis Ababa Climate Action Plan (2021-2025) includes action to reduce heat risks in the city
IRAN	The Islamic Republic of Iran has no national HAP. The Readiness Proposal for the National Adaptation Plan 2025 prepared by Iran's Department of Environment in collaboration with the Food and Agriculture Organization under the Green Climate Fund recognizes that worsening heatwaves are a significant risk to health.

Leveraging Frontier Science to Improve Adaptation Efforts

Extreme heat is now recognized as one of the most urgent global health risks, threatening billions of workers and communities exposed to unsafe temperatures. With recent years being the hottest on record, urgent and coordinated action is needed to protect populations and strengthen resilience. Yet, this challenge is not only about implementing HAPs — it is fundamentally about deepening our scientific understanding of how humans live, work, and adapt in a rapidly warming world. Addressing heat risks effectively requires bridging knowledge gaps and advancing research that connects the biological, environmental, and social dimensions of heat exposure and health outcomes.

Moving forward requires expanding and strengthening scientific research across multiple disciplines— from biometeorology, physiology, and climatology to public health, social sciences, and occupational health. Each field provides essential insights into how heat interacts with human bodies, environments, and systems. Integrating these disciplines can help us better predict vulnerability, understand thresholds of human tolerance, and design targeted interventions that are both context-specific and equitable. This multidisciplinary approach not only supports evidence-based adaptation but also ensures that heat-health strategies remain responsive to changing climate realities.

While the research outcomes discussed in this report focus mostly on lessons related to HAPs characteristics and implementation, they also highlight important gaps within the research area itself. In particular, there has been limited evaluation of HAPs and similar policy in low- and middle-income countries, underscoring the need for rigorous evaluation of HAPs in these contexts. Where HAPs have shown some success in reducing deaths, further research is needed to better understand whose lives were saved, the extent to which these outcomes can be directly attributed to the implementation of HAPs, and which contexts most support these successes.

Further research is also needed in the areas of governance and integration; where studies on governance, resource allocation, and the integration between HAPs (with broader climate adaptation strategies) remain limited. Evidence gaps are also evident in relation to vulnerable populations, particularly individuals experiencing mental ill-health and those within the specialised sector of Maternal, Newborn, and Child Health. There is a need for more detailed data on cases during non-heat-events; longitudinal indoor temperature measurement studies; longitudinal studies and randomized controlled trials to understand cooling interventions. Research to determine more localized hazard definitions and ways of most effectively targeting vulnerable groups; would support differential planning and implementation within local contexts. In relation to integration with wider climate change knowledge and strategies, advancing research into relationships between extreme heat and air pollution impacts would strengthen both policy, governance and healthcare, in contexts where these health pressures are experienced simultaneously. Furthermore, exploring transferability of HAPs and implementation to other settings, would be beneficial in supporting the expansion of reduced heat-health risks, especially as future heat predictions become a reality.

Strengthening scientific understanding in this way, directly enhances the effectiveness and applicability of HAPs. By grounding HAPs in locally relevant data, physiological

evidence, and community-informed perspectives, they can evolve beyond emergency responses into initiative-taking frameworks that safeguard health, livelihoods, and development. Ultimately, improving the science behind how we experience and respond to heat will allow societies to build resilience that is inclusive, sustainable, and grounded in the realities of life in a warming world.

National HAPs Indicators for Implementation and Impact

The effectiveness of (HAPs) or their functional equivalents depends not only on the appropriateness of planned interventions, but critically on the extent to which implementation and impact can be monitored, assessed, and iteratively improved. Embedding monitoring and evaluation (M&E) at the design stage of heat action planning, is primarily essential to ensure accountability, by verifying whether planned actions are implemented. Additionally, impact indicators such as morbidity, mortality, and service demand enable assessment of whether interventions reduce health risks, while routine monitoring supports timely adaptation during rapidly evolving heat events. Finally, indicator inclusion enables comparability over time and across jurisdictions, strengthening learning, evaluation, and peer exchange across countries. Global reviews and guidance consistently identify weak or uneven M&E as a persistent limitation of heat planning, undermining effectiveness and institutional learning.

The following assessment groups National HAPs (or nationally recognised equivalents) according to their explicitness and operationalisation of implementation and impact indicators in publicly accessible national systems and guidance. Plans are classified into one of three categories through assessing the maturity of indicatorisation, not of overall policy ambition or heat risk exposure.

Category 1: Extensive indicator inclusion

Countries in this first category have the clearest ability to monitor rollout and effects of their plans. These include France, Italy, United Kingdom, South Korea and South Africa. In these contexts, heat action systems operate as recurring national mechanisms that connect alerting and response to measurable health and service indicators. The defining feature is institutionalised linkage between triggered actions (alerts and response levels) and measured outcomes (morbidity, mortality, and health-system signals). The principal advantage of this category is that it enables credible, near-real-time governance: alerts and actions can be audited, health impacts can be tracked, and systems can be iteratively improved across seasons.

Beyond this, these countries are best positioned to shift from "monitoring events" to "monitoring equity and resilience", by strengthening disaggregation (age, pregnancy status, disability, occupation, informal settlement residence), embedding vulnerability mapping into routine dashboards, and widening outcome constructs beyond acute morbidity and mortality. Disadvantages of this category encompass systems inadvertently prioritising what is easiest to measure (for example, hospital utilisation) while under-capturing less visible burdens, such as informal worker exposure, household heat stress, or mental health impacts. A second limitation is that surveillance and evaluation require stable data pipelines, analytic capacity, and clear inter-institutional response mandates, otherwise indicator systems risk becoming symbolic rather than actionable. Nevertheless, many countries, globally, have much to learn from countries within this category.

Category 2: Moderate indicator inclusion

The moderate category reflects a strong strategic and coordination framework, that clearly acknowledges the need for measurement,but lacks a single nationally standardised operational indicator architecture applied uniformly across a decentralised governance system. The United States National Heat Strategy (2024–2030) falls within this category. Its advantage is institutional capacity: the federal system has substantial analytic and surveillance infrastructure, and the strategy creates a coherent platform for harmonising monitoring approaches. The main disadvantage, though, is fragmentation; as indicators and implementation monitoring can remain dispersed across federal, state, local, and sectoral systems, limiting comparability, and making national "rollout and impact" assessment more complex than in countries with centrally coordinated operational plans. Therefore, consolidation is recommended through defining a minimum national indicator set, that connects alerts and response triggers to a small number of routinely measurable health-system and population outcomes, while preserving flexibility for local expansion.

Category 3: Limited indicator inclusion

In this category, heat planning (or its equivalents) are present, but systems generally show weak explicitness on implementation and impact indicators, or rely on dispersed monitoring that is not consolidated into a national M&E framework. Countries in this group encompass Argentina, Australia, Brazil, Canada, China, Germany, India, Indonesia, Japan, Mexico, Russia, Saudi Arabia, and Türkiye. A common pattern is strong emphasis on hazard awareness and early warning, paired with limited specification of measurable rollout indicators (such as coverage, protocol uptake, cooling-centre activation, and workplace compliance) and limited articulation of outcome indicators beyond general intentions. This lack of standardised M&E weakens recognition of health impacts, reducing the timeliness of response, decreases sustained financing, and leads to uneven implementation.

The practical pathway here is staged indicatorisation, and the WHO (2008) provides a structured basis for embedding evaluation and strengthening indicator design[15]. Countries should begin with a small, feasible indicator "starter set", that most systems can implement: (i) an implementation bundle, linked to alerts (activation status, risk communication reach,

[15] https://iris.who.int/server/api/core/bitstreams/79111f86-8583-4b25-be8e-7b183bfa14ba/content

service readiness checks, cooling or water point activation where applicable), and (ii) an impact bundle, using routine health data (all-cause mortality signals, heat-related illness codes or syndromic proxies, emergency department / ambulance activity).

Overall, the categorisation of national HAPs underscores that effective heat governance depends less on policy presence than on measurable implementation and impact. Countries with embedded indicator systems are better positioned to protect health, learn across heat events, and justify sustained investment, while others require deliberate integration of monitoring frameworks to translate plans into effective action.

Characteristics of HAPs Implementation

The implementation of HAPs for adaptation to reduce heat implications of climate change for human health is taking place within the G20 and BRICS members, through their various policy and governance frameworks. It is difficult to state with certainty the extent to which the many actions laid out in HAPs are being implemented. Implementation escalates during heatwaves and in preparation for the summer months, when higher temperatures and heatwaves are expected. What is being implemented from HAPs is variable. Where national or regional plans exist, these need to be adopted at the local scale, in rural and urban areas, including down to the neighbourhood level – for some adaptation activities. Some aspects of HAPs can be implemented on a wide scale and supported through high or overarching levels of government. Other adaptations require localised implementation in communities, households, schools, clinics and hospitals. The following section outlines the main forms of implementation taking place, as evidenced through published research on HAP implementation within BRICS and G20 members.

Implementation timelines and phases: Often there is no reporting of the timelines for HAP implementation in the studies that were reviewed. Adaptation activities take place in three periods, namely, the pre-season, heat season, and post-season periods. Each period sees trends in specific adaptation steps. In the pre-season, training, emergency preparedness planning and information sharing typically takes place. Advance planning allows organizations to prepare ahead of a heat event, or the main heat season. During the heat season, activities escalate in frequency, variety, and scale, with high heat warning systems and alerts activated, public awareness messaging, medical assistance, cooling efforts and exposure reduction prioritised. In the post-season period, there is opportunity to review patterns of heatwaves, actions taken, their effectiveness, and challenges to effective implementation. Upgrading of plans usually takes place after significant heat events. Coordination of efforts is of great importance across all three periods but requires particularly focused efforts during the heat season.

Governance of implementation: In some places, most notably within Europe, there is a lead body which is responsible for implementation of HAPs and therefore guides implementation. However, governance arrangements for implementation typically tend to be less coordinated and more varied in other countries, than in European Union cases. A combination of state and non-state institutional arrangements are common, particularly in relation to tailoring heat alert protocols to local vulnerabilities and characteristics. Implementation of HAPs has also been facilitated by leveraging partnerships between stakeholder groups, in order to facilitate community engagement, localisation, and integration of heat adaptation to existing structures and emergency response plans.

Commonly implemented adaptation measures

Adaptation measures that are most often evident are forecasting and early warning-based systems, which alert populations to upcoming high heat events. These take place at a variety of scales with some warning systems focused on city or local government scale, others nationally, or a combination of scales. Early warning systems are typically supported by existing meteorological monitoring and forecasting systems, within countries, and at sub-national scales. For example, the Chinese meteorological system reports can be oriented towards healthcare, in order to provide early warnings which are preventive of heat-health impacts. Similarly, in South Africa, the national weather service provides warnings for severe weather, including heatwaves, and uses appropriate widespread messaging with a colour-coded and numerical warning system. Humidex-based warnings are used in Canada, within areas that experience high humidity along with high temperatures, during summer. Colour signal systems for heat alerts have also been implemented across multiple countries in Europe, as well as Canada, the USA, and India.

Communication of early warnings is critical to the success of forecasts and modelling that alert stakeholders to the eventuality of high heat events. There are multiple formats used for communication of heatwave warnings. These include text messaging, and messaging apps such as WhatsApp; traditional mass media; social media; public service announcements and press releases; and email notifications to health authorities. Messaging uses high-quality data for customized communications, provides emergency communications at the beginning of summer, in advance of forecasted heat events, and during events, with a common reliance on passive, low-cost channels of communication like social media, news alerts, and email. Implementation of early warning systems differs somewhat between urban and rural areas.

Resource-intensive communication plans are typically implemented in urban areas, while there is often a reliance on leveraging social networks in rural areas. Low tech communication systems, such as community phone trees or verbal communication, can be used in places which have few resources or access to mass media.

Box 1: Best Practice Example - Early warning systems, Canada

Canada does not have a national level HAP in place; however, a number of cities and towns have localised plans which provide early warnings of heat events along with advisories on appropriate general responses and practical support from healthcare systems and service. These warning systems require effective triggers to initiate alerts or to alter alert levels. In Canada, the humidex is used as the basis for triggering these alerts. Environment Canada defines humidex as "an index devised to describe how hot or humid weather feels to the average person." The humidex combines the temperature and humidity into one number to reflect the perceived temperature." A high humidex will trigger an alert and is utilized as a measure which triggers heat events because it has a proven physiological relevance and a correlation with mortality. Furthermore, humidex is used in combination with other indicators of health impacts of heat such as increased hospital admissions and coronary reports to trigger or upgrade alerts. A combination of humidex, temperature and air pollutant measurements can also be used. Once an alert is triggered, preplanned processes come into effect with alerts targeted at responders and the general population. In many localities, the local or regional public health provider is responsible for issuing the alerts. Some Canadian communities (e.g. Hamilton, Fredericton, and Windsor) are using graduated colour heat meters to communicate the alert and the health risks associated with a particular alert level. This works to raise awareness of risks as well as providing an overall alert. The importance of timing for heat alerts is considered, with the first heat event of a season being given the highest priority in terms of timeous alerts, since this is typically the most dangerous

The City of Montréal has had a Heat Alert and Response System (HARS) in place since 2004. The Montreal Heat Response Plan (MHRP) has five levels - normal, seasonal watch, active watch, alert level, and an intervention level. Each level triggers specific actions based on weather and health indicators such as the humidex. Stakeholders involved in implementation of the MHRP include government agencies (led by the Montreal Public Health Department), healthcare providers and partners at both regional and local scale (for example, hospitals, emergency services, psychiatric hospitals, rehabilitation centres), and community organizations. Once the humidex indicators trigger an alert, a pre-planned protocol for widespread dissemination of the alert is followed. This includes media (television, radio), billboards, community outreach (pamphlets, posters), and information meetings held in healthcare settings. In order to maximise the effectiveness of public outreach and alerts, communication formats and messaging are periodically reviewed through surveys and focus groups which assess their comprehension, acceptability and feasibility. Through repeated training and capacity building activities undertaken over long periods, healthcare professionals have a good understanding of their roles and measures to be implemented during a heat wave. Despite this, once an alert is given, implementation of heat reduction and management responses is not without challenges. For example, it has proven difficult to identify vulnerable populations, to ensure that there are sufficient medical and social-support personnel available during heat waves and challenges in accessing air-conditioned spaces by those who need to make use of cooling shelters.

Resource allocation and funding sources: Adaptation activities are funded or resourced through a variety of sources, with funding strongly linked to the scale at which the HAP is governed and implemented. National government department funding is sourced mainly from national health and/or environmental management, and climate change departments. International funding takes place through supranational organisations such as the WHO, and the European Union. National institutes of health and scientific research are often supporters of HAP implementation; when this is linked to research and innovation in planning etc. At a sub-national scale, funding and resources are supplied through localised agencies of state departments, provincial or state-specific disaster management and response funds. Government subsidies for the provision of healthcare, infrastructure, and occupational health and safety are available for use by HAP implementing agencies. City governments play a role in funding implementation of activities such as cooling centres, community outreach, alerts and longer-term urban planning initiatives. Civil society organisations and networks also contribute towards the resourcing of heat-related adaptation activities, typically at the local scale – with resourcing taking the form of finance, volunteerism, and communication support. Where research on matters of heat-related health, policy responses, and HAP implementation take place, funding is sourced from international scientific research funders, science, environmental and technology grant funding at international and national scale, philanthropic organisations, self-allocation of funds held by researchers in existing budgets. Underfunding and the lack of a coordinated funding architecture, is a perennial problem for both HAP implementation and research projects on heat-health relationships and responses.

As with many public health concerns, education and community outreach are commonly implemented in relation to heat-health risks and prevention. Education often takes the form of public awareness raising across the general population, but can also be focused training to build capacity for the reduction of health effects of heat, or managing heat emergencies. Training directed at medical services takes place in a number of countries, in order to build the capacity of healthcare professionals and frontline health workers. Training is also directed at building government officials' awareness of heat-health risks and preventive actions. Outreach education is directed at education systems and school children, vulnerable groups, and for community agency staff and volunteers, who lead heat response activities in many cases. Community outreach and education through workshops and linked to healthcare settings have been used to raise awareness and target health-focused responses to heat by communities. Similarly to the communication channels used by early warning systems, public education takes place through top-down and bottom-up communication strategies, with segmentation based on age, workplace, and socioeconomic status, with the content of messaging being most useful if it is tailored to meet the needs and communication preferences of the target group.

Outreach commonly takes place through the distribution of health information in different languages via flyers, pamphlets, websites, apps, local media sources and billboards. Media campaigns, including press releases, advertisements, information sharing and advisories in local radio broadcasts and newspapers, are regularly utilised. Where vulnerable groups are not easily accessible through commonly used channels, a more targeted approach which considers local conditions and the needs of specific vulnerabilities, is required.

Sector-based adaptation activities are well-documented implementation measures of HAPs. Healthcare mobilisation and emergency preparedness are prioritised prior to summer, and during heat events. Pre and post heat period activities focus on educating healthcare professionals to respond to heat illness, particularly in the emergency medicine sector; development of toolkits for healthcare facilities; table-top simulations; development and running of heat-stroke clinics for medical professionals, including emergency services. Resources are used to increase capacity for health emergency management, within hospitals, and across national health systems. Additionally, HAP implementation is evident in an increased focus on the implementation of patient-centred strategies for managing heat, and continuous evaluation of nursing home measures to support the prevention of physical and mental health impacts of heat.

Cooling centres and exposure reduction: HAPs have been implemented across many countries, including in heat hotspots in India, the USA, Canada, Chile, Argentina. Exposure reduction through cooling centres includes facilitating access to existing public facilities, which will allow for keeping cool in hot weather and providing new and/or temporary facilities for cooling and exposure reduction during heat events. Climatized or open air-conditioning shelters are provided, regulated indoor temperatures in public buildings such as community centres and libraries, ensuring access to drinking water, extending the opening hours of public pools; as well as the use of elderly centres as cooling shelters and facilitated cool areas for schools. Cooling by water spray points and spray parks, as well as the provision of fountains and recreational water features also offer outdoor cooling spaces. Medical and social care focused on schools and health settings as cooling centres provides shelter spaces for vulnerable people, and as points of treatment. Furthermore, operating as sites for 'collective' cooling, these centres offer increased social contact for isolated individuals who may need assistance. Systems for acquiring key resources like ice, fresh water and cooling technology, are an important part of making cooling centres effective – as heatwaves are predicted to become more extensive.

Alternative urban planning considerations and changes to buildings and infrastructure are being taken up as longer term adaptations, considering the predicted increase in temperature, and the increased frequency and length of heatwaves. HAPs implementation therefore includes advocating for climate friendly urban areas; the addition of cool roof technologies on existing buildings; shifting planning and building regulations towards requiring greener buildings and the inclusion of open spaces; and when new developments are planned, infrastructure and architectural design to support protection from the sun and maximise ventilation and cooling. Conservation of existing tree cover within built up areas is prioritised in some cities, as well as tree planting, and the creation of green corridors and green roofs. Funding programs for greening roofs and facades have been instituted to assist in making buildings less prone to the effects of heat and thereby reducing health risks to their inhabitants.

Innovative features of HAPs embrace a variety of low-tech interventions and digital tools to strengthen resilience against excessive heat. For example, in Ahmedabad, India, reflective roof painting in informal settlements, and misting sprinklers at bus stops, have been introduced. In South Korea, personalized heat alert messaging through mobile telephone networks is used. Under the G20's Disaster Risk Reduction Working Group, there is an initiative to introduce universal early warning systems, which could include heatwave alerts, by 2027.

Box 2: Best Practice Example - Multi-pronged Heat Action Plan Implementation, India

India has experienced warming trends which are consistent with globally observed patterns. Recognition of these growing heat risks associated with increasing exposure to excessively high temperatures and heatwaves has led to the formulation and implementation of HAPs across many cities. The city of Ahmedabad, in the largest district in the western state of Gujarat, is well known for the implementation of South Asia's first HAP in 2013 in response to a damaging heatwave in 2010.

The HAP is designed to tackle heat through a multi-faceted approach to reducing heat-related mortality and morbidity which includes the three common elements of community outreach to disseminate information and raise awareness, early warning systems and healthcare capacity building. Implementation of these main areas of action are spread across the pre-season, heat season, and post-season periods as required. Ahmedabad's HAP serves as a framework for implementing an early warning system.

The HAP has worked well due to the combination of efforts included within the plan and through the format of implementation. Efforts were evaluated as successful because they were cost-effective, easy to maintain, and tailored to local needs and resources. The early warning system put into place offers accurate and timely alert systems. The HAP recognises differential vulnerability and has therefore implemented a targeted approach among vulnerable populations in order to communicate effectively and meet their specific needs. Community outreach and building capacity in the health sector has included the formulation of heat-related health information plans and strategies to reduce heat exposure within households, neighbourhoods and within public places. Media dissemination of heat alerts and public awareness campaigns involving religious and civil society actors are central to outreach and preventive measures. Efforts at reducing heat exposure by offering cooling opportunities have been widely implemented, including the installation of mist sprinklers at traffic signals and bus stops equipped to cool residents

and commuters. Efforts also include a focus on cooler roofing, particularly in slum areas, and increased green cover within the city. Provision of water during heatwaves offers support to the most vulnerable and exposed of the urban population. Within the healthcare sector, medical services have increased capacity to deal with heat-related illness through training and some additional resourcing.

Multiple stakeholders across sectors and geographical areas participated in the formulation of the HAP and continue to engage through subsequent years of roll out. These include government departments and agencies at the municipal and district levels, local NGOs, communities, and healthcare providers. Civic involvement and technical partnerships from the development period of the plan has strengthened localisation efforts and innovation over time. Higher level public, civic and academic organisations such as the Public Health Foundation of India, Indian Institute of Public Health-Gandhinagar, the Natural Resources Défense Council, and international partners have also been involved in implementation and assessments of the impacts of HAP-driven efforts.

Coordination mechanisms have successfully supported preparedness for extreme heat and timeous responsiveness to heat events. Agreement amongst key stakeholders that the HAP implementation be led by a coordinating organisation is central to this success. In Ahmedabad, and several other Indian cities, this role is played by the municipal commissioner or municipal nodal officer, who is responsible for heat alert dissemination such as alerting state authorities, communicating with the media, and disseminating information to various vulnerable groups. Strong political will and leadership from city government further supports the coordination and resourcing of HAP implementation. Localised leadership and coordination is nested within a broader network of institutionalised disaster management and has been further guided by WHO since 2008, offering additional support to planning and responses. Resource allocation and funding sources for the implementation of the HAP is derived from state-specific disaster response funds, and external funders but there is a lack of centralized financial architecture and opportunity for more extensive funding.

Over time, simple but ongoing monitoring of implementation measures has led to further policy changes such as the relocation of hospital wards, which reduces heat-related admissions.

With many lessons learned and transferable to other cities through the successes of the HAP implementation Ahmedabad, there is a concern that HAPs should pay greater attention to longer term transformational adaptation such as through urban management, greater resourcing and new technologies, as there is a risk of over-reliance on the success of relief-oriented and preparedness measures.

Lessons learned through practicing adaptation for heat-health risk

The focus in this section is the lessons learned through implementation, and practicing adaptation to address or prevent heat effects, and thereby reducing the health implications of heat. When implementation has worked well, there are a number of factors which come into play:

HAPs generally outline multiple forms of interventions. Implementation actions should be multi-pronged to allow for more than one form of heat-impact alleviation to be implemented during a heatwave, but also to facilitate public education and preparedness for heatwaves. A combination of early warning, public education, and healthcare mobilization are reported as effective in reducing heat-related mortality and morbidity, especially among vulnerable populations. Furthermore, the importance of accurate and systematic surveillance and data collection to support decision-making, resource allocation and policy changes, should not be underestimated as a component of heat responsiveness.

Leadership and coordination are key factors in ensuring that the implementation of HAPs is successful. Strong leadership is required to prioritise heat as a health-related challenge, and to champion the use of resources to combat the impacts of heat on health. Community engagement is important to ensure that action plans have practical and well-understood implementation steps, that are also well-accepted by communities, or that assistance from communities and civic groups can be mobilised as needed – to make implementation smoother and more effective. Intersectoral coordination is needed between leadership and governance hierarchies, as well as across sectors such as healthcare, communities, industry and government. Early involvement of stakeholders in a well-coordinated planning and preparation process fosters greater collaboration and improved outcomes. This facilitates greater effectiveness, smoother and efficient implementation of preparation and responses to high heat.

Local-level implementation is extremely important. Of particular importance is the adaptation of generalised policy and plans to suit the needs and conditions at the local-scale. Plans should be tailored to local contexts and needs, in order to enhance their effectiveness when implementation takes place. For example, urban design, building cooling and ventilation improvements – to lower indoor temperatures – can be advised through HAPs and public education. However, local architecture, socio-economic conditions and available resources will differ, thereby requiring informed adaptation of the specific forms of intervention in a locality. The scale of adaptation measures is something to be considered. This is because there are differences in which prevention and response actions are best suited to address health effects. These differences relate to budgets; the availability and power of implementation actors and institutions in how and where (and how successful) adaptation measures can be.

Within variable contexts, concern for the development of strategies should be prioritised for low-resource settings where governments have limited capacity to implement comprehensive long-term programs.

Lessons Learnt for Effective Heat Resilience

An analysis led by GHHIN, UNDRR and WMO[16] of heat resilience structures and measures in 12 countries, revealed several useful lessons. The case study countries comprised of Argentina, Australia, Bangladesh, Canada, Ecuador, Egypt, France, India, Senegal, Republic of Korea, United Kingdom, and United States, all which traversed different regions and development levels.

- Intentional involvement of- and consultation with- local communities is indispensable.
- A collaborative approach involving all relevant multiple sectors (health, transport, agriculture, water, energy, disaster management, housing) is needed in tackling extreme heat.
- ·A reliable early warning system is critical to the effective and timely issuance of heat warnings.
- Investment in heat resilient infrastructure is no longer an option in mitigating and adapting to climate change impacts.
- Health systems strengthening through infrastructure modification, increased allocation of resources and training of personnel is key in the reduction/elimination of mortality and morbidity due to heat illnesses.
- Data collection and research is pivotal for the comprehension of heat events, assessment of interventions and improvement of HAPs.
- Public-private partnerships strengthen the execution of HAPs, through leveraging the private sectors' expertise and resources.
- Solid policies and regulations are a pre-requisite in the enforcement of heat mitigation actions.

Implementation Gaps and Challenges

While HAPs (or an equivalent) are used as vital policy tools to address excessive heat by most G20 and some BRICS countries, there remain significant gaps in implementation and consequently areas for improvement. These include:

Lack of institutional coordination: Poor coordination across various government levels and sectors hampers implementation and accountability. This includes vertical fragmentation between local and national governments, and horizontal disconnects across relevant sectors such as health, planning, social services and labour. This fragmentation makes operationalizing the interagency coordination needed for successful implementation of plans difficult to undertake and can result in fragmented implementation. Furthermore, a lack of clear roles hinders implementation. There is a lack of systematic policy integration. Policy coordination can be a hindrance as there is a lack of integration of health implications of heat into long-term climate change and health planning, which can centre on disasters, rather than long-term public health considerations. Regional inequalities also hamper implementation, and inadequate regional collaboration can be a further barrier to HAPs' implementation.

Single-Sector Governance and lack of collaboration: Most heat responses remain confined to health or meteorological departments, with limited engagement from urban planning, labour, housing, transport, and social protection sectors. This siloed governance undermines integrated action and reduces the potential for co-benefits across development, equity, and environmental resilience. Additionally, poor collaboration with other stakeholders, such as community leaders, the community, local government, private sector, and NGOs limit the opportunities for leveraging resources leading to inefficient and ineffective responses.

Lack of a legal mandate: Most G20 and BRICS countries do not classify heatwaves as natural disasters. The absence of a legal mandate means that dedicated emergency funding is not released, compromising preparedness and responsiveness. A change in classification would allow access to national disaster funds, rather than relying on municipal budgets, and would enable coordinated emergency responses. An exception is Japan, where heatwaves are recognized as disasters, as was the case in the 2018 heatwave.

Urbanization and planning: Rural to urban migration coupled with unplanned development of urban areas is increasing the vulnerability of cities to extreme heat. This is because heat mitigation measures are rarely considered in the provision of temporary or permanent housing, through green and brownfields development. This leads to building of structures that are not adapted to extreme heat, and the creation of more urban heat islands. HAPs and implementing agencies typically lack direct influence over urban planning and private property, which further limits implementation of preventive measures, especially in the short term. Limited long-term urban planning – in relation to this aspect of climate change adaptation – is weaker than other aspects of climate change impacts, such as storms, flooding and sea-level rise.

Resource limitations: The development, implementation and sustainability of HAPs require technical and financial commitment. In contexts such as low-income, urban neighbourhoods, and rural areas where these resources are limited, or infrastructure is poorly developed, heat mitigation measures are few to non-existent. As noted in earlier discussions on the funding of implementation of HAPs, underfunding is an ongoing problem at all scales. The coordination of funding remains a challenge especially as overall governance of the development and implementation of HAPs is fragmented and requires concerted efforts for improved coordination and collaboration. Overall effectiveness is constrained by budget limitations. There is a failure of existing plans to prevent heat-related deaths. Limited financial autonomy of implementers hampers the ability of stakeholders and actors to adapt implementation plans, to be responsive to emergent needs, or to perceived limitations of planned implementation. There is

[16] Global Heat Health Information Network, UNDRR, WMO (2025). An Assessment of Heat Action Plans: Global standards, good practices and partnerships

a need for flexibility in the roll-out of implementation plans, which can be constrained by limited autonomy and tight procurement or budget controls.

Comprehensive surveillance mechanisms: There is a need for better systems for identifying, recording, and monitoring the impacts of heatwaves on the health of populations. This will allow for earlier interventions during heatwaves and enhanced readiness for future heat events. Where these systems do not exist, or are not well integrated with other response mechanisms, these need to be developed and unified with other systems, such as those of healthcare provision.

Insufficient localization: As a result of top-down planning, action plans are often too generic, reflecting a one-size-fits- all approach, and fails to adapt to local vulnerabilities, and local climate variations. Cities are often prioritized leading to the neglect of heat stress in rural areas. There is a need for formal HAPs in many local scale jurisdictions, and improved support from national and regional governments for the rollout of local adaptation strategies.

Need for improved science: Quality science and evidence is critical to understand the most practical and effective ways to adapt in terms of heat exposure. A major hindrance to success is limited access to resources – which support improved science, particularly in ensuring sufficient high quality data, that is timeously gathered or produced. When HAP implementation is underfunded and when data-gathering related to weather, local socio-economic conditions, and healthcare systems is inadequate, this can limit the successful implementation of even strongly developed plans.

Neglect of vulnerable populations: Insufficient targeting of vulnerable populations and communities, and a lack of information about vulnerable groups, is a limiting factor for successful implementation of HAP interventions. Inadequate attention to vulnerable populations gives rise to equity gaps and emphasizes the need for inclusive planning. For example, there is a need to expand inclusion of mental health and Maternal, Newborn, and Child Health in HAPs. Greater recognition is needed that the social systems affecting vulnerable populations play significant roles in the success of heat action plans. Higher levels of illiteracy and low phone ownership contribute to asymmetrical heat warning access, and income limitations affect the capacity of individuals and households to avoid or cope with heat effects. Overall, improving identification of vulnerable populations, especially within rural areas, and in poorer communities, is needed. Poor and marginalised communities need greater efforts at targeting for outreach, education and preventive measures.

Data and monitoring constraints: The accurate prediction and timeous response to extreme heat episodes is dependent on sufficient meteorological data and solid monitoring systems. There is a risk of alerts being delayed due to media deadlines, and there is a need for improved coordination of data, forecasting, warning messages and media/publishing times and cycles.

Weak monitoring and evaluation systems: Unavailability of health-related data on heat-related illnesses makes monitoring and reporting on the effects of heat more challenging. Inadequate collection of real-time data on heat-related illnesses, or mortality impacts response times and forward planning. The lack of reliable outcome assessments hampers evaluation of whether action plans are having the desired response. Monitoring and evaluation improvements are recommended to enhance frameworks, including standardised indicators, and regular reporting. This will contribute to improved preparedness of health and social systems.

Lack of long-term, structural planning: Many action plans focus on short-term, reactive solutions to heat stress, and fail to embed the responses in the development of long-term resilience. Adaptation measures that integrate with urban planning, building regulations, or infrastructure design and technology can contribute to building of long-term resilience.

Lack of awareness by the public: Individuals and communities often do not perceive heat as a serious health threat and are not aware of the risks posed by exposure to extreme heat. Heat threats are often eclipsed by more visible and dramatic disasters. Consequently, there is poor response to heatwave warnings and adherence to heat preventive advice. There is a need for more effective and persistent communication, and innovative information dissemination methods, particularly for those groups who are less likely to be reached through traditional communication methods.

Lack of political awareness and will: Within government, there are varying perceptions of heat as a public health priority, with many decision-makers lacking awareness and/or political commitment to address heat-related challenges. This can stem from ambivalence to the issue, and limited awareness of guidelines. Additionally, competing issues of governance in relation to climate change impacts and environmental management, means that resources are spread thinly, and when they are available, officials, practitioners and politicians are pulled in multiple directions by varied calls for responsiveness. This is worsened in developing contexts, where urban growth challenges, a weak state, and multiple simultaneous challenges divide the attention of leadership and communities.

Inadequate strengthening of health systems: Healthcare infrastructure (personnel, facilities, equipment, medication) that have not been sufficiently improved to accommodate patients with heat-related illnesses, or endure extreme heat events, will easily be overwhelmed in the unfortunate eventuality. Improved healthcare capacity in non-climate-controlled settings is particularly important. Where improvements are slow, this can be partly ascribed to a lack of familiarity with plans among healthcare organisations, along with stretched resources and multiple priorities.

Mental health: Consideration of mental health and general well-being is less prominent than that of the physical health implications of heat. Few HAPs in the reviewed studies explicitly address the mental health effects of heat, and responses to these illnesses. This limits the integration of mental health and wellbeing responses into strategic planning and implementation measures.

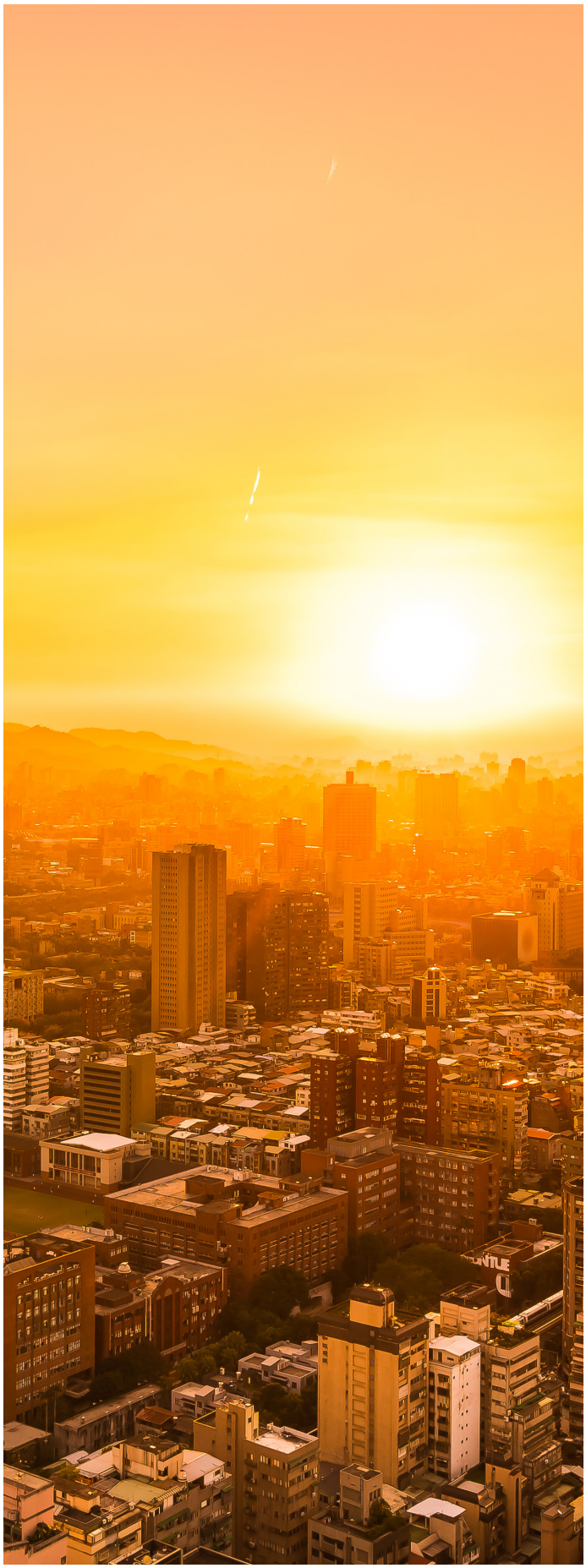
Most HAPs Lack Comprehensive Vulnerability Assessments and Long-Term Resilience Strategies: Few HAPs incorporate systematic vulnerability mapping that combines demographic, physiological, occupational, and environmental risk factors. Without such assessments, interventions often overlook the complex interplay between heat exposure, poverty, gender, age, and health conditions. Long-term resilience strategies are rarely embedded, leading to repeated short-term responses, rather than sustained adaptation.

Early Warning Systems Are Emphasized, Missing Proactivity in Evaluation: While early warning systems have become central to many HAPs, there is insufficient attention to how warnings translate into action and measurable outcomes. Initiative-taking, iterative evaluation— linking warnings, responses, and health outcomes—is seldom institutionalized, limiting learning and continuous improvement in heat management systems.

Conclusions and next steps

Extreme heat is a defining health and development challenge of the 21st century, demanding urgent, coordinated, and science-informed responses. While many countries have made important strides in developing and implementing HAPs, critical gaps persist in their design, coordination, and sustainability. Addressing these gaps requires reframing HAPs, not merely as emergency measures, but as long-term instruments for resilience-building, equity, and social protection.

The way forward must rest on stronger interdisciplinary collaboration, and locally grounded evidence. Integrating insights from biometeorology, physiology, climatology, and public health can transform fragmented interventions into cohesive systems of prevention, preparedness, and adaptive capacity. Moreover, embedding heat-health strategies within broader climate adaptation and urban development agendas, will ensure that responses address structural vulnerabilities and produce co-benefits for livelihoods, wellbeing, and environmental sustainability.



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