Heat Health Action Plans: Lessons from Ahmedabad

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1. History of Heatwave in India and Ahmedabad.

Ahmedabad in a 600 year old city in the western part of India. It is the main economic centre of state of Gujarat. Its population is about 7 million. Summer in Ahmedabad is from April to June. Ahmedabad city has been historically one of the very hot cites of India where summer temperatures regularly go up to 44 or 45 °C. As the city is fairly away from main Arabian sea hence the summer months are hot and dry. Temperatures peak in third or fourth week of May. From June temperatures start declining with increasing humidity due to south-west monsoon which sets in by third or fourth week of June in Ahmedabad. Ahmedabad's weather station is located at the Ahmedabad airport campus, and it has weather records are available for more than one hundred years.

Every 2-3 years Ahmedabad faces high temperatures crossing 45 °C and heat waves. Over the years the hot days have increased and the temperature has been going up gradually with milder winters and hotter summers. In 2010 a major heat wave struck Ahmedabad with temperature reached 46.8 °C on 21st May which was a record. On 27th May 2016 another major heat wave was recorded in Ahmedabad with temperature reaching 47.8 °C which was highest in 100 years1. On 11th May 2022 Ahmedabad recorded temperature of 45.8 °C. And from 1st April 2022 to 12 May Ahmedabad continuously recorded maximum temperature of 40 °C or above for almost consecutive 40 yeas except one day2. India Meteorological Department (IMD) data shows that temperatures are going up in Gujarat with less cold waves and more heat waves3. Such increase in heat waves is seen world over due to climate change. May parts of India are also recording increasing temperatures over the years with increasing frequency of heat waves. After major heat wave in Chicago in 1995 and heat wave in Europe in 2003, USA and many European countries developed heat action plans to protect the population from heat wave related health damage and mortality. These plans have been effective in reducing mortality over the years during heat waves.

2. Heat wave of 2010 and sharp rise in mortality in Ahmedabad

Ahmedabad's experience with extreme heat resulted in devastating health consequences for city residents in May 2010. During that period, daily maximum temperatures peaked at 46.8 °C, a temperature recording not observed in the city in nearly a century4. In 2010 India Meteorological Department (IMD) designated multiple days as heatwaves (April 17–18 and May 13– 15, 17, and 20–25). IMD criteria call for a heatwave declaration when the daily maximum temperature registers 5 °C over a long-term (30 year) maximum temperature average of less than 40°C; or an excess daily maximum temperature of 4 °C over the long-term historical maximum temperature of more than 40 °C. On days when the actual daily maximum temperature registers above 45 °C, is a heat wave is declared regardless of the normal historical maximum temperature5.

Our team of researchers investigated the human health consequences of this event through a study estimating excess mortality (the number of "extra" daily deaths observed in the city during

the heatwave months in 2010, comparing daily mortality counts to the same months in prior year -2009 and subsequent year -2011, when such high temperatures were not recorded). This study was published in 2014 4. This method allows for partial adjustment of potentially confounding seasonal factors (e.g., air pollution levels) that might also influence all-cause mortality within the city, with the aim of better isolating the effect of excess temperatures on health effects. The Ahmedabad Municipal Corporation (AMC) Office of the Registrar of Births and Death provided data on total daily mortality counts for the heatwave year (2010) and two adjoining years (2009 and 2011), when the city recorded somewhat lower temperatures (1.76 °C lower daily maximum temperature and 1.26 °C lower mean temperature) enabling the our team to calculate expected mortality counts (an average of 2009 and 2011) and observed mortality counts (2010) over a 7-day moving average during the month of May when the most heatwave days were declared in 2010. The authors accessed daily temperature data from IMD Meteorological Aerodrome Report (METAR) station at Ahmedabad airport. Overall, the study estimated an average of 143.9 (± 48.13) daily deaths during May 2010, compared to an average of 100.58 (± 10.34) daily deaths observed in 2009 and 2011. On a monthly basis, the analysis estimated 1,344 excess deaths in May 2010 compared to the non-heatwave years, a 43% increase in the observed mortality count. For this analysis, women were observed to have higher daily mortality rates than men, a disparity that was especially wide when the analysis was restricted to the heatwave period (May 19-25). Such information is important when considering the health and economic burdens on women in South Asia linked to worsening extreme heat exposures6. While data limitations prevented the authors from analysing patterns in cause-specific mortality, as well as specific heat-mortality relationships for vulnerable subpopulations (e.g., people living in informal slum dwellings or people suffering from chronic disease), this study was important in that it marked the first documentation of heat-mortality relationships in an Indian and south Asian city. The analysis conducted by Azhar et al. (2014)4 is important in demonstrating that, even while populations in Ahmedabad and other South Asian cities typically experience elevated temperatures during the heat season and some adaptive measures to that exposure are in place, extreme heat still poses a significant threat to human health. In light of the evidence demonstrating higher mortality during extreme heat events and the scientific consensus that climate change is increasing temperatures across South Asia7, increased attention to extreme heat adaptation strategies is urgently needed across the region.

3. Development of Ahmedabad heat action plan – process and improvements

The devastating daily mortality rise in May 2010 documented by the above mentioned study was an eye opener for the city authorities and worked as a driver for the authorities to set up a system to protect its citizens from any such extreme heat events in future. After the 2010 heat wave, despite the lack of a national policy on extreme heat that time, Ahmedabad city leaders wanted to prepare for the growing threat of rising heat which became the genesis of Ahmedabad Heat Action Plan (HAP). The Ahmedabad Municipal Corporation (AMC) collaborated with the knowledge partners like Indian Institute of Public Health-Gandhinagar (IIPHG), the Public Health Foundation of India (PHFI), and the Natural Resources Defense Council (NRDC) to prepare a plan for the city to deal with the threat of rising extreme heat. This coalition , loosely called Ahmedabad Heat Action Study Group, carried out a series of activities between year 2011 to 2013 such as organizing a stakeholder meeting, analysing temperature and death data, vulnerability surveys, focused group discussions, training workshops of healthcare providers, and

development of forecasting system in for heat waves. All these activities culminated in formation of first HAP for Ahmedabad city. This was launched by the Mayor and the Commissioner of the city in April of year 20138. This event was substantially covered in local media.

The first Ahmedabad HAP included local tailormade solutions to help citizens and vulnerable communities adapt with rising heat under three key strategies. We reproduce the key strategies as described in that document:

- ***Building Public Awareness and Community Outreach*** to communicate the risks of heat waves and implement practices to prevent heat-related deaths and illnesses. Disseminating public messages on how to protect people against extreme heat through media outlets and orientation materials, such as pamphlets and advertisements on heat stress prevention. Use text messages, email, radio and social media, such as WhatsApp. Special efforts to be made to reach vulnerable populations through inter-personal communication from March to June annually.
- ***Initiating an Early Warning System and Inter-Agency Coordination*** to alert residents of predicted extreme temperatures. The AMC has created formal communication channels to alert government agencies, health officials and hospitals, emergency responders, local community groups, and media outlets of extreme temperatures forecasted by the Indian Meteorological Department's (IMD) Meteorological Centre located in Ahmedabad.
- ***Capacity Building Among Health Care Professionals*** to recognize and respond to heat-related illnesses, particularly during extreme heat events. Such trainings focus on medical officers of urban health centres, paramedical staff, and community health staff so that these experts can effectively prevent and manage heat-related cases and reduce mortality and morbidity.

The plan was periodically evaluated9 in order to update it regularly and eventually a newer fourth strategy was also added in the Ahmedabad HAP in year 201510 which is ***Reducing Heat Exposure and Promoting Adaptive Measures*** by launching new efforts including mapping of high-risk areas of the city, increasing outreach and communication on prevention methods, access to potable drinking water and cooling spaces during extreme heat days. Collaboration with non-governmental organizations is also identified as a means to expand outreach and communication with the city's most at-risk communities, and a draft city-wide Cool Roofs Program. The citywide Cool Roof Program includes mandatory, voluntary, and low-income housing focused measures.

4. Impact of heat action plan and lives saved in Ahmedabad

Any plan to deal with impact of heat waves on health should be evaluated for its effectiveness. Such as study was carried out on the effectiveness of Ahmedabad HAP in 2017. Results from this preliminary study published by by Hess et al. (2018)11 indicates that the plan has already helped the city to achieve meaningful reductions in health impacts. In that study, researchers sought to quantify how mortality changed in the city when the HAP was launched in 2013 by comparing a pre-HAP implementation period (2007-2010) to post-HAP years (2014-2015). To estimate those changes, the team obtained daily all-cause mortality counts from AMC and developed estimates of how the city's total population changed over time to calculate daily mortality rates in post HAP period. By accounting

for population growth between the pre- and post-HAP implementation periods, a change from 4.64 million in 2007 to 6.71 million in 2015, the researchers were able to adjust for an increasing denominator population and account for any changes in mortality patterns that might be linked to a change in city population. To explore health effects by level of extreme heat observed in the city, the researchers categorized METAR maximum temperature data by days with any IMD-triggered heat alert (forecasted maximum daily temperature above 40 °C), as well as specific IMD heat alert threshold levels: yellow (daily maximum temperature forecast of 41-43.4 °C), orange (daily maximum temperature forecast of 43.5-45 °C), and red (daily maximum temperature forecast >45 °C) .

The analysis found that overall, the city's all-cause mortality rate was lower during the post-HAP implementation period compared to the pre-HAP period. Specifically, the study estimated 1,190 (95% CI: 162-2,218) avoided deaths annually in the city after the HAP was implemented, compared to the years before HAP implementation. Importantly, the highest proportion of those aggregate health benefits (650 avoided deaths, 95% CI: -208, 1508) were observed on the hottest (red warning) days, with successively lower proportions on days with slightly cooler temperatures (336 avoided deaths on orange warning days, 95% CI: 240-443 and 203 avoided deaths, 95% CI: 130-277 on yellow warning days). The authors also noted that this finding depended on the inclusion of data from 2010, an especially hot pre-HAP implementation year, because there were relatively few very hot days in the pre-HAP period from which exposure-mortality associations could be derived. The authors acknowledged that non-HAP related heat adaptation (e.g., including improving natural population resilience to extreme heat, increasing utilization of air conditioning, or changes in exposures to outdoor temperatures etc.) may have also contributed to the estimated health benefits. Hence further studies are needed to see the benefits of HAP.

While the health benefits of heat adaptation plans have been evaluated in a handful of other settings, including the United States12,13 and Canada14, this analysis represents the first estimation of those benefits in India. Now that the city's HAP has been in place for a decade, city leaders are interested in understanding which components of the plan (e.g., delivery of heat forecasts, public communication of the warnings, provision of water stations, and preparedness in healthcare settings) are especially effective in achieving health benefits15 and how such interventions might be further strengthened to reach vulnerable groups. Further analysis of health, demographic, and environmental data in the city can help to provide more precise information on the efficacy of HAP interventions and a path forward for continued refinement and improvement of the city's heat preparedness and response efforts.

5. Scaling up of the Ahmedabad HAP via NDMA and other agencies.

Authorities at the local, state, and national levels in India continue to draw learnings from the Ahmedabad HAP as they step up the deployment of local extreme heat warning systems and preparedness plans. Organizations like NRDC and PHFI-IIPHG are collaborating to support the development and execution of HAPs. In India, preparation for and response to heat waves are coordinated by the National Disaster Management Authority (NDMA)16. They are supported by the heat predications of IMD. In order to create heat response plans, NDMA and IMD have been collaborating with 23 of India's 28 states recognized as heatwave prone states. After substantial evidence generated by Ahmedabad HAP related studies and discussion with Ahmedabad team the NDMA recognised

heat waves as natural disaster and took lead to develop heat action plans in the whole country. The first heat action plan guidelines were released in 2016 by NDMA based on Ahmedabad HAP. Since 2017 NDMA has been organizing yearly pre-summer workshops at the national and regional level with important stakeholders, including state and city administrators, state disaster management authorities, academic institutions, and civil society organizations that are actively involved in extreme heat planning and response in India. In 2019, NDMA amended its "National Guidelines for preparation of action plan – Prevention and Management of Heat Wave", which serve as a guide for state and local governments in developing HAPs. The amended guidelines put a new emphasis on the role of the built environment such as cool roofs for example which provide a simple and cost-effective solution by improving indoor thermal comfort and reducing energy demand for indoor cooling. Now many states and cities in India have HAPs, even though its implementation remains variable.

6. Lessons from Ahmedabad HAP

Ahmedabad Heat Action Plan (AHAP) is pioneering plan in south Asia with focus on one city and was based on analysis of temperature and mortality. It has been implemented since 2013 continuously every year with assessment each year following the heat seasons. The plan in implemented by Ahmedabad Municipal Corporation with technical support from IIPHG and NRDC. In the process of implementation support and review of the plan over ten years we have observed various lessons for the success of the plan. Here we present some of the key lessons.

1. Need for appointing a Nodal officer for Heat action Plan work by the city government. Ahmedabad city appointed a deputy health officer as nodal officer for heat action planning. Dr Tejas Shah has been working on the heat action plans of Ahmedabad as nodal officer since 2013 consistently. His main job is to receive the temperature predictions and alert the various departments and agencies as well as media of impending heat waves. This is one of his additional responsibilities as Deputy Health officer. AMC has entrusted this work to Dr Tejas continuously without any change over last 10 years. This helped built up expertise in the officer and develop contact with other stakeholders which helps in better implementation of the program. This is a very crucial lesson which other cities and state wanting to implement HAP should follow. The person chosen as nodal officer should be active and dedicated to it.

2. Using Local available health and temperature data: This data was used from Ahmedabad for calculating correlation between temperature and mortality to show the impact of extreme heat on health. Ahmedabad Municipal corporation officers and elected representatives got convince of heat action plan's need because using local data of daily mortality and temperature we could show that there were 800 additional deaths in one week in the city during the heat wave. This was very simple data with no fancy modelling or complex statistics nor any assumptions which helped the local politicians and bureaucrats to easily understand the impact of heat and the need for HAP to protect the lives of the citizens. Thus each city and districts should workout the impact on mortality and if possible on morbidity using local available date. Using fancy mathematical models borrowed from west some times are not so effective in convincing local policy makers on the impact of heat as can be done with local simple data on death and temperature. These data are available for most big and

medium size cities. The need is to collect this data and analyse them for form the basis for local HAP.

3. Involving all levels of local government: This HAP formulation and implantation involved all levels of local government including Mayor, standing committee chair, Commissioner, deputy commissioner and Medical Officer of Health. Form the very first meeting of the scientists held in 2011 March – one year after the heat wave of 2010, with help of NRDCs international experience, the team always briefed the mayor, deputy mayor, health committee chair and commissioner about the heat related work and involved them actively in development and release of the HAP. This ensured political and administrative commitment which is crucial to any such plan to succeed. Plans developed by some consultant without involvement of the local government will not succeed.

4. Learning from all over the world and adapting it to local conditions of the city. Given NRDC's global experience the HAP development benefited from their knowledge. NRDC could also rope in global expertise and brought in various global best practices which then the team adapted to local city situation to make a simple and practical plan which was informed by international practices. Sometimes international examples and experiences are more useful to convince the bureaucrats.

5. Writing of the HAP in detail: The written document of HAP included locally calculated thresholds and actions to be taken by each department and the public in detail. The heart of the plan is the written document which gives the details of the various actions in the plan and what each stakeholder will be doing under various alert levels. Initial plan was very long which was then realised that not many government and municipal officers who are very busy would read. So, an "Easy Read" version was made. The well written plan help maintain consistency of communication and messaging as well as action. We also revised the plan each year so that new elements can be added and not so useful or impractical actions can be removed.

6. Planning well in advance: Heat action planning cycle each year started in January or February. The plan was launched in March end or April beginning. And it was implemented April to June. Early planning gave AMC enough lead time to do the needed preparations. Doing meeting, table top simulation exercises, workshops and training of various stakeholder was done from January to March so that all the stakeholders are familiar with the HAP and ready to act during the heat season. Many activities in local government take long time to implement due to various administrative and finance related procedure, hence early start was very crucial so that the plan implementation started in time for the heat season.

7. Active communication strategy: Involving Mass media, social media and local community-based NGOs to reach the key messages to the vulnerable communities for action was very important. More than half of the actions to prevent heat exposure and early treatment have to be taken at the community level by people. Hence communication of the key actions – Dos and Don'ts during heat emergency needs to be well communicated to the most vulnerable poor slum dwellers as well as lower middle-class populations. To reach these populations we used the print

media, TV, Radio and in later years social media with standard messages, interview and advertisements. This over the years created much awareness and action at the community level. This is very important part of each HAP.

8. Review of implementation of the HAP each year: After the heat season the team reviewed the implementation of the plan and its effectiveness. The focus was on finding success and learning lessons for improvement from the shortcomings. Adding new activities to improve the plan was done based on local innovations and international new knowledge. This helped the plan to improve over the years and make it more effective.

9. Building formal partnerships via MOUs between various stakeholders: It is important to build formal partnerships between various stakeholder such as AMC, IIPHG, NRDC, State government etc. Also forming informal linkages and friendships with these and other stakeholders is equally important. The formal MOUs provide the continuity over the years as key officers like Mayors, Commissioner and deputy commissioner and health officers change over the year, but a written MOU forms the basis for continued activities even when the officers change. Forming informal linkages helps to motivate the staff which is doing the HAP work as extra duties on top of their regular work. It also helps understand their constraints and innovative ideas which may not come out in formal settings.

10. Need for External facilitation and flexible budget: The external facilitators for Ahmedabad HAP were NRDC and IIPHG. They helped to steer the program. External facilitation and budget by NRDC, CDKN and other donors help to sustain the activities via appointment of full-time research staff and providing faculty time to drive the project activities. NRDC's program staff was very proactive and visited regularly to guide and move the project activities in the right direction with pace. They also provided global best practice evidence and expertise which helped the project a lot. NRDC also brought in international experts and services which were not easily available in India. IIPHG provide local contextual knowledge, statistical and analytical capacity and close connection with the government. All of this is essential for success of the project.

11. Documentation and dissemination of the efforts for larger impact and recognition. Ahmedabad HAP team over the ten years have produced 5-6 key international publications as well as several policy briefs, several media articles, many presentations, workshops and tools for other cities to develop such a plan. Thus, the success of the plan was well documented with international publications and national dissemination. This provided much higher visibility and appreciation for the project. This is very useful for maintaining the motivation of the teams and making the efforts in one city a platform for others to learn from. It also provided international recognition and received awards that motivated the team.

7. Conclusion and Way Forward

The development, implementation and review of Ahmedabad Heat Action Plan over the last 10 years provided very useful practical example to learn from how a local threshold-based heat action plan can be implemented in a developing country city with low resouces. The lessons from this action plan should be taken up by other

cities, states and national authorities to adapt and replicate it in each of the cities, district and at national level. Given the rapid rise of temperatures due to climate change, and the predicted most conservative paths of temperature rise which indicate substantial rise of the temperatures in future, each city and district has to prepare a plan to protect the citizens from the high temperature and heat waves. Ahmedabad HPA lessons given above will go a long way to help city and state authorities to make the local heat action plans to protect its populations. The National and state agencies like NDMA, SDMA and health dept as well the IMD have to take joint lead to protect the people in future from heat waves.

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