Understanding Heatwave Mortality in New Delhi (India) as a Public Health Issue

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Abstract

India is extremely vulnerable to climate change adversities especially heat waves due to its geography and both high population and population density (World Bank data, 2020). Since last decade extreme temperatures (50 degree Celsius) have been seen during the summers. (Kumar and Singh, 2021). Thus, this paper aims to understand how People in Delhi cope with heatwaves and what steps have been taken by both national and state government to mitigate theses the issues faced by people due to heatwaves. In this paper I have studied the national guidelines on Heatwave action plan and Delhi's government Climate change action plan. Moreover, a survey was conducted to understand how people have coped with heat waves and see if the measures taken by the government had reached to the public.

The paper concluded that further research is needed on the topic and Delhi government need to develop a Full-fledged Heat wave action plan as the Climate change action Plan is not sufficient to mitigate heatwaves mortality. The results also present interesting findings that the major factors behind heatwave vulnerability are as social isolation. type of accommodation, age and. existing medical conditions. The paper also presents simple and affordable techniques that people use to safeguard themselves from heatwaves such as usage of wet air coolers and spraying water on roofs in the morning and evenings.

Relevance to Development Studies

Development is a term that encapsulates multiple strands of life, be it social justice for minorities to protecting our biodiversity. Among the purview of development studies, and the broader practices of development, there is significant stress laid on tackling issues that are arising and growing due to the climate change crisis. Climate change impacts the environment, which in turn affects those who inhibit the environment. The effects of climate change have largely been seen in natural disasters, and gradual changes in weather across the globe, which have killed thousands, destroyed homes, and severely caused harm to food and economic sources. The one who suffer the most are the **economically weak**, and the physically infirm in developing nations.

One of the most notable aspects of climate change is seen in how warm countries are now getting consistently warmer, and the cold ones, even colder. The Northern plains of India are among the worst hit areas that are seeing alarming rise in summer temperatures and prolonged and more frequent heatwaves. In this paper, I delve into how citizens of Delhi (the Indian capital situated in northern India) are coping with the heatwaves of 2022. By doing so, I identify the urgent need to create policies and action plans to help the most vulnerable populations in the city for whom such heatwaves are near-/fatal. Effectively, this paper contributes to development studies by contributing to the scholarship around climate change along with identifying areas where development workers, policymakers, the **government,** and NGOs can direct their attention to, such as providing immediate assistance to protect the ones most at-risk in densely populated areas with relatively scant resources that lack adequate policies and responses to such heatwave crisis.

Chapter-1 Introduction to Climate change and Heatwave

1.1) Current global climate change trends

Climate change is proceeding at an alarming rate, with devastating consequences. Almost every year breaks some horrible record, from the harshest heat waves to the most rapid glacier melt. We've known for decades that rapid climate change is caused by the release of greenhouse gases. But instead of reducing them, in 2019 the world was emitting 50% more CO_2 than in the year 2000 and emissions are still rising. (Kurzgesagt, 2022)

It is evident that climate change is the biggest global threat of the 21st century which has put the lives and well-being of billions of people at an increased risk. Research by Campbell et al. (2018, 210) suggests the same. Kumar and Singh (2021) claim that globally, extreme weather conditions due to climate change have led to extreme temperatures, and heavy rainfall that causes floods and massive destruction. Furthermore, countries such as India are more vulnerable to such natural disasters.

As climate change becomes more pronounced this trend will have exponential growth. (Field et al., 2012). This can be seen in the form of typhoons in China and Japan, and severe heat waves in India and Japan, reaching temperatures as high as 48 degrees Celsius and 40 degrees Celsius respectively.

Indeed, since the 1900s (the preindustrial era) earth's average surface temperatures have increased by 2 degrees (Lindsey and Dahlman, 2021). This 2-degree Celsius rise is a result of the extreme accumulation of heat, which leads to lower snow cover, rising sea levels, heavy rainfalls, and extreme heatwaves.

1.2) Heatwave trends in India

Comparatively warm countries such as India tend to ignore heatwaves as a prominent issue as the high temperatures continue to be seen as normal. The government has largely failed to take nationwide adequate measures to tackle the rising temperatures in India It is important for the policymakers to divert their attention to the issue to prevent loss of lives due to heatwaves.

Extreme heat directly affects human health, labor market, overall productivity, and agriculture. High temperatures impact economy and human health through heat strokes, as the circulatory

system of the body gets affected. Heatwaves puts the human body under severe strain and can be severely dangerous for young children as well as people over 65 (WHO, 2008)

India is often considered as the one of the most vulnerable countries to climate change adversities and heatwaves. Being the 2nd most populous country, with approximately 1.38 billion people (World Bank data, 2020) with a considerably high population density. It is one of the most disaster-prone countries in the world making it extremely vulnerable to extreme climate adversities. (ibid)

Furthermore, India, being one of the fastest growing economies, is moving towards urbanization at a very fast pace. According to the trends, people in the urban areas (33.6 percent) will exponentially increase due to the fall of the Indian agrarian sector (Kurzgesagt, 2022). Urbanization comes with its unique challenges. For instance, Urban heat Islands (UHI) are one of the main reasons leading to heat wave mortalities. Several North Indian cites are already going through extreme and prolonged heatwaves, so they will only exacerbate these mortalities. (ibid)

It is very difficult to establish the vulnerability pattern in the Indian context due to high socio – spatial segregation, high Gini, i.e. high-income disparity. All these factors directly correlate to household needs, even basic amenities such as electricity and water supply (Dupont, 2004; Sidhwani, 2015).

As a result of extreme socio-economic segregation, illegal or unauthorized development have occurred in hazardous areas. As they lack any urban planning and increasing population density, these areas are not prepared for emergency situations. For example, if there is a fire or a earthquake, the ambulance or fire trucks would not be able to enter the highly dense areas as these lanes are way to short due to public encroachment. Thus these areas are the most vulnerable as they are not equipped to cope with a heat wave (WHO 2010).

The urban middle/upper-middle class in Delhi rely heavily on air-conditioning to keep the indoor temperatures bearable. Thus, in densely populated areas, this cause power-outages for several hours as the energy supply is not capable to bear the capacity of hundreds of thousands of air-conditioners running at the same time. The power outages pushe even healthy adults to the vulnerable group (<65 and older). Increased temperatures when added to the high pre-existing pollution levels make the situation worse. This puts the public health sector under considerable strain.

It is evident from studies such as Singh *et. al.* (2021), Pai *et. al*. (2013) Mishra (*et al.,* 2017) and (Murari *et al.,* 2015) that heatwaves are occurring in India. Their research also shows that Delhi especially is facing more and more episodes of heatwaves, despite it being on a higher altitude, and thus, should not have such high temperatures. Chapter 3 will take a closer look at temperature trends in India.

Chapter 2 - Research Design

2.1) Relevance and Justification

Developing countries like India which have pre-existing high temperatures tend to ignore heatwaves as a prominent issue due to other severe issues holding governmental priority.

In the recent years, extreme temperatures have been seen throughout India. In fact, during a 2015 heatwave news reports of melting pavements made international headlines (Sarma, A. et al. 2019). When it comes to the death statistics and cause of death, as noted above, heat-related death or heat mortality is still not an officially recognized indicator in the registered cause of death in India.

India faced its maximum recorded temperatures exceeding 50 degrees Celsius. (Kumar and Singh, 2021). In June 2019, several states faced soring high temperatures; Rajasthan had a temperature of 50.3-degree Celsius, other states like Haryana, Uttar Pradesh, Delhi and Allahabad had temperatures between 48-50 degrees Celsius. (Economic Times, 2019).

Despite adverse climate change effects such as tornados, floods, and rising pollution levels in the national capital, rising temperatures, extreme heat, and heatwaves are still not recognized as a significant or imminent health risk in India. Heat and health-related policies are still underdeveloped in India. “Heat-related mortality is an ever-increasing threat to public health”. (Kumar and Singh, 2021 pp 2). Still, there is little discussion on the effect of extreme heat on individual health.

It is important to study how heatwaves affect various health-based indicators to better identify and prepare vulnerable populations, and to estimate and predict the health impacts of climate change. (Sarma, A. et al. 2019). Data related to the increasing frequency, duration, and intensity of heatwaves is key to making policy-based interventions.

Developing countries are leading towards unprecedented urbanization, and adequate knowledge of the impact of rising extreme temperatures with growing urbanization in the developing countries is a research gap (Sarma, A. et al. 2019).:

India is facing one the worse heatwaves ever recorded in history, with temperatures exceedingly above 50 degrees in several states of India. This research aims to study the effects of the ongoing April – May heatwave on the people of Delhi.

Delhi has been chosen as the population for this study due to its geography and its influence value as a capital. Delhi as the Indian capital is considered the blueprint for other Indian states. Geographically speaking Delhi is one of the hottest states in India. Thus, Delhi faces 5-8 at least extreme heatwaves since 2018. In 2019, Indian government released guidelines on heat wave protection and states were asked to follow and create a localized action plan. Despite this, the Delhi government has no official heatwave action plan. Heatwave morality is still not an official indicator in the postmortem reports. Thus, it's very important to see how the people of Delhi adapt to heatwaves.

2.2) Research objectives and question

This research aims to studying the rising heatwaves in Delhi, their impacts on individual health status, and how people cope. As per 2022, Delhi has no official heat wave action plan even though Delhi is the most polluted state in India, making people severely vulnerable to heatwaves due to existing poor health conditions. Thus, this paper aims to understand how people residing in Delhi cope with heatwave and

to what extent do they believe the government has helped them prepare for the heat wave. The paper therefore also looks at heatwaves as a public health policy issue and assesses the policy readiness of the government.

For now, no peer review analysis of the Indian national heatwave action plan is done to my knowledge. Thus, through this paper I am going to analyze this and explore how the policy aims to understand how the National heatwave action plan intends to achieve it aims to curb heatwave mortality.

Main RQ: What factors determine the health status of the population in East Delhi during a heatwave? What are the common coping mechanisms (simple and affordable solutions used), and how ready is public policy to respond to this?

Sub-question 1: What are the most important factors (e.g., social isolation, age, type of accommodation, and pre-existing medical conditions) that explain (subjective) health status during a heatwave?

Sub-question 2: How do people in East Delhi coped with heatwaves?

Sub-question 3: To what extent issues raised in the National Guidelines for Heat Action Plan have been adopted in the Delhi Climate change action plan? To be analyzed based on

preparedness and capacity building for healthcare system; collaboration and inter-agency coordination; public awareness and community outreach; and vulnerability assessment.

2.3) Methodology

This research uses both qualitative and quantitative research methodology. To study The National Heatwave action plan and Delhi Climate change action plan, qualitative methods such as content analysis and qualitative data analysis was used.

Initially a desk review of the policy documents was conducted. This desk review helped me in understanding how heatwave from an Indian context and how both national and state governments aim to tackle heatwaves. Before starting the data analysis a intestine literature review was conducted. For answering the first and second sub question, primary data was collected.

Descriptive statistics have been used to analyze the primary Data using Microsoft excel. The survey also has open ended questions which have been analyzed through qualitative data analsysis.

Sample selection for data collection

Delhi has been divided into 9 different zones Considering the scope and limitations of the study, a huge sample section is not viable. Thus, only one zone has been chosen for this study. The chosen zone is East Delhi.

East Delhi is the perfect fit for this study. East Delhi is one of the most densely populated areas, and the most marginalized communities resides here. These two factors are key when we see which population is most vulnerable to heatwaves.

The sample section was done based on randomized stratified probability sampling as this study does not aim to target any specific caste, creed, gender, age group, income levels etc.

For this sample section, East Delhi was divided into 4 parts; north, east, west and south and 15 people were randomly selected to be part of the research as per their will. Making a total of 60 participants for this research.

Data Collection Tool:

For this research, a Google Forms survey was used as the data collection tool. Four Research assistants were used for the data collection process. These four students are final year bachelor’s in journalism students. They are well versed in such data collection techniques, and

I briefed them on the content and objectives of my research and emphasized the importance of asking the questions in a non-leading way (see Annex for the survey questionnaire).

The questionnaire has been inspired from the recent study being conducted on Heatwaves and vulnerable populations: Mapping their needs in The Hague done by Dr. Sylvia I. Bergh and coauthors. Prior consent was taken from the authors before using the survey questions as a base for my questionnaire. All the questions in the survey have the option of further elaboration if the respondent is interested in quoting their views.

The four regions of East Delhi were divided into the four-research assistant. Each person had to collect data from 15 people from their allocated zone. This process took 1 week.

Data collection by the assistants was done with the help of Google Forms. They asked questions to the people and recorded the answers on the forms online. This method was chosen over pen and paper survey so that I can monitor the real time responses.

2.4) Challenges and Limitations

Geographically speaking, India is a huge country and is diverse in nature. This diversity is also reflected in the different climate conditions different states have. This study is limited to Delhi, which in no way represents India. Thus, scalability is the biggest limitation of this study due to limited time and funds. Also due to Covid several issues were faced in primary data collection which was a major concern and challenge for this study.

Again, due to limited time and fund, I could not collect empirical evidence on several indicators. The main indicator being the indoor house temperatures. If I had time and resources the best way to collect this data would have been to setup devices in people houses and measure the indoor temperatures in buildings made with different materials.

Chapter 3 – Background

3.1) Temperature Trends in India

As per the Indian Metrological Department (IMD), in 2018, the mean temperature was +0.41 degrees Celsius higher than the 1981-2010 average (NDMA, 2019). According to national disaster management authority, the last 10 hottest years in India were from 2004- 2018, and estimates show as each year passes by the mean temperatures will keep rising exponentially (NDMA, 2019).

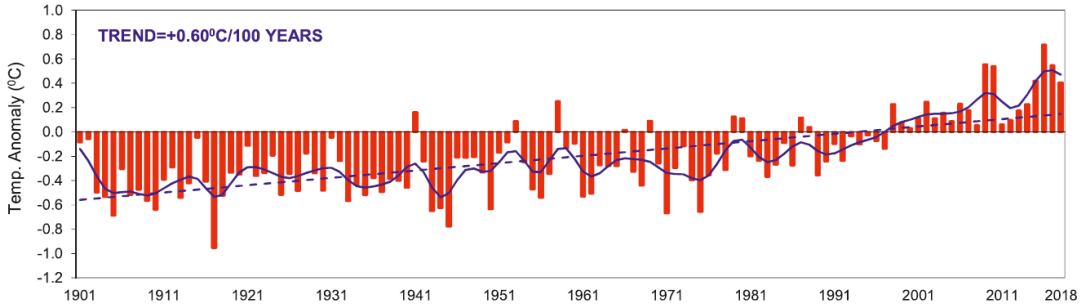


Figure 2 Mean temperature anomalies since 1901-2018. The dotted line represents the linear trend in the time series, whereas the solid blue curve represents the variation in the sub decadal time scale variation. Source: (NDMA, 2019)

This trend of rising temperatures is not just seen in the summers. It can be seen throughout the year. What is most concerning is the rise in temperature during the winters (=0.59 degree Celsius) as shown in the figure 1. Such gradual and insidious changes in temperatures lead to changes in rainfall patterns, and prolonged summers, resulting in increased frequency and intensity of extreme weather events.

India currently in May 2022 is facing the worst heatwave ever recorded with temperatures exceeding 50 degrees (The guardian, 2022) in most of the North Indian cites. India is witnessing such extreme temperatures since 2018. In July 2019, temperatures exceeded 51 degrees (Climate Impact Lab, 2019) too. These temperatures where the hottest for the month of July recorded globally, and the 2022 heatwave is expected to break this mark. (ibid) Epic India present's an interesting temperature prediction in correlation to different scenarios, i.e., with RCP 8.5 and 4.5. The higher emission scenario is the Representative Concentration pathway (RCP 8.5). In this scenario, the emission will rise like the last decade in the future too. Whereas RCP 4.5 is a scenario in which all the countries cut down their emission aggressively as agreed in the Paris Accord (Climate Impact Lab, 2019).

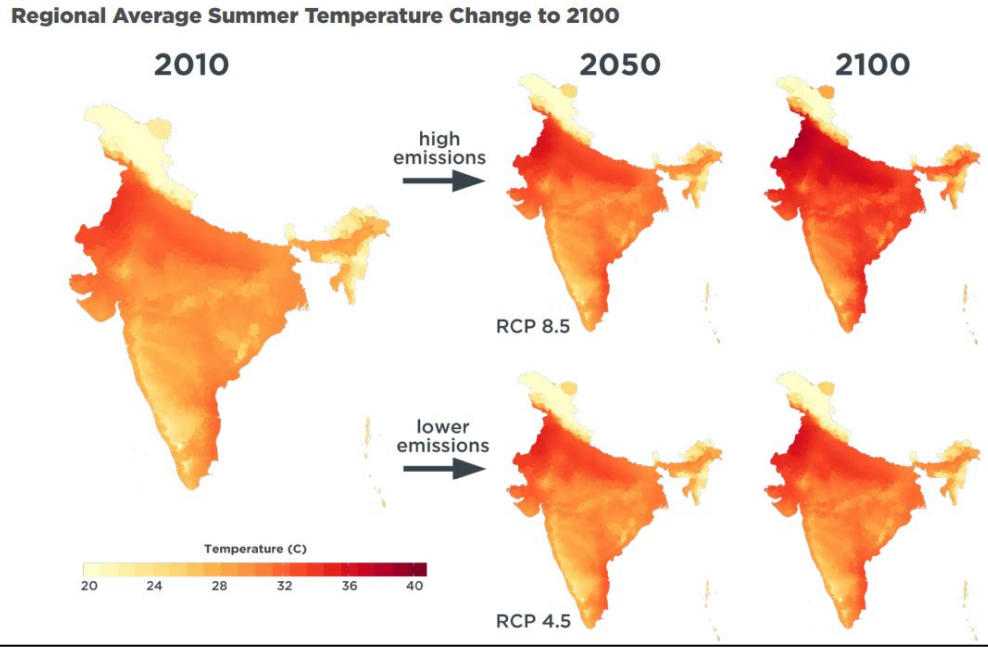


Figure 2 Average daily summer temperature. On the right, we can see the rising temperatures due to the increasing emissions (Source: Climate Impact Lab 2019)

Figure2 shows the average temperatures predictions in the summer under the two scenarios discussed above. As we can see in the current scenario, the north and the Indo-Gangetic plain regions have the highest temperatures.

On the right-hand side are the two different scenarios, on the top side the temperatures trends are calculated according to RCP 8.5. In this scenario the overall spatial temperatures are almost the same, whereas the warm states have become even hotter, which is not surprising. Average summer temperatures rang from 36-38 degree (Climate Impact Lab, 2019). Similar trends for RCP are almost similar to the 2050-year mark for RCP 8.5. This is a huge decrease in the temperatures and does bring hope.

This trend analysis does provide an insight into the future, but it is important to keep in mind that the average or mean temperature does not represent the reality of the situations because people rarely live at mean/average temperatures. Throughout the year there are severe hot and cold days. Thus, finding out the trend of how many numbers of extreme temperature days provides a deeper insight into the problem. Figure 3 shows the average number of days at different temperatures. (Estimated for a year throughout the country).

Rising temperatures and heatwaves were not considered severe issues in India till now, due to the low numbers of direct heat wave mortality, ironically which is still not an official indicator in the list of death causes (NDMA, 2019). When we think of heat waves and rising temperatures as the steeping stones to floods, cyclones, droughts, hailstorms, and unusual rainfall patters the mortality numbers spike to a level which cannot even be recorded (NDMA, 2019).

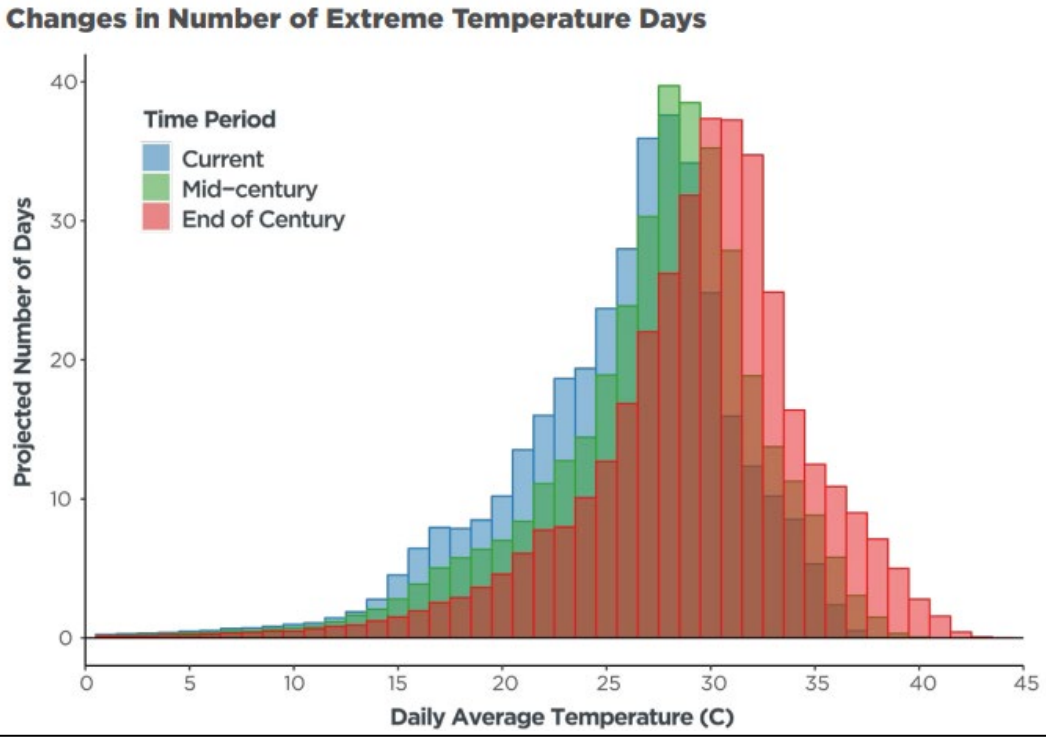


Figure 3 - The average number of days at different temperatures (estimated for a year throughout the country). Source :Climate Action Lab, 2019.

In Figure 3 we can see, On the x-axis, each bar represents a change of one degree and the y-axis the bar represents the number of days a specific temperature will last. The three different bars, blue, green, and red represent the current time period, mid-century (year 2050) and end of century (year 2100) respectively.

It is evident that the number of extremely hot days are increasing exponentially. The number of hot and severely hot days have increased quite a bit, which predicts more and more prolonged heat waves. In 2010, 35-degree Celsius lasts up to ~5 days, whereas in 2050 this number moves to ~16 and in 2100 to ~43. (Climate Impact Lab, 2019).

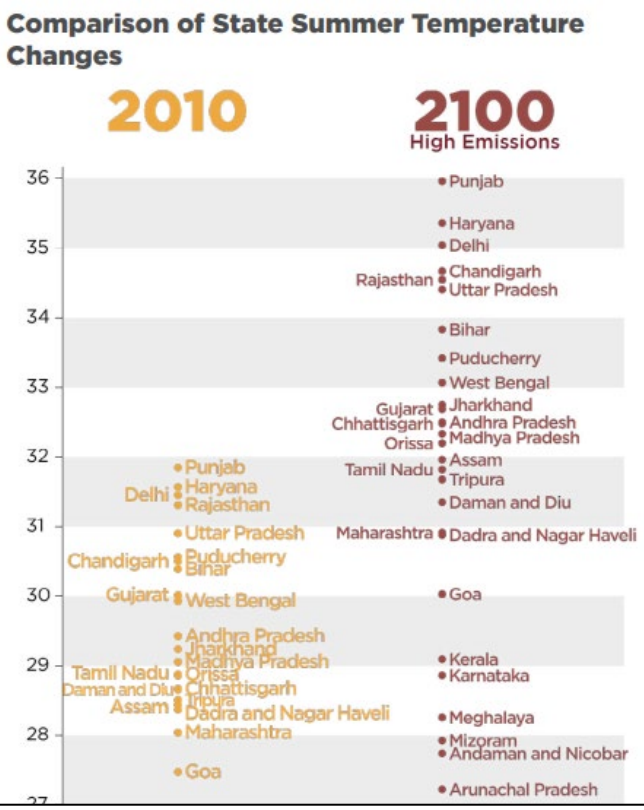


Figure 4- **Temperature predictions of different Indian states** in the year 2100 in comparison to 2010 (Source: Climate Impact Lab, 2019).

Stats such as a rise in 1-, or 2-degree C temperature over a period are not able to provide a picture of how it would affect the common man.

Thus, the figure 4 helps us understand these number better. For example, we can see the average temperatures for Punjab, Haryana and Delhi are the highest (~ 31-32 degree) in 2010.

For the same states, we can see that the temperature will reach as high as 36 degrees in the year 2100. This brings a sense of what this rise in temperature would mean to locals residing on those areas.

3.2) Heat wave mortality trends

In the previous section, we have seen rising temperatures in two different scenarios. If we keep moving on the same emission levels, the predictions clearly show extreme and prolonged heat waves. These heatwaves would lead to increased mortality numbers. Thus, it's important to study the Mortality-temperatures projections. Higher emissions are positively correlated to higher number of mortality numbers. Figure 5 shows how the death rate spikes till the end of 21st century. The red line represents RCP 8.5 scenario. Here it's evident that by the year 2100, we would have more than 60 excess deaths per 100,000 population (Climate Impact Lab, 2019). If we keep underreporting deaths in mind and put an extra 10 percent increase, the excess deaths rate would become 1.54 million excess deaths by the end of 21st century. (Climate Impact Lab, 2019).

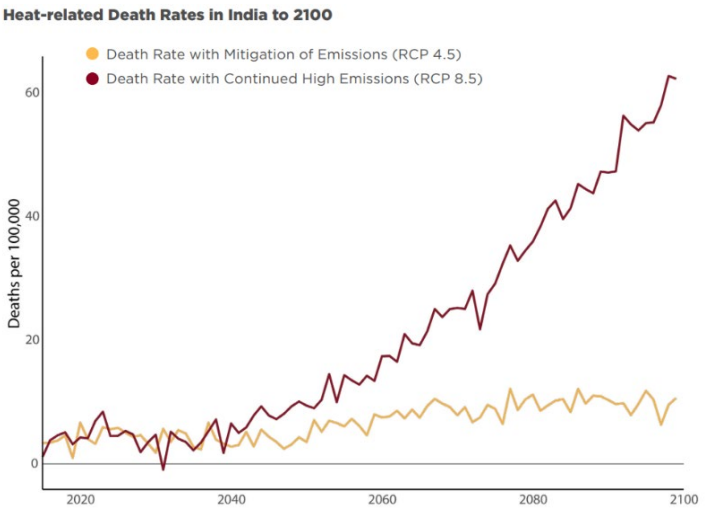


Figure 5- How the death rate will spike till the end of 21st century Source – (Climate Impact Lab, 2019).

Although the yellow line does provide some comfort as we can see that mitigation efforts have worked and have led to reduction in death rate by a good margin. Under the 4.5 RCP scenario, we can see that the excess death rate drops by about 80 percent (Climate Impact Lab, 2019).

3.3) Heatwave classification in India.

Heat wave is a time span or a period of high temperature. This high temperature is usually more than normal maximum temperature for that local zone. In India, heat waves usually occur during the months of March -June, sometimes extending till July.

The World Meteorological Organization defines a heat wave as a condition in which maximum temperatures are higher by at least 5 degrees than the average maximum temperatures for consecutive 4-5 days. (NDMA, 2019). However, a heatwave cannot be classified similarly throughout the world, as it is very much dependent on the local conditions, thus each place has their own classification of a heat wave.

In India heat wave is defined as when the maximum temperature reaches 40 degrees Celsius or more in land-locked plains, for coastal areas 37 degree or more and 30 degrees or more for

hilly areas (NDMA, 2019). According to the Indian meteorological department (IMD), for a heat wave to be considered the following criteria must be met (NDMA, 2019).:

1) **Based on Departure from the Normal:**

- Heatwave – 4.5 degree to 6.4 degree Celsius
- Severe heat wave - more than 6.4 degree Celsius

2) **Based on actual maximum treatment (only used for regions lying in the plains)**

- Heat wave – temperature is less than or equal to 45 degrees Celsius
- Severe heatwave – temperature is less than or higher to 47 degrees Celsius

Such conditions must exist at least for a consecutive period of 2 days, and at sub stations of IMD, for it to be classified as a heat wave (NDMA, 2019).

According to the annual climate report by IMD, the mean temperatures have increased at a rate of 0.63 degrees over the last 100 years. In the summer season (March-June), several anomalies have been seen and the average temperatures have risen at a rate of 0.56 degree over the last 100 years. (NDMA, 2019). Since the last 5 years, more than 8 heatwaves have occurred lasting over 3-4 days on an average during each summer season (NDMA, 2019). Whereases states such as Punjab, Haryana, Delhi, and Rajasthan have faced extreme heatwaves lasting even 10 days. It is evident that the north of India is more vulnerable to extreme heat waves, and on an average the norther states do suffer from at least 5-6 heat waves a year (NDMA, 2019).

3.4) Impact of heatwaves in India

In the recent years, heat wave mortalities have increased at a very high rate. Unusually high temperatures were observed during April-June in years 2010-2016 all over India. Since 1992-2015 heatwave mortality numbers reached 24,223 (NDMA, 2019). Since 2015 several steps have been taken to curb heatwave morality and they have been successful to bring down the number of heatwave morality from 2040 in 2015 to a 1111 in 2016, 384 in 2017 and mere 35 in 2018 (NDMA, 2019). While the decrease in heatwave mortality does look promising, one must bear in mind that these are government statistics, and the numbers are likely to be underreported. The heatwave related deaths are underreported in India because heatwave mortality is not an official indicator of causes leading to a person's demise.

The 2022 summer brought one of the most extreme heatwaves in India, Afghanistan, Pakistan, Bangladesh, and Sri Lanka ever faced, temperatures exceeding over 50 degrees in North Indian

states such as Delhi, Rajasthan, Haryana, and Punjab. This massive heatwave has impacted over 1.5 billion people (The guardian, 2022) and getting dangerous as the respite from the heat that monsoon season brings is still 2 months away.

In May, the highest temperature recorded was 54 degrees Celsius. In Delhi. Northwest, and central India have witnessed the hottest temperatures in the last 122 years (The guardian, 2022). The heatwave had a severe impact on agriculture too; wheat yield dropped by a massive 50 percent in some of the areas in India (The guardian, 2022).

According to the World Meteorological Organization, March of 2022 was the hottest recorded month with a mean temperature of 33.1 degree Celsius which is almost 1.86 degree higher than the average (Yale Climate Connection, 2022). Whereas April brought one of the hottest days seen in Indian history with temperatures reaching 51 degrees Celsius (Yale Climate Connection, 2022).

In the hottest positions of the day in April 29-30, wet bulb temperature (see below) in northern India crossed the thresholds for young, healthy adults and old age people alike, making everyone extremely vulnerable. In Delhi, the ambient temperature on 30 April was 47.4, for which the critical wet bulb temperature would be between 27-28 degrees. However, the observed wet bulb temperature was around 30 degrees Celsius (Yale Climate Connection, 2022). Smiler results were seen in other densely populated cites of India such as Mumbai and Kolkata.(Yale Climate Connection, 2022).

Delhi is one of the worst hit areas, in a span of 45 days, 5 massive heatwaves have been seen with temperatures exceeded 49 degrees Celsius. For now, only 26 deaths have been reported throughout the country (Yale Climate Connection, 2022: BBC, 2022). These numbers do not present the real mortality numbers because as noted above, heat wave mortality is not a officially registered cause of death in India. Thus, these numbers are highly speculative, and heatwave mortality is often underreported. India has been famous for underreporting deaths; WHO reported that Indian government at least underreported the covid 19 deaths by 8 percent. (BBC, 2022)

At the same time, India has adapted to some extent to curb these mortality numbers. Several cites, and states have launched heatwave action plans, early warning system have been kept in place by IMD. Even the 2022 heatwave warnings were given by the IND, but India still has a long way to go as warnings is a very important step but to prevent more deaths much more must be done.

3.5) Previous Heat wave action plan implementations in India:

Ahmadabad launched the first heat wave action plan In India. This plan outlined several key issues such as raising awareness, increasing community outreach, strengthening the primary health sector, and communicating adaptive measures to reduce heat exposure.

The main objective of this plan was to come up with an effective early warning system and a response action plan. The key challenges were to unify civic bodies such as local and city administration working together, response mechanisms for the emergency health line, managing death data, and collaborating with IMD to provide direct access to local data. This heat wave action plan sets an example on how to identify key risk communities and stakeholders and creating necessary infrastructure which is accessible by public for cooling. Using different ways of communication to help relay the warning and response mechanisms (NDMA, 2019).

Odisha (Indian state) used this action plan as a blueprint to formulate a localized blueprint. Finally, in 2019, a pan-India heatwave action plan was developed, and several key lessons learned from the Ahmedabad action plan helped developing it. The national heatwave plan is discussed in the chapter 4 in detail.

Chapter - 4 Conceptual frameworks and Concepts

4.1) Indoor Heat Exposure on Mortality

Many heat-health related studies tend to ignore the exposure to elevated indoor temperatures, and just analyze the health risks among the general population (Klepeis *et al.* 2001). A case crossover analysis of indoor heat exposure on mortality and hospitalization among the elderly was done by Lenick *et al.* (2020). This study aimed to bridge the knowledge gap of the eminent role of indoor heat exposure in heatwave mortality, indoor heat-health thresholds, vulnerably, and adaptive capacity. Several studies such as (CDC 2013a; Fouillet *et al*. 2006) have reported that larger number of heatwave mortalities occur due to indoor heating. Due to this, the poor, marginalized, socially isolated and elderly people are at the greatest risk. (Lenick, C *et al.* 2020; Fouillet *et al.* 2006; Kaiser *et al.* 2007; Semenza *et al.* 1996).

It is important to identify to what extent does this knowledge gap exits, as it would be wrong to say that indoor heat as cause of mortality has not been studied. Studies among which the aspect of indoor heat's effect on health has been discussed has shown interesting findings such as Uejio *et al* (2016) suggest that in certain cases the indoor heating effect has also been seen in the larger cities with high prevalence of air conditioning inside the houses (Uejio etal.2016). White Newsome *et al*. (2012) also made similar suggestions. Increase in indoor heat temperatures can lead tp several health conditions such as sleep problems (van Loenhoutetal 2016), and cognitive failure (Cedeño Laurent *et al*.2018), and decrease in respiratory and cardiology function efficiency (McCormacketal.2016). These are very interesting and important findings but as Lenick, *et al.* (2020) have argued, the above-mentioned indoor heat related studies are "overwhelmingly cohort based" (Lenick *et al.* 2020, 127007-2). In most cases, the indoor heat data was extracted directly from the houses of the people who were impacted by the heat. The authors on the other hand suggest that using a population-based study methodology would provide a deeper insight and a more complete picture of the situation, which previous research have largely failed to do. (Lenick *et al.* 2020) Although this comes with its own challenges of calculating the daily "indoor thermal comfort of the house hold and neighborhood level" (Lenick *et al.* 2020, 127007-2)

The research done by Lencick (*et al.* 2020) addresses the above knowledge gap by using a novel and interesting methodology in which the researchers decided to use segregated heat data to build a deeper understanding. For example, building energy models, parcel level data and

the hourly metrological data to get estimates of the indoor heat exposures and build a population-based health study (Lenick *et al.* 2020, 127007-2). As mentioned above, certain studies have estimated the health impacts of the indoor heat on vulnerable populations, but this is the only study which uses the building energy models to calculate heat exposure (Lenick *et al.* 2020, 127007-2). This is what makes the study by Lenick *et al.* (2020 interesting, and is being discussed in this research paper as its chosen methodology is unique and addresses a huge knowledge gap, thus fitting perfectly as background research for my study.

Interestingly it was found out that people closer to the age of 65 years were not vulnerable to a larger extent, which generally has been seen in trend analysis, while people aged 78 and older were classified as a high mortality risk (Lenick *et al.* 2020, 127007-12). To summarize, the study suggests that short term exposures to high indoor heat is correlated to extreme health effects, and mortality. In the sampled area, strong correlation has been seen between heat related health outcomes and emergency hospitalizations, increase in emergency telephones, (911 calls) and increased mortality. (Lenick *et al.* 2020, 127007-12)

Studies such as Oleson *et. al.(*2015), Marsha *et. al.* (2018), and Rohat *et al*. (2019) suggest that global and reginal climate trends suggest that the heat stress is expected to increase with time. Thus given the projected estimates, it important to study how heat waves affect us, and how do we prevent it and curb heat wave mortality, using localized and well-researched heat wave action plans.

4.2) Effect of housing materials on thermal retention in relation to urban heat islands and energy expenditures.

Lately, it has been seen that building materials are adding to the thermal stress and increasing energy consumption rapidly. (Wonorahardjo *et al*. 2019). Both issues directly corelate to each other and are the main reasons behind rising indoor heat temperatures further leading to urban heat islands (ibid).

According to operational energy findings, the leading three aspects of high energy consumption and high indoor temperatures are “building envelop, building type, household appliances” (Wonorahardjo *et al*, 2019). Previous studies have shown that climate conditions and outdoor heat do play a very important role, especially for old and traditional buildings (ibid).

It has been established thorough several studies that building materials such as **brick and cement** are one of the main causes for urban heat islands (UHI) as these materials have very high thermal retention capacity. (Wonorahardjo, 2012; Andoni; Wonorahardjo 2018). Due to

this, rise in indoor temperatures is seen during the day, while during the night the brick and concreate walls release the heat outdoors (ibid). In densely populated areas, such as Delhi and other major cities, this leads to Urban Heat Islands, which as we have seen above, correlate to adverse effects on health.

Due to this phenomenon, energy consumption increases rapidly, usage of air conditioning escalates to tackle indoor temperatures, which not only leads to higher carbon emissions, but the air-conditioners also release warmer air outside further increasing temperature.

As we have established from the points above that choosing the right building material plays a key role in conserving energy and reducing both indoor and outdoor temperatures, it important to understand, therefore, which material is most suitable. In 2019, Wonorahardjo and co-authors did several experiments through which they studied the thermal behavior of the most common building materials such as brick, aerated concrete, wood, and glass (Wonorahardjo *et al*, 2019). They found that all the above building materials have different characteristics in relation with thermal retention. Bricks and cement have higher density and heat retention compared to aerated concrete materials for example wood (Wonorahardjo *et al*, 2019). "The wider the temperature between the building and the surrounding air, the higher the heat absorption and release" (Wonorahardjo *et al*, 2019).

For this experiment Wonorahardjo exposed different type of materials of 1m x 1m each to a heat radiation through 2-thousand-watt halogen lamps for straight 4 hours. Following which, 4 hours were given to cool down. These experiments took place in an urban kampong in a tropical area using Energy 2D software.

The results were broken down into two different categories, heat retention in block walls (BW), which largely consists of brick walls. The second category being "heat inhibition and insulated sandwich wall (ISW) (under the BW shows a 0.32 degree C increase in indoor air temperature, while in the heat island intensity was 0.74 degree C higher than BW (Wonorahardjo *et al*, 2019).

This experiment provides empirical evidence on how different materials react upon heat exposure, I argue that it is important to include this in polices, especially in countries like India that, as seen above, are highly vulnerable to heatwaves.

4.3) Urbanization, social isolation, and vulnerability and their effects in Heatwave mortality.

Climate change, rising temperatures, heat islands, indoor heat exposure are some of the common attributes attached to heatwaves. One of the lesser studied concepts is the effect of social isolation on heat wave mortality. With my background knowledge on the heatwave I hypothesize that the vulnerable population, i.e. people aged 65 and above, could be vulnerable due to social isolation.

Study done by the Kim *et al* (2020) on social isolation and vulnerability to heatwaves related mortality in the urban elderly population is a one of the unique and interesting research due to its methodology and it responds to my hypothesis. Social isolation is often linked to urbanization. According to a United Nations report 2018, urbanization can be understood as a socio-economic process which affects several factors such as one's personal lives, lifestyles and at the same time, has an effect on the surrounding environment, social structures, urban and rural infrastructures (Kim *et al.* 2020)

Urbanization is a global phenomenon, it is estimated that approximately 55 percent of the world population has moved to the urban areas, and that out of 3 people, 2 are estimated to become a part of the urban population by 2050 (Kim *et al.* 2020). Several studies such as Satterthwaite (2009) and Hajat *et al.* (2010) have discussed how rising temperatures correlate to a person's mood, stress levels, and also cause hormonal changes (Kim *et al.* 2020). Studies done in the UK and US have shown that people are more vulnerable to heat wave mortality in urbanized areas (ibid.). Heat island effects, high population density, and air population are considered major factors leading to increased vulnerability. Social isolation has rarely been a part of the mainstream heatwave mortality discussions (ibid.).

Already more than half of the world population has moved to urban areas, and are living a lifestyle which actively involves long working hours, high stress and anxiety levels. Depression, loneliness is very common, leading to social isolation. Several studies have shown the negative health effects of loneliness, both on mental and physical health (Kim *et al.* 2020).

Social isolation and its effects on health have largely been studied; it is associated with loneliness, high stress levels, increased blood pressure, high cholesterol and cortisol levels, feebler immune system, cardiovascular issues and many more. Due to which people above the age of 65 who live alone are severely vulnerable, as they are not able to get the right social

support, and are incapable of calling for assistance, leading to increased chance of heatwave mortality (Kim *et al.* 2020).

Several epidemiological studies have analyzed the effects of social location to some extent urbanization and its effects on heatwaves. The study by Kim *et al.* (2020, 2) decided to provide empirical proof; they have postulated that "increased social isolation in more urbanized areas may be associated with higher vulnerability to heatwave related health risks".

To measure urbanization, district level population, population density per km^2 and percentage of urban population data was used. The difficult part was to quantify the aspect of social isolation. According to several studies, social isolation is generally defined as loneliness or social disconnectedness, which could be due to various reasons such as a lack of social network (Weiss, 1973), and it has an inverse relationship with social capital (Kim, *et al.* 2020, 2). Social capital largely consists of 5 major defining characteristics, which Kim *et. al*. (2020, 2) has defined as

> 1) community networks, voluntary, state, personal networks, and density; 2) civic engagement, participation, and use of civic networks; 3) local civic identity, sense of belonging, solidarity, and equality with local community members; 4) reciprocity and norms of cooperation, a sense of obligation to help others, and confidence in return of assistance; 5) trust in the community

For this recent study, social network and hosing environment were key indicators along with 6 indicators that would help get this data were social gatherings, how much the neighbours have trust in each other, and how much do they mutually help each other. On the other hand, the type of house in which the person lived was recorded. The households were divided into apartments, and detached houses (Kim *et al.* 2020, 2).

The results of this study provide a great insight into the effects of social isolation and health impacts. Coming to the hypothesis of the research, it assumed a significant positive association between social isolation and vulnerability to heatwave related mortality, especially in the elderly population. Interestingly, it was observed that elderly males were at a higher risk to heatwave mortality compared to females (Kim *et al.* 2020, 5). This could be due to assertion of social capital and health; males have higher cardiovascular and psycho- biological issues due to stress than females, (Kim *et al.* 2020, 2). Although several other studies (Donaldson *et al*., 2003; Fouillet *et al*., 2006; Macey and Schneider, 1993; Vassallo *et al.,* 1995) have reported that elderly females are more vulnerable to heatwave mortality. The author does say that due

to poor social relationship patterns in the sample population such results have been found. (Kim *et al.* 2020, 5) To summarize, this study provides empire evidence that increased urbanization is leading to increased social isolation, which in turn makes people susceptible to heat waves, and that it can have severe health impact.

4.4) Effect of temperatures on the human Body:

How people are impacted by heatwaves and hot temperatures are determined by an array of factors such as how the level and the time of exposure. Understandably, it is likely that if one spends, for instance, several hours in the sun, they are likely to get heatstroke as opposed to someone who spends only a few minutes. A person's age, heat tolerance capacity, health among other factors can also determine for how long and how much they can stand high temperatures. All these factors together, determine how badly a person is affected by heatwaves, and if they are fatal to them. It has been observed by (WHO, 2008) that rise of temperatures is directly related to rise of death caused of heatwaves.

WHO states that "The normal human body temperature range (36.1–37.8 ºC) is maintained by the hypothalamus which constantly regulates the production and loss of heat" (WHO, 2008) It further states that (WHO, 2008)

> "Heat is lost to the environment by: (1) radiation through electromagnetic waves in the form of infrared rays; (2) convection through water or air circulating across the skin; (3) conduction through cooler objects in direct contact with the skin; and (4) evaporation of sweat." (WHO, 2008)

However, in the event of extreme and/or prolonged exposure to high temperatures causes adverse impact on the whole body, especially the cardiovascular system, such that "[w]hen environmental heat overwhelms the body's heat-dissipating mechanisms, core temperature rises" (WHO, 2008) as explained in the figure 6 below.

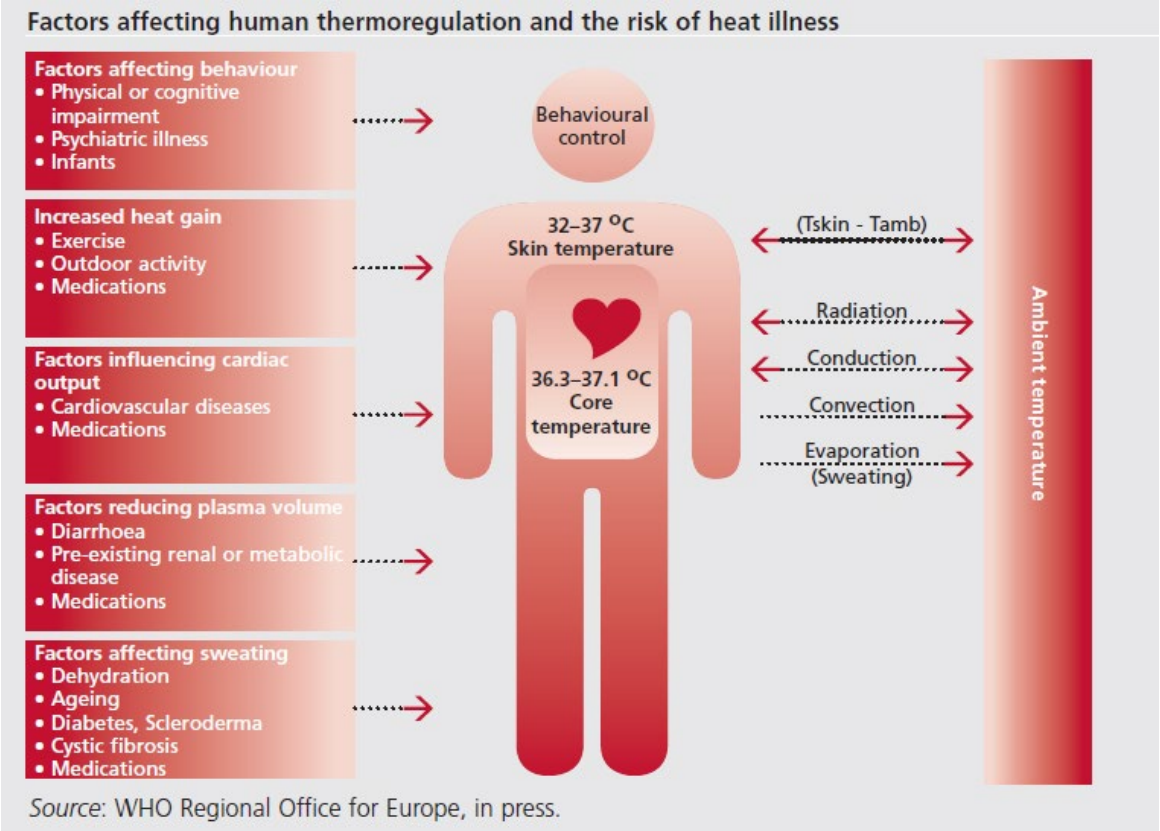


Figure 6- Factors affecting Human Thermoregulation and the risk of heat illness. Source (WHO, 2008)

Furthermore, one may be aware that when the temperature of the environment in which a person finds him/herself is higher than their body/skin temperature, then the body's cooling mechanism is activate through evaporation, or in layman's term, sweating. However, if there is too much humidity in the air, and there is no breeze/wind movement, coupled with personal factors such as dark, tight clothes, and dehydration can lead to fatal heatstroke (WHO, 2008), while health issues such as include "heat rash, heat oedema, heat syncope, heat cramps and heat exhaustion", which range from mild to severe, can become a regular occurrence [ibid].

Chapter – 5 Heat wave action plan in India

The National Disaster Management Authority produced the first national guidelines for heat wave action in 2016 (NDMA 2019). The guidelines were inspired by Ahmadabad, the first city to have a tailored heatwave action plan in India that was introduced in 2013 (Padmanaban 2021). However, the recorded high temperatures in the subsequent years of 2017 and 2018, and the increased environmental instability necessitated a need for a review of the current guidelines to help "improve the capacity of States to deal with heat wave management in a planned manner" (NDMA 2019, v). This has thus birthed the current national guidelines for heat wave action plan that was introduced in 2019.

$.1) National Guidelines for Heatwave Action Plan 2019

The heat wave action plan seeks to provide a structure that can be the foundation for developing plans, implementation strategies, interagency coordination, research, and knowledge production, but also monitor activities in states, cities and towns. The action plan insists on understanding the built environment and also how heatwaves affect vulnerable populations. The action plan outlines seven key strategies essential in heat management. The key strategies are articulated below in figure 7.

Figure 7 National heat wave action plan key strategies (Source NDMA 2019: 13)

In providing a framework for states in formulating a heat action plan, the government has produced a checklist that states should follow when creating an action plan. The checklist consists of eight steps as follows:

	STEPS	DESCRIPTION
1	Government engagement	This step involves active participation from the state leaders, district leaders, municipal health agencies, disaster management authorities and local partners. This is to ensure the production of a comprehensive plan with inter-agency cooperation.
2	Appointing state nodal agency and officer	Each state should appoint a nodal officer for the state and its respective district levels to be in charge of their heat action plans. The Nadal Agency and its officer will be key in identifying gaps in the plan , and also in the participation of the different stakeholders (departments, partners and the public)
3	Vulnerability assessment and establishing heat health threshold temperatures	-Each state and its respective districts should identify vulnerable areas and popu lations which will be key in formulating priorities for strategic targeting and different mitigation measures and thresholds in different areas.
4	Drafting and developing the heat action plan	The state nodal officer and the agency, with the coordination o f the local Indian Meteorological Department (IMD) , will prepare early warning systems through study of summer seasons forecasts in accordance with the approved local state temperature thresholds.
5	Team preparation and coordination	Key training of state and agency officials for the forthcoming heat season. This also involves accurate information sharing and having a well -developed inter -agency response plan with roles and responsibility clearly pronounced.
6	Implementation and monitoring	The public should be given accurate information on how to best respond in the event of extreme heat. This involves proper dissemination of information to cater for different groups especially the vulnerable groups.
7	Evaluating and updating the plan	A heat wave action plan should have flexibility as climate change is an ever - evolving phenomena and has to be continuously updated to deal with emerging emergencies and new factors. With the end of each heat season, each state sh ould have mechanisms in place to do an assessment of the heat action plan from the existing processes, its outcomes and impacts and identify improvements for the next season.

Table 1: Checklist for States to Develop Heat Action Plan (Source: NDMA 2019: vii)

As of 2016, ten states and 6 cities have a heat action plan. States such as Gujarat, Karnataka, Odisha, Uttar Pradesh, Andhra Pradesh, Telangana, Rajasthan, Tamil Nadu, Bihar and Haryana have full-fledged heat action plans while Maharashtra and Kerala were in the final finalizing process of a heat action plan. Ahmedabad leads the way in cities with a heat action plan with Surat, Nagpur, Vijayawada, Bhubaneswar, Gorakhpur and Hazaribagh the other cities with one (IRADe 2020: 15).

Of particular interest in this paper is the State of Delhi. While Delhi does not have a tailored heat action plan, it has a comprehensive Delhi Action plan on climate change that was introduced in 2019. While the Delhi Action Plan on Climate Change has been formed in line with the National Action Plan on Climate Change and its guiding principle (2016 : 2), of particular interest will be how it affords a platform for a framework regarding how to deal with heatwaves and providing mitigation efforts for heat management.

5.2) Delhi State Action Plan on Climate Change

The Delhi Action Plan on Climate Change (SAPCC) was created due to a directive issued by the Government of India through the Ministry of Environment, Forest and Climate Change (MoEF & CC) to each state to discern the state specific climate change concerns and come up with an action plan that will help tackle the impacts of climate change at the local level and also identify different strategies to stanch the emerging effects. This directive came as India ratified and adopted its commitment to the Paris Agreement (NCT of Delhi 2019: 20).

The Delhi Action Plan, however, seeks to strike a delicate balance where while it addresses the pressing concerns and the priorities of the country, it still keeps up the state's development agenda and pioneer efforts for mitigating climate change in an effective manner (NCT of Delhi 2019: 20). Such a three-pronged attack does not in any way inspire confidence of every concern being given the attention it deserves and risks the whole effort being clogged with the weight of too many moving parts.

As this is the only available plan for any form of climate change in the state, **an attempt will be made on this paper to see as to what extent issues raised in the National Guidelines for Heat Action Plan are part of it.** This will be done by using the **key strategies** where they will be grouped into four criteria. These criteria are **preparedness and capacity building for healthcare system; collaboration and inter-agency coordination; public awareness and community outreach; and vulnerability assessment.**

An important factor to consider is the focus of the SAPCC and the initiatives that have been taken by the Delhi government to combat climate change. The SAPCC has identified key sectors that are important in achieving meaningful climate change action while keeping pace with development initiatives and also staying in line with the country's priorities. These sectors are energy and power, transportation, urban planning, forest and biodiversity, agriculture and horticulture, health, vulnerability assessment, water resources, strategic knowledge on climate change, and monitoring and evaluation system and implementation plan.

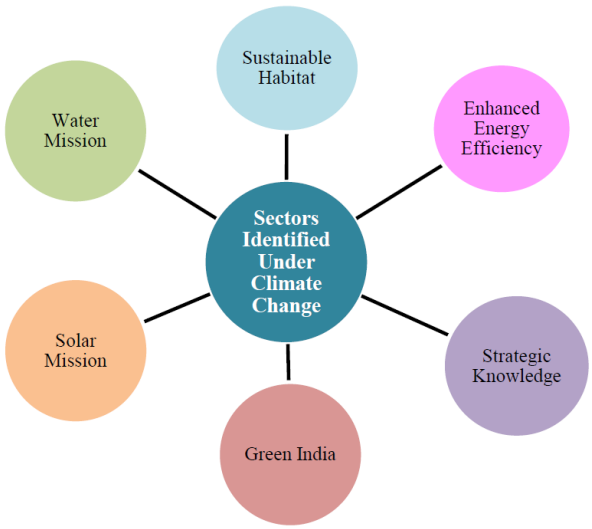


Figure 8: Different sectors identified under the Climate Change Action Plan
(Source: NCT of Delhi 2019: 41)

Most of the criteria identified through the national guidelines for a heatwave action plan fall in few of these sectors mainly health, and strategic knowledge, which perfectly highlights the scale of the SAPCC and its ambition and raises more questions regarding how accurately components concerning heat waves are being tackled and managed.

5.2.1) Vulnerability Assessment

The National guidelines for the heat action plan have identified the importance of doing a vulnerability assessment as its crucial for the design of better targeted strategies and intervention measures at local levels. It identifies vulnerability based on age, chronic disease, pregnancies, occupation, types of housings, physical disabilities among others (NDMA 2019: 10). The SAPCC has provided a comprehensive road map on its vulnerability assessment which focuses on **three steps; identifying fragile sectors, identifying impacts of climate change on vulnerable sectors of the state and finally the identification of vulnerable groups and the effects they face by the impacts of the climate change** (NRT of Delhi 2019: 183). Of particular interest is the third step as it connects to what has been mentioned in the heat wave action plan. The SAPCC have come up with an index of multiple depravity that is an amalgamation of social capital, human capital, financial capital and physical capital that can be used to determine the vulnerable populations, and their degree of adaptability in the event of the effects of climate change or in mitigation efforts (NRT of Delhi 2019: 200).

This provides a comprehensive and detailed description of how the vulnerability assessment will be done and how the vulnerable groups will be identified. Of particular importance is looking at the data through the lens of how the identified vulnerable groups are able to adapt either to the increasing effects of climate change or the mitigation efforts put in place by the state. It also points to a more accurate and responsible allocation for funds for each targeted group. How much it accomplished though remains to be seen.

5.2.2) Preparedness and capacity building for healthcare system

The National guidelines for heat wave action plan explores how to deal with heat related illness. It recognizes how heat waves lead to increased morbidity and mortality of different population groups. It calls for hospitals to have preparedness measures to be able to manage heat related illnesses and also provide help to ensure that the health system is not overwhelmed. Such measures include not only having a detailed action plan and an operation framework that will tackle heat related illness, but also have a response to climate sensitive diseases (CSD), rapid assessment of health cases suspected heat stroke, having rapid response teams (RRT), adequate arrangement of staff, beds, ORS, essential medicines and equipment, outreach clinics and health centers in neighborhoods, proper networking between health facilities, accurate and on time reporting of heat related cases, and capacity building of all health personnel (NDMA 2019: 17).

Meanwhile the SAPCC approach to health looks at it through the lens of having contaminated soil, unclean and unsafe water, improper disposal of human waste and excrement, poor housing situations and insects and rodents. The particular section makes an argument for proper environmental sanitation (NRT of Delhi 2019: 132). Thus, this does not put into account heat related illnesses as a major concern. Worse still, regarding the number of deaths cited for different diseases and illnesses, none were cited in relation to heatwaves or heat related illnesses. As such, the strategy is geared very specifically to the perils of neglect of proper environmental sanitation.

Heatwave related illnesses are given a passing mention and acknowledgment that is no more than three sentences long, and are not included in the Delhi government programs and policies (NRT of Delhi 2019: 140). This difference is brought even into sharp focus when one considers that the Government of Delhi uses the NDMA issued Dos and Don'ts, which are circulated through the health centers and departments (Harigovind 2022). While they provide easy disseminable information, they show the lack of a coherent plan to deal with heatwaves and related illnesses. As such a measure necessitates the population to visit a health center to learn what they need to avoid and follow. This greatly shows disregard of heatwaves as a health concern.

5.2.3) Public awareness and community outreach.

Outreach programs are essential in providing and communicating vital information to the public. The national guidelines for heatwave action plan advocate for early warning and communication systems, which the whole population will understand. This has resulted in a color-coded system for heat alert and suggested actions. This is also used in the SAPCC.

Colour Code Signals for Heat Alert and Suggested Actions

Colour Code	Alert	Warning	Impact	Suggested Actions
Green (No action)	Normal Day	Maximum temperatures are near normal	Comfortable temperature. No cautionary action required.	Normal activity
Yellow Alert (Be updated)	Heat Alert	Heat wave conditions at isolated pockets persists for 2 days	Moderate temperature. Heat is tolerable for general public but moderate health concern for vulnerable people e.g. infants, elderly, people with chronic diseases	(a) Avoid heat exposure. (b) Wear lightweight, light-coloured, loose, cotton clothes. (c) Cover your head
Orange Alert (Be prepared)	Severe Heat Alert for the day	(i) Severe heat wave conditions persists for 2 days (ii) Through not severe, but heat wave persists for 4 days or more	High temperature. Increased likelihood of heat illness symptoms in people who are either exposed to sun for a prolonged period or doing heavy work. High health concern for vulnerable people e.g. infants, elderly, people with chronic diseases.	(a) Avoid heat exposure– keep cool. Avoid dehydration (b) Wear lightweight, light-coloured, loose, cotton clothes (c) Cover your head (d) Drink sufficient water- even if not thirsty (e) Use ORS, homemade drinks like lassi, torani (rice water), lemon water, buttermilk, etc. to keep yourself hydrated (f) Avoid alcohol, tea, coffee and carbonated soft drinks, which dehydrates the body (g) Take bath in cold water frequently. In case of SUNSTROKE: Lay the person in a cool place, under a shade. Wipe her/him with a wet cloth/wash the body frequently. Pour normal temperature water on the head. The main thing is to bring down the body temperature. Consult a Doctor immediately.
Red Alert (Take Action)	Extreme Heat Alert for the day	(i) Severe heat wave persists for more than 2 days. (ii) Total number of heat/severe heat wave days exceeding 6 days.	Very high likelihood of developing heat illness and heat stroke in all ages.	Along with suggested action for Orange Alert, Extreme care needed for vulnerable people.

Figure 9: Color code signals for heat alert (Source: NDMA 2019: 15)

The SAPCC however goes even deeper into provide actions to ensure an effective program outreach. It identifies actions such as use of social media platforms; constant use print, electronic media and radio; school children awareness programs; identification of new partners to raise awareness; health professionals capacity building; and having a feedback mechanism than can help improve the reporting and awareness process (NRT of Delhi 2019: 142). Such measures speak to a more detailed approach to raising awareness and also getting the right information to the general population. Its effectiveness however is something that will be properly further in the chapter.

5.2.4) Collaboration and inter-agency coordination

The national guidelines for heatwave action plan hinge on different departments, agencies, local government, and organizations having coordination and working together. This is done through an identification of stakeholders, collaborative plans, accurate sharing of information and knowledge generation. This can be seen from the consultation process that NDMA exercised where they had representatives from various ministries/departments, states representatives, academic and research institutions and also concerned stakeholders in the private sector (NDMA 2019: i,v). The SAPCC recognizes the need for strategic knowledge and its importance for stakeholders and enhancing inter-agency collaboration. The SAPCC identifies that it heavily relies on community and private sector involvement. It identifies stakeholders from state agencies in the different sectors identified by the SAPCC such as universities and research institutes like Delhi University, Mahatma Gandhi Institute for Combating Climate Change (MGICCC), small, medium and large-scale industries associations, NGOs, international multilateral organizations, CSOs and Media (NRT of Delhi 2019: 24). While this shows an extensive drive for collaboration and knowledge creation and sharing, the fact that it is still an all-encompassing plan that has too many moving parts brings concern as to **how much time and dedication will be put in mitigating heatwave and related illnesses.**

5.3) Conclusion

While the country has put forward national guidelines for heatwave action plan, the fact that the capital still lacks a dedicated heatwave action plan does not inspire confidence especially when one considers the extensiveness of the SAPCC and the ambitious goals it has set on achieving. One cannot shake the fact that it's more of a good policy on paper but lacking the capacity for a proper implementation plan. An analysis on how the existence or non-existence of a heatwave action plan has translated into the efforts the government of the state of Delhi has done to mitigate the efforts of heat waves has been done in the next chapter,

Chapter- 6 Finding and Data Analysis

6.1) Introduction

In this chapter, I will discuss the first sub question, i.e., How to people of East Delhi cope with extreme heatwaves? For the purpose of this analysis, coping is being referred to as a set of practices people followed during to safeguard themselves from the heatwaves. Other than these practices Coping is also being used to as people's day to day life experiences.

This chapter will start with a descriptive analysis of the data acquired by the survey. This descriptive analysis is going to provide a baseline into the selected sample's life and further analysis will tell us how heatwaves effected people's life in accordance with the baseline.

6.2) Descriptive analysis

In this section I am going to create a baseline which would help give important insights into the selected sample's life in absence of heatwave and thus a better understanding on how the heatwaves effect on health.

6.2.1) Housing description

To start with we aim to establish the living situation of the sample. The first section of the survey shows us that 65.7 percent of the population lives in apartments and flats or studio, 8.2 percent lives in Housing complexes/ societies, 5 percent in studio flats, which can also be seen in the figure 10

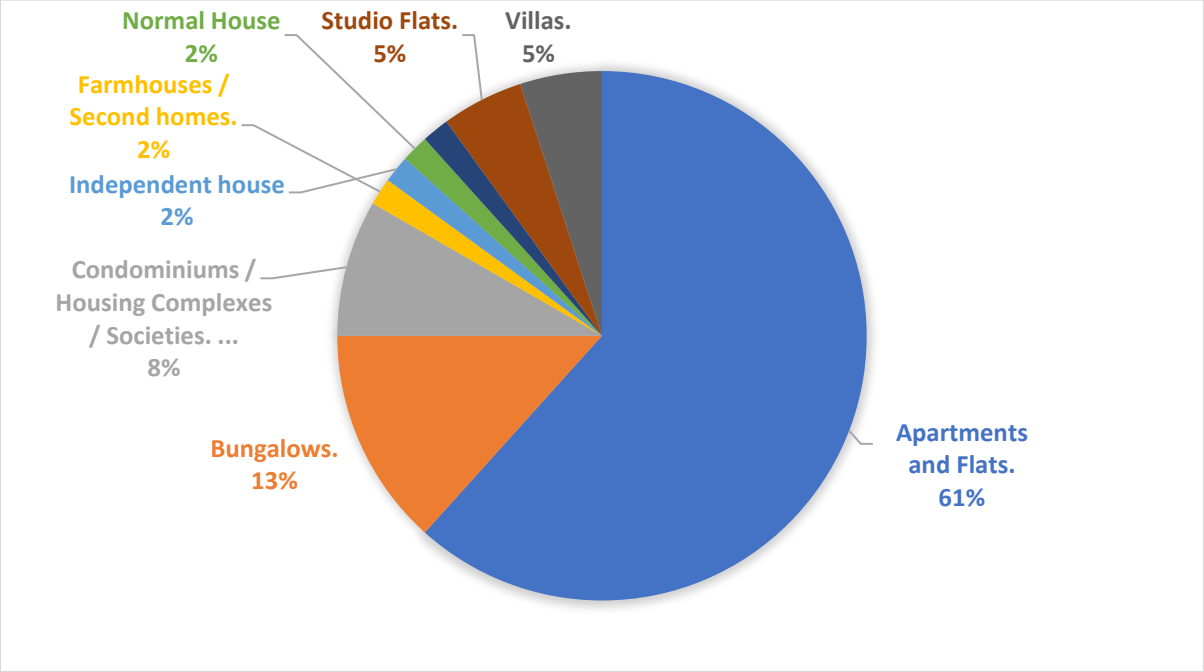


Figure 10 – Percentage distribution of different housing types

According to world population review, Delhi's population density is 29,259.12 people per square mile. This number is mainly consisting of either slums or the tightly packed residential societies. (World

population review, 2022). Thus, based on this data it can be said that **close 80 percent of the sample population lives under highly dense residential complexes.**

The next question in the survey helps us understand the levels of indoor heat exposure the sample population goes through. Due to the time, scale, and fund limitations of this survey we cannot provide empirical evidence of the indoor heat exposure which has been explained in chapter 2 under section 2.4 challenges and limitations.

I have targeted these issues using the desk review on heat absorption on the different types of material used for house construction in respect to outdoor temperature and the effect of cross ventilation on indoor heat.

The most used housing materials used in Delhi are bricks, cement, mud, limestone slits and Teen (aluminum sheets). Teens are largely used either in slums or temporary constructions as a replacement for roof (proest, 2021).

In the survey we found that that 95 percent of the houses are built of red bricks and cement, as the chapter 4 under section 4.2 we have seen that brick and concreate have the most heat retentive capacity. Based on this information and the extremely high temperatures ranging from 40 degree C till 50 degrees C (Zee News, 2022) in the ongoing 2022 heatwave we can establish the presence of extremely high indoor temperatures and formation of urban heat wave islands.

With the help of the above questions, we have established a baseline on how the housing is leading to increased exposure to in Delhi, further we need to establish the baseline and find out preexisting health conditions of our sample, which would help us build on how people have coped from the heatwave's adverse health effects.

6.2.2) Health and heatwaves

With the help of the survey, we found out that the general health of the selected sample was good or better than good. 70 percent of the population reported that the overall health of the household is good or better than good during the ongoing summers of 2022. This indicator fulfills the requirement of creating the baseline that the sample population consists of healthy individuals and thus we can study what they do to stay in such health in adverse heatwaves.

It is also important to identify that different age groups react to health adversities differently, as we have seen in chapter 3 and 4 , people beyond the age of 65 are the most vulnerable to heatwaves. Although an individual who is already sick becomes extremely vulnerable to heat waves too. Thus, with the help of the data collection, it was seen that the people within the age of 40 plus were falling sick more often or had preexisting health conditions. Among which 18.3 percent had preexisting cardiovascular issues, 10 percent had chronic lung disorders and 28.3 percent had diabetes. This has been further elaborated in the figure 11.

This data gives us a perfect starting point to analyze how different people coped with the heatwaves. With the help of the above data, we can say people above the age 40 and with preexisting conditions defined above are extremely vulnerable in this sample.

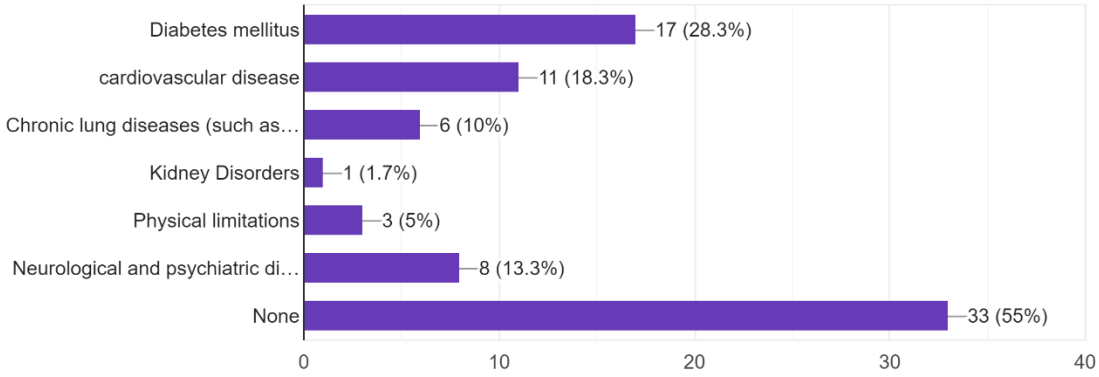


Figure 11 – Underlying medical Conditions

6.3) Response to Heatwaves and Coping mechanisms

In the above sections we have established the housing and health baseline, in this section I aim to build upon the baseline of the preexisting health conditions and the housing situation of the sample and find out how have people coped through the ongoing heatwave.

Coping entails a lot of things; thus, it is important to identify what coping referees to in the context of this research. Considering the objectives and limitations of the study explained in the chapter above. This research aims to understand the concerns people have regarding the heat waves. Building on their concerns how they have tackled these concerns, what types of simple and affordable solutions are being used by the people, how people have adapted to the heatwaves in terms of daily routine, food habits and understand if this change in daily routine have made them more vulnerable due to social isolation.

6.3.1) Major concerns regarding the heatwaves.

As we discussed in the Chapter 3, scorching temperatures are not a new development. Historically Delhi has been a hot zone due to its geographical position. Thus, people have been adapted to high temperatures from a long time, but as we saw in the chapter 3, section 1 the temperatures in the last 5 years have touching 50 degree C which ranges in extreme and is extremely severe for the human body as explained in the chapter 4 section 4.4.

Thus, as we aim to understand how people on the ground react to these extreme temperatures, we asked the major concerns people have with heatwaves. The data reveals serval concerns which people had, although mostly everyone shared some similar concerns mentioned below.

1) The rising indoor temperatures
2) Severe Dehydration
3) Water Shortage
4) Electric Cuts

The above-mentioned concerns were shared by 80 percent of the population, rest of the population also shared at least one of the above-mentioned Conditions. Nikhil Sharma (Name changed due to privacy concerns) explained how the above-mentioned issues interact with each other.

“I live in a shared apartment in a 20-story high building, During the day the walls heat up too much and release heat inside the house. It feels like you are surrounded by a heater which is releasing heat constantly. Due to extreme heat everyone either uses water coolers or Air conditioners, the transformer is not capable of such loads, thus we experience long power cuts especially in peak afternoon hours. Due to this we are not able to cool down the house and are practically living in a hot box”

According to the comments above, people are stuck in a vicious circle, as temperature rises, energy demands increase massively due to increase usage of air conditioners in the houses. Due to this energy consumption is increasing and the main source of electricity in Delhi is Coal (Down to earth, 2020), which exponentially increases the pollution levels and thus temperatures.

75 percent **of the sample population have air conditioners at homes, and 78 percent of the people indicate that the air conditioners are capable to cool down the houses but in reality, they fail to do so** because of the reason mentioned above.

Although due to massive coal shortage occurred in April due to Covid 19 supply chain issues. A SOS was disseminated by the government that less than one day of coal was left. (NDTV, 2020) and as mentioned above Delhi is going through a massive heatwave thus the energy requirements soared up. Due to the combination of both issues massive power cuts were seen in Delhi.

Amit Mishra (name changed) reporter by profession commented in the survey that “In the Month of April, massive power cuts were seen throughout Delhi. In the slums and outskirts of Delhi, consecutive power cuts were seen throughout the night for more than 1 week.”

I do agree that due to covid 19 the capital went through sever coal shortage and thus the energy demands were not meant, but this does not mean that in previous years this has not been the trend. Delhi current power generating capacity is 7590 Megawatts (statista, 2022), while the energy needs during the summer have exceeded 8000 megawatts. Thus, even if Delhi had enough coal, they could not have met the energy demands.

5.3.2) Adapting to heatwaves using simple and affordable solutions

This section will first elaborate further on how people cope, this section targets on the different JUGAR (famous slang for frugal Innovation in Delhi) people do in Delhi as the conventional methods such as use of air conditioners are not able to do the job, and neither are affordable. The next section will focus on how people have changed their daily life to adapt to the heatwaves.

As a Indian, I have seen firsthand how innovative people use innovative ways to cope with the extreme temperatures. Similar observations were found out through the data collection. According to the data analysis I found out that using a wet air cooler was the most common instrument of cooling down the house. 90 percent of the participants confirmed that wet air cooler was the preferred choice to maintain the indoor heaters.

Wet air coolers are the same as air coolers but with a localized tweak. An electric fan is attached in a box made up of heavy plastic sheets as they are affordable. Out of the four walls, 3 are covered with dried grass. At the base a small water tank is created, through a small water pump, water is equally distributed throughout the 3 sides.

Ahana Gupta (name changed) mentioned that "We use wet air coolers throughout the day, as they even work on low voltage unlike Ac's. Due to high energy consumption during the heatwaves the voltage fluctuates a lot, and this is the only device which performs even on low voltages." She further explains the science behind these coolers.

"These coolers work on the principle of evaporation causes cooling. The coolers are placed outside the windows where the fan faces inside the house and other three sides interact with the dry hot air. As the dry and hot air passes through the wet grass and it cools down and is retains a bit of moisture, this air is pulled by the fan and circulated into the room. This is better than using AC as I feel that it provides natural cooling and house does not feels suffocated as fresh air is coming through."

Several other types of simple and affordable solutions'are used to cope with the heatwave, most of them work on the same principles as explained above. 60 percent of the people in the sample spray water on the terrace in the mornings and evenings to keep the concreate from absorbing heat. 20 percent of the people have created gardens on the terrace to prevent heat retention by the concrete. Among the population who lives in apartments, 80 percent reported that a extra aluminum sheet is put upon the terrace so that it can reflect back the sun light and heat, thus the concrete absorbs minimal heat, keeping the houses warmer.

Ashok Nath (name changed) mentioned "I live in a slum and cannot afford Ac and has only one wet air cooler. To prevent the house from heating up they put of bori on the windows and keep spraying them with water, through cross ventilation air circulation is down and the house temperature gets regulated."

"Bori" in the above comment is a huge bag brown bag made of cloth material. These bags are used for packing vegetables in larger quantities and have high water retention capacity.

One of the residents mentioned "When going outside, especially on a 2-wheeler (scooters/bikes). People wrap wet cloth on hands and face to safeguard themselves from the getting heat strokes or sun burns"

These were the interesting and Quique ways simple and affordable solutions'used by the people to safeguard themselves from the heatwaves. Several other common steps were taken to tackle the heat such as, 52 percent of the sample used heavy cloth blinds to limit the heat and sunlight from entering the house. Almost everyone in the sample reported that they prefer using lighter and looser clothes during the summers especially during heatwaves. 90 percent of the people opened the windows and doors during morning, evening, and nights so that through cross ventilation the house can be cooled down.

6.3.3) Adaptations made in daily life due to heatwaves

This section will focus on how people made changes in their day to day lives due to the heatwave. To this study adaptation here refers to how people daily schedule changed according to the temperature, how people's eating habits changed, to what extent social isolation was faced due to heatwaves?

The data shows that 76 percent of the sample population tried their best to avoid going out during the afternoon, 80.6 percent of the people started their day early and tried to finish outdoor chores either in early morning or late evenings. Sarthak Sharma mentioned "I am enrolled in 2nd shift of my college which starts at 12 pm, still I prefer going to the college at 8 am to avoid travel during the peak temperature"

Sanjeev kumar (name changed) mentioned that "my house is under construction and laborer's have denied working from 12-5 pm. The normal working hours were used to be from 10 am till 7 pm. Now due to the heat waves they come at 7 am work till approximately 12 and as it starts getting hot, they go back home and start the work again in late evenings and continue for a few hours. This change occurred as one day a girl got a heat stroke and she fall from a height on solid concrete and got seriously injured."

Moving on to the eating habits, 73.3 percent people reported that they have lost appetite due to increased temperatures and are eating lesser quantities. The similar trend is seen in outdoor food consumption, 71.2 percent of the population reports that outdoor food especially junk food consumption has gone down as the temperatures are rising.

Seema (name changed) mentioned that "my junk food consumption has reduced quite a bit. This has happened mainly because most of my time is spent indoors. Other than this hot and oily food upsets the tommy and adds to the strain the human body faces due to extreme temperatures, thus I try my best to eat healthy food which calms down the body. Lassi (form of yogurt) consumption has increased quite a bit as it both hydrates the body and is very good for digestion."

Through the survey we found that fruits consumption especially watermelons has increased, people are drinking up to 8 or more glasses of water in a day. Food items which are light and healthy are being consumed more for example, people prefer heaving lentil soup over heavy dishes such as lamb meat for dinner.

Interestingly, 84.2 percent of the sample population was using supplements during the ongoing heatwaves. Largely these supplements were in form of multi vitamins. This result was foreseen, what was interesting to find out was that 90 percent of the sample population was using ORS (Oral Rehydration Solution) powder to maintain hydration at least once a day.

ORS is a solution which consist of basic salts required for the body and glucose. It is consumed by mixing the solution into the water. Thus, it is a one in all solution, providing both energy and hydration. The other key reason for using ORS was the affordability. Manu (name changed) said "ORS packets come in different flavors and are so affordable than any other hydration product does not even comes close to its price. ORS packets cost 2 INR while other hydration drinks cost around 20 INR."

6.4) Major Factor's affecting the health during the heatwave:

This Section aims to answer find out what were the major factors that affected the sample population health. This data has not been empirically measured in this study, we aim to study the subjective nature of their health and corelate it to people's responses to factors such as Age, eating habits, social isolation, type of accommodation, and premedical conditions.

In the previous sub sections above, we have already studied that Type of accommodation is one of the very important factors behind one's health. To start with type of accommodation has been divided into two segments, first the type of house the household lives in such as a flat in an apartment building, slums, bungalows etc, second if they own it or not.

As we have seen above the first point directly correlated to the concepts of rising in door heat temperatures and urban heat islands. Second point correlated to the stress that comes with a monthly price that must be paid during heatwave where overall expenses increase too.

As we saw that majority (70 percent) percent of the population lives in either flats/apartment es or studio flats which are largely made of Brick and Cement, the two most heat retention material's which leads to higher indoor heat temperatures and urban hate island effects.

Thus, people living in such apartment sin comparison to bungalows or houses with open space such as gardens were less vulnerable from heatwaves and were considerably healthier. Similar results can be seen for people who own the houses in comparison to people who rent the houses.

As explained in the chapter 4, social isolation has made people more vulnerable in the west, this was not seen in the sample population, which I do believe can be said for whole of Delhi. Indian societies at large live in extended families i.e grandparents, parents and sometimes relatives too live under a common roof are part of one household. Thus, social isolation is not seen in such families. There is plenty of support for members who are vulnerable to heatwaves such as kids and grandparents. Social isolation would make be a major factor to affect health during the heatwave, but social isolation was not reported among the sample population.

From the findings above its subsections, it can be said that factors such as age and preexisting medical conditions are the leading factors defining vulnerability. Our sample population shows that people above the age group of 45 are more likely to fall sick due to heatwave and similarly people with cardiovascular and respiration issues seemed highly vulnerable to heatwaves.

6.5) Delhi Government's efforts to tackle the ongoing heatwaves.

This section investigates how the existence or non-existence of a heatwave action plan has translated into the efforts the government of the state of Delhi has done to mitigate the efforts of heat waves. This analysis will be seen from the public lens as what efforts reached the people on the ground. rather than policy documentation.

Among the sample population selected for this sample 68.3 percent of the people reported that they were not prepared for this extreme heatwave, and neither were aware that its is going to happen.

As mentioned in chapter 5, development, and implementation of an early warning system for heatwaves was the most important key strategy to create awareness and move onto preparedness and mitigation. Delhi government did incorporate this into their Climate change action plan, but as the data suggest the message is not being passed into the public due to poor implementation.

Some of the people reported that Delhi government and IMD reported the early warnings using twitter. Later these were reported on the news channels. Although this was done when the heatwave had already started.

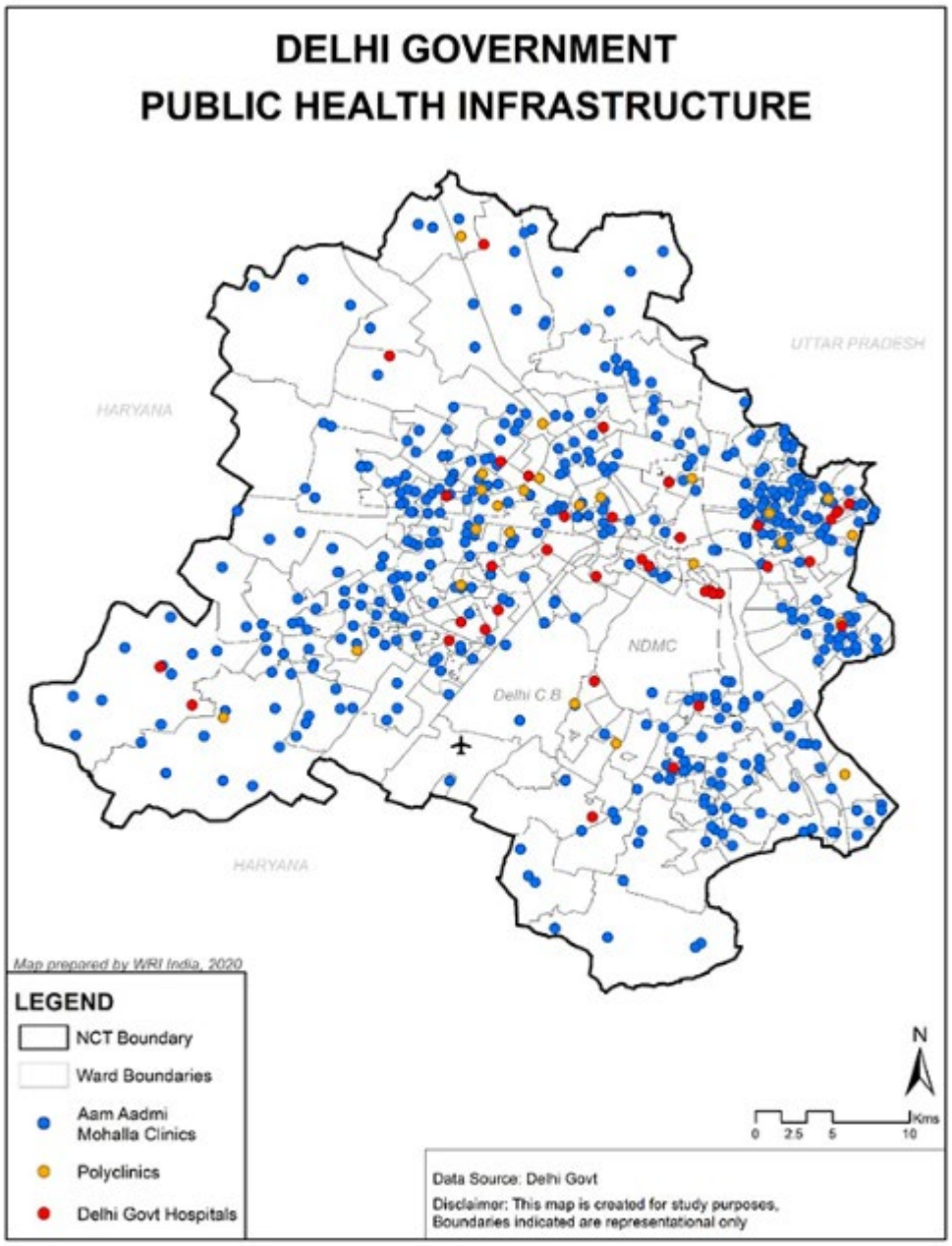
Amit (name changed) mentions “There has been no prior warnings from the government that he is aware of, even if the government did warn, it would not be of much help unless they also provide mitigation measures”.

Better impanation measures of the warning systems are needed to relay the message as marginalized sections of Delhi, slums and densely populated areas are the most vulnerable. Thus, they need to be targeted. Nukar nattak (Street plays and announcements) are a very efficient method of announcements in sums and rural areas. Newspaper headlines, public service announcements should be made on Radio and TV every hour. Measures like these have the capacity to reach people.

In mitigation heatwaves Delhi Climate change action plan has only used creating awareness as the key strategy, which too is not very successful. Thus, the question is how people react to a heatwave adversity.

72.7 percent of the population reported that there is not helpline number they can call which is made for heatwave adversity. At the same time 70 percent of the population also reported that all their concerns related to heatwaves and if there are any health-related issues caused by either heat wave or anything was taken care by the Mohalla clinic’s.

Mohalla clinics the new and reformed primary health centers launched by the Government of Delhi in 2015. Delhi government has created a network of these health centers throughout the city. 1 health center has a patient load of 60,000. By 2025 one health center aims to cover 20,000 people (GOV Delhi, 2022). The map shows how Delhi has been covered with a network of health centers.



Improving Delhi's public health sector has been the key objectives of the government since last 6 years (Lahariya, 2020). The government has aimed to strengthen the primary health sector. Due this preventive approach major health issues are being diagnosed at early stages and treated well thus reduced term patient load of secondary and tertiary hospitals massively. (ibid). These health centers are free of cost for everyone this includes both consultation and medicine costs, thus making them highly accessible and effective. (ibid)

Chapter 7 - Conclusion and recommendations

India is one of the most vulnerable counties to climate change adversities such as Heatwaves. Despite this India has ignored heatwaves as prominent issues. It is very important to diverge the attention of the key stakeholders and policy makers towards this issue to create a policy window for heatwave action plans.

These results of this study have shown how people have coped during April – May 2022 heatwave. We found that Heatwave has affected people life in a major manner. Due to heatwaves people reported a loss in appetite, severe dehydration was faced by the sample population. Interestingly it was seen that people with the age of 45 and above have also fallen under the vulnerable age groups due to the underlying medical conditions and formation of urban heat island effects.

People have gone through extreme high terameters in Delhi because the results show that most the houses are build with bricks and cement which have Avery high heat retention capacity. Due to this people did not feel comfortable or safe even inside their houses.

To overcome these issues the sample population has reported several interesting techniques which are being sued in Delhi. These techniques largely work at the same concept of evaporation causes cooling thus a large amount of water is used. Due to this water scarcity was reported during this heatwave. Among solutions'the usage of water in air coolers is the best one. Other than to cope with the heatwaves people had to change their daily routine.

As explained in the chapter 3, social isolation has made people more vulnerable in the west, this was not seen in the sample population, which I do believe can be said for whole of Delhi. Indian societies at large live in extended families i.e grandparents, parents and sometimes relatives too live under a common roof are part of one household. Thus, social isolation is not seen in such families. There is plenty of support for members who are vulnerable to heatwaves such as kids and grandparents.

The second research question of this study has been around the national heatwave guidelines and how Delhi has incorporated those in the Climate change action plan.

Through this study we have seen that the national government has launched guidelines on targeting heatwaves in 2019, all states are supposed to use these guidelines and create a localized heatwave action plan. It's been 4 years but still the national capital (DELHI) neither

has an action plan to target heatwaves nor has taken steps to mitigate the issues faced by the people. The results of this study clearly indicate that early warning system has failed to relay the message to the people.

Although when we look at heatwave mortality from this lens, the government is doing very well to curb the mortality through the pre-existing health system. This does arise the question that can the public health system alone can handle the heat wave related health issues or does the government requires a heatwave action plan.

I do agree that the health system is doing its job well, but to tackle the issues of heatwave and mitigating the issues Delhi government requires major changes in energy policy, City development and management policy also requires a strong heatwave action plan.

The health sector only targets heatwave induced health issues faced by the Delhi citizens. It fails to mitigate other issues being caused the heatwaves such as formation of urban heat islands or rising energy demands during the heatwaves. These issues need to be tackled as are the reasons behind the unease people go through during the heatwaves.

7.1) Recommendations

In the above chapters we have seen that the building material is responsible for increased indoor temperatures and further heat island effects. Similar results were seen in the study, thus, to tackle this the government should use both Stick and Carrot methods as policy tools.

Prices of cement and bricks should be increased, and subsidy should be provided on materials which absorbs less heat such as hollow concrete bricks or aerated concrete blocks. Usage of green roofs and green walls should be advertised.

The government also needs to support the frugal innovations people have done and upscale them. For example, the government can start a production line for air coolers also subsidize them. More awareness should be on techniques to bring down indoor temperatures rather than using AC.

The government also needs to acquire alternative source of energy than coal while increasing the energy capacity as severe power cuts and voltage fluctuations have been observed through the results during heatwaves.

Larger shades should be installed, and green belt should be increased into the sides of the roads as pedestrians and street vendors have no other alternative. Air condoned public transport should be either subsided or made free during the heatwaves.

Heatwave as a challenge cannot be resolved by a single policy response, the government needs to build public -private patronships to mitigate these issues. Urban planning, energy policy and health policy has incorporated heatwaves as a serious issue and come up both short term solutions as presented in the paragraphs above and need to plan with long term objectives such as increasing green belt, increasing the usage of public transport, reducing emissions, using clean energy such as nuclear, solar and wind.

To conclude the state governments in India to start acknowledging heatwave as a major concern and come up with localized heatwave action plans based on the national guidelines. At the same time the national government needs to step in and act as a regulatory body for the state action plans. The national government has the resources to do monitor and evaluate the action plans and recommend states how on the fall comings.

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Annexure

Heat wave response mechanism

This survey aims to understand how people are adaptiing to heatwaves in the Delhi

1. Q1) Do you give permission for the use of your answers?

   Mark only one oval.

   - ◯ Yes
   - ◯ No

2. In which zone are you located in?

   Mark only one oval.

   - ◯ 1. South
   - ◯ 2. South East
   - ◯ 3. South West
   - ◯ 4. West Delhi
   - ◯ 5. North
   - ◯ 6. North East
   - ◯ 7. North West
   - ◯ 8. Central
   - ◯ 9. East

3. Type of house you live in?

Mark only one oval.

- ◯ Bungalows. ...
- ◯ Apartments and Flats. ...
- ◯ Penthouses. ...
- ◯ Studio Flats. ...
- ◯ Villas. ...
- ◯ Condominiums / Housing Complexes / Societies. ...
- ◯ Farmhouses / Second homes. ...
- ◯ Slum (pakka/kaccha)
- ◯ Other: _____

4. Type of property?

Mark only one oval.

- ◯ Rental House
- ◯ Purchase house

5. Type of roof and house construction

Mark only one oval.

- ◯ Brick and cement
- ◯ Mud and brink
- ◯ slits
- ◯ Teen

6. Do you have a outdoor area nearby?

Tick all that apply.

- [ ] Garden (own)
- [ ] Balcony (own)
- [ ] Garden (jointly)
- [ ] Balcony (jointly
- [ ] None

7. Rate your household member health?

Mark only one oval.

- ◯ Poor
- ◯ Fair
- ◯ Good
- ◯ Very good
- ◯ Excellent

8. Which age grp of the household genreally is sick or has underlyingmedical condtions

Tick all that apply.

- [ ] 0-10
- [ ] 11-18
- [ ] 19-25
- [ ] 26-40
- [ ] 41-55
- [ ] 56-65
- [ ] <65

9. Do you use home care/assistance ?

Mark only one oval.

- ◯ Yes *Skip to question 12*
- ◯ No *Skip to question 13*
- ◯ Other: _____

10. Is anyone in the household taking medication for any of the following conditions (multiple answers possible)?

Tick all that apply.

- ☐ Diabetes mellitus
- ☐ cardiovascular disease
- ☐ Chronic lung diseases (such as asthma)
- ☐ Kidney Disorders
- ☐ Physical limitations
- ☐ Neurological and psychiatric disorders
- ☐ None

11. Does anyone in the household use a mobility aid (multiple answers possible):

Tick all that apply.

- ☐ Wheelchair
- ☐ Mobility scooter
- ☐ Walking aid (rollator, crutches)
- ☐ Other
- ☐ No
- ☐ Other: _____

Home care

12. What type of home care assistance does the household has?

Response to tempreature

Now there are a few questions about what your life and the household's life is like when the outside temperature gets hot. We say this when the temperature rises above 40 degrees. (Current heat wave)

13. Are you concerned about any of the following during a heat wave (multiple answers possible)?

Tick all that apply.

- [ ] How you feel
- [ ] Whether you can cool yourself down
- [ ] How hot it gets inside the house
- [ ] Change to your daily rhythm
- [ ] Your health
- [ ] How to cool yourself down
- [ ] Let the cost of you cool down
- [ ] The duration of the warm period
- [ ] That you will have less contact with people
- [ ] Your sleep rhythm
- [ ] Other:

14. What do you do to keep your house cool?

Tick all that apply.

- [ ] Keep the sun out with curtains
- [ ] Keep the sun out with blinds
- [ ] Extra shower / bath
- [ ] Using a wet cloth
- [ ] Wet your clothes
- [ ] Wear light colors
- [ ] Wear looser clothes
- [ ] Keep windows and doors open in the morning
- [ ] Keep windows and doors closed in the morning
- [ ] Keep windows and doors open in the afternoon
- [ ] Keep windows and doors closed in the afternoon
- [ ] Keep windows and doors open at night
- [ ] Keep windows and doors closed at night
- [ ] Stay inside more
- [ ] Go outside more
- [ ] Drink more
- [ ] Using a fan
- [ ] Using an air conditioner
- [ ] Cool your feet with, for example, a foot bath / bucket / bowl
- [ ] Use of a parasol
- [ ] Looking for coolness indoors
- [ ] Find a cool place outside your home
- [ ] Plant sprayer with water to cool your face
- [ ] Other: _____

15. Q16) If it gets hot (above 40 degrees Celsius):Are you adjusting your daily life?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

16. Do you go out less?

Mark only one oval.

- ◯ No
- ◯ Yes

17. Do you go out more during the day?☐ Yes ☐ No

Mark only one oval.

- ◯ Yes
- ◯ No

18. Do you go outside more when it is a bit cooler (e.g. morning and evening)?

Mark only one oval.

- ◯ yes
- ◯ No

19. Are you trying to limit exercise?

Mark only one oval.

- ◯ Yes
- ◯ No

20. Are you going to cancel or move appointments and activities?

Mark only one oval.

- ◯ Yes
- ◯ No

Eating and Drinking habbits

21. Do you drink more when it gets hot? Estimate how much?

_____

22. When you are thirsty what do you drink?

Tick all that apply.

- [ ] water
- [ ] Tea
- [ ] Coffee
- [ ] Lemonade
- [ ] Soda or non-alcoholic beer
- [ ] Alcohol (e.g., a beer, a glass of wine) juice
- [ ] Other: _____

23. Do you eat less during extreme heat?

Mark only one oval.

- ◯ Yes
- ◯ No

24. How does tempreature effetcs your outdoor (oily/packed) food consumptiion?

Mark only one oval.

- ◯ Increase
- ◯ Decrease
- ◯ Same

25. Do you prefer any kind of food items which help you relax in high heat?

26. Do you take any suppliments during heatwave?

Mark only one oval.

- Yes
- No

27. If yes, what type of suppliments do you take?

Social Habbits

There are now a few statements about your contact with others. You may answer yes, sometimes, and no.

28. you feel more lonely than usual during a heat wave?

Mark only one oval.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

29. There are people I can talk to well

Mark only one oval.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

30. I feel isolated from other people

Mark only one oval.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

31. There are people I can turn to

Mark only one oval.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

32. There are people who really understand me

Mark only one oval.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

33. I'm part of a group of friends

Mark only one oval.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

34. My social contacts are superficial

Mark only one oval.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

Awareness about Heatwaves

35. Are you monitoring the weather?

Mark only one oval.

- ◯ Yes
- ◯ No

36. Do you remember seeing reports from the municipality about the heat last year?

Mark only one oval.

- ◯ Yes
- ◯ No

37. What sources do you use to inform you about possible heat waves? For example, about weather warnings and how to stay safe during a heat wave?

Tick all that apply.

- ☐ Radio
- ☐ TV
- ☐ Newspaper
- ☐ Online
- ☐ Via acquaintances
- ☐ Other: _____

38. How informed are you about what to do to stay safe during a heat wave?

Mark only one oval.

- ◯ Not informed at all
- ◯ Not informed
- ◯ Neutral/Medium
- ◯ Informed
- ◯ Highly Informed

39. Do you know if you have ever seen advice on how to stay safe during a heat wave/extreme heat?

Mark only one oval.

- ◯ Yes
- ◯ No

Frugal Innovation

40. Do you have Air conditioning at home?

Mark only one oval.

- ◯ Yes
- ◯ No

41. Does the air conditioning is enough to keep the houshold cool?

Mark only one oval.

- ◯ yes
- ◯ No

42. If you do not have air conditing what do you use to keep the houshold cool

Tick all that apply.

- [ ] Celing Fan
- [ ] Water Cooler
- [ ] Table Fan
- [ ] Hand Fan
- [ ] Other: _____

43. What do you do to save yourself from the heatwave when outdoors

_____

44. What do you do to save yourself when you are indoors?

Tick all that apply.

- [ ] Close blinds or curtains during the day
- [ ] Open windows and doors when the outside temperature drops in the evening and at night
- [ ] Set the balanced ventilation to summer mode
- [ ] Using an air conditioner
- [ ] Use a fan
- [ ] Shadow Lookup
- [ ] Limit Effort
- [ ] Drink enough
- [ ] Discuss your medication use with the pharmacist or doctor or general practitioner
- [ ] Plant sprayer with water to cool your face
- [ ] Other: _____

Respeonse to adversity

45. What kind of heatwave related health problems do you face or anyone else in the household faces? Report age of the person facing issues?

_____

46. If anyone in the home feels unwell due to a heatwave, what do you do?

_____

47. Does the mohalla clinic /other health centres or hospitals able to provide enough assiatnce to heatwave induced emergnecy ?

Mark only one oval.

- ◯ Yes
- ◯ No

48. Is there a helpine for heatwave raelted health issues

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Not aware

49. Do you think the local medical store attendent capable enought to deal with such isues?

Mark only one oval.

- ◯ Yes
- ◯ No