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VULNERABILITY ASSESSMENT OF HOUSE HOLDS IN BHUBANESWAR TO HEAT STRESS

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Contents

Executive Summary

Extreme heat and heat stress are worsening worldwide due to the worsening effects of climate change. These impacts can be felt more in the cities, where the city's physiology has concrete, brick buildings and decreased landscapes. Heat stress is especially very difficult for the vulnerable population. Heatwave management and minimising populations' exposure to heat stress will be necessary to keep cities safe, resilient, sustainable (SDG 11) and support residents' income and productivity targets (SDG 8).

In India, there is a well-recognised association between heatwaves and morbidities and mortalities. There is evidence of a threshold at 40 °C above which mortality increases[1]. The city of Bhubaneswar has often witnessed heat-based extreme weather events in the past. It hosts a population of 0.8 million, Bhubaneswar the capital of Odisha is one of the key urban centres of India and home to at least 436 slum[2]pockets (Census 2011). The variations in temperature, relative humidity in city, and increase in population increase the heatwave incidents of mortality and morbidity. Heatwaves often lead to heat-health issues. Such situations make it critical to be sensitive to the devastating impacts of climate change, especially on the vulnerable sections of society. With an increasing number of people getting affected by extreme temperatures, heat wave should be treated as a calamity and need a systematic approach rather than an aberration. This report captures the challenges faced by the people due to heat waves and is a vulnerability assessment of communities prone to heat stress and its associated risks.

The purpose of this report is to underline the importance of the Heat Stress Action Plan (HSAP) and to generate evidence-based solid policy recommendations to integrate them into the current and future climate actions at the local, state and national level. A comprehensive index was developed comprising nine sectors and twenty-six sub-sectors to understand the impacts of extreme heat events on vulnerable populations' health, work productivity, and livelihoods. It includes the sectors namely, Housing, Cooking, Sanitation, Water, Electricity, Health, Awareness, Transport, and their respective sub-sectors. The following indexes are selected as

[1] V. K. Desai, S. Wagle, S. K. Rathi, U. Patel, and H. S. Desai, "Effect of ambient heat on all-cause mortality in the coastal city of Surat, India," *Current Science*, vol. 109, no. 9, pp. 1680–1686, 2015.

[2]Bhubaneswar Municipal Corporation , 2015-16, http://bmc.gov.in/BMCProfile.aspx

they are compounding risks/ impacts. They interact with the existing risk and tend to exacerbate climatic impact.

The study identified heat and vulnerability hotspots to help city governments deploy targeted measures to mitigate impacts of heat stress. The city-level vulnerability assessment of Delhi proves that urban poor are most vulnerable to heat stress and its associated impacts. Notably, households are most susceptible to heat stress due to housing viz., the material used and its structure, lack of access to basic services such as water, and electricity. These aggravate heat and result in deterioration of health, loss of lives, and livelihoods.

A critical factor that emerged from the study is that households do not have sufficient awareness and knowledge about heatwaves and local institutions' adaptive and mitigation strategies. In a scenario of low affordability for health insurance, public health systems must be improved while focusing on knowledge dissemination as part of the preparedness.

Heat stress impacts are visible through the aforementioned sectors, so cities can combine sectoral initiatives with a well-defined and coherent framework that ties mitigation and adaptation together. Specific sectors like public health, housing, infrastructure, and services provide entry points. The recommendations outline an overarching framework to ensure maximum impact through sector-based initiatives.

To ensure this, stakeholders need to be involved in the planning and executing heat stress minimisation interventions. Measures have to be both short-term and long term in promoting heat stress management and its planning.

Vulnerability Assessment of Households in Bhubaneswar to Heat Stress

Climate change has already started to show its impacts with the increase in extreme weather events across the globe. In its study, the United Nation's Intergovernmental Panel on Climate Change (IPCC) maintains that there will be "Global Warming of 1.5C"[3]. As per the latest IPCC AR6 it is virtually certain that hot extremes (including heatwaves) have become more frequent and more intense across most land regions. Impacts of heat stress are more severe in urban areas due to Urban Heat Island (UHI) effect (CCA, 2016). Heat stress-induced deaths in 2100 are estimated to be about 85 per 100,000 (Climate Impact Lab 2019). It is, therefore, inevitable that there will be frequent hotter days/temperature extremes than the normal overland areas as global mean surface temperatures increase. Heatwaves are also going to increase in frequency, duration, and intensity. It is most likely to create health impacts that may include morbidity and mortality, along with causing heat stress.

Furthermore, the changes in climate and climate variability bring about significant changes in the weather extremes, creating a substantial threat to human health. In countries with adequate reporting systems, it is being registered that heatwaves are causing a large number of deaths. The World Meteorological Organization statements on the status of global climate during (March 2016) showed that global temperatures continue to increase, and the year 2016 recorded historically high global temperatures (approximately 1.1° C /1.98 °F above pre-industrial levels), surpassing the record set in 2015. The health impacts of the heatwaves range from cardiovascular, respiratory, neurological, and psychiatric diseases. In severe cases, it results in mortality. Its consequences will become more pronounced with climate changes. It logically gives rise to critical questions, what does this increasing temperature mean for human health?

[3] Pachauri, R. K., Allen, M. R., Barros, V. R., Broome, J., Cramer, W., Christ, R., . . . Dasgupta, P. (2014). Climate change 2014: synthesis report. Contribution of Working Groups I, II and III to the fifth assessment report of the Intergovernmental Panel on Climate Change: Ipcc.

How would communities cope with extreme temperatures? Proper responses can help in minimising heat-health consequences. Therefore, public health programmes will become critical to prevent the occurrence of heat-related diseases caused by heatwaves (Jang et al., 2013)[4]. Heat stress-related illnesses are manageable and even preventable if proper responses and actions are taken, such as avoiding high-temperature exposure.

The combination of rising temperatures and a large vulnerable population will exacerbate the impacts of heatwaves in India and other developing countries. As per the IPCC AR6 (2020), surface temperatures over South Asia will likely increase greater than the global average, with projected increases of 4.6°C (3.4°C–6.0°C) during 2081–2100.

Studies show that Low and Middle-Income Countries (LMICs), including India, are most likely to bear a very high burden of deaths (World Health Organization, 2014)[5]. Further, it will impact the availability of public services of water supply, electricity, sanitation of water, and food availability for consumption. Located close to the equator, India experiences a hot tropical climate. Monsoon showers intersperse long, dry, hot summers, and then hot wet summers replace monsoons. The heatwaves in India will rise with climate change.

Heatwaves in India are declared by the Indian Meteorology Department (IMD) when a particular station reaches at least 40 °C or more in Plains, 37 °C or more in coastal stations, and at least 30 °C or more in Hilly regions. Mentioned below are the criteria for declaring a heatwave:

(a) Based on Departure from Normal

i) **Heat Wave**: Departure from normal is 4.5°C to 6.4°C

ii) **Severe Heat Wave**: Departure from normal is >6.4°C

Based on Actual Maximum Temperature (for plains only)

[5] World Health Organization. (2014). Quantitative risk assessment of the effects of climate change on selected causes of death, 2030s and 2050s: World Health Organization.

i) **Heat Wave**: When actual maximum temperature ≥ 45°C

ii) **Severe Heat Wave**: When actual maximum temperature ≥47°C

The above criteria should be met at least in 2 stations in a Meteorological sub-division for at least two consecutive days to declare heatwave. It will be declared on the second day (IMD, 2018).

Indian Institute of Tropical Meteorology has given the following criteria for Heat Waves:

a) If maximum temperature is ≥ 39°C and minimum temperature ≥ 90th percentile of the observed minimum temperature for that day

b) If maximum temperature ≥ 95th percentile of the observed maximum temperature for that day, and actual maximum temperature is ≥ 39°C, and maximum temperature departure from normal is ≥ 3.5°C or maximum temperature is ≥ 44°C

c) If maximum temperature ≥ 99th percentile of the observed maximum temperature for that day, and actual maximum temperature is ≥ 39°C, and maximum temperature departure from normal is ≥ 5.5°C or maximum temperature is ≥ 46°C

Hot days(HOT): if satisfying A

Heat Wave (HW): if satisfying B

Severe Heat Waves (SHW): if satisfying C

1 Heatwaves

A heatwave is a prolonged period of excessive heat along with excessive humidity. In urban areas, “Urban Heat Island effect comes into play.” It is primarily due to the absorption of solar energy by the buildings, roads, and other infrastructures, resulting in higher temperatures. The heatwaves can cause blackouts and power outages, especially in areas that experience the urban heat island effect. In India, the months between March to June are typically the hottest in India, with temperatures reaching up to 45 degrees Celsius in certain areas. Loss of lives during a heatwave is caused by direct and indirect effects due to worsening of pre-existing conditions, the latter being far more common than the former. Utmost priority must be given to prevent

heat-related illnesses in a vulnerable population, especially women, children, and the elderly, as well as the poor and marginalised (slum population, homeless). The need of the moment is to prepare comprehensive strategies to deal with adaptation to extreme temperatures. Various criteria for determining the heat waves include percentile thresholds of maximum temperature, excess heat indices (Panda et al., 2017)[6]; positive Extreme Heat Factor (EHF); Multi-measurement index (Meehal et al. 2009)[7]; and Exceedance index[8] (Fischer et al. 2010). Heat Stress is primarily classified into the following five[9] types.

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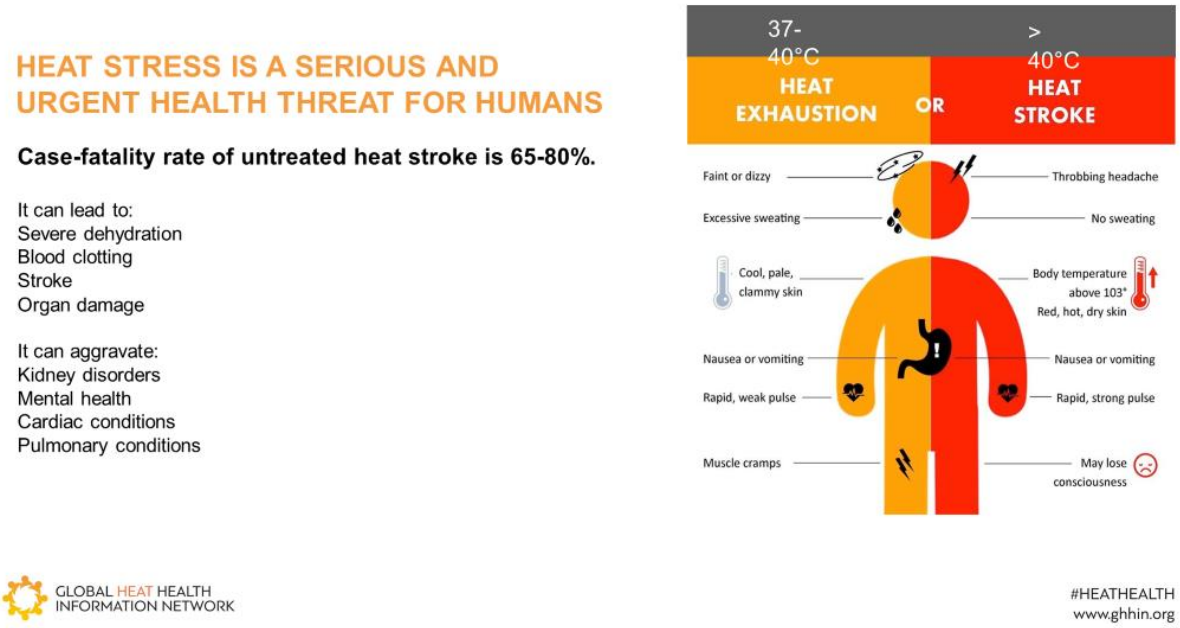
[6] http://amir.eng.uci.edu/publications/17_JGR_HW_India.pdf
[7] Meehl, G.A., Tebaldi, C., Walton, G., Easterling, D., McDaniel, L., 2009. Relative increase of record high maximum temperatures compared to record low minimum temperatures in the US. Geophys. Res. Lett. 36 (23)
[8] Fischer, E.M., Schär, C., 2010. Consistent geographical patterns of changes in high-impact European heatwaves. Nat. Geosci. 3 (6), 398–403
[9] Heat Stress - Heat Related Illness by CDC. We thank everyone who contributed to this much needed report "Vulnerability Assessment to Heat stress of Household in Delhi''. International Development Research Centre, Government of Canada, supported the Review Report.
[10] http://amir.eng.uci.edu/publications/17_JGR_HW_India.pdf

(EHF); Multi-measurement index (Meehal et al. 2009)[11]; and Exceedance index[12] (Fischer et al. 2010). Heat Stress is primarily classified in the following five[13] types.

1. Heat Rash
2. Heat Cramps
3. Heat Exhaustion
4. Heat Syncope
5. Heat Stroke



Heat Rash: Itchy Rash with small red bumps at pores in a setting of heat exposure; bumps can sometimes be filled with clear or white fluid

Heat Cramps: Painful contractions of frequently used muscle groups in the heat exposure setting, often with exertion.

Heat Exhaustion: Sweaty/Diaphoretic; Flushed skin; hot skin; average core temperature; +/- dazed, +/- generalised weakness, slight disorientation

[11] Meehl, G.A., Tebaldi, C., Walton, G., Easterling, D., McDaniel, L., 2009. Relative increase of record high maximum temperatures compared to record low minimum temperatures in the US. Geophys. Res. Lett. 36 (23)
[12] Fischer, E.M., Schär, C., 2010. Consistent geographical patterns of changes in high-impact European heatwaves. Nat. Geosci. 3 (6), 398–403
[13] Heat Stress - Heat Related Illness by CDC. We thank everyone who contributed to this much needed report "Vulnerability Assessment to Heat stress of Household in Delhi''. International Development Research Centre, Government of Canada, supported the Review Report.

Heat Syncope: Brief Generalised loss of consciousness in a hot setting, the short period of disorientation if any

Heat Stroke: Flushed, dry skin (not always), core temperature ≥ 40-degree C, (103°F or higher), altered mental status with disorientation, possibly delirium, coma, seizures, tachycardia, +/- hypotension

2 Heatwave in India

Heatwave is one of the extreme weather events (EWE) (Kamaljit Ray). In 50 years (1971-2019) EWE killed 1,41,308 people. Of this, 17,362 people were killed due to heatwave — a little over 12 percent of the total deaths recorded[14].. From 1998 to 2018, the intensive occurrence of heat stress caused material damage and affected the quality of life like none in the last 100 years. Temperatures peaked 49° to 50 °C and lasted for almost a week, resulting in a massive spike in heat strokes, other heat-related illnesses, and death. The year 2019 was the seventh warmest year on record since nationwide meteorological records keeping commenced in 1901. Since about 50% of India's GDP is already dependent on heat -exposed work like agriculture, mining and construction — there would be an immediate, palpable impact, one worth $250 billion[15]. Approximately 23 states were affected by heat stress in 2020 compared to just 9 in 2015[16]. This needs to be tackled by the Heat Action Plans through improved sensitisation, capacity building, inter-agency coordination, and enhanced data collection.

June and July 2019 have been the hottest months recorded globally, with National Oceanic and Atmospheric Administration (NOAA) confirming June 2019 being the most desirable on records, + 0.95^{o}C above normal average temperature. On 26th May 2020, Churu in Rajasthan bagged the record as the hottest place in India and the entire world. On the same date, 10 of the 15 world's hottest sites were in India, including Delhi NCT, which recorded its hottest day of

[14] Kamaljit Ray, R.K. Giri, S.S. Ray, A.P. Dimri, M. Rajeevan, An assessment of long-term changes in mortalities due to extreme weather events in India: A study of 50 years' data, 1970–2019, Weather and Climate Extremes,Volume 32,2021,100315,ISSN 2212-0947, https://doi.org/10.1016/j.wace.2021.100315.

[15] By Jonathan Woetzel, Dickon Pinner, Hamid Samandari, Hauke Engel, Mekala Krishnan, Brodie Boland, and Carter Powis.McKinsey Global Institute. Climate risk and response: Physical hazards and socioeconomic impacts January 16, 2020

[16] https://ndma.gov.in/sites/default/files/IEC/Booklets/HeatWave%20A5%20BOOK%20Final.pdf

May in 18 years at 47.6^{o} C. Parts of North Western, Northern, and Central Plains of the country experienced severe heat waves during May.

The annual average temperature of the earth has risen by 2° C until 2006, and this may further increase by another 1.5°-2° C by 2030[17]. Within 50 years, 1.2 billion people live in areas as hot as the Sahara if greenhouse gas emissions keep rising (Chi Xu, Timothy A. Kohler et.al, 2020).

Heatwaves cause the highest number of deaths than deaths caused by any other natural hazard in Indian cities[18]. However, it needs to be highlighted that extreme temperatures can adversely impact human health and the ecosystem. Despite being one of the top three killers in the country, heat waves are not a natural calamity by the Government of India.

3 Understanding Heat Stress Vulnerabilities

3.1 Study Area Selection

The selection process was carried out by identifying vulnerable areas through Land Surface Temperature (LST) maps and locating slum settlements. The LST maps intend to choose the heat hotspots. The areas identified in Delhi were with LST > 40 C. Besides, data on ambient air temperature measured by Automatic Weather Stations (AWS) was procured from IMD (India Meteorological Department) and municipal corporations for mapping. A total of 10 hotspots were identified in the Bhubaneswar.

[17] IPCC, 2018: Summary for Policymakers. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. *World Meteorological Organization, Geneva, Switzerland, 32 pp*

[18] Kamaljit Ray, R.K. Giri, S.S. Ray, A.P. Dimri, M. Rajeevan, An assessment of long-term changes in mortalities due to extreme weather events in India: A study of 50 years' data, 1970–2019, Weather and Climate Extremes,Volume 32,2021,100315,ISSN 2212-0947, https://doi.org/10.1016/j.wace.2021.100315

Bhubaneshwar Surveyed Hotspots	Ward Number
Neheru palei, Infocity backside	1
Sriram Nagar slum	5
Jagannath Ambatota slum	6
Sailashree vihar, Mahavir vasti	7
Munda sahi, Rangamatia upara sahi	9
Doordarshan kendra	12
Ekamra villa	15
Ghatikia village	23
Mangala slum	20
Subash nagar slum	65
Bhubaneshwar -10 Hotspots	

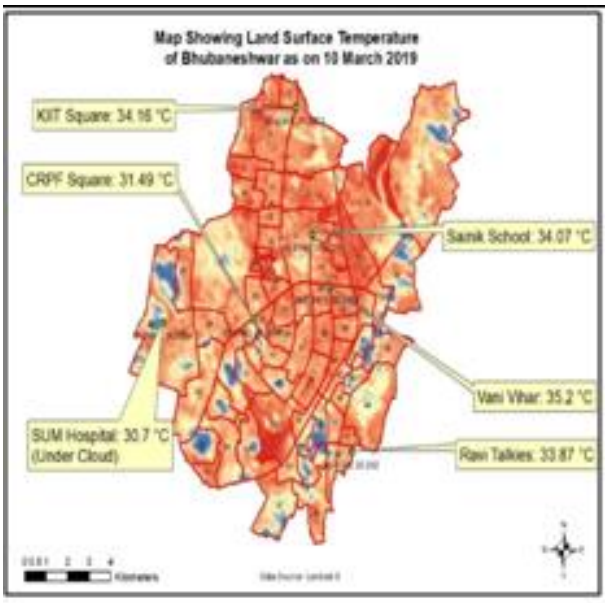


Figure 1: Bhubaneswar- Heat Vulnerable Hotspots and Map

4 Methodology

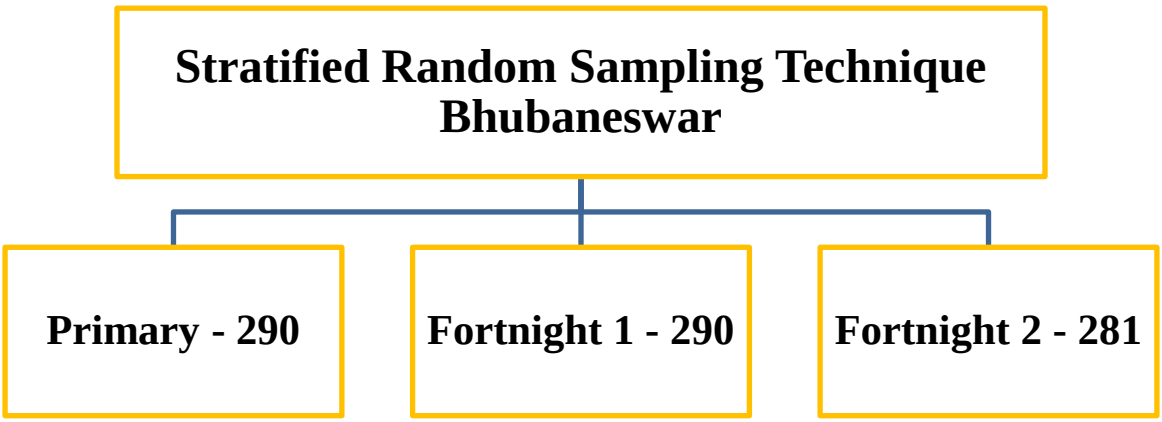
4.1 Purpose of the Study

This study aims to understand and analyse the implications of extreme heat on the health, productivity, and livelihoods of vulnerable groups, especially the working population (like construction workers, vendors, rickshaw pullers, factory workers, casual labourers, maids/helpers and office workers.), women, children, and senior citizens. To select appropriate, innovative and affordable climate adaptation measures for improving health and livelihood resilience for the urban population. It would help strengthen the capacity of key stakeholders to facilitate the implementation of the Heat Stress Action Plans and their long-term sustainability in the selected areas through training. Facilitate active use of information and evidence for policy-makers to drive the implementation of the Heat Stress Action Plans into municipal disaster strategies for better preparedness. The research framed a detailed quantitative and

qualitative framework for the assessment to develop a framework for heatwave mitigation and building the adaptive capacity of the people.

4.2 Selection of Participants

The identification of vulnerable population included economically weaker sections, women, children and elderly and working individuals such as construction workers, factory workers, transportation, sweepers, laborers and vendors /street hawkers. The vulnerability mapping was done by overlapping layers of identified vulnerable areas with vulnerable sections. Further, comprehensive household surveys were conducted to measure the susceptibility to heat stress. A total of 392 households participated in the study.



4.3 Declaration

The participants were aware before the survey that the information shared will be used only for research purposes, and hence, there is no risk foreseen with the study.

4.4 Confidentiality and participation in the survey

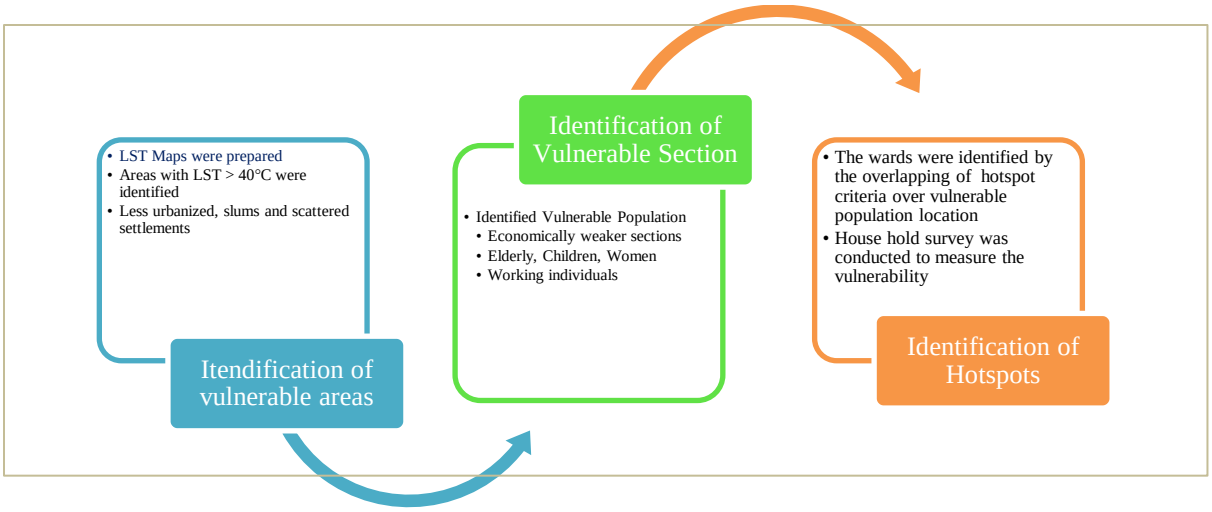
Participation in the survey was voluntary, and they could withdraw at any stage of the survey. The information gathered would be kept confidential.

4.4 Ethical consideration

Consent from participants was taken, and all the questions in the survey were verbally explained to the enrolled participants before the survey.

4.5 Survey design, Study area selection and data collection

The survey assessed the impact of heat stress on health, work productivity, and livelihood. The sample size was 300 households (HHs), and two sets of questionnaires/ research tools were used to capture the base information about household members and a fortnight longitudinal survey to capture the impact of heat stress in the previous 15 days on individual health, productivity, and livelihood. The surveys were initiated in the first week of May 2018 after the pilot surveys. Multi-level-stratified sampling was used for selecting 300 households within the hotspots identified in each city. For better analysis, vulnerable groups were categorised and recognised, such as the drivers, casual workers, shopkeepers, construction workers, slum dwellers, street vendors, children and women, and the elderly directly exposed to heat. Hotspots were identified based on the surface temperature recording, over April to May 2016 & 2017, geographic location (ward level), and the socio-economic conditions identified as hot spots, having small means to adapt to the heat stress.



Detailed questionnaires for household-level surveys were structured in epi-info software, and a stratified random sampling technique was used to conduct field surveys were conducted in the selected slums of the city. In addition, structured interviews were carried out at the household level. The investigators collected data by going door-to-door and helping the identified groups in responding where required.

Under the survey, the impacts of extreme heat events on the health, work productivity, and livelihoods of the vulnerable population were determined using a comprehensive index of compounding factors that exacerbate climatic impact. It comprises of total nine sectors and twenty-six respective sub-sectors of services that are critical to heatwave as listed in the table.

S.No.	SECTORS	SUB - SECTORS
1	**Sanitation**	Type of Toilet
		Individual Toilets
2	**Water**	Water Source
		Water Source Location
		Water Collection Time
		Frequency Water Supply
3	**Electricity**	Electricity Cut-off
4	**Health**	Access to Health Infra- Public/Private/Both
		Distance Hospital
		Health Insurance
5	**Transportation**	Mode of Transport
6	**Housing**	Years of Occupancy

		Number of Rooms
		Type of House
		Floor Type
		Roof Type
		Wall Type
		Number of Windows
		Wall Colour
7	**Cooking**	Cooking Place
		Cooking Fuel
8	**Awareness**	Heat Stress Awareness
		Awareness about use of Medical facilities for heat
		Awareness about availability Medical measures from ULB
9	**Heat Stress Symptoms**	Heat Exhaustion
		Heat Stroke

4.6 Data analysis

Primary survey data was collected and cleaned on the Epi-Info platform. The primary survey provided basic household information and general knowledge about heat stress and its implications. The other set was a longitudinal tool to monitor the impact of heat stress on the selected household members over 14 days. Most of the families were Below Poverty Line (BPL), and their occupations included labours, daily wage earners and mobile workers. The primary and fortnightly surveys conducted in each city were compiled on the Epi-info platform. Further, the data was analysed using EXCEL, SPSS and STATA.

5 Results

5.1 General characteristics of studied participants:

During summer, with the rising temperatures, heat stress affects the residents. It has some discernible impacts, such as a rise in mortality, an increased strain on infrastructure (power,

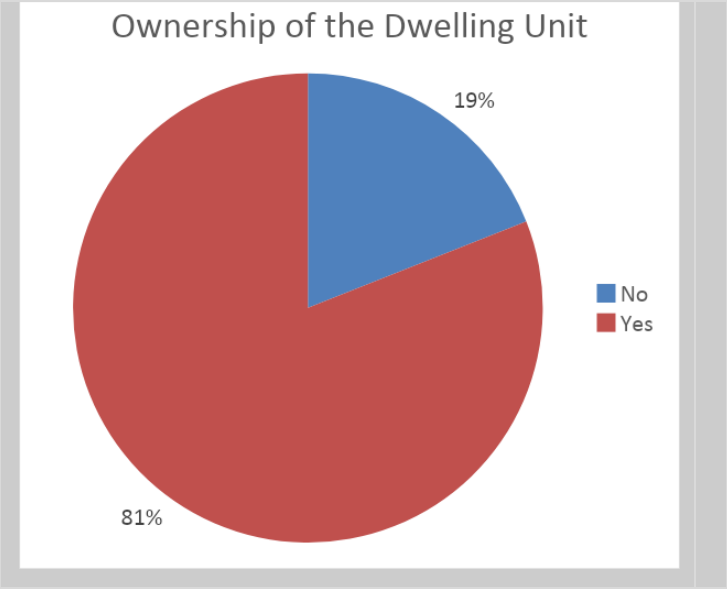
water, and transport), and ecosystem services. However, we know that the vulnerable sections, especially the poor, are more prone to heat. The economically disadvantaged and have limited access to resources and services. The synergistic effects of heat stress may, eventually, prove to be fatal for some. It must also be mentioned that the type of house, its building material, the number of hours spent indoors, and cooking may also add to the heat stress. A survey conducted in poor settlements highlights how lack of critical infrastructure and services aggravates heat stress on people.

5.2 Housing

5.2.1 Dwelling Ownership:

DWELLING OWNERSHIP			
Bhubaneswar city	**No**	**Yes**	**Total**
Absolute Numbers	56	234	290
Percentage distribution (Within Options)	19.31	80.69	100

Table-5.1.1 (a)



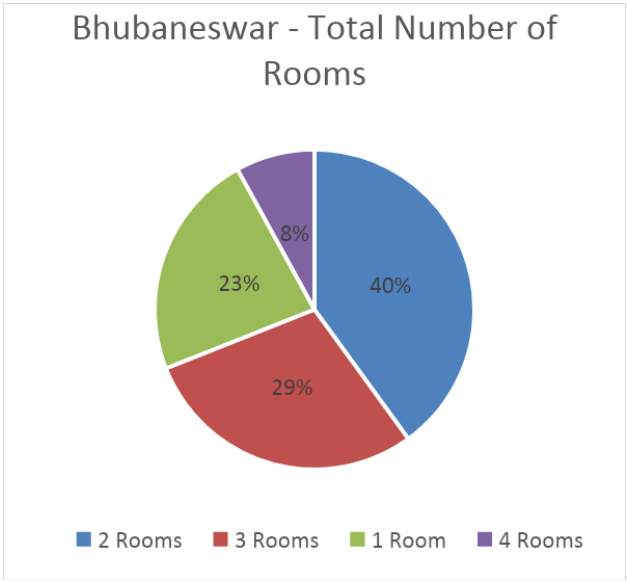
Graph- 5.1.1 (a)

It was reported that around 81% of participants own the dwelling units. It is thus more accessible for the house owner to introduce required structural amendments to combat the heat.

5.2.2 Total number of rooms:

Number of rooms in a dwelling unit					
Bhubaneswar city	**1 Room**	**2 Rooms**	**3 Rooms**	**4 Rooms**	**5 Rooms**
Absolute Number	67	117	83	23	0
Percentage distribution (Within Options)	23.1	40.34	28.62	7.93	0

Table-5.1.2 (a)



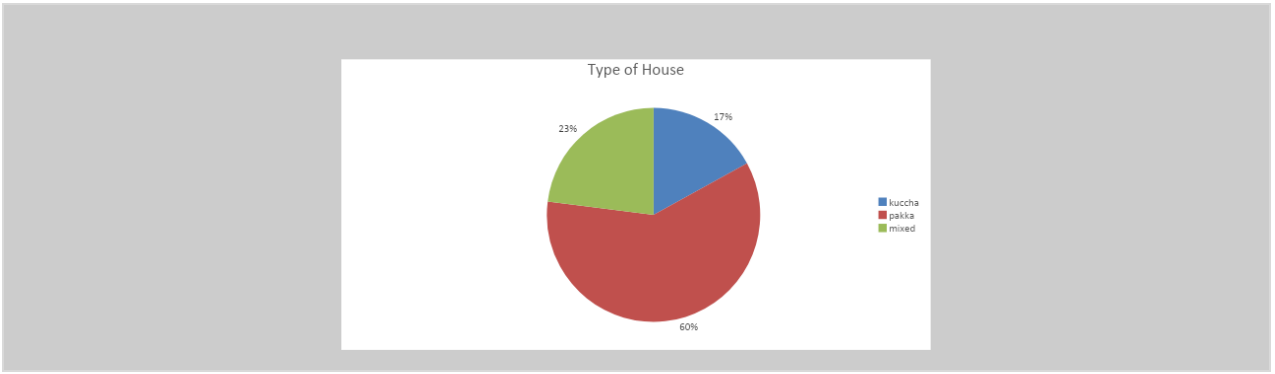
Graph-5.1.2 (a)

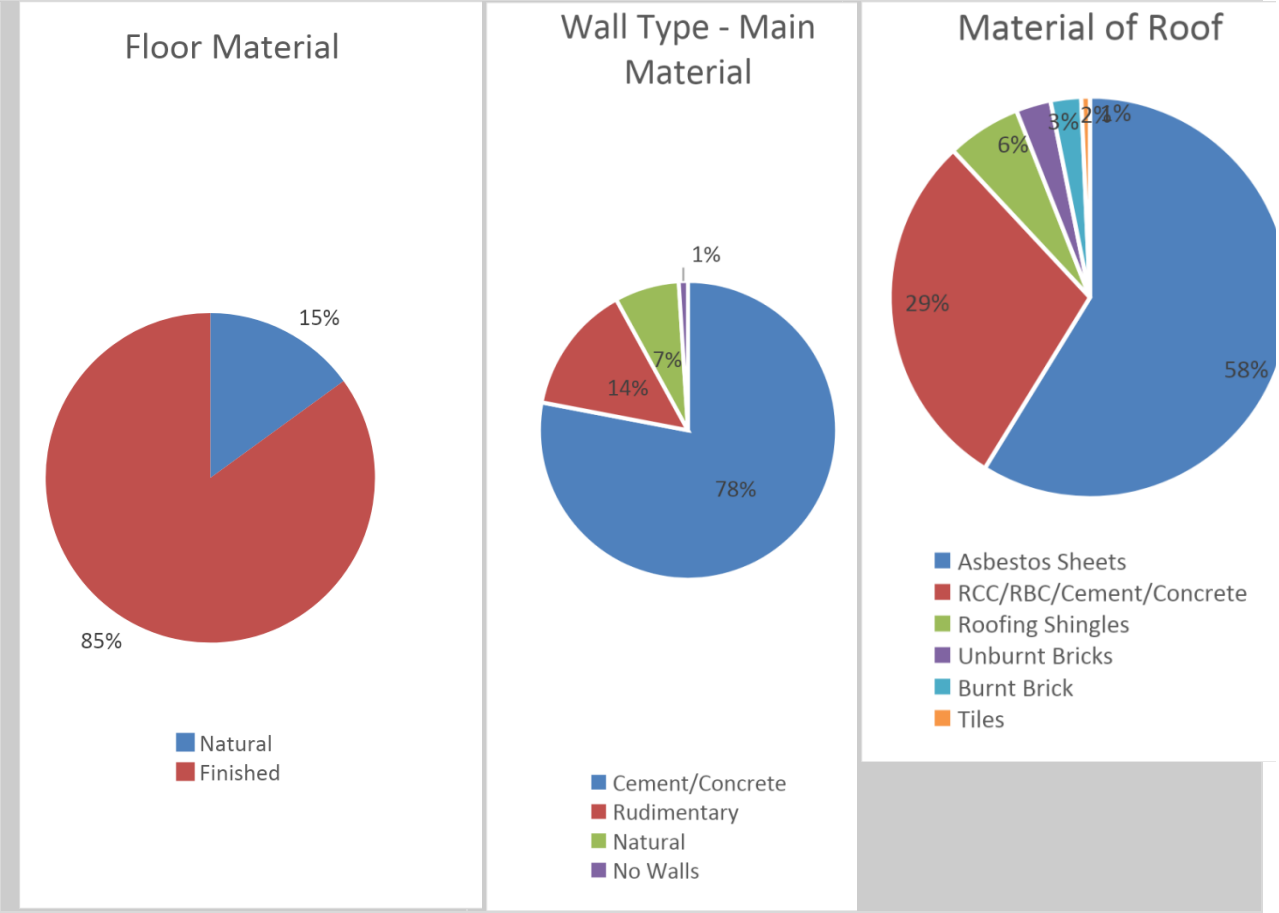
The average number of rooms per dwelling unit in most households is two, accounting for about 40 % of the households. Whereas only 37 % approximately have a dwelling unit with three or more rooms.

5.2.3 Type of housing structure, floor material, wall material, and roof material

HOUSE TYPE				
Bhubaneswar city	**Kuccha**	**Pakka**	**Mixed**	**Total**
Absolute Number	50	173	67	290
Percentage distribution (Within Options)	17.24	59.66	23.1	100

Table- 5.1.3(a)





Graph - 5.1.3

FLOOR TYPE					
Bhubaneswar city	**Natural**	**Rudimentary**	**Finished**	**Others**	**Total**
Absolute Number	44	0	246	0	290
Percentage distribution (Within Options)	15.17	0	84.83	0	100

Table- 5.1.3(b)

WALL TYPE

Bhubaneswar **city**	**No Walls**	**Natural**	**Rudimentary**	**GI/Metal/Asbestos Sheet**	**Cement/Concrete**	**Others**	**Total**
Absolute Number	3	20	40	1	226	0	290
Percentage distribution (Within Options)	1.03	6.9	13.79	0.34	77.93	0	100

Table – 5.1.3(c)

According to table 5.3.3 (a), most of the respondents' houses(60%) in the sample are pucca that helps adequately protect from the high temperatures. The most common material used for building the flooring and walls is cement used (85%) and (78%) respectively 5.3.3 (b,c),. However, asbestos sheets are the most common material used for the roof (58%).

People suffer from high retention of heat due to the usage of materials like cement and asbestos. Therefore, there is a need for affordable and heat resilient alternative building materials other than those mentioned above. Activities such as tree plantation for reducing the urban heat island effect, improving the natural cooling of existing construction through retrofitting, improving the living standards in the settlement may be adopted to minimise heat associated risk.

5.2.4 Number of windows, exterior wall paints

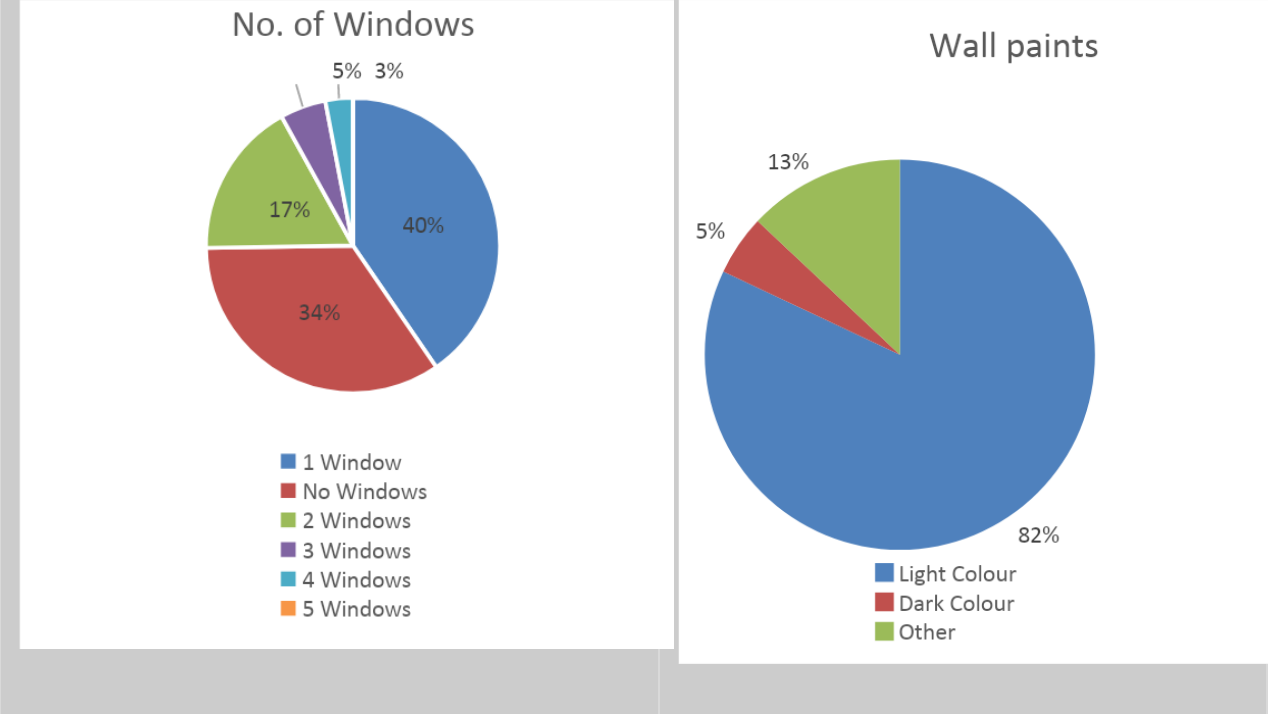
WINDOW NOS.						
Bhubaneswar city	**No Window**	**1**	**2**	**3**	**4**	**5**
Absolute Number	100	115	48	15	8	1

Percentage distribution (Within Options)	34.48	39.66	16.55	5.17	2.76	0.34

Table- 5.1.4(a)

OUT WALL COLOUR				
Bhubaneswar city	**Light Colour**	**Dark Colour**	**NA**	**Total**
Absolute Number	239	14	37	290
Percentage distribution (Within Options)	82.41	4.83	12.76	100

Table- 5.1.4(b)



Graph- 5.1.4

In the sample settlements, about 34% have no windows at all, followed by 40% have one window. In all, 74% of the sample has poor ventilation, and only 26% have two or more windows (table 5.1.4(a)). A poorly ventilated and confined dwelling unit might cause a lack of airflow, resulting in one of the causes of heat-related vulnerabilities. The exterior wall paint, however, is helping the citizens to deal with heat much better. Around 82% of the sample households have light colours on the exterior walls (table 5.1.4 (b)). This practice will help

combat heat and is not an impending factor that exacerbates heat stress among the residents. However, more focus is on passive cooling techniques to allow ventilation and natural light inside the house.

Implications: The poor housing quality in terms of design and the materials used in these settlements exacerbates discomfort and potential health risks during extreme heat, particularly heatwaves. The poor housing also increases the indoor temperature as the houses heat up quickly, and in peak hot season, these houses cool down very slowly. Staying home during heatwaves may lead to other health risks in heat vulnerable households, and overcrowding inside the house might aggravate these risks.

5.3 Cooking:

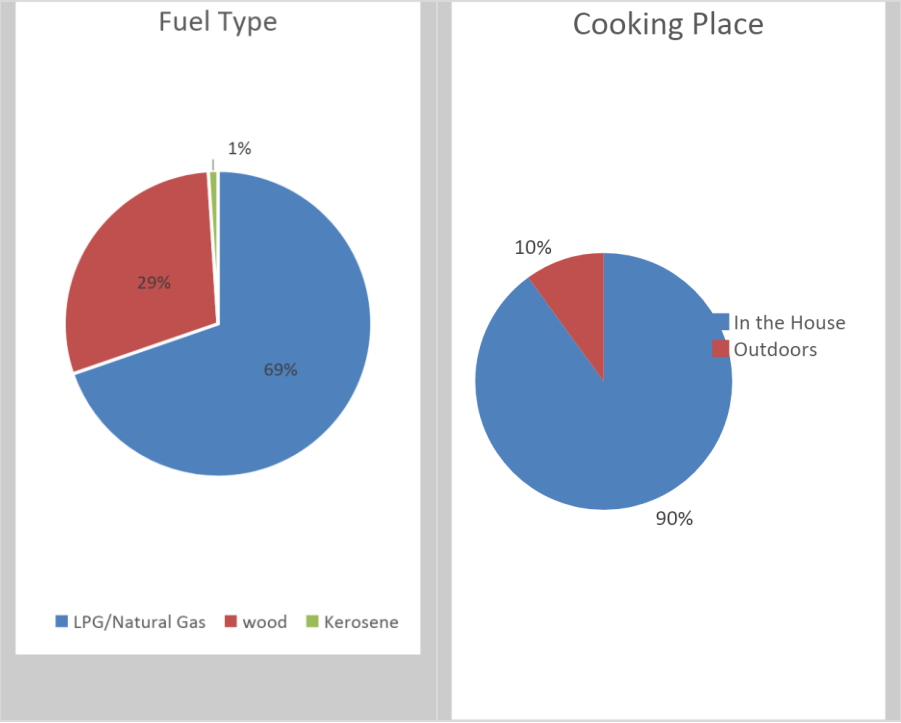
5.3.1 Type of fuel

	Fuel type								
city	**Electricity**	**LPG/Natural Gas**	**Biogas**	**Kerosene**	**Coal/Lignite**	**Charcoal**	**wood**	**Animal Dung**	**Total**
Absolute Number	1	199	0	4	1	0	85	0	290
Percentage distribution (Within Options)	0.34	68.62	0	1.38	0.34	0	29.31	0	100

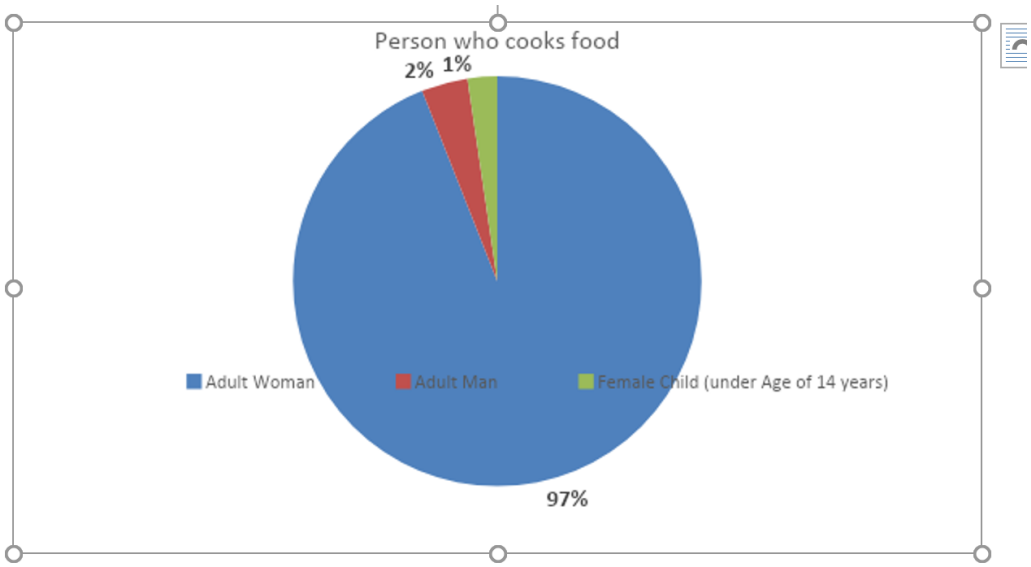
Table-5.2.1(a)

COOKING PLACE				
Bhubaneswar city	**In the house**	**Within premises**	**Outdoors**	**Total**
Absolute No.	261	1	28	290
Percentage distribution (Within Options)	90	0.34	9.66	100

Table-5.2.1(b)



Graph-5.2.1(a)



Graph-5.2.1(b)

Table 5.2.1 (a) indicates that the majority of the households surveyed (69%) have access to LPG/ Natural Gas for cooking purposes. However, 31 % still depend on unsustainable sources such as wood and kerosene for cooking. It may lead to heat getting trapped, resulting in increased vulnerability. 90% of the households have a facility to cook food in the house. It is found that above 97% of adult females cook food in the house, and the ones using wood for cooking are most vulnerable. Clean energy promotes better preparedness towards heat and decreases the cooking time with almost no health impacts on the households. Cooking time has a bearing on heat exposure of females in households. Hence, while cooking fuels may not be a critical factor impacting heat stress, heat exposure could exacerbate heat stress.

Implications: The females in the households are exposed to extreme heat while cooking. During a hot period, cooking increases heat exposure and makes women vulnerable to heat stress. The location of the kitchen within the premises also increases the risk of a rise in indoor temperatures and pollution due to their ill-designed housing structure, poor ventilation, and availability of few windows and the type of fuels used in the cooking

5.4 Sanitation:

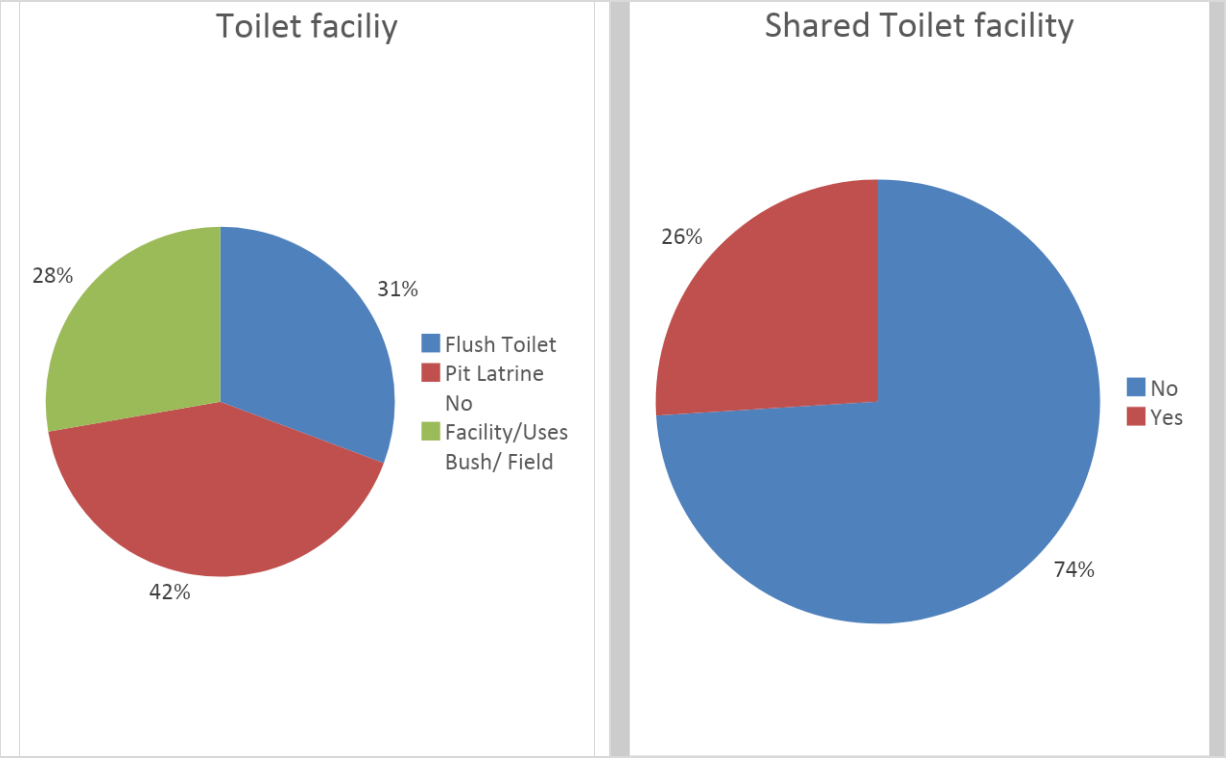
5.4.1 Access to toilet

Type of Toilet Facility						
Bhubaneswar city	**Flush Toilet**	**Pit Latrine**	**No Facility/Uses Bush/ Field**	**Composting toilet**	**Other**	**Total**
Absolute Number	89	121	80	0	0	290
Percentage distribution (Within Options)	30.69	41.72	27.59	0	0	100

Table- 5.3.1(a)

Public toilet used by households			
Bhubaneswar city	**No**	**Yes**	**Total**
Absolute Number	157	54	211
Percentage distribution (Within Options)	74.41	25.59	100

Table- 5.3.1 (b)



Graph- 5.3.1

The sample survey shows that 75% of the households have access to either pit latrines or flush toilets. 74%, making the majority, do not use a shared facility for sanitation purposes (table-5.3.1 (a)). Since there is already an awareness of hygiene among households, no actions are needed in the majority; however, 25% with either no toilet or composting toilet facilities should be empowered to continue to transition as they are under high risk. Sustained efforts should be taken to maintain consistency of hygiene. However, sanitation is not a critical factor leading to heat stress.

Implications: Availability of sanitation is not a critical factor in combatting heat stress for the majority. However, the focus should be on those with no toilet facility as its absence might create numerous health issues, especially for women and children. Access to sanitation services is essential for the health of heat vulnerable households.

5.5 Water

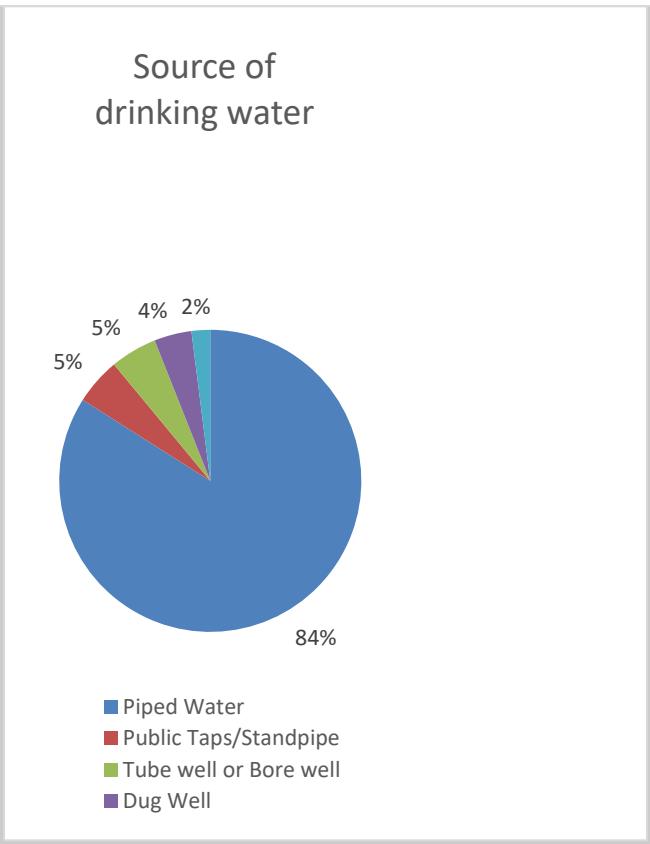
5.5.1 Access to water supply

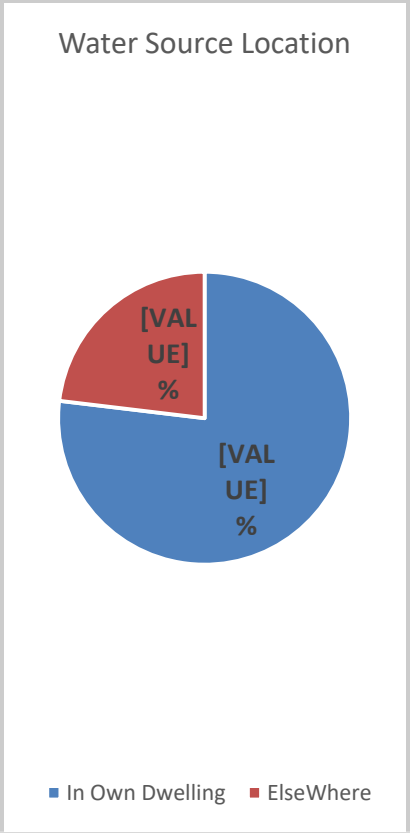
Access to Water Supply									
Bhubaneswar city	**Piped Water**	**Public Taps/Standpipe**	**Tube well or Borewell**	**Dug Well**	**Tanker water**	**Surface Water**	**Bottled Water**	**Other**	**Total**
Absolute Number	243	15	14	13	0	0	0	5	290
Percentage distribution (Within Options)	83.79	5.17	4.83	4.48	0	0	0	1.72	100

Table- 5.4.1(a)

Water source location			
Bhubaneswar city	**In own dwelling**	**Elsewhere**	**Total**
Absolute Number	223	67	290
Percentage distribution (Within Options)	76.9	23.1	100

Table- 5.4.1 (b)


Source of drinking water
4%
2%
5%
5%
84%
Piped Water
Public Taps/Standpipe
Tube well or Bore well
Dug Well


Water Source Location
[VALUE] %
[VALUE] %
In Own Dwelling
ElseWhere

Graph-5.4.1 (a)

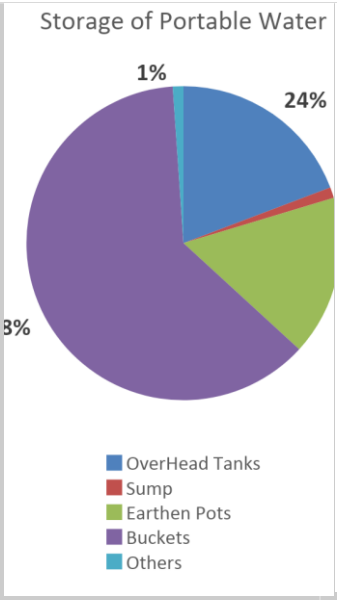
Graph-5.4.1 (a)

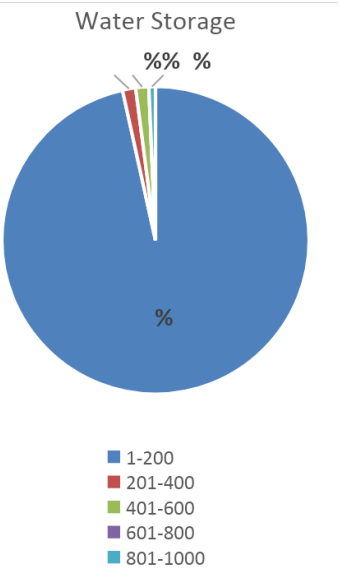
Table 5.4.1 (a) shows that 84% of the sample households have access to the piped water supply. Others water from unsustainable sources like public taps, tankers, bottled water, nearby streams, dug wells, groundwater supply. For 77%, the water source is within the premises while 23% still have to fetch water. It may lead to vulnerability towards heat and other health implications such as diarrhoea, cholera, diarrhoea, dysentery, hepatitis A, typhoid. There may be limited water supply during the peak hot season due to low- water pressure , poor access to water from different sources, and increased water demand or scarcity. Mitigation actions for affordable user tariffs, adding more households in the distribution network, water dispensing trucks, and water storage facilities at the community level.

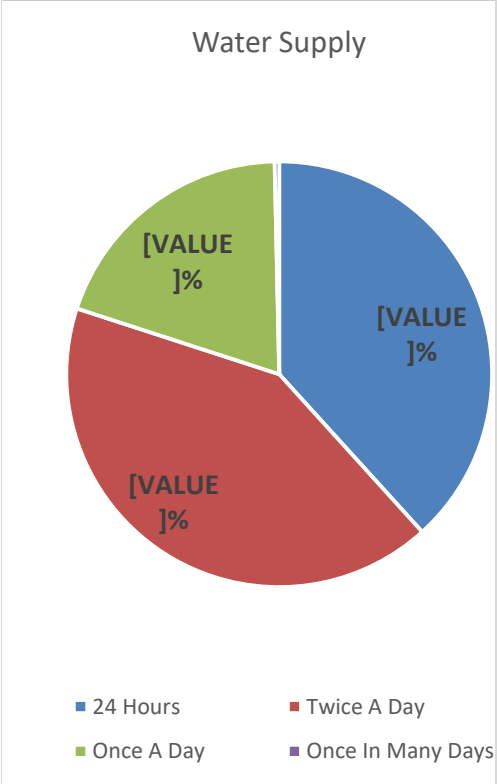
5.5.2 Water Supply (litres):

Frequency of water supply					
Bhubaneswar city	**24 *7**	**Twice a Day**	**Once a Day**	**Once in Many Days**	**Total**
Absolute Number	111	121	57	1	290
Percentage distribution (Within Options)	38.28	41.72	19.66	0.34	100

Table- 5.4.2


Storage of Portable Water
1%
24%
3%
OverHead Tanks
Sump
Earthen Pots
Buckets
Others


Water Storage
%% %
%
1-200
201-400
401-600
601-800
801-1000


Water Supply
[VALUE]%
[VALUE]%
[VALUE]%
24 Hours
Twice A Day
Once A Day
Once In Many Days

Graph- 5.4.2

According to table 5.4.2 (a), 20% of the sample households are supplied water once a day. The frequency of water supply needs to increase to avoid risk on high heat days. To mitigate water shortage, measures such as spreading awareness on the water conservation techniques among the households could be adopted.

Implication: Access to safe and affordable water available to all is critical during heat stress. Its scarcity might result in securing water from unreliable sources. It not only increases public health risk but raises the issue of water security.

5.6 Electricity:

5.6.1 Electricity supply and frequency of power cuts in summer months 5.6.2 :

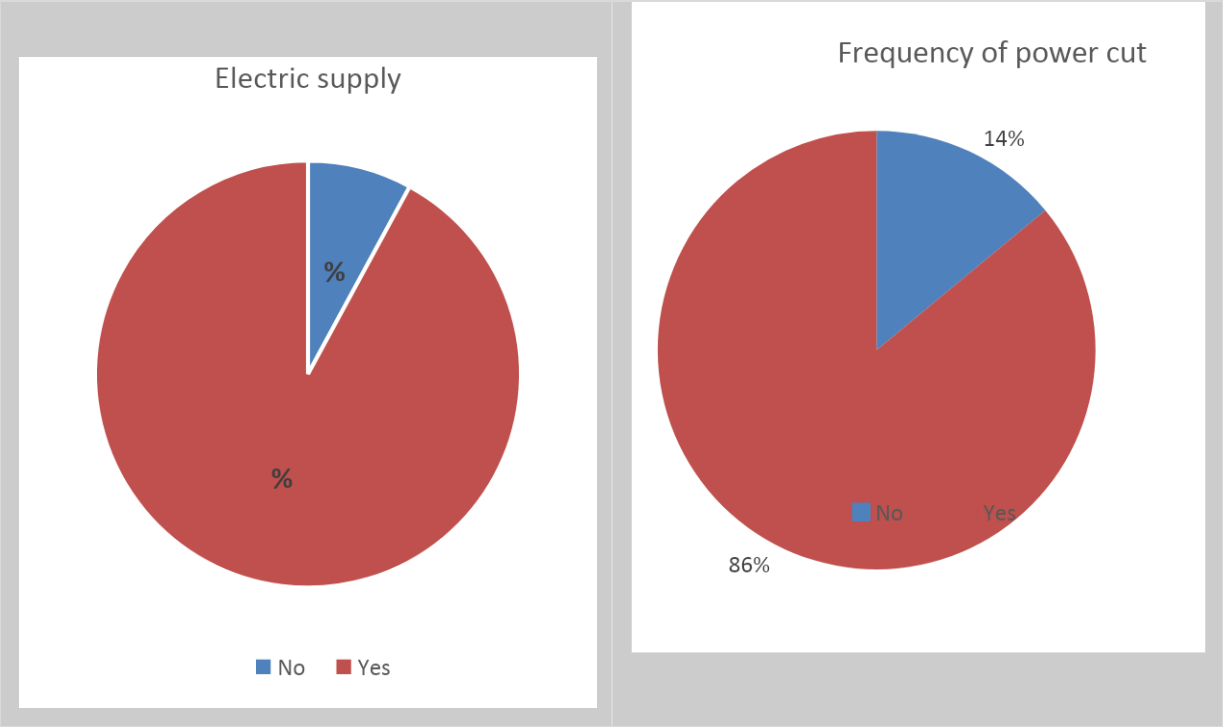
Uninterrupted supply days			
Bhubaneswar city	**No**	**Yes**	**Total**
Absolute Numbers	23	267	290
Percentage distribution (Within Options)	7.93	92.07	100

Table- 5.5.1(a)

All 92% of households are connected to the grid (have legal electricity connection). Therefore, it is not a disrupting factor. However, the survey shows, 86% of the sample households claim that they face power cuts (Table 5.5.1 (a)). Solar power may be harnessed. The govt should also ensure power supply during hot periods in the summer season.

POWER CUT			
Bhubaneswar city	**No**	**Yes**	**Total**
Absolute Numbers	37	230	267
Percentage distribution (Within Options)	13.86	86.14	100

Table- 5.5.1 (b)



Graph- 5.5.1

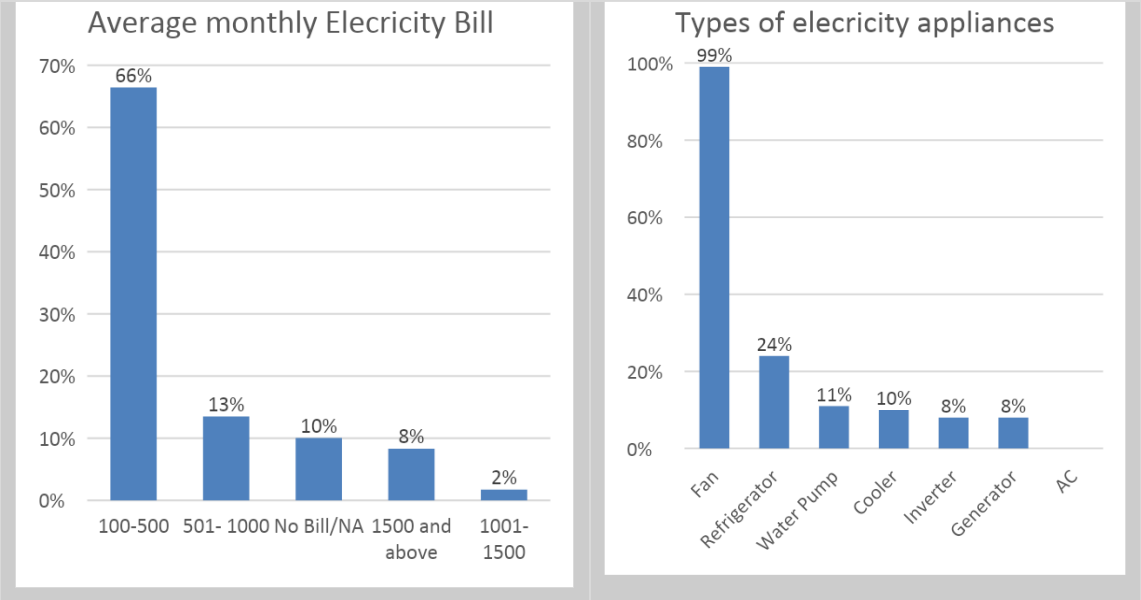
5.6.3 Types of electric appliances used and electricity Bill:

Electrical appliances							
Bhubaneswar city	**AC**	**Fan**	**Cooler**	**Refrigerator**	**Water Pump**	**Inverter**	**Generator**
Absolute Number	1	287	28	70	32	22	22
Percentage distribution (Within Options)	0.37	98.97	9.66	24.14	11.03	7.59	7.59

Table- 5.5.2(a)

Average electricity expense						
Bhubaneswar city	**No Bill/NA**	**100-500**	**501-1000**	**1001-1500**	**1500 and above**	**Total**
Absolute Number	29	192	39	5	24	289
Percentage distribution (Within Options)	10.03	66.44	13.49	1.73	8.3	100

Table- 5.5.2 (a)



Graph- 5.5.2

The majority of the households have fans, followed by refrigerators and water pumps (table- 5.5.2 (a)). 66% had expense in the range of INR 100-500 (table- 5.7.2 (b)). The majority of the respondents incurred higher than INR 500 as the expense. As a way out, the households should be trained about harnessing natural resources for mitigating heat stress. This will also help the households in minimising their electricity costs.

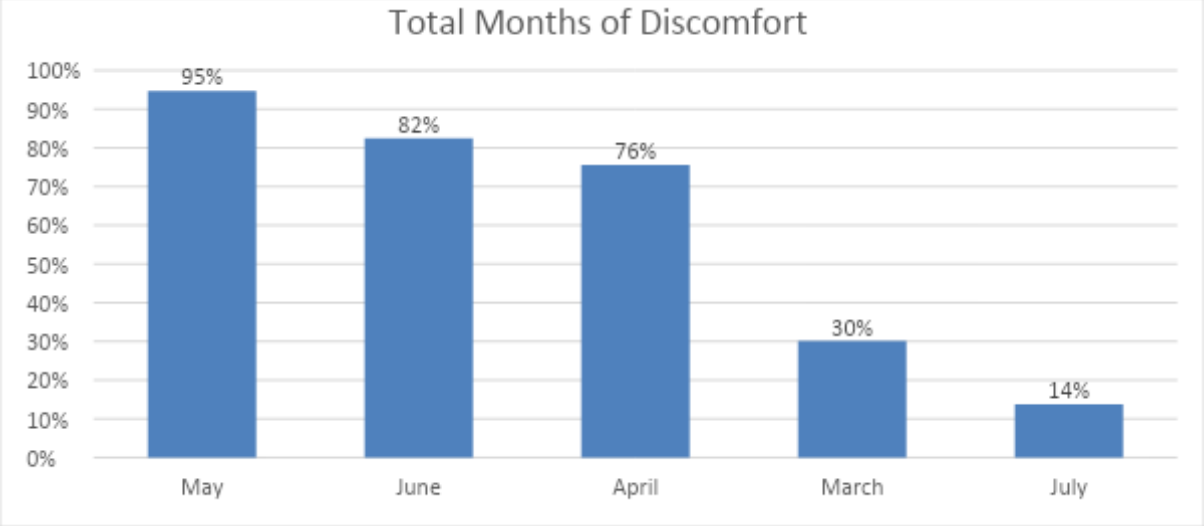
Implication: Accessibility to electricity helps to minimise the acute impacts of heat stress, especially during the heatwave. High temperatures exacerbate energy insecurity for those living in poor neighbourhoods, as these communities typically bear the brunt of the heat.

5.7 Health:

5.7.1 Mapping the High Heat Period

Heat stress Months								
Bhubaneswar city	**Jan**	**Feb**	**March**	**April**	**May**	**June**	**July**	**August**
Absolute No.	3	9	342	859	1075	937	156	7
Percentage distribution (Within Options)	0.26	0.79	30.11	75.62	94.63	82.48	13.73	0.62

Table-5.6.3



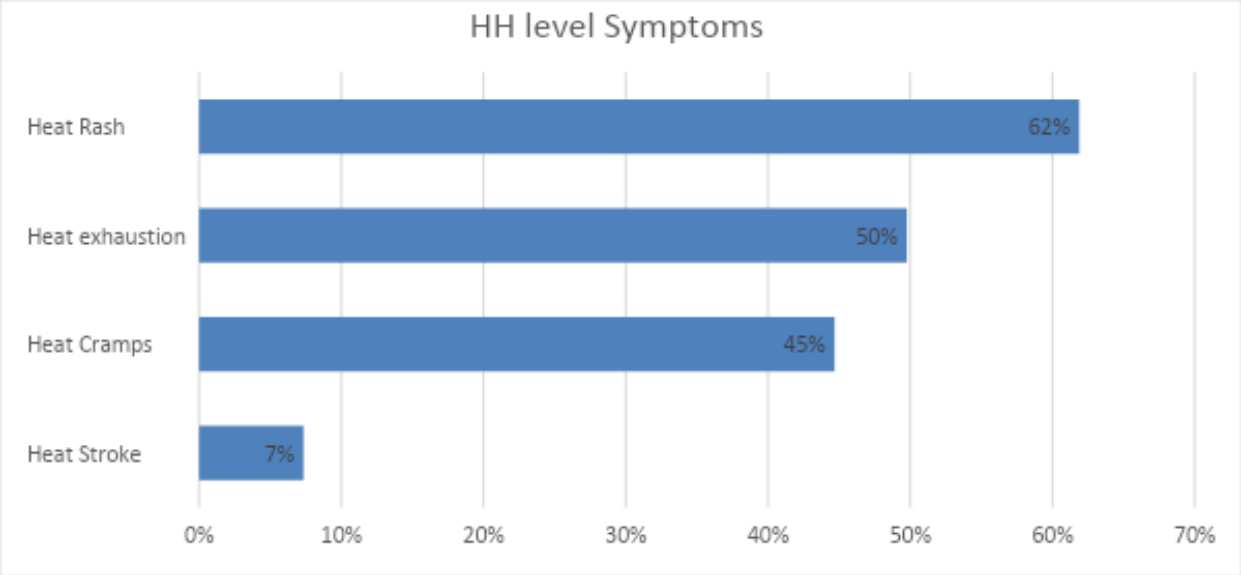
Graph-5.6.3

Bhubaneswar experiences summer from May to July as it falls under North India's core heatwave zone. The hot season intensifies in May, June, and July. During this period, the temperatures peak and result in severe heatwave conditions, deterioration in public health, and causing heat stress. During these months, extreme caution has to be adopted, and the government should share heat stress advisory among the households.

5.7.2 Time of Heat discomfort during the day: (Dot graph to be retrieved from Probal Sir, Image of the graph)

Dot graphs to be added and results to be retrieved from the same

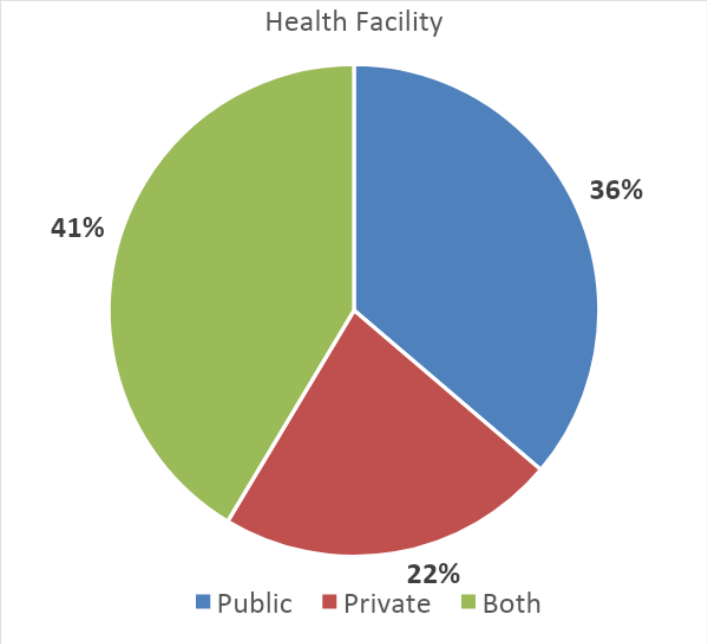
5.7.3 Household Reporting Heat Stress Symptoms



Graph-5.6.5

Households reported heat stress symptoms— 62 % reported heat rashes, 50 % said they suffered heat exhaustion, 45 % bore heat cramps. The figures indicate that heat stress is a growing public health issue.

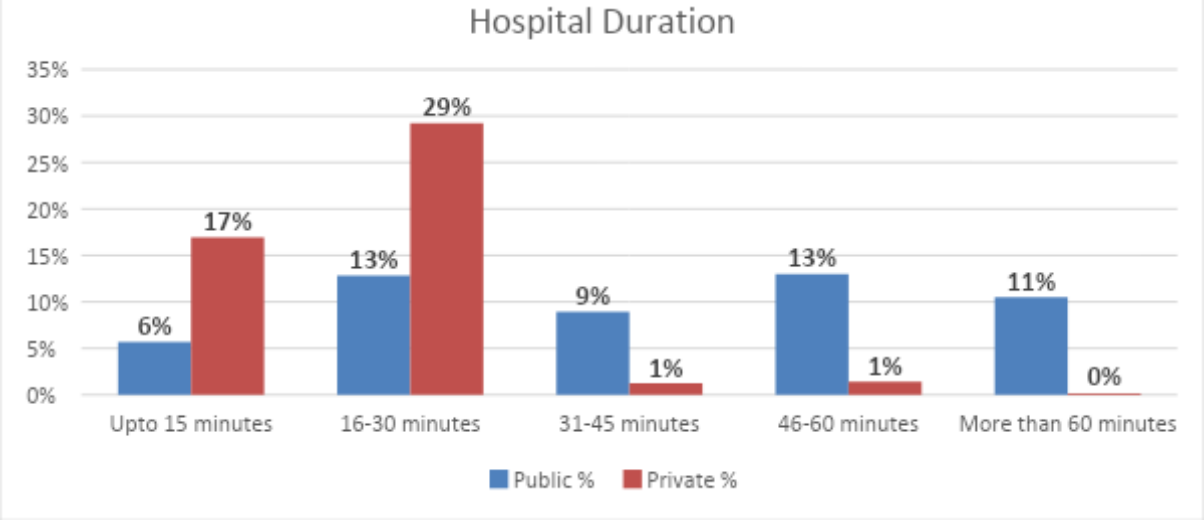
5.7.4 Access to health infrastructure:



Graph-5.6.1

About 36 % of the households accessed public health care. However, 22 %accessed only private health care. 41 % accessed both public and private health care facilities

5.7.5 Distance from nearest health centre



Graph-5.6.2

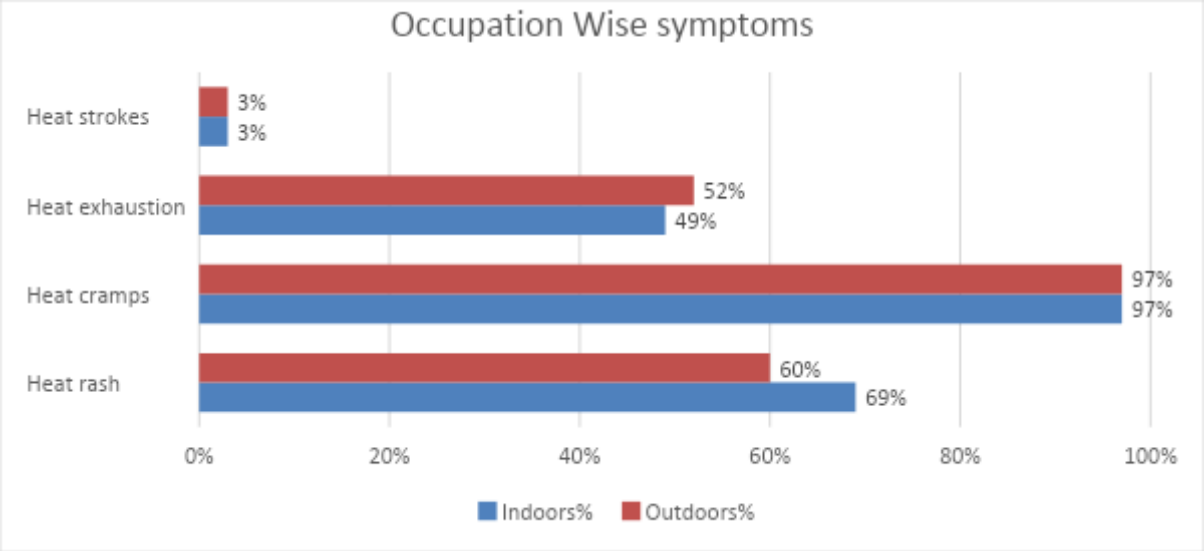
About 17 % had private health facilities within 15 minutes from their home, and 6 % of public health facility users took up to 15 minutes. Similarly, about 29 % of private health facility users and 13 % of public health facility users took 16-30 minutes. It indicates that there is limited access to public health facilities. If it is corroborated with percent of households accessing public health facilities, it suggests that people travel a long distance to visit available facilities due to their low affordability.

Impact of heat on health:

5.7.6 Occupation Wise Symptoms

Bhubaneswar City	Heat rash		Heat Cramps		Heat Exhaustion		Heat Stroke	
	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor
Absolute Numbers	385	250	543	409	273	217	21	13
Percentage distribution (Within Options)	68.63	59.95	96.79	98.08	48.66	52.04	3.74	3.12

Table-5.6.6



Graph-5.6.6

According to Graph-5.6.6 indoor workers suffer more than outdoor workers. Indoor and outdoor workers suffer most from Heat cramps (97 percent) followed by Heat rash (69 percent indoor, 60 percent outdoor).

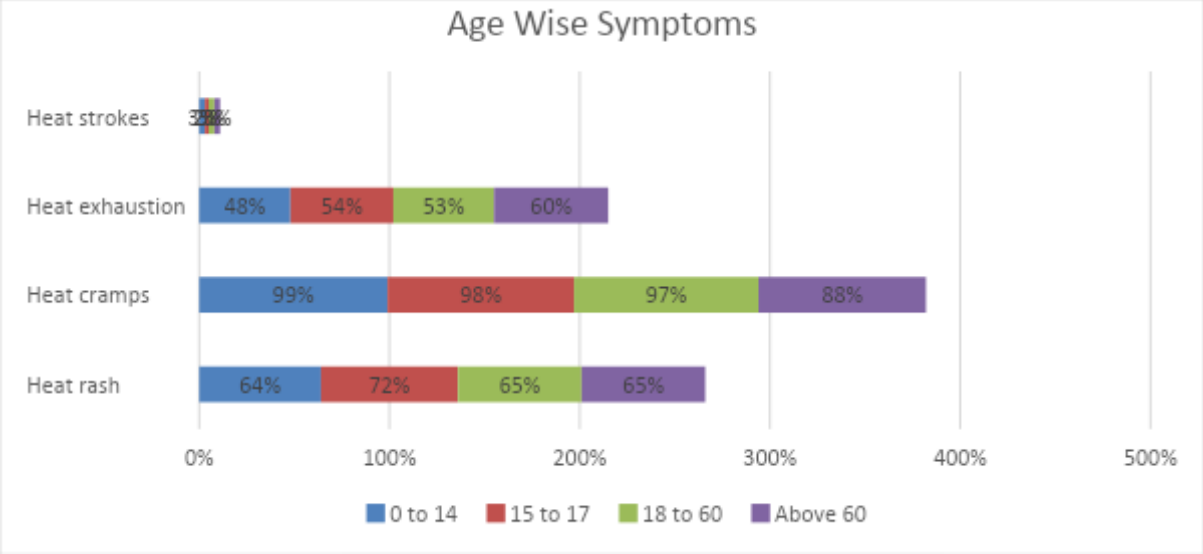
Occupation type	1st Heat stress Symptoms	2nd Heat stress Symptoms
Outdoor workers	Heat cramps	Heat Rash
Indoor Workers	Heat cramps	Heat Rash

5.7.7 Age Wise Symptoms

Bhubaneswar	**Heat rash**				**Heat Cramps**				**Heat Exhaustion**				**Heat Stroke**			
	0 to 14	**15 to 17**	**18 to 60**	**Above 60**	**0 to 14**	**15 to 17**	**18 to 60**	**Above 60**	**0 to 14**	**15 to 17**	**18 to 60**	**Above 60**	**0 to 14**	**15 to 17**	**18 to 60**	**Above 60**
Absolute No.	196	39	479	26	302	53	714	35	147	29	389	24	9	1	25	1
Percent	64.	72.	65	65	98.	98.	97.	87.	48	53	52.	60	2.	1.	3.	2.5

age distribution (Within Options)	05	22	.1		69	15	01	5		.7	85		94	85	4	
Percentage distribution (Within Cities)	19.96	14.55	21.6	24.3	25.57	16.83	26.25	26.72	15.7	11.2	18.16	22.6	4.46	1.92	4.77	4.35

Table-5.6.7



Graph-5.6.7

Across all the ages, heat cramps followed by heat rash and Heat exhaustion are the most common symptoms. A majority of Children and adolescence from the period 0 to 14 and 15 to 17 respectively have reported symptoms of Heat cramps. Similarly, Adults or the working class ranging from 18 to 60 have reported the majority suffering from Heat cramps followed by Heat rash. Senior citizens above 60, also suffer most from Heat cramps.

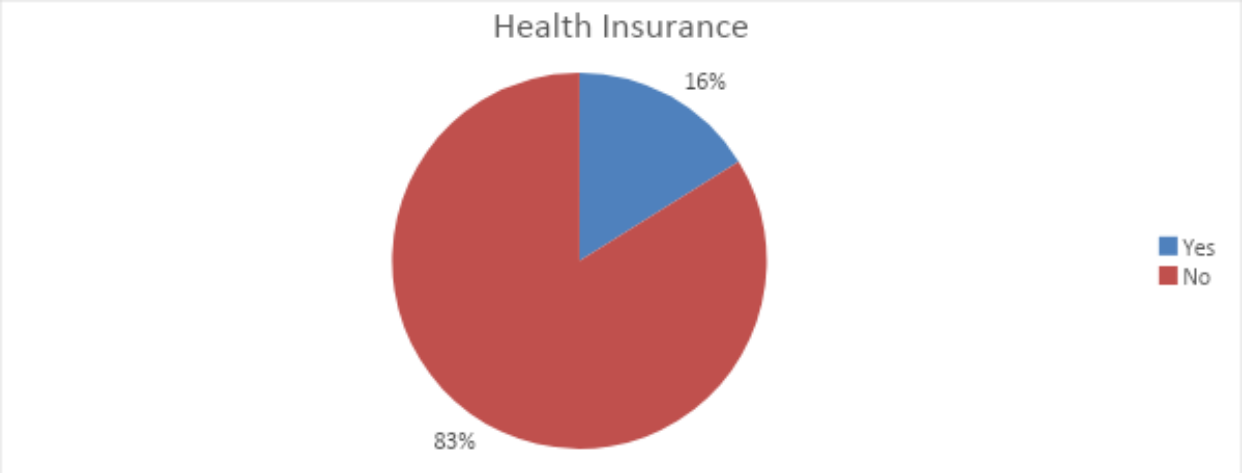
Age group	1st Heat symptoms	2nd Heat symptoms
0 to 14	Heat cramps	Heat Rash
15 to 17		
18 to 60		
Above 60		

5.8 Health insurance

5.8.1 Health Insurance among Households

Health insurance				
Bhubaneswar city	**Yes**	**No**	**Don't know**	**Total**
Absolute Numbers	46	242	2	290
Percentage distribution (Within Options)	15.86	83.45	0.69	100

Table- 5.7.1



Graph- 5.7.1

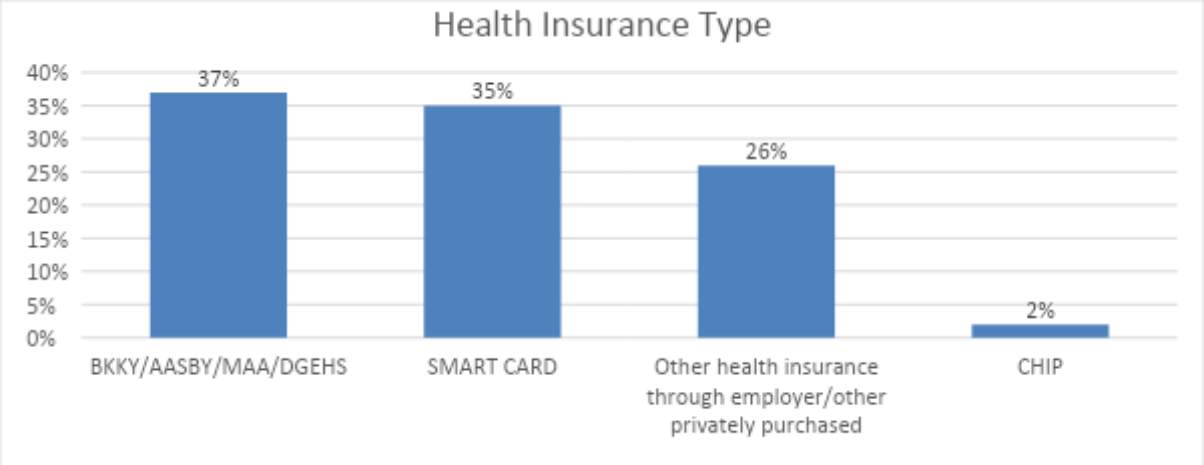
As per graph 5. 7.1 (a), 83% of the people do not have access to health insurance. Due to affordability, most households are out of the insurance network and have inferior awareness about government-sponsored medical schemes such as Ayushman Bharat Pradhan Mantri Jan Arogya Yojana. To improve access to health insurance, the government should develop insurance schemes for people significantly below the poverty line, and the local government hospitals should treat heat stress illnesses free of cost.

5.8.2 Source of health insurance

Source of hhealth insurance								
Bhubaneswar city	ESIS	Aam Aadmi Bima Yojana Mother Absolute Affection / Delhi Government Employees Health Scheme	CHIP	SMART CARD	Other health insurance through employer/ other privately	Medical reimbursement from employer	Others	Total

					purchased			
Absolute No.	0	17	1	16	#	0	0	#
Percentage distribution (Within Options)	0	37	2	35	#	0	0	#

Table- 5.7.2



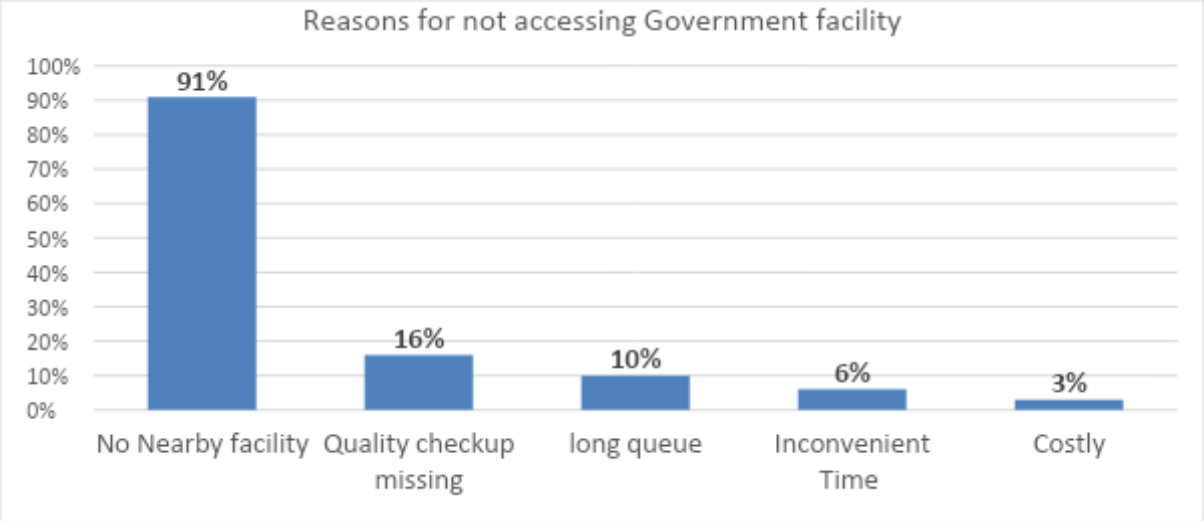
Graph- 5.7.2

The graph 5.7.5(a) shows that about 37% have State Health Insurance and another 35%with smart health cards for clinical information. These are the govt sponsored schemes to help economically weaker sections of society to access medical care. While some households have health insurance, bringing more people under the health insurance net by improving access, making schemes affordable and increasing awareness about benefits.

5.8.3 Reasons for not accessing government health facility

Reasons of not using government facilities							
Bhubaneswarcity	**Non-Availability**	**Timing**	**Absence of employees**	**Waiting Time**	**Poor quality**	**Expensive**	**Other**
Absolute No.	62	4	0	7	11	2	0
Percentage distribution (Within Options)	91.18	5.88	0	10.29	16.18	2.94	0

Table- 5.7.3



Graph- 5.7.3

Table 5.7.3(a) indicates that no nearby facility is the most (91%) prominent reason for not accessing public facilities. The other reasons are quality check-ups (16%), long queue (10%), inconvenient time (6%) and affordability (3%).

Implications: Heat stress often results in frequent hospitalisations during hot months, and it results in financial strain on households, especially on patients with chronic health conditions. Public health systems need acute measures to respond to heatwave.

5.9 Women-specific impacts of heat stress

The impact of heat stress on women is manifold. Many physiological and environmental factors play a critical role in causing more heat stress among women and putting them more at risk for heat-related mortality. Through the studies conducted on Gender inequality, it is inferred that women are more likely than men to be affected by climate change. Female mortality due to heat-stroke shows an increasing trend since 2011 in the age group of below 14 years, whereas male mortality has been reducing continuously. With the growing heat stress, women become vulnerable as their ability to thermoregulate is compromised. There are increasing heat-related illnesses and stillbirth among pregnant women, which further intensify due to social norms and gender discrimination embedded in society. Moreover, pregnant and post-partum women and their infants are uniquely vulnerable to the health impacts of climate change due to the many physiologic and social changes that occur as a result of pregnancy. Also, it is observed that high temperatures can give rise to air pollutants causing chronic health effects, such as respiratory diseases and allergic reactions.

Among the working women from economically weaker sections, the heat stress vulnerabilities are high, and it further increases due to resource crunch and insufficient adaptive capacities. Low-income women are disproportionately vulnerable to the ill-effects of climate variability and change, in part because of gender inequalities (e.g., unequal political, social, economic, and cultural rights; lower levels of access to resources, information, and education; and lower levels of participation and influence in shaping policies and decision-making processes at all levels, including the household). It has also been observed that high temperatures can give rise to air

pollutants causing chronic health effects, such as respiratory diseases and allergic reactions. For the working women, the factors affecting their thermal comforts, such as air temperatures, radiant temperature, humidity, and air movement, expose them to various health risks. Besides, personal factors that affect thermal comfort are viz., clothing insulation, and metabolic heat. Furthermore, outdoor workers are also vulnerable to urban heat island effects. It has also been observed that high temperatures can give rise to air pollutants causing chronic health effects, such as respiratory diseases and allergic reactions.

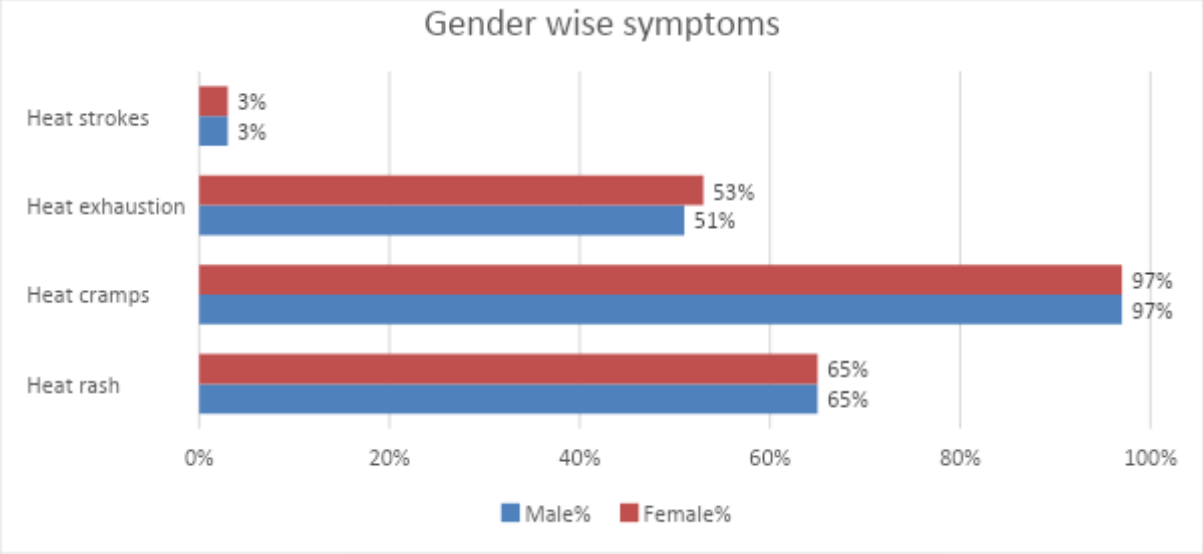
Furthermore, the lack of timely access to information on heat alerts increases their risk of heat stress. Their exclusion in decision-making and adaptation behaviour adds to their vulnerability, making them less aware of adaptation strategies and mitigation measures.

5.10 Impact of Heat on Gender

5.10.1 Differential Impact of heat on heat stress symptoms:

	Heat rash		Heat cramps		Heat Exhaustion		Heat Stroke	
Bhubaneswar	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Absolute Number	348	391	519	584	273	315	18	18
Percentage distribution (Within Options)	65.05	65.17	97.01	97.33	51.03	52.5	3.36	3

Table- 5.8.1



Graph- 5.8.1

The heatwave has a differentiated impact on gender. Females suffer more severe implications of heat stress than men. About 97 % of women bear heat cramps, with another 65 % suffering from heat rash, and about 53 % of women are affected by heat-rash. Being the caregivers, women proactively work both outdoor and indoor, which often puts them at higher risk of heat stress.

The survey highlights that the women are equally vulnerable to symptoms like heat cramps followed by heat exhaustion, and heat rash is most common among the sample. The table above shows that males and females experience similar heat stress symptoms. It is observed that heat rash is more common in males, while heat stroke is more common in females. Heat strokes are standard in the women as they stay indoors, and social norms, housing design, and its material aggravate heat-stroke conditions and other public health concerns.

5.11 Impact of Heat Stress on Livelihoods and Productivity

Due to the rise of heat stress, its impact reflected on the wage and productivity loss amongst the working population, especially in vulnerable sections of the society.

5.11.1 Average Wage Loss:

Average Wage Loss						
Bhubaneswar City	**No wage loss**	**1-999**	**1000-1999**	**2000-2999**	**3000 and above**	**Total**
Absolute No.	278	108	19	14	7	426
Percentage distribution (Within Options)	65.26	25.35	4.46	3.29	1.64	100
Percentage distribution (Within Cities)	23.13	42.19	73.08	73.68	35	27.97

Note: No Wage Loss was not considered while calculating the Average Wage Loss.

Table- 5.9.1

Graph- 5.9.1

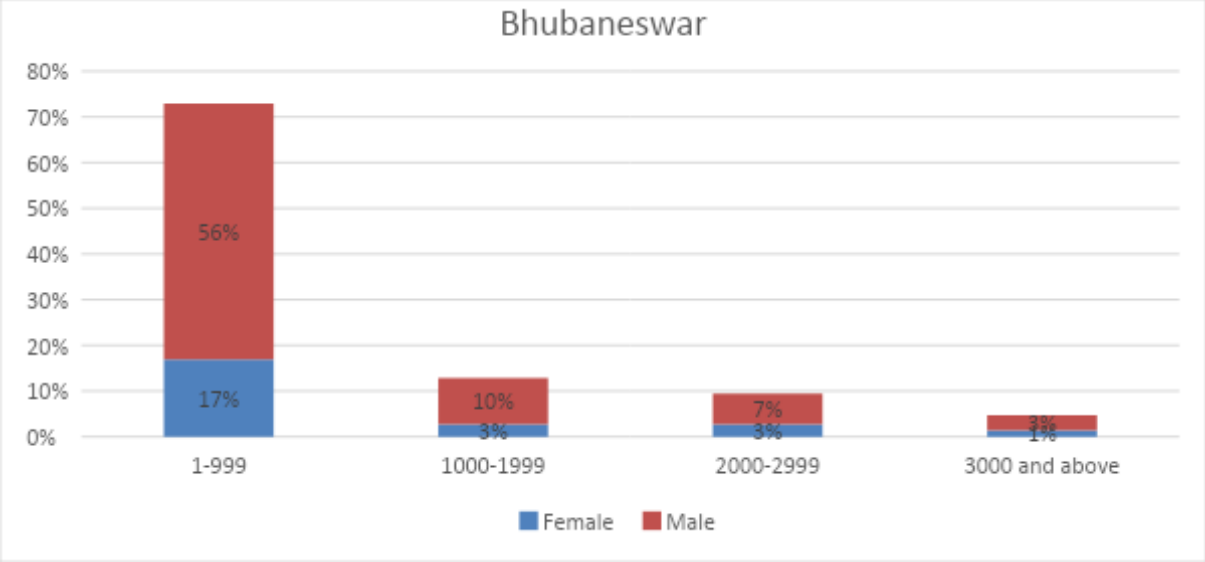
The average wage loss in the city falls under the category INR 1 to 999. The survey shows that the majority of casual workers fall in class 1 to 999.

5.11.2 Gender Wise Wage Loss:

	Wage loss code					
Gender	**No wage loss**	**1-999**	**1000-1999**	**2000-2999**	**3000 and above**	**Total**
Female	66	25	4	4	2	101
	65.35	24.75	3.96	3.96	1.98	100
	23.74	23.15	21.05	28.57	28.57	23.71
Male	212	83	15	10	5	325
	65.23	25.54	4.62	3.08	1.54	100
	76.26	76.85	78.95	71.43	71.43	76.29
Total	278	108	19	14	7	426
	65.26	25.35	4.46	3.29	1.64	100
	100	100	100	100	100	100

Note: No Wage Loss was not considered while calculating the Gender Wise Wage Loss.

Table- 5.9.2



Graph- 5.9.2

The survey shows that most males (76% out of the total) experienced wage loss due to heat compared to the women involved in work. Both males and females experience wage loss in the category INR 1 to 999. The average monthly wage loss in females in INR 20 while in males is INR 120.

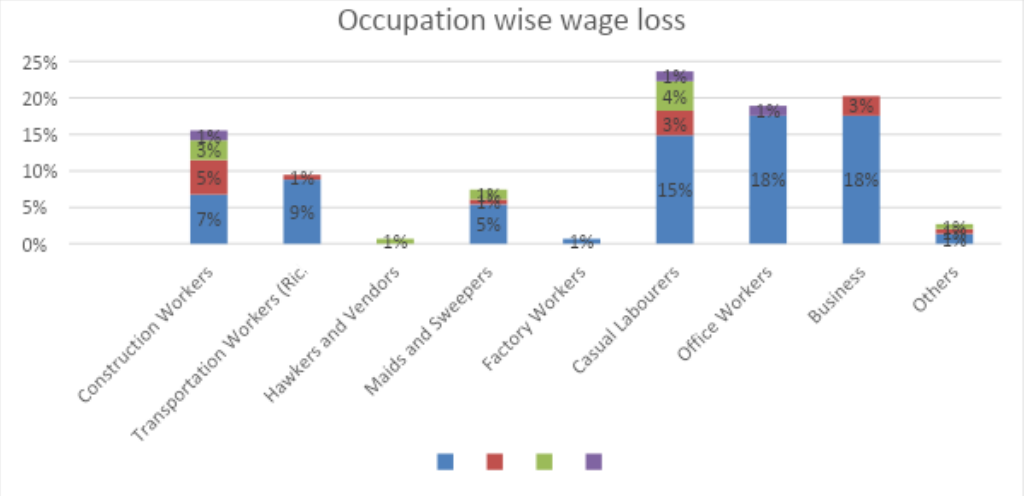
5.11.3 Occupation wise Wage Loss:

	Wage loss code				
Occ code	**No wage loss**	**1-999**	**1000-1999**	**2000-2999**	**3000 and above**
Construction Workers	46	10	7	4	2
Transportation Workers (Rickshaw/Auto likewise)	26	13	1	0	0
Hawkers and Vendors	2	0	0	1	0
Maids and Sweepers	16	8	1	2	0
Factory Workers	0	1	0	0	0
Casual Labourers	62	22	5	6	2
Office Workers	62	26	0	0	2
Business	51	26	4	0	1
Others	13	2	1	1	0

Note: No Wage Loss was not considered while calculating the Occupation Wise Wage Loss.

Table- 5.9.3

Numerous occupations were considered while calculating the occupation wise wage loss in the city.



Graph- 5.9.3

Table- 5.9.3 shows that the casual labourers are most affected by the high heat days as the maximum wage loss is reported in the daily causal labourers (23 percent). This is due to the high share of involvement and low share of income; the business category follows them. Hawkers and factory workers are least affected amongst the identified occupations

5.12 Productivity Loss:

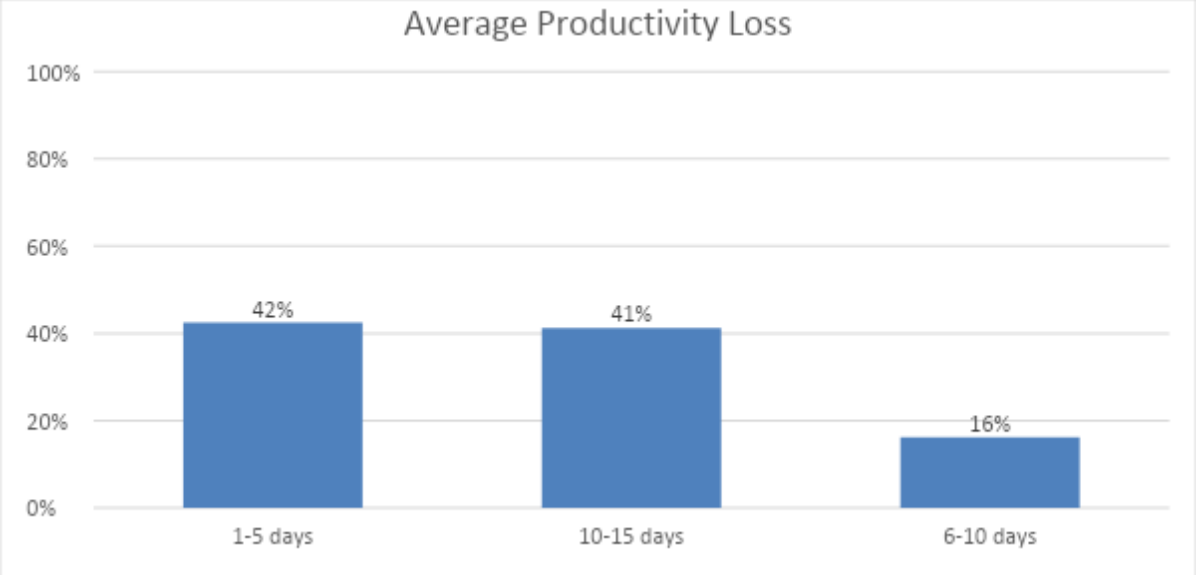
5.12.1 Average Productivity Loss

Average Productivity Loss						
city code	**No absence**	**1-5 days**	**6-10 days**	**10-15 days**	**more than 15**	**Total**
Bhubaneswar						
Absolute Numbers	346	34	13	33	0	426
Percentage distribution (Within Options)	81.22	7.98	3.05	7.75	0	100
Percentage distribution	25.55	32.69	72.22	73.33	0	27.97

(Within Cities)						

Note: No Absence was not considered while calculating the Average Productivity.

Table- 5.9.4



Graph- 5.9.4

Graph- 5.9.4 show that with the loss in wages, the productivity of the individuals is also highly affected. A majority (42 percent) of the working population had reported the loss in the working days by 1 to 5 days during the heat stress period, followed by 10 to 15 days (41%) in a month. A high percentage of productivity loss is observed amongst the working population making a total 83 percent.

5.12.2 Gender Wise Productivity Loss

	Productivity Loss				
Gender	**No absence**	**1-5 days**	**6-10 days**	**10-15 days**	**Total**

Female	82	8	1	10	101
	81.19	7.92	0.99	9.9	100
	23.7	23.53	7.69	30.3	23.71
Male	264	26	12	23	325
	81.23	8	3.69	7.08	100
	76.3	76.47	92.31	69.7	76.29
Total	346	34	13	33	426
	81.22	7.98	3.05	7.75	100
	100	100	100	100	100

Note: No Absence was not considered while calculating the Gender Wise Productivity.

Table- 5.9.5

Graph- 5.9.5

Table- 5.9.5 shows that similar to wage loss, the males (76 percent) are at a more significant loss than females. A majority of males and females experience productivity loss in 1 to 5 days. The average days lost due to high temperature for both males and females is one day per month

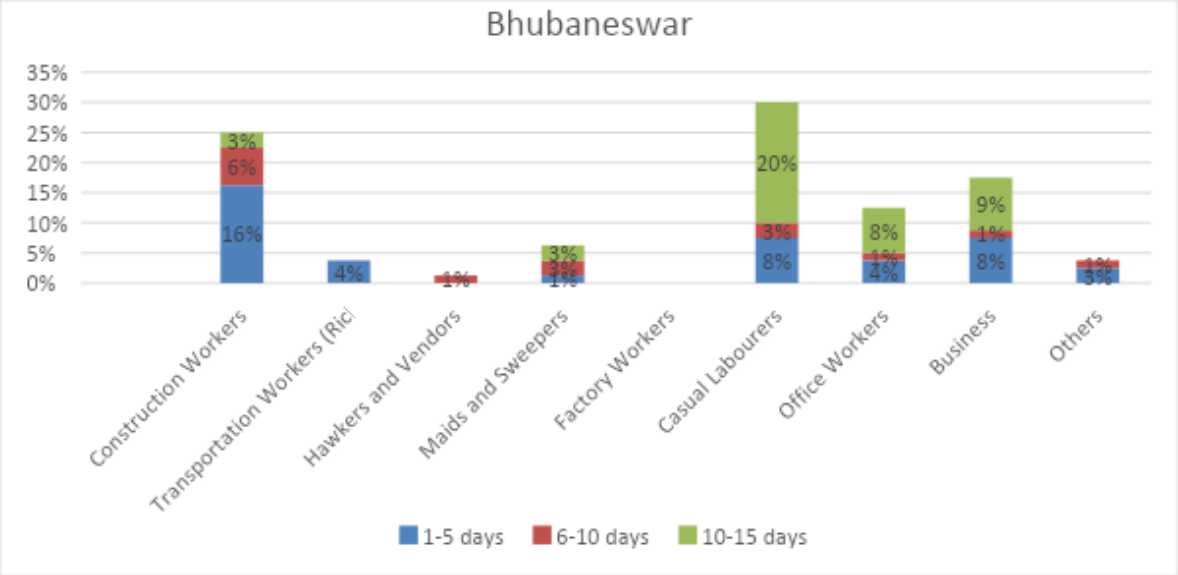
5.12.3 Occupation wise productivity Loss

Productivity Loss					
Occ type	**No Wage loss**	**1-5 days**	**6-10 days**	**10-15 days**	**Total**
Construction Workers	49	13	5	2	69
Transportation Workers (Rickshaw/Auto likewise)	37	3	0	0	40
Hawkers and Vendors	2	0	1	0	3
Maids and Sweepers	22	1	2	2	27
Factory Workers	1	0	0	0	1
Casual Labourers	73	6	2	16	97
Office Workers	80	3	1	6	90
Business	68	6	1	7	82
Others	14	2	1	0	17

Note: No Absence was not considered while calculating the Occupation Wise Productivity.

Table-5.9.6

The occupations considered while calculating the occupation wise productivity loss in the city are:



Graph -5.9.6

Table- 5.9.6 shows that casual labourers and construction workers are most affected during high-temperature days as the maximum productivity loss is reported in the casual workers (31percent) followed by the construction workers (25 percent). Prolonged working hours, unsuitable working conditions, and lack of sensitisation are some reasons behind the loss. It is observed that factory workers and hawkers/vendors are the least affected amongst the identified occupations.

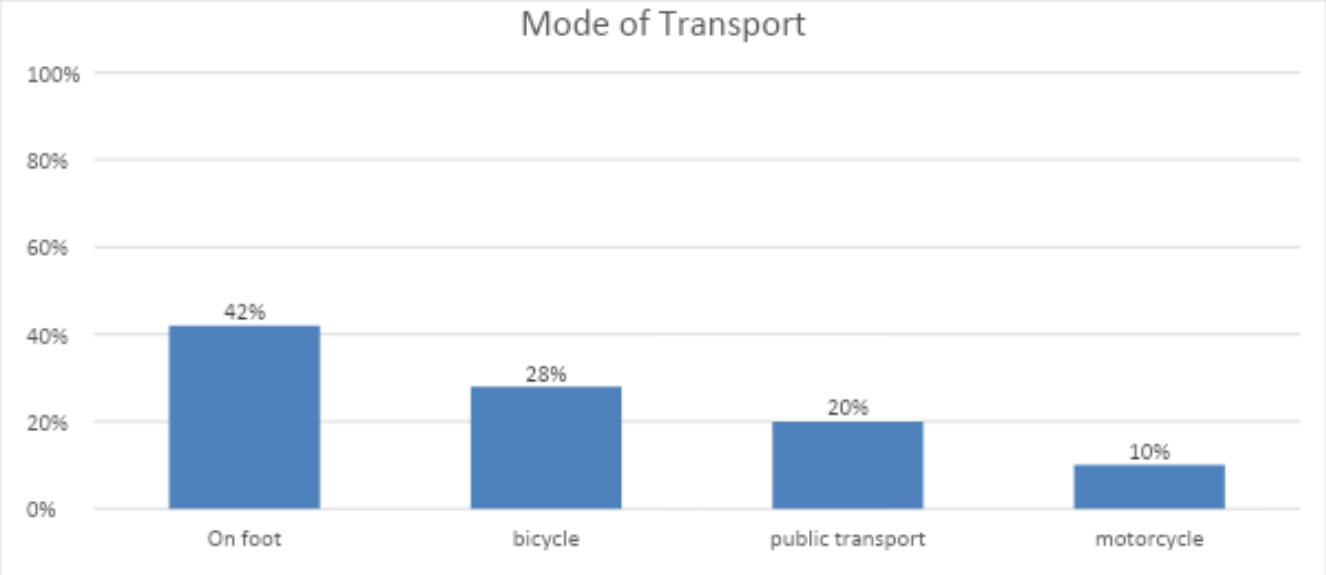
5.13 Transport:

5.13.1 Methods used for commuting (workplace/school):

Mode of transport								
Bhubaneswar city	**On foot**	**bicycle**	**motorcycle**	**car**	**public transport**	**rickshaw**	**others**	**Total**
Absolute Number	326	215	81	2	153	0	0	777

Percentage distribution (within options)	41.96	27.67	10.42	0.26	19.69	0	0	100

Table- 5.10.1



Graph- 5.10.1

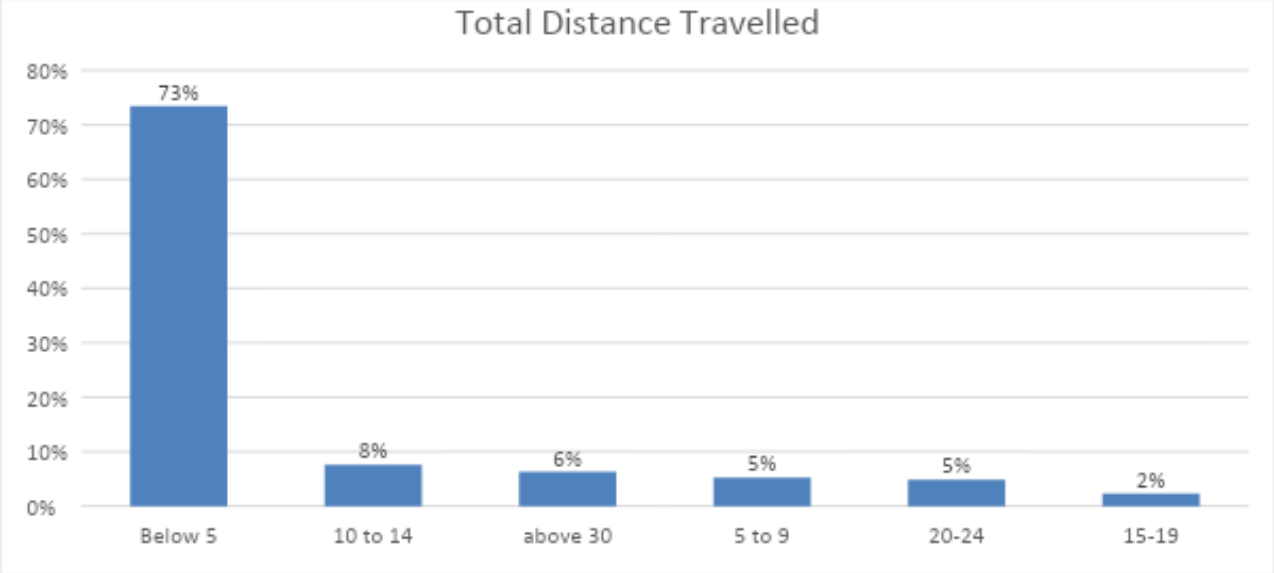
Table- 5.10.1 above indicates that the most preferred mode of transportation is on foot (42 percent), Bicycle (28 percent), and public transport (20 percent) are the most common ways used for commuting. Travelling on foot can trigger heat-related illness if required measures are not taken in due course of time.

5.13.2 Total Distance Travelled:

DISTANCE TRAVELLED								
Bhubaneswar city	**Below 5**	**5 to 9**	**10 to 14**	**15-19**	**20-24**	**25-29**	**above 30**	**Total**
Absolute Numbers	834	60	86	26	55	3	72	1136

Percentage distribution (Within Options)	73.42	5.28	7.57	2.29	4.84	0.26	6.34	100
	100	100	100	100	100	100	100	100

Table- 5.10.2



Graph- 5.10.2

The graph- 5.10.2 shows that the maximum (73 percent) sample households travel within the vicinity of 5 Km to reach their respective workplace/schools. Whereas, the maximum distance of 30 km is travelled by 6 percent of the total population.

The survey result highlight that given the underlying poverty, they prefer going on foot. The place of work/school is found within 5 Km; the vulnerability of the people can be more during the peak summer while walking on the foot/cycling to their workplace. Building awareness about mitigation measures like promoting umbrellas, head cover, and carrying water are cost-effective measures for these communities.

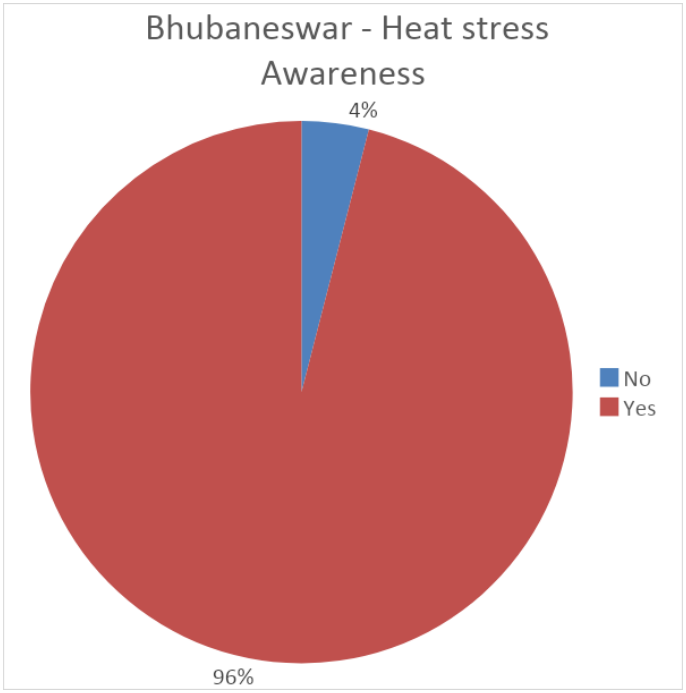
Implications: The opportunities and challenges of increasing transportation access are not well understood by the city. Poor affordability forces people to walk long distances and makes it important to have more green public spaces.

5.14 Awareness:

5.14.1 Awareness of the term "Heat Stress"

Heat Stress Awareness			
Bhubaneswar city	**No**	**Yes**	**Total**
Absolute Number	13	277	290
Percentage distribution (Within Options)	4.48	95.52	100

Table- 5.11.1



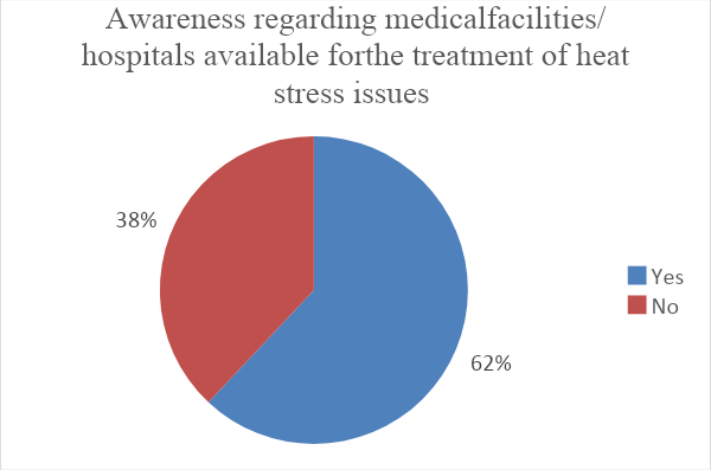
Graph- 5.11.1

Acc. to Graph-5.11.1 a majority of 95 percent of the sample population is aware of the term heat stress and its implication. The local govt can very well use this knowledge to help build coping strategies for the households in the locality. The stakeholders could ensure that information is disseminated among households about the impacts of heat stress and ways to mitigate it. Along with this, heat alerts could also be issued on social media/T.V. /mobile phones too.

5.14.2 Awareness about Medical facilities offering treatment for heat stress

Medical facilities				
Bhubaneswar city	**Yes**	**No**	**Don't know**	**Total**
Absolute Number	179	110	1	290
Percentage distribution (Within Options)	61.72	37.93	0.34	100

Table- 5.11.2



Graph- 5.11.2

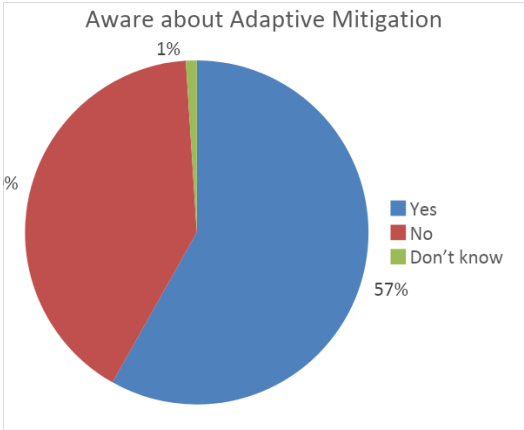
About 62% of the sample households are unaware of the medical facilities offering treatment for heat stress (graph- 5.11.2 (a)). To deal with this, the local administration during the pre-hot season should disseminate all the useful information. Medical camps may also be set up from

time to time for health check-ups during the hot season and spread awareness among the households.

5.14.3 Awareness about adaptive mitigation strategies adopted by ULB

MITIGATION STRATEGIES ADOPTED BY ULB				
Bhubaneswar city	**Yes**	**No**	**Don't know**	**Total**
Absolute Numbers	170	117	3	290
Percentage distribution (Within Options)	58.62	40.34	1.03	100

Table- 5.11.3



Graph- 5.11.3

In terms of awareness of the adaptive mitigation strategies adopted by the government, table-5.11.3 indicates that a majority (57 percent) of the sample population are aware of the adaptive mitigation strategies adopted by the government. Although 40 percent still lacks awareness on mitigation strategies on the heat-health issues and ways to deal with this. The local government

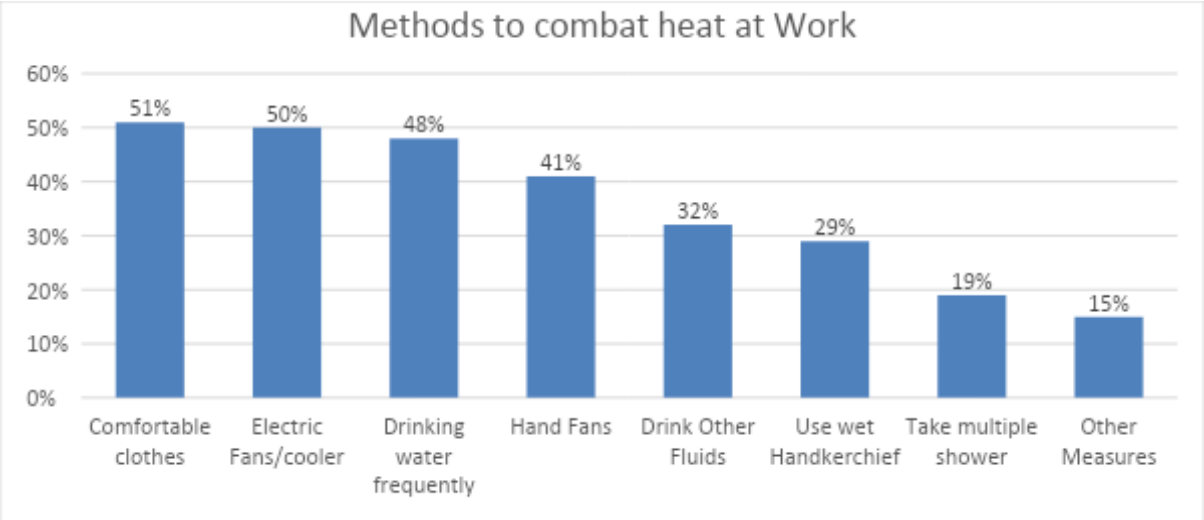
should spread awareness on the issue as this will help decrease any health emergency among households.

5.11 Adaptation

5.12.1Coping of heat related discomfort at work

Coping Heat at Work								
Bhubaneswar city	Comfortable clothes	Hand Fans	Electric Fans/cooler	Drinking water frequently	Use wet Handkerchief	Drink Other Fluids	Take multiple shower	Other Measures
Absolute No.	148	119	146	140	85	93	56	43
Percentage distribution (Within Options)	51.03	41	50.34	48.3	29	32.07	19.31	14.83

Table-5.12.1



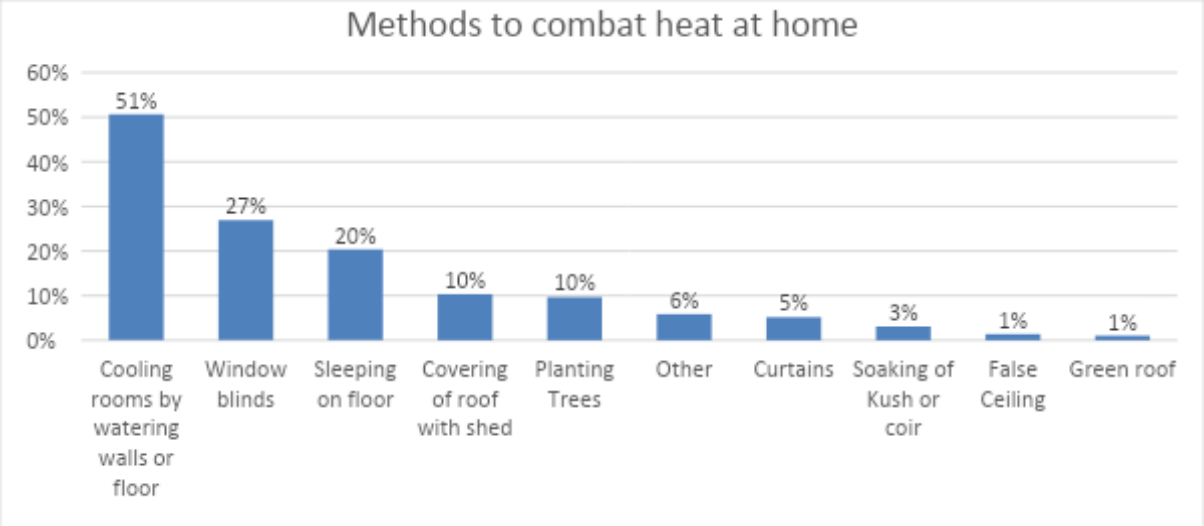
Graph-5.12.1

Acc. to Graph-5.12.1, the most convenient way to cope heat-related discomfort at work are comfortable clothing (51percent), usage of electric fans/coolers (50 percent), drinking water frequently (48 percent) and likewise.

5.11.2 Initiatives at HH level to combat heat

METHODS TO COMBAT HEAT AT HOME										
Bhubaneswar city	**Window blinds**	**Curtains**	**Soaking of Kush or coir**	**Sleeping on floor**	**False Ceiling**	**Green roof**	**Covering of roof with shed**	**Planting Trees**	**Cooling rooms by watering walls or floor**	**Other**
Absolute Number	78	15	9	59	4	3	30	28	147	17
Percentage distribution (Within Options)	26.9	5.17	3.1	20	1.4	1.03	10.3	9.7	51	6

Table- 5.12.2



Graph- 5.12.2

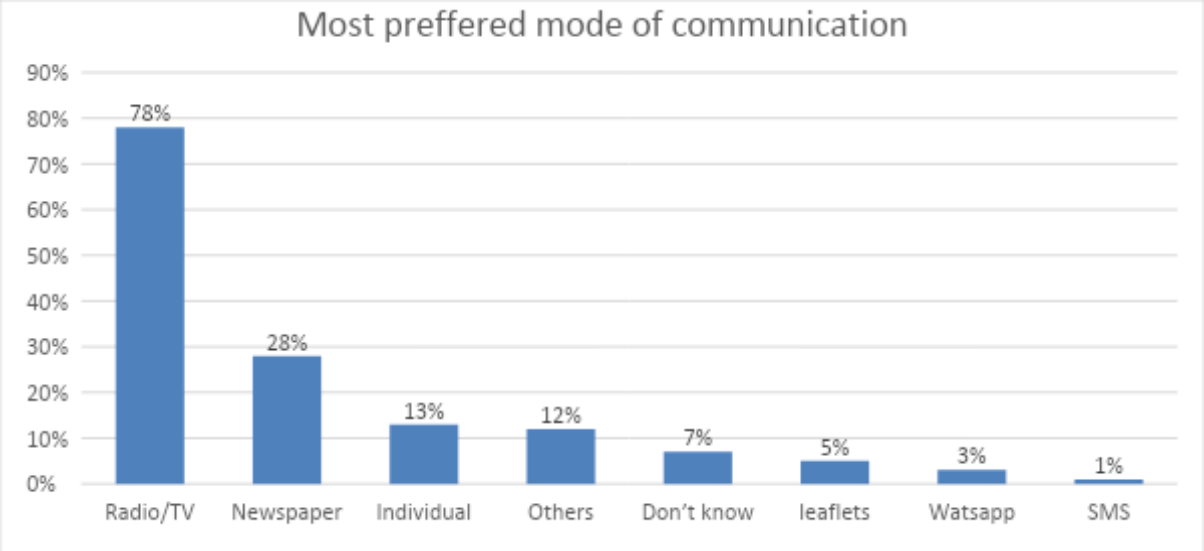
Graph- 5.12.2 shows that the most preferred methods to combat heat at the household level are – cooling the roof by wetting the walls (51percent), usage of window blinds (27 percent) , sleeping on floor (16 percent) and likewise.

5.12.3Preferred medium of communication strategies:

5.14.4 The medium of communication for receiving alerts

PREFERRED COMMUNICATION STRATEGIES								
Bhubaneswar city	**SMS**	**WhatsApp**	**Leaflets**	**Newspapers**	**Radio/TV**	**Individual**	**Others**	**Don't Know**
Absolute Numbers	4	10	14	80	227	38	36	20
Percentage distribution (Within Options)	1.38	3.45	4.83	27.6	78.3	13.1	12.4	6.9

Table- 5.12.3



Graph-5.12.3

Table- 5.12.3 shows that among the preferred medium of communication strategies, radio (78 percent) is the most preferred medium for communication alerts. This is followed by newspaper (28 percent) and individual (13 percent).

Implications: The preferred medium, as the survey shows radio/TV , for information sharing, should be used by the city-level authorities to spread awareness about heatwave and advisories to deal with its associated health impacts.

6. Conclusions and Key recommendations

The analysis of the city level vulnerability assessment indicates that urban poor are most vulnerable to heat stress and its associated impacts. Notably, due to heat stress, the households are most susceptible to the housing viz., the material used and its structure, access to services such as water, and availability of services such as electricity. It aggravates the issues and results in deterioration of health and loss of lives and livelihoods among the households. However, a critical factor that emerged from the study is that the households have very little knowledge and awareness about the adaptive and mitigation strategies adopted by the local institutions. In a scenario of low affordability for health insurance among households, the public health systems must be improved and focus on knowledge dissemination about heat stress.

While the impacts of heat stress are visible through the sectors, the cities can combine sectoral initiatives with a well-defined and coherent framework that ties mitigation and adaptation together. These provide entry points to combat heat stress in specific sectors of public health, housing, infrastructure, and services. The recommendations also outline an overarching framework to ensure the maximum impacts of these sector-based initiatives.

5.15 Public Health

5.15.1 Key challenges

1. The households don't have access to public health facilities in immediate areas. They were thereby making it difficult to access public health facilities in case of an emergency.
2. Most households prefer to visit public hospitals due to their affordability or trust in the public health care system.
3. Senior citizens struggle the most from heat cramps and heat exhaustion among the household members, indicating that indoor heat stress is a huge challenge.
4. The effects of heat stress are causing public health issues among households, and access to public health in the vicinity is essential.

5.15.2 Way Forward

1. The public health centres may be built closer to the neighbourhood to cater to all the people. These centres should be provided, especially in the identified heat vulnerability zones of the city.
2. Awareness of the potential effects of heat stress and ways to mitigate it should be disseminated to the households.
3. The line workers such as Angawadi and Asha workers should routinely visit the senior citizen to monitor their health. For this necessary sensitisation and training should be done for these workers.

5.16 Transport

5.16.1 Key challenges

1. Since most of the residents live close to their working place, most of them walk to their place of work. However, walking is problematic because the footpaths are not well constructed, poorly lit, or broken, and lack greenery to maintain thermal comfort.
2. During the peak summer, public health risks might increase for the people walking to their work. It may cause thermal discomfort and could lead to a loss of workdays. The heat-vulnerable people, e.g., older people or pregnant women, might not be in a situation to travel.
3. Roads in extreme heat can cause it to melt and concrete surfaces to distort and rip. It makes cycling very difficult for people working in neighbouring areas.

5.16.2 Way Forward

1. Construction of footpaths to ensure people walk with ease to their work to allow people to walk on shaded surface due to greenery. It needs to be highlighted here that it helps lower surface and air temperatures by providing shade and evapotranspiration.
2. Green plantations may be carried around the pavements and designated places to sit to cool foot walkers.
3. Building awareness about mitigation measures like promoting use of umbrellas, head cover, and carrying water are cost-effective measures for these communities.
4. It is improving the road quality to better deal with the changing temperatures and allow the vehicles to move.

5.17 Housing

5.17.1 Key challenges

1. The un-affordability to buy houses has forced people to stay in small size houses. Often, resulting in many people living in small spaces and an increase in indoor temperatures. Among the informal settlements, investment is still lower due to high rental tenure and inadequate housing finance.
2. The design, materials, and construction methods are often inappropriate, given the increased exposure to heat stress vulnerabilities. These structures are particularly

exposed to the effects of rising temperatures and trapping of heat inside the house and allow very little ventilation.

3. The microclimate needs to be improved and livable to make it thermally comfortable. Existing housing options may not meet the needs of vulnerable sections of society, especially the elderly.

5.17.2 Way forward

1. Provide support to mitigate the extreme impacts of heat stress by painting the roof white, increasing fluids intake, and wearing cotton clothes.
2. On-site upgrading may be undertaken to improve heat stress vulnerabilities due to housing by improving the building design and material.
3. Encourage pro-poor housing finance by making traditional markets and credit mechanisms accessible to the urban poor.

5.18 Water

5.18.1 Key Challenges

1. Due to rising temperatures, there is often water shortage, and there may be limited water availability of water due to low pressure.
2. There are challenges with the reliability of the availability of water from different sources.
3. The local watersheds are severely stressed, and dry spells due to heat stress do not enable recharge.

5.18.2 Way forward

1. Widen the network of municipal water supply to the households to ensure adequate water availability.
2. Improve water availability and its quality to minimise the dependence of households on other sources of water supply.
3. Educate people to prepare for water shortages by using less water and using it wisely, too.
4. Implement affordable water tariffs for households to improve water access.

5.19 Electricity

5.19.1 Key Challenges

1. High demands for electricity in the peak summer tend to increase during heat stress, which puts a strain on existing systems and potentially leads to shortages. It often results in frequent power cuts and blackouts.
2. The power tariffs may be too high for low households, making it less affordable among poor households.
3. Electricity cuts can leave people vulnerable, primarily elderly, kids, and women, to the risks of heat and have cascading impacts on other urban services.

5.19.2 Way forward

1. Focus on being paid both on the electricity generation but also on connecting more households in its network.
2. Technological alternatives for electricity should be explored to ensure energy efficiency.
3. Electricity conservation measures may be shared with the households.
4. Heat stress awareness and Adaptive measures

5.20 Heat stress awareness and Adaptive measures

5.20.1 Key Challenges

1. Low-income residents often have sparse information on vulnerability due to heat stress. Lacking information on the risks inherent because of extreme temperatures and heat stress is enormous, especially in informal settlements.
2. The households have insufficient knowledge of the adaptive and mitigation measures to deal with heat stress, such as households are not aware of the medical facilities offering treatment for heat stress. They have very little information on such measures being undertaken by their ULB.
3. Due to unaffordability, most of the households are out of the insurance network. It decreases the ability of households to take care of medical expenses and limits their ability to access private medical facilities in case of emergency.

5.20.2 Way forward

1. Use social media platforms to increase access to information on heat alerts, heat stress advisories.
2. The government Hospitals organise health check-ups/sensitisation workshops with households in the community.
3. Develop affordable health insurance schemes, especially for the vulnerable sections of society, such as the elderly, poor, and women.

5.21 Livelihood and productivity

5.21.1 Key challenges

1. The majority of the workers suffer a lot due to heat stress as they lose their wages and lose their man-days of work.
2. The growing heat stress and extreme outdoor temperatures make it difficult for the outdoor workers, and the causal workers are most at risk of losing wages.
3. Travelling to the workplace may also lead to office workers experiencing heat exhaustion during high temperatures.
4. Along with the loss in wages, the productivity of the individuals is also positively affected.

5.21.2 Way forward

1. The focus should be on improved urban design, and sustainable planning can help increase the green spaces, and cooling the environment is critical to minimising heat-health issues.
2. Develop an early warning system for heat stress that helps in preparedness strategies and activities.
3. There should be flexibility in working hours, especially for outdoor workers during the hot peak period. It will also improve the worker's productivity.
4. The heat stress evidence base needs to be reviewed regularly to design advisories on targeting specific groups with prevention strategies.
5. During peak summer, the special intervention plan should be developed.

6 The overarching framework for Sustainable heat stress response

The coherent measures taken in each of the identified sectors will help in minimising the extreme impacts of heat stress vulnerabilities among the households. Along with this, a macro framework is much needed that will help in further strengthening these measures and built in the policymaking process to address these challenges and adapt for future challenges. These measures include viz, governance and institutional framework, local institutional capacity; resilient infrastructure; improving socio-economic conditions, encouraging public-private partnership. Their components are detailed in the table below.

Macro- framework component	**Short Term Actions**	**Long Term Actions**
Governance and institutions	-Heat Action Plans -Health-system preparedness Monitoring and health surveillance -Clarity of role and coordination among agencies - - -Cool roofs Public awareness and community outreach Uninterrupted access to the basic	-Climate risk reduction in alignment with heat reduction -Policy development -Post heatwave review on the existing plan and updating the plan -Minimising vulnerability due to heat stress

Macro- framework component	Short Term Actions	Long Term Actions
	services	
Local institutional capacity	-Building capacity for better system response and preparedness -Early warning system - Temperature forecast	-Strengthening existing system structures to make it more responsive -Community engagement for the inclusion of vulnerable household -Emergency preparedness
Resilient infrastructure	-Pooling resources -Improving coverage and service delivery -Social infrastructure: Capacity building communities, community based organisation, and mobilisers such as Mahila Arogya Samiti, Self-Employed Women's Association (SEWA), ASHA workers, aanganwadis	-Setting heat standards and implementation for urban planning, infrastructure, industries, services like transport, building design, road, water resource management, etc -Revising the existing building Regulation Encouraging the passive building designs -Affordable tariffs
Improving socio-economic conditions	-Implementation of central/state-sponsored schemes on services and	-Redevelopment of the households below the poverty line to combat

Macro- framework component	Short Term Actions	Long Term Actions
	housing	heat. Measures like cool roofs - Access to basic services
Encouraging public-private partnership	-Collaboration with non-government and civil society -Private hospitals to provide treatment for heat stress -Resource mobilisation	-Health insurance for the vulnerable, especially the poor, elderly, and women -Joint venture for infrastructure development/service delivery

Table: Macro- Framework for reducing Heat stress vulnerability

Heat stress has to be managed at the local level, which necessitates comprehensive planning and coordination. A macro framework that will consider the sector-specific initiatives and tie them well within the macro framework to ensure its sustainability and effective management.

However, to ensure this, the stakeholders need to be involved in the planning and executing heat stress minimisation interventions. These measures have to be both short-term and long-term, which helps promote heat stress management and its planning. The outcomes of such steps are:

1. Transparent allocation of roles and responsibilities of all the stakeholders for better preparedness and prompt response to heat stress.
2. Identify vulnerable hotspots in the city and take measures specific to those areas.
3. Knowledge dissemination and capacity building of the communities, including the institution and the stakeholders.
4. Heat stress management plans to mitigate any impacts of heat stress effectively.