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Adaptation at Scale in Semi-Arid Regions

Heat Stress – Vulnerability, health impacts, and coping strategies in rural communities in the semi-arid region of Maharashtra, India

CARIAA-ASSAR Working Paper

Adithya Pradyumna, Ramkumar Bendapudi, Dipak Zade, Marcella D'Souza

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This study addresses socially differentiated questions on how risks and responses to heat stress vary among the different social categories in the rural communities in the semi-region of Maharashtra and thereby identifying the vulnerable groups as well as the important factors that affect vulnerability to heat stress.

Key Words: heat stress, heat related symptoms, differential vulnerability, rural health, semi-arid regions

About CARIAA Working Papers

This series is based on work funded by Canada's International Development Research Centre (IDRC) and the UK's Department for International Development (DFID) through the **Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA)**. CARIAA aims to build the resilience of vulnerable populations and their livelihoods in three climate change hot spots in Africa and Asia. The programme supports collaborative research to inform adaptation policy and practice. Titles in this series are intended to share initial findings and lessons from research and background studies commissioned by the programme. Papers are intended to foster exchange and dialogue within science and policy circles concerned with climate change adaptation in vulnerability hotspots. As an interim output of the CARIAA programme, they have not undergone an external review process. Opinions stated are those of the author(s) and do not necessarily reflect the policies or opinions of IDRC, DFID, or partners. Feedback is welcomed as a means to strengthen these works: some may later be revised for peer-reviewed publication.

Contact
Collaborative Adaptation Research Initiative in Africa and Asia,
c/o International Development Research Centre
PO Box 8500, Ottawa, ON
Canada K1G 3H9
Tel: (+1) 613-236-6163; Email: cariaa@idrc.ca

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Abstract

Increasing temperatures are likely to impact human health. An increase in severe heat wave days and heat mortalities has been observed in India over the past few decades. A report by National Disaster Management Authority states that about 22,562 heat related deaths were reported between the periods 1992 to 2015. A body of literature is available on heat stress in urban areas and for few occupational settings. However, there is little evidence on the heat experience, impact of heat exposure, and adaptation measures to heat stress in the rural context. In this context, the study examines vulnerability of rural communities to heat stress in the semi- arid villages in Maharashtra state in India.

The study was conducted in Jalna district, located in the central part of Maharashtra state. Three villages were selected from Jafrabad and Bhokardan blocks in the district. From each of the three villages, a sample of 20% total households accounting for 215 households was selected for detailed household survey. The outcome of interest- occurrence of at least one Heat Related Symptom (HRS) in the individual was cross tabulated against each variable, through which odds ratios were calculated.

Exposure to heat in various circumstances, both outdoors and indoors were reported. The major HRS were found to be headache, heavy sweating and fatigue, which were mild or moderate in nature. Age, gender, wealth and pre-existing health conditions were significantly associated with occurrence of HRS. Regarding exposure, working outdoors during mid-day, roofing material and indoor ventilation were significantly associated with occurrence of HRS.

Existing coping strategies appear to be inadequate to protect people from heat stress. A long-term strategy in terms of knowledge about HRS and infrastructure and access to timely medical facilities is needed. Development of effective surveillance mechanism is needed to monitor heat mortalities in the future. Priority should be given to develop a comprehensive state level heat action plan for Maharashtra, which addresses the urban and rural communities.

About ASSAR

All authors of this working paper are team members in the ASSAR (Adaptation at Scale in Semi-Arid Regions) project, one of four hotspot research projects in CARIAA. The international and interdisciplinary ASSAR team comprises a mix of research and practitioner organisations, and includes groups with global reach as well as those deeply embedded in their communities. The ASSAR consortium is a partnership between five lead managing institutions - the University of Cape Town (South Africa), the University of East Anglia (United Kingdom), START (United States of America), Oxfam GB (United Kingdom) and the Indian Institute for Human Settlements (India) – and 12 partners – the University of Botswana, University of Namibia, Desert Research Foundation of Namibia, Reos Partners, the Red Cross/Crescent Climate Centre, University of Ghana, ICRISAT, University of Nairobi, University of Addis Ababa, Watershed Organisation Trust, Indian Institute for Tropical Meteorology, and the Ashoka Trust for Ecology and the Environment.

Working in seven countries in semi-arid regions, ASSAR seeks to understand the factors that have prevented climate change adaptation from being more widespread and successful. At the same time, ASSAR is investigating the processes – particularly in governance – that can facilitate a shift from ad-hoc adaptation to large-scale adaptation. ASSAR is especially interested in understanding people's vulnerability, both in relation to climatic impacts that are becoming more severe, and to general development challenges. Through participatory work from 2014-2018, ASSAR aims to meet the needs of government and practitioner stakeholders, to help shape more effective policy frameworks, and to develop more lasting adaptation responses.

Why focus on semi-arid regions?

Semi-arid regions (SARs) are highly dynamic systems that experience extreme climates, adverse environmental change, and a relative paucity of natural resources. People here are further marginalised by high levels of poverty, inequality and rapidly changing socio-economic, governance and development contexts. Climate change intersects with these existing structural vulnerabilities and can potentially accentuate or shift the balance between winners and losers. Although many people in these regions already display remarkable resilience, these multiple and often interlocking pressures are expected to amplify in the coming decades. Therefore, it is essential to understand what facilitates the empowerment of people, local organisations and governments to adapt to climate change in a way that minimises vulnerability and promotes long-term resilience.

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About the authors

Adithya Pradyumna *is a researcher at the Society for Community Health Awareness, Research and Action (SOCHARA), Bangalore and the Watershed Organization Trust. His broad area of interest is environmental health, and he has worked on climate change, air pollution, food systems and health. He graduated from St John's Medical College, Bangalore (MBBS) and the London School of Hygiene and Tropical Medicine (MSc Public Health)*.

Contact: adithya.pradyumna@gmail.com

Ramkumar Bendapudi *is the research lead for WOTR within ASSAR. He has a PhD in Agriculture and Resource Economics from West Virginia University, USA. He is engaged in research in various thematic areas under ASSAR, including vulnerability and wellbeing, water management and agriculture and climate services.*

Contact: ramkumar.bendapudi@wotr.org.in

Dipak Zade *is a Researcher at Watershed Organisation Trust. He has done Masters in Anthropology from Pune University. His current research interests include health, vulnerability and natural resource management. Within ASSAR, he is engaged in research related to heat stress and human health.*

Contact: dipak.zade@wotr.org.in

Dr. Marcella D'Souza *is the Executive Director of the Watershed Organisation Trust. She is a physician by training and a Takemi Fellow at the Harvard School of Public Health. Marcella has more than three decades of experience working in the fields of rural development and community health. Within ASSAR, she is engaged in research related to vulnerability, gender, and health and heat stress.*

Contact: marcella.dsouza@gmail.com

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Abbreviations

CI:	Confidence Interval
HH:	Household
HRS:	Heat Related Symptoms
MGNREGS:	Mahatma Gandhi Rural Employment Guarantee Scheme
OR:	Odds Ratio
WOTR:	Watershed Organisation Trust

1. Background

The risks of heat related illnesses and deaths are likely to increase due to rising temperatures (Intergovernmental Panel on Climate Change, 2014). In India, there has been an increasing trend of heat wave related deaths in the last few decades. A report by National Disaster Management Authority highlights that between the periods 1992 to 2015, about 22,562 heat related deaths were reported (Government of India, 2016). In fact, heat stroke was the second major cause of natural deaths in India accounting for 15% of the deaths during the decade 2001- 2012(Paul and Bhatia, 2016). Most studies on the health impacts of heat have been conducted within the context of officially declared heat waves. It has been found that significant mortality and morbidity can be attributable to heat exposure. The effect could be up to 43% increase deaths due to heat wave in urban India (Azhar *et al.*, 2014).

Future climate projections for India indicate that heat waves will likely be more intense, have longer durations, and occur more often and earlier in the year. Intensification of heat waves will also lead to increased mortality rates (Dholakia, Mishra and Garg, 2015; Murari *et al.*, 2015). Gasparrini (2015) while assessing mortality risk due to high and low ambient temperature found that death attributable to extreme heat were about the same as moderately high temperatures.

Increasing heat exposure is linked to occupational health risks and negatively impacts work productivity (Kjellstrom, Holmer and Lemke, 2009; Dash and Kjellstrom, 2011). Venugopal (2015) studied workers in select organized and unorganized Indian work sectors in the context of occupational heat stress impacts on the health and productivity. The authors found that productivity issues were reported most commonly among outdoor/semi outdoor occupations with high workload (e.g., brick manufacturing, metal fabrication, construction etc.), whereas productivity losses were reported less frequently among indoor workers.

Ingole (2015) found an immediate association of high temperature and non-infectious disease mortality in a study conducted in rural western India. Men in working age involved in outdoor activities like agricultural and industrial workers were more vulnerable to heat.

In Gujarat and Rajasthan, workers in the rural and semi urban industries of ceramics, pottery, iron works and stone quarry were found to be vulnerable (Nag *et al.*, 2009). In the rural context, it was found that amongst the rice farm workers in West Bengal, high workplace heat exposure caused heat strain and reduced work productivity (Sahu, Sett and Kjellstrom, 2013).

Apart from decreased work productivity, increased temperatures also have other social impacts. A 21- year rural longitudinal survey conducted in Pakistan (Mueller, Gray and Kosec, 2014) shows that men move out of the village due to extreme heat stress and that the landless and asset less poor are more likely to do so. A large scale study conducted in Thailand found that working under heat stress conditions is associated with worse overall health and psychological distress (Tawatsupa *et al.*, 2010).

A recent study from urban India identified exposure (geographic location, housing characteristics and occupational and behavioral factors), susceptibility (age, pre-existing health status, and socioeconomic factors), adaptive capacity (access to health services and information, coping mechanisms, and societal factors (infrastructure, information, and social capital) determine vulnerability to heat (Tran *et al.*, 2013). Pre-existing conditions, such as cardiovascular diseases, may be exacerbated by heat stress (Khan, Malik and Rehman, 2014). However, there is little evidence of the heat experience, impact of heat exposure, and adaptation measures to heat and heat waves in the rural context.

Most of the above studies examine vulnerability to heat stress due to work exposure (occupational hazard) and focused on urban areas. Very few studies have attempted to understand the factors contributing to vulnerability of the communities. In this context, this study examines vulnerability of rural communities to heat stress in the semi- arid villages in Maharashtra state in India. The specific objectives addressed by the study are:

(i) To identify the categories of the rural population that are most vulnerable and susceptible to heat stress
(ii) To quantify heat related symptoms and illnesses in the rural communities
(iii) To identify factors contributing to vulnerability to heat stress
(iv) To examine various existing strategies to manage heat stress

2. Methodology

Study Location

The study was conducted in Jalna district which is located in the central part of Maharashtra state in northern Marathwada region. The district has a sub-tropical climate with average annual rainfall ranging between 650 to 750 mm. The district experiences years of drought with annual rainfall recording as low as 400 mm. The hot dry summer season is from March to June. During summer, the maximum day temperature ranges between 42°C and 43°C (Website of Jalna District, 2017). The summer months are dry, with relative humidity generally between 20% and 25% in the afternoon.

The blocks of Jafrabad and Bhokardan in Jalna district were selected as there was anecdotal evidence of few deaths due to heat stress in 2014. Exploratory visits were undertaken during the months of April and May 2015 to select the villages. The factors considered for selecting the villages were: sparse vegetative cover, lack of access to water and remoteness. Three villages were purposively selected for the study, namely *Adha* and *Sindi* in the Jafrabad Block and *Goshegoan* in the Bhokardan block (Figure 1). In *Goshegaon* village, the local government authorities had provided water in tankers during summer of 2015. Village *Adha* had a primary health sub- centre in the village whereas the nearest government health care system for *Sindi* and Goshegaon villages is located at a distance of 15 km and 7 km respectively.

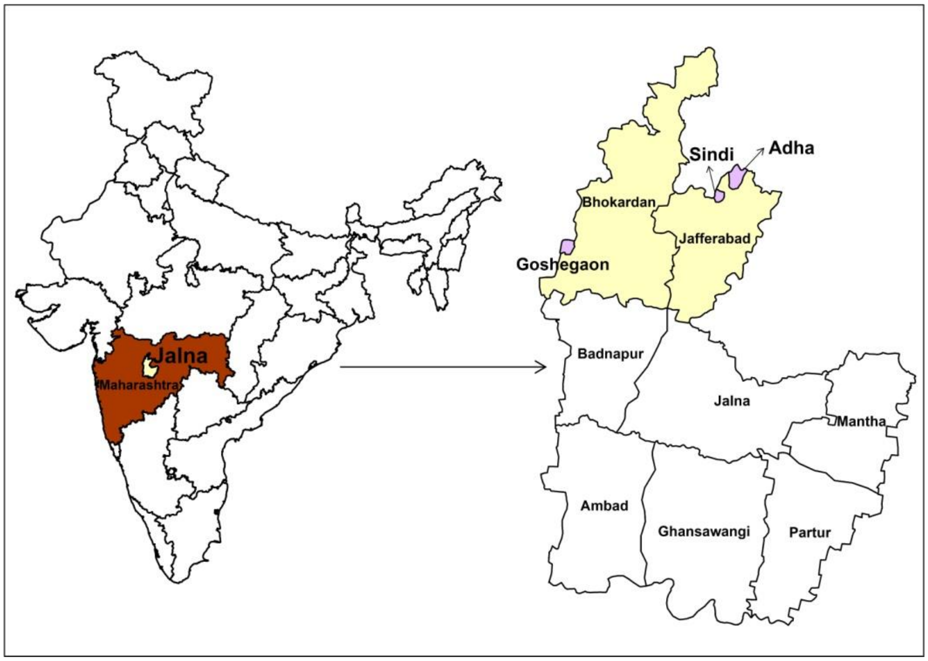

Figure 1: Location map of Jalna district.

Sample Survey

Households in each village were categorized according to socio-economic criteria (based on a participatory wealth ranking exercise[1]). From each of the three villages, a sample of 20% of total households was selected for survey. Stratified random sampling was used for selecting the respondent households. Accordingly, the sample households were selected in proportion to the number of households in the respective wealth categories. In total 215 households contributed to the detailed household survey (Table 1).

Table 1: Sample details.

Category	Total Households	Sample Households
Very Poor	226 (21.9%)	46 (21.4%)
Poor	420 (40.7%)	87 (40.5%)
Middle Class	241 (23.3%)	51 (23.7%)
Better off	146 (14.1%)	31 (14.4%)
Total	**1033 (100%)**	**215 (100%)**

[1] Wealth ranking exercise is a participatory tool for classifying the households based on the indicators related to land ownership, asset ownership, food security, migration and sources of income. The households are classified as- very poor, poor, middle class and better off. For more details, refer supplement in the Annexure attached.

Information collected from the respondents included: living conditions (housing structure, access to water for drinking and domestic use, access to electricity), work profile (type of livelihood activities, exposure to outdoor heat), heat and health problems (pre-existing health conditions, self-reported heat related symptoms, access to medical facilities and sources of information on preventive measures) and coping mechanisms by the communities.

Data collection

A structured questionnaire was developed and pretested. Individual interviews were conducted in the month of May 2016, which is the peak summer period in Maharashtra. An adult household member was selected as the respondent who provided information regarding all other members of the family (in the context of exposure to heat and heat related symptoms).

The types of Heat Related Symptoms (HRS) considered included: small blisters or pimples, dry mouth, fatigue, leg cramps, heavy sweating, intense thirst, rapid heartbeat, headache, leg swelling, paranoid feeling, swelling of face, fever, diarrhoea, hallucinations, vomiting and fainting. Hallucinations and fainting were considered as severe HRS whereas the rest were considered as mild HRS for analysis.

The sample households comprised of 1224 individuals. Out of these, there were 671 male members and 553 female members (accounting for 55% and 45% of total individuals, respectively). About 64% of the total household members were in the age groups of 15-30 years and 31-59 years.

About 18% of persons interviewed belonged to households that were very poor and 37% to households that were poor (based on wealth ranking). The majority of the households belonged to forward caste category (62% of total sample households) followed by scheduled caste category (23%). Illiteracy is prevalent among 25.6% of individuals covered by the survey. About 37% of individuals reported wage labour (agricultural and non-agricultural) as the major summer occupation (Table 2). About 23% of the individuals indicated farming as an important livelihood source. Non-income generating activities such as household chores, education and other such activities were indicated by 22% of the total individuals from the sample.

Table 2: Socio-demographic characteristics of the study population

Variable	Number of individuals (% of total, *n*=1224)
Gender	
- Male	671 (54.8)
- Female	553 (45.2)
Age	
- 0-4	104 (8.5)
- 5-14	212 (17.3)
- 15-30	450 (36.8)
- 31-59	330 (27.0)
- 60+	128 (10.5)
Wealth ranking	
- Very poor	223 (18.2)
- Poor	448 (36.6)
- Middle class	335 (27.4)
- Better off	218 (17.8)
Caste category	
- Scheduled caste	276 (22.8)
- Scheduled tribe	57 (4.7)
- Nomadic and Denotified Nomadic Tribes	44 (3.6)
- Vimukta Jati Nomadic Tribes	13 (1.1)
- Other Backward Classes	66 (5.4)
- Forward caste	757 (62.4)
Education	
- Illiterate	286 (25.6)
- Primary school	210 (18.5)
- Secondary school	450 (39.8)
- High school	122 (10.8)
- Graduate and above	54 (4.8)
Summer occupation	
- Non income generating activities	205 (22.2)
- Farming	211 (22.9)
- Agricultural and non-agricultural labour	342 (37.0)
- MGNREGS work	113 (12.2)
- Others	52 (5.6)

Descriptive statistics and cross tabulations were used to analyse the data. Vulnerability is seen in the context of occurrence of heat related symptoms. The occurrence of at least one HRS in the individual was the health outcome of interest. At least one HRS was cross tabulated against each variable, through which odds ratios (OR) were calculated. Furthermore, confidence intervals and p-values for the odds ratios were also calculated to identify variables of interest for further analysis.

3. Results

Heat related symptoms among the households

The impacts of hot weather were found to range from discomfort to illness. The types of health concerns included headache, fever, vomiting, weakness, 'paranoid' feeling (as expressed by people), restlessness, dizziness and fainting. At the local Primary Health Centre (in Adha village) approximately 15-20 cases of gastroenteritis were seen each day during summer. Cases of allergy, fever, vomiting and dizziness were also observed.

Among the heat related symptoms experienced by the household members, headaches, heavy sweating, fatigue, intense thirst, dry mouth and small blisters/ rash were found to be the most commonly reported symptoms (Figure 2).

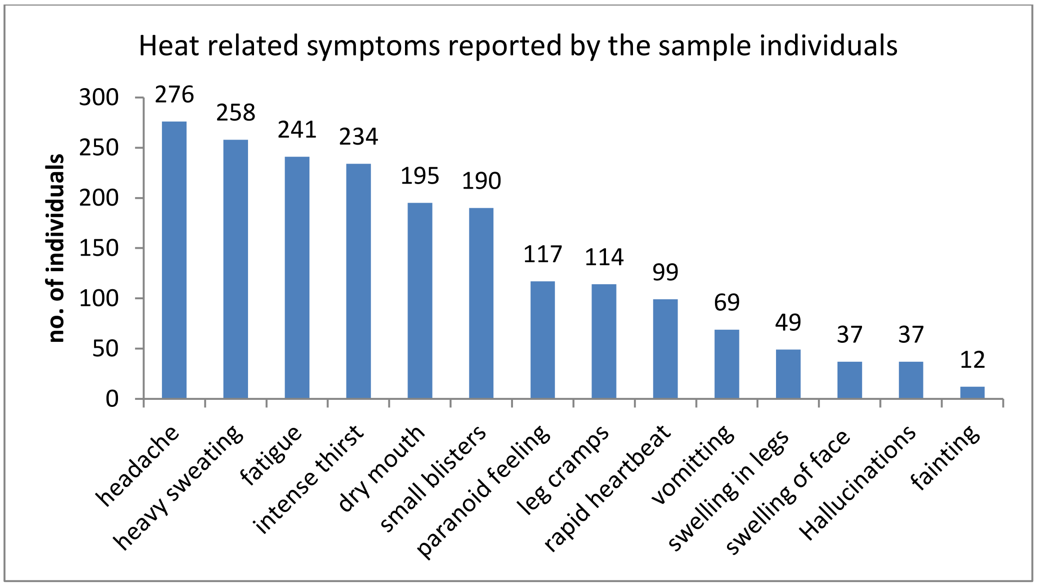

Figure 2: Heat Related Symptoms reported by the sample individuals.

Of all household members, 46.2% experienced at least one HRS during the study period. On average, at least two individuals were affected per household (Table 3). Individuals from 64.5% households experienced fever and 21.5% households experienced diarrhoea during the study period.

Table 3: Occurrence of heat related symptoms (HRS) at individual level.

Particulars	Number of individuals (% of total, *n*=1224)
Total individuals experiencing at least one HRS (%)	566 (46.2)
Average individuals affected in each household	2.64
Heat stress categories	
- No HRS (%)	658 (53.8)
- Mild HRS (%)	523 (42.7)
- Severe HRS (%)	43 (3.5)

Vulnerability to heat stress

The analysis is based on the framework given by Tran *et al.* (2013) wherein heat vulnerability is conceptualized as a function of interacting biophysical and socioeconomic determinants that can be broken down into heat hazard probability as well as factors associated with population exposure, susceptibility and adaptive capacity (Tran *et al.*, 2013; Figure 3).

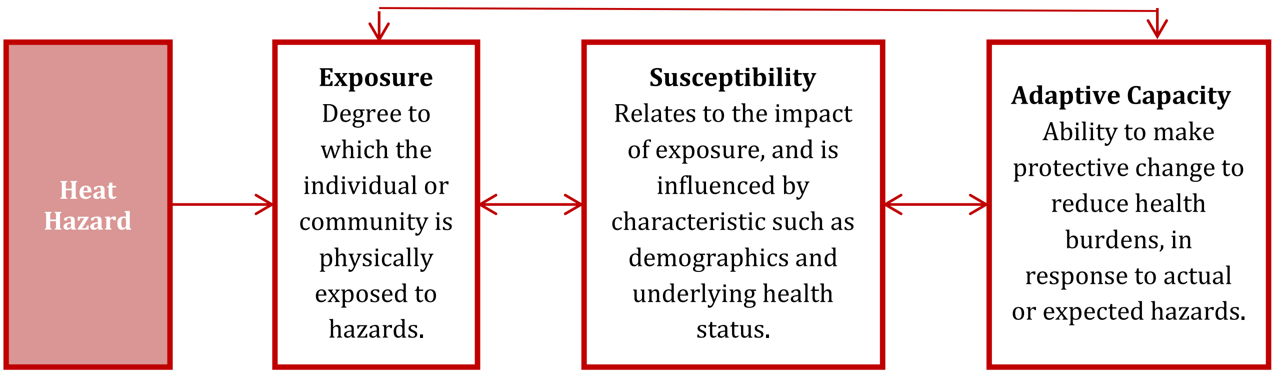

Figure 3: Framework for assessing heat vulnerability (adapted from Tran *et al.*, 2013)

Susceptibility factors

Susceptibility components included age, gender, wealth and preexisting health conditions.

Both men and women reported suffering from HRS. However, the percent of men indicating HRS (49.5%) is relatively more as compared to women (42%). Women were relatively less affected as compared to the men with the OR of 0.75 (0.6, 0.94). This could be due to higher exposure of men to outdoor heat thereby resulting in more HRS.

It was found that elderly and children (McGeehin and Mirabelli, 2001; Oudin Åström, Bertil and Joacim, 2011; Lundgren *et al.*, 2013; Li *et al.*, 2015) are more susceptible to heat stresses. In our study also it was found that elderly (>60 years old) were more affected as compared to children under 4 years with the OR of 0.16 (0.09, 0.29) and those between 5- 14 years (OR 0.23) and those under 30 years of age (OR 0.55). Only adults between 30-59 years of age, who are engaged in livelihood activities, were more affected (OR 1.86) than the elderly (Table 4). This is also the age group where higher percent of individuals (71.2%) reported heat related symptoms.

Table 4: Occurrence of HRS in relation to demographic variables (Univariate analysis)

Parameter	Odds Ratio (unadjusted)	Lower CI	Upper CI	p-value
Gender				
- Male (ref)				
- Female	0.75	0.6	0.94	0.012
Age				
- 0-4	0.16	0.09	0.29	<0.001
- 5-14	0.23	0.15	0.37	<0.001
- 15-30	0.55	0.37	0.82	0.003
- 31-59	1.86	1.22	2.85	0.004
- 60+ (ref)	1			
Wealth categories				
- Very poor (ref)				
- Poor	1.07	0.78	1.48	0.676
- Middle class	0.67	0.48	0.94	0.021
- Better off	0.52	0.36	0.77	<0.001
Pre-existing health conditions				
- None (ref)				
- At least one pre-existing health condition	6.34	4.16	9.66	<0.001

People with low socio economic status (Harlan *et al.*, 2006; Li *et al.*, 2015) are found to be more susceptible to heat stresses. In this study area also, those belonging to middle class category with OR 0.67 (0.48, 0.94) and better off families with OR of 0.52 (0.36, 0.77) were less affected as compared to the very poor. Higher number of individuals from the 'very poor' and 'poor' categories reported at least one HRS (about 51% and 53% of total individuals in respective categories) as compared to the individuals in the 'better off' category (only 35%).

Individuals with pre-existing health conditions were considered to be susceptible to heat stresses (McGeehin and Mirabelli, 2001; Li *et al.*, 2015). Among the 1224 total individuals in the sample households, at least one pre-existing health condition was indicated in 157 individuals (about 13% of the total sample population). The pre-existing chronic health conditions (that ranged from asthma to cancer), makes such individuals relatively more susceptible to heat related stresses. Those with at least one pre-existing chronic health condition were disproportionately affected with OR of 6.34 (4.16, 9.66; Table 4).

The majority of the sample population in the study area belonged to Forward Caste and Scheduled Caste categories. There was not much difference in the individuals reporting HRS among the two social categories.

Exposure factors

Exposure can be affected by hazard factors, amplifying factors and protective factors (Tran *et al.*, 2013). In this study, hazard factor is considered to be the exposure to peak heat hours, amplifying factors include type of occupation and type of roofing) and protective factors (coping strategies). In this section, the key amplifying factors are discussed.

Exposure to heat was reported both during outdoors and indoors. While the working population of adults is exposed to direct sunlight outdoors, elderly and children were exposed to hot indoor environments during afternoons due to faulty building designs and material. Those from the poorer sections and from the lower castes were disproportionately exposed based on their daily activities and roofing material used for the houses.

Figure 4: Villages working at MGNREGS sites during summers. *Source*: WOTR.

Exposure due to livelihood activities

One of the amplifying factors affecting exposure was the type of occupation an individual is engaged in. Majority of the individuals from the sample households (72%) were engaged in outdoor livelihood activities during summer months such as faming on own land, wage labour (agriculture, non-farm) and in Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), a government employment scheme).

Occupation (especially physically intense occupations) is a known risk factor for heat related illness (Jackson and Rosenberg, 2010; Centers for Disease Control and Prevention, 2011). Those engaged in wage labour or labour intensive government employment scheme-MGNREGS works were more affected as compared to those engaged in non-income generating activities such as household chores and education. 67% and 65% of the individuals engaged as wage labourers and MGNREGS workers respectively reported heat related symptoms (Table 5).

The OR also show that those engaged in farming, labour activities (agriculture and non-agriculture) and MGNREGS were more affected with OR of 2.05 (1.38, 3.03), 3.35 (2.33, 4.80) and 3.71 (2.28, 6.04) respectively) as compared to those performing non-income generating activities (Table 5).

Table 5: Occurrence of HRS in relation to other variables (Univariate analysis)

Parameter	Odds Ratio (unadjusted)	Lower CI	Upper CI	p-value
Summer occupation				
- Non-income generating activities (ref)				
- Farming	2.05	1.38	3.03	<0.001
- Agricultural and non-agricultural labour	3.35	2.33	4.80	<0.001
- MGNREGS labour	3.71	2.28	6.04	<0.001
- Others	1.95	1.06	3.61	0.03
Minutes spent performing activities outdoors during peak heat hours				
- 0 (ref)				
- 1 to 90 minutes	1.56	1.00	2.44	0.050
- 91 to 180 minutes	2.88	1.90	4.35	<0.001
- 181 to 360 minutes	1.75	1.14	2.69	0.010
Exposure				
- Type of roof				
- Tin (ref)				
- Cement slab	0.69	0.52	0.92	0.011
- Others	1.96	1.22	3.13	0.005

The work day was divided into four segments – morning (4 AM to 11 AM), mid-day (11 AM to 3 PM), afternoon (3 PM to 5 PM), and evening (5 PM to 7 PM). Of these, mid-day and afternoon together were considered as peak heat hours. This was based on local people's opinion on peak heat hours of the day. The total number of individuals exposed to peak heat hours for 1.5 to 6 hours is 428 (55%) (Table 6). Majority of these individuals were engaged in physically exertive work such as wage labour (47.9%) followed by farming (20%). About 14.7% worked as MGNREGS labourers during peak heat hours (Figure 5). Individuals exposed to higher duration to sunlight during peak heat hours were affected more than those not exposed (Table 6).

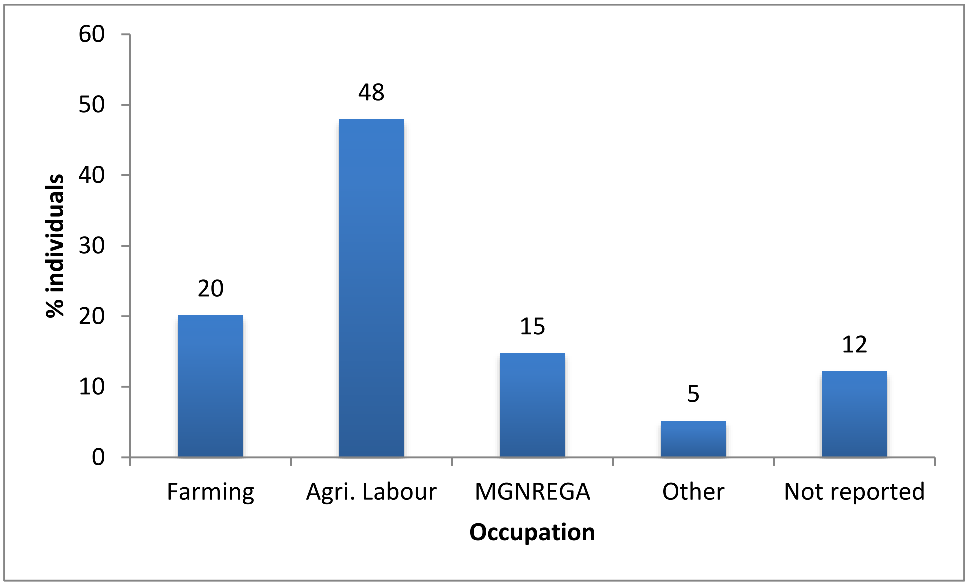

Figure 5: Occupation reported by Individuals exposed outdoors for more than 1.5 hours during peak heat hours (11 am- 5 pm; *n*=428)

Table 6: Time spent outdoors during peak heat hours

Time spent outdoors during peak heat hours for work or activities	No. of individuals
0	195 (25.4)
< 1.5 hours	145 (18.9)
1.5 to 3 hours	255 (33.2)
3 to 6 hours	173 (22.5)
Total individual responses	768 (100)

Exposure during other household chores

Apart from the livelihood activities, other household activities could also result in exposure to heat. Over 96% households collect firewood from field and forest. In 43.7% households, only women take the responsibility for collection of firewood. About 84% of households indicated spending more than 4 hours each week on this activity. The preferred time for this activity was in the morning, early evening and evening.

On an average, during summer, the time taken for collecting water was 71 minutes (against 40 minutes during other seasons). In over 93% households, the women were primarily responsible for fetching water. But during summer, men also support women in fetching water. Similar to the practice of collecting firewood, water too is collected during morning, early evening and evening hours.

Type of Roofing

Another amplifying factor of exposure is the type of shelter or dwellings. A large proportion of households (about 74% of sample households) were living in tin-roofed houses. Tin roofs get heated quickly during daytime as compared to cement slab roofs but they also cool up rapidly as compared to the cement roofs. About 47% of respondents residing in tin roofed houses indicated at least one HRS as compared to 38% living in cement slab houses (Table 7). Cross ventilation helps in dissipating heat. However, only 13% of the households reported having cross ventilation in all rooms. Those living in households with cement roof were less affected with odds of 0.69 (0.52, 0.92) as compared to those with tin roof.

Table 7: Roofing material

	Total individuals living in those houses	Total individuals who experienced at least one HRS	Proportion of individuals experiencing at least one HRS
Tin	887	412	47.0
Cement slab	260	99	38.1
Others	82	52	63.4

Figure 6: Tin roof households in the villages. *Source*: WOTR.

Without adequate rest and recovery time, people become more vulnerable to heat stress (Khan, Malik and Rehman, 2014). Poor design of houses with inadequate ventilation (lack of windows) could exacerbate the condition.

Adaptive factors

Individuals, families and the community take various steps to cope with heat and its impacts. Reducing exposure by changing work timings, resting under trees, resting between working hours, planned reduction in work, using fans indoors, staying hydrated, eating appropriate foods and using protective clothing are some of the means used. These address the immediate problem at hand and mostly employed during hot days or following them.

Ceiling fans (67%) and table fans (13.5%) were the most common ways to manage heat in summer. But prevalence of fans also varied, depending on the socio-economic status of the households and access to electricity. For example, the Scheduled Caste (SC) and Vimukta Jati and Nomadic Tribes (VJNT) families mostly have earthen houses with low ceilings, which made it structurally difficult to have ceiling fans. Ceiling fans also implied additional cost to the poor families.

Finding time to rest was found to be a challenge for women having responsibilities at home and in the fields. Some shared that they rest for one or two days when they are ill. Others who work on their own land stated that they rest for an hour or more at home during the afternoons. People prefer to sit outdoors under the shade of trees. It was also observed that some house, especially ones which did not have trees around, have erected a thatched roof propped up by sticks outside the front of the house. Traditional cots were also kept outside the houses in the shade during summer months.

About 25.6% households reported no specific measures being used. Almost all families reported increased consumption of water for drinking during summer. Almost 60% of families change their cooking schedules, with most of them (49.8%) cooking earlier in the day during summer months. In majority of households, male and female members slept outdoors and changed their sleeping pattern (waking up earlier in summers).

Figure 7: Elderly woman resting outside house during summer afternoon. *Source*: WOTR.

Regarding the most basic coping strategies, respondents were most affirmative in the case of drinking more water. Other simple strategies such as seeking shade, staying indoors, wear protective clothing, change work schedule, avoid outdoor activity received less affirmative responses (only sometimes), which indicates limited scope to adopt such measures (Figure 8: **Coping strategies employed by respondents during very hot weather (*n*= 215).**).

Almost 89% and 79% respondents reported that the water bodies and tree cover in their respective villages were poor or very poor.

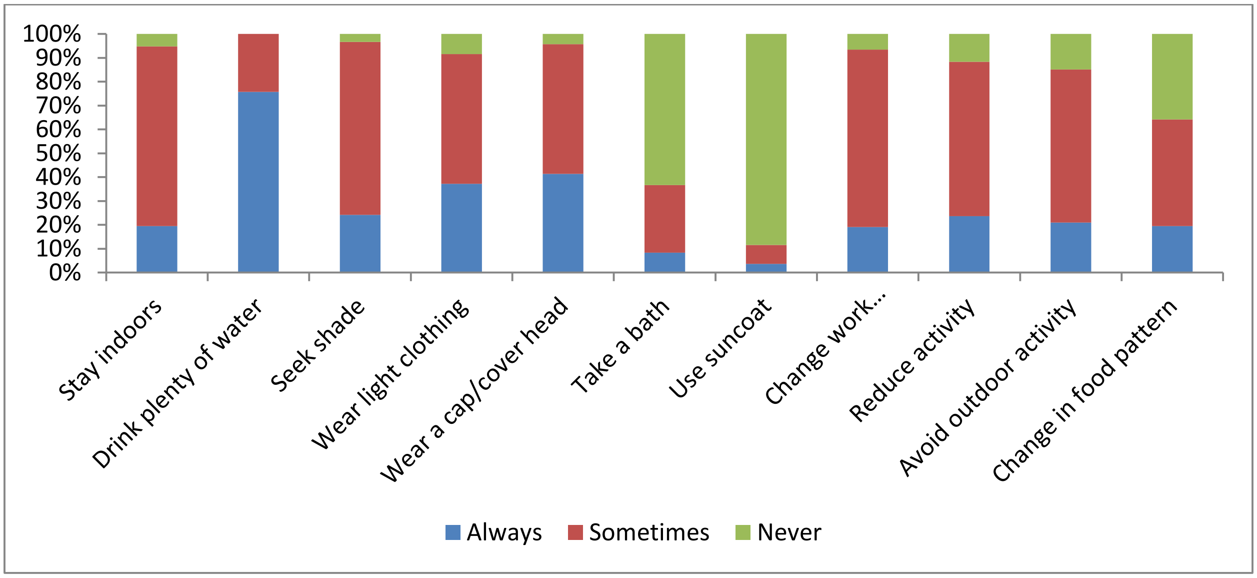

Figure 8: Coping strategies employed by respondents during very hot weather (*n*= 215).

A significant proportion of households (44%) approached private doctors in the case of heat related symptoms. The average distance between villages and their preferred healthcare facilities was 9.5 km. Most people reported that the doctor they consulted was qualified (94.6%). While individuals provided various reasons for inconvenience of visiting healthcare providers; poor transport facilities (65.7%) was the most important, followed by distance to health centre (41.4%) and cost of utilizing healthcare (31.4%).

Table 8: Information source on heat stress

Medium	Number	Percentage (*n*=215)
At least one reliable source of information (TV, Radio, newspaper, medical professional)	114	53.0
Hear-say	49	22.8
Didn't hear any information	52	24.2

About 53% of total sample households reported having received information on heat stress from at least one reliable source like TV, radio, newspaper or a medical professional. Majority of respondents (72% of sample households) felt it was important to have access to weather information. About 23% households received information only through word of mouth (Table 8). Other sources included information from friends, TV, family members, and doctors.

In recent years, heat action plans have been prepared at state level (e.g. Uttar Pradesh, Andhra Pradesh, Orissa and Telengana), city level (e.g. Ahmedabad, Nagpur) and district level (e.g. Hazaribaug in Jharkhand state). Broadly, these action plans aim to build public awareness and community outreach; develop early warning system and institutional mechanism for inter-agency cooperation; capacity building of health care professionals and promote adaptive measures. Their effectiveness on the ground needs to be assessed.

4. Conclusions

Heat related symptoms were highly prevalent in the area and can serve as useful indicators of heat stress. The major heat related symptoms were found to be headache, heavy sweating and fatigue, which were mild or moderate in nature. It is therefore important to identify and address the heat stress condition before it attains severe or fatal condition.

Findings indicate that age, gender, wealth and pre-existing health conditions were significantly associated with occurrence of HRS. Regarding exposure, working outdoors during mid-day, roofing material and indoor ventilation were significantly associated with occurrence of HRS.

Working men and women (31-59 year category) were found to be most vulnerable as compared to all other age groups. Women were relatively less vulnerable as compared to men. The type of livelihoods and housing structures influence exposure to heat stress. It was found that individuals performing physically intensive tasks were more vulnerable to heat stress and so were individuals residing in tin roofed houses. Further studies are needed to monitor the indoor temperature of various housing structures (including roofing, ventilation, and location of windows, walls and floor) and the effect on individuals.

Existing coping strategies appear to be inadequate to protect people from heat related stresses. It is important to make changes to work schedules, improve awareness of the communities to heat stress and take adequate precautionary measures. A major challenge in rural areas in the context of heat stress is accessibility to well-equipped health centres. A more long term strategy in terms of knowledge about heat stress symptoms and infrastructure and access to timely medical facilities is needed. For this, investments in upgrading of rural health infrastructure to handle heat stress related incidences should be considered.

In future, population exposed to heat waves is projected to increase. Hence, there is a need for pre-emptive strategies to ensure that people in areas where heat waves are not yet a phenomenon, are adequately supported to reduce their vulnerability. Improving health systems will benefit not just in the context of heat related illnesses, but for all illnesses, and so it is a no-regret intervention. Heat stress symptoms are easily recognised and can be used for early identification and prevention of more serious impacts such as heat stroke. Such measures will help protect individuals as well as the livelihoods. Effective planning through development of surveillance mechanism to monitor heat related mortalities and morbidity could help in mitigating and avoiding heat related stresses and deaths in the future.

At present there are heat action plans for some states and for few cities. Maharashtra does not have a state level heat action plan. Therefore, priority should be given to develop a comprehensive state level heat action plan for Maharashtra, which addresses the urban and rural communities.

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6. Annexes

Note on Wealth Ranking

Wealth ranking exercise is a participatory tool used by WOTR for categorizing the households in different economic categories based of certain pre-determined indicators. This exercise is facilitated by the WOTR field staff and carried out in a village meeting which is attended by at least half of the village households. During this meeting, each household is categorized in one of the four categories- very poor, poor, middle class and better off. This is done by a consensus and is accepted by all. The results are then presented in the next village Gram Sabha, which ratifies the list of families within each category and then it is displayed in a common place in the village (Gram Sabha is a meeting of all adults who live in the area covered by the Panchayat).

Through WOTR's experience of conducting Wealth Ranking with villages in the past, the following criteria for each economic category have been developed. They are intended as guidelines only, and each village should decide which criteria make sense in that village, and make changes to the guidelines.

Very Poor:

- Less than 2 acres of rain-fed land
- Distress migration for more than 6 months of the year
- Food security for only 2 months of the year
- Dwelling place is a hut
- Possesses no livestock
- Single parent families without any support

Poor:

- 2 to 10 acres of rain-fed land
- Distress migration during four months of the year
- Food security from their own land for 2 to 6 months
- Dwelling place is a hut

Middle class:

- More than 10 acres of rain-fed land or less than 5 acres of seasonally irrigated land
- Substantial source of income (meet expenses)
- Food security for the whole year
- Own a motorcycle/three wheeler/bullock cart

Better off:

- More than 5 acres of seasonally irrigated land or 3-5 acres of perennially irrigated land
- Have good income (have surplus income)
- Food security for the whole year
- Dwelling place has 3 or more rooms
- Own a car

Wealth ranking is one of the participatory tools used under WOTR's Wasundhara Approach. The approach combines WOTR's proven technology of watershed development with its strategy for socio-economic empowerment. It supplements watershed development by helping women and the poor start livelihood initiatives and exercise their political voices. The wealth ranking helps towards equitable contribution of various economic groups towards village development. Here middle class and better-off households contribute more as compared to the poor and very poor households. This also helps in proportionate representation of all economic groups in the Village Development Committee.

Additional tables

Table 9: Household demographics of the sampled households across the three villages (village-wise data)

	Adha	Sindi	Goshegaon	Total sample
No. of HH sampled	62 (28.8%)	66 (30.7%)	87 (40.5%)	215 (100%)
No. of individuals in the sample	352 (28.8%)	391 (31.9%)	481 (39.3%)	1224 (100%)
No. of males	193 (28.8%)	221 (32.9%)	257 (38.3%)	671 (100%)
No. of females	159 (28.8%)	170 (30.7%)	224 (40.5%)	553 (100%)
Avg. ± SD HH size	5.5±2.8	5.8±2.8	5.5±1.9	5.6±2.5
Avg. ± SD age	29.3±18.3	27.8±19.3	29.2±19.7	28.8±19.2
Avg. ± SD HH monthly income	3767±2215	4585±3153	3338±1916	3844±2484
n (%) elderly (>60) employed among elderly (*n*=128)	22 (59.5%)	21 (58.3%)	26 (47.2%)	69 (53.9%)
n (%) own home	62 (100%)	66 (100%)	82 (94.3%)	210 (97.7%)

Table 10: Household demographics of the sampled households across the three villages (wealth ranking wise data)

	Very Poor	Poor	Middle class	Better off	Total sample
No. of HH sampled	46 (21.4%)	87 (40.5%)	51 (23.7%)	31 (14.4%)	215 (100%)
No. of individuals in the sample	223 (18.2%)	448 (36.6%)	335 (27.4%)	218 (17.8%)	1224 (100%)
No. of males	125 (18.6%)	250 (37.3%)	179 (26.7%)	117 (17.4%)	671 (100%)
No. of females	98 (17.7%)	198 (35.8%)	156 (28.2%)	101 (18.3%)	553 (100%)
Avg. ± SD HH size	4.8±1.5	5.2±1.7	6.4±3.1	6.7±3.4	5.6±2.5
Avg. ± SD age	28.5±19.4	29.0±18.8	28.2±19.0	29.6±20.2	28.8±19.2
Avg. ± SD HH monthly income	2618±1314	3403±1919	4769±2408	5382±3799	3844±2484
n (%) elderly (>60) employed among elderly (*n*=128)	9 (37.5%)	24 (53.3%)	20 (62.5%)	16 (59.3%)	69 (53.9%)
n (%) own home	44 (95.7%)	83 (96.5%)	51 (100%)	31 (100%)	209 (97.7%)

Table 11: Occurrence of heat-related symptoms in various sections of the study population

Variable	*n*	Persons reporting at least one HRS	% reporting at least one HRS
Gender			
- Male	671	332	49.5
- Female	553	234	42.3
Age			
- 0-4	104	18	17.3
- 5-14	212	50	23.6
- 15-30	450	190	42.2
- 31-59	330	235	71.2
- 60+	128	73	57.0
Wealth ranking			
- Very poor	223	114	51.1
- Poor	448	237	52.9
- Middle class	335	138	41.2
- Better off	218	77	35.3
Caste category			
- Scheduled caste	276	138	50.0
- Scheduled tribe	57	12	21.1
- Nomadic and Denotified Nomadic Tribes	44	10	22.7
- Vimukta Jati Nomadic Tribes	13	9	69.2
- Other Backward Classes	66	27	40.9
- Forward Castes	757	363	48.0
Education			
- Illiterate	286	152	53.1
- Primary school	210	107	51.0
- Secondary school	450	222	49.3
- High school	122	44	36.1
- Graduate and above	54	27	43.5
Summer occupation			
- Non income generating activities	205	73	35.6
- Farming	211	112	53.1
- Agri and non-agri labour	342	222	64.9
- MGNREGS work	113	76	67.3
- Others	52	27	55.3

Table 12: Utilisation of health systems for HRS

Parameter	Total (%; *n*=215)*
Use of home remedies	
- Always	4 (1.9)
- Often	44 (20.6)
- Rarely	100 (46.7)
- Never	64 (29.9)
- Used to do previously	2 (0.9)
Households that ever visited any healthcare provider for HRI	95 (44.2)
[Multiple responses] Number of HHs that visited:	
- Hospital	10
- PHC	15
- Private doctor	67
- Sub-centre	9
- ASHA	2
- Other	0
Average distance from village from most preferred healthcare facility for HRI in KM (SD)	9.54 (10.61)
Median distance from preferred healthcare facility for HRI in KM	5.5
Was the doctor qualified?	
- Yes	88 (94.6)
- No	1 (1.1)
- Don't know	4 (4.3)
Condition of healthcare facility	
- Cooler than outside	77 (81.1)
- As hot as outside	14 (14.7)
- Don't know	4 (4.2)
Convenience of visiting a health practitioner	144 (67.3)
Distance to health centre as a barrier to visit (*n*=70)	29
Poor transportation facilities (*n*=70)	46
Cost of visit (*n*=70)	22
Long wait time (*n*=70)	4

** except where specified in the table*

Table 13: Frequency of factors associated with heat stress, and other socio-demographic features (individual as unit)

	Very poor (*n*=223)	Poor (*n*=448)	Middle class (*n*=335)	Better off (*n*=218)	Total (*n*=1224)
SOCIO-DEMOGRAPHIC FACTORS					
Gender					
- Male	56.1%	55.8%	53.4%	53.7%	54.8%
- Female	43.9%	44.2%	46.6%	46.3%	45.2%
Age categories					
- 0 to 1	1.8%	1.1%	1.8%	.5%	1.3%
- 1 to 4	8.1%	5.4%	9.0%	7.3%	7.2%
- 5-14	15.7%	19.6%	14.9%	17.9%	17.3%
- 15 to 30	38.1%	35.7%	38.2%	35.3%	36.8%
- 31 to 59	25.6%	28.1%	26.6%	26.6%	27.0%
- 60 and above	10.8%	10.0%	9.6%	12.4%	10.5%
- Summer occupation					
- None	19.7%	12.3%	17.6%	21.6%	16.7%
- Farming	6.3%	13.8%	18.5%	33.5%	17.2%
- Agriculture labour	16.1%	23.7%	17.6%	7.3%	17.7%
- Non-agriculture labour	13.9%	13.4%	7.2%	4.6%	10.2%
- Salaried	0.0%	1.1%	0.0%	0.5%	0.5%
- Artisan/craftsman/household industry	3.1%	0.9%	3.6%	1.4%	2.1%
- Petty business/trade	4.0%	0.7%	0.6%	0.0%	1.1%
- Livestock rearing	0.9%	0.4%	0.3%	0.5%	0.5%
- MGNREGS work	13.0%	8.7%	9.6%	6.0%	9.2%
- Other (specify)	0.0%	0.2%	0.3%	0.0%	0.2%
- Not applicable (age < 15 years)	22.9%	24.8%	24.5%	24.8%	24.3%
OTHER DRIVERS OF VULNERABILITY					
	Very poor (*n*=223)	Poor (*n*=448)	Middle class (*n*=335)	Better off (*n*=218)	Total (*n*=1224)
At least one pre-existing health condition	13.0%	13.2%	13.1%	11.5%	12.8%

Table 14: Frequency of factors associated with heat stress, and other socio-demographic features (household as unit)

SOCIO-DEMOGRAPHIC FEATURES					
	Very poor (*n*=46)	Poor (*n*=87)	Middle class (*n*=51)	Better off (*n*=31)	Total (*n*=215)
Caste category					
- Scheduled Caste	34.8%	27.6%	9.8%	19.4%	23.7%
- Scheduled Tribe	8.7%	4.6%	3.9%	0.0%	4.7%
- NT/DNT	2.2%	1.1%	3.9%	6.5%	2.8%
- VJNT	4.3%	1.1%	0.0%	0.0%	1.4%
- Other Backward Class (OBC)	6.5%	4.6%	5.9%	6.5%	5.6%
- Open	43.5%	60.9%	76.5%	67.7%	61.9%
HOUSING					
	Very poor (*n*=46)	Poor (*n*=87)	Middle class (*n*=51)	Better off (*n*=31)	Total (*n*=215)
Type of roof material					
- Tin	93.5%	82.8%	68.6%	29.0%	74.3%
- Cement Slab	0.0%	10.3%	23.5%	54.8%	17.8%
- Others	4.4%	6.9%	7.8%	16.1%	7.9%
Cross-ventilation in all rooms					
- Yes	4.3%	13.8%	13.7%	23.3%	13.1%
- No	54.3%	54.0%	64.7%	50.0%	56.1%
- No windows	41.3%	32.2%	21.6%	26.7%	30.8%
Tree cover over the household	8.9%	12.8%	8.2%	12.9%	10.9%
Kitchen related					
- Separate kitchen	50.0%	42.5%	54.9%	58.1%	49.3%
- Cooking done indoors during summer	43.5%	55.8%	51.0%	67.7%	53.7%
- Kitchens with windows	4.3%	16.1%	21.6%	25.8%	16.3%
- Kitchens with open windows	4.3%	12.6%	21.6%	25.8%	21.6%
- Any other ventilation opening in kitchen	60.9%	56.6%	62.7%	62.1%	59.8%

FACTORS RELATED TO EXPOSURE					
	Very poor (*n*=46)	Poor (*n*=87)	Middle class (*n*=51)	Better off (*n*=31)	Total (*n*=215)
Responsibility for firewood collection among adults					
- Women only	50.0%	41.4%	51.0%	32.3%	44.1%
- Men only	4.3%	4.6%	12.2%	9.7%	7.0%
- Both women and men	45.7%	54.0%	36.7%	58.1%	48.8%
Households where children also help collect firewood	15.2%	11.5%	17.6%	12.9%	14.0%
- Girl child helping with firewood collection	8.7%	4.6%	9.8%	6.5%	7.0%
Hours per week for fuel wood collection					
- One hours	2.2%	0.0%	0.0%	3.3%	.9%
- Two hours	6.7%	8.0%	2.0%	3.3%	5.7%
- Three hours	2.2%	10.3%	8.2%	6.7%	7.6%
- Four hours or more	88.9%	81.6%	89.8%	86.7%	85.8%
Time of firewood collection					
- Early morning	0.0%	0.0%	0.0%	13.3%	1.9%
- Morning	24.4%	26.4%	29.8%	13.3%	24.9%
- Mid-day	6.7%	5.7%	8.5%	13.3%	7.7%
- Early evening	11.1%	5.7%	4.3%	10.0%	7.2%
- Evening	6.7%	10.3%	6.4%	3.3%	7.7%
- Multiple timeslots reported	51.1%	51.7%	51.1%	46.7%	50.7%
Timing for fetching water					
- Early morning	0.0%	0.0%	2.0%	3.3%	.9%
- Morning	13.0%	13.8%	9.8%	10.0%	12.1%
- Mid-day	0.0%	1.1%	0.0%	0.0%	.5%
- Evening	2.2%	2.3%	3.9%	3.3%	2.8%
- Multiple time slots	84.8%	82.8%	84.3%	83.3%	83.6%
OTHER FACTORS RELATED TO VULNERABILITY					
	Very poor (*n*=46)	Poor (*n*=87)	Middle class (*n*=51)	Better off (*n*=31)	Total (*n*=215)
Recent occurrence of fever in the household (past 2 months)	53.3%	65.5%	74.5%	64.5%	65.0%
Recent occurrence of diarrhea in the household (past 2 months)	19.6%	19.5%	22.0%	29.0%	21.5%

Barriers to access healthcare					
- Distance	10.9%	14.9%	15.7%	9.7%	13.5%
- Lack of transportation	26.1%	26.4%	15.7%	9.7%	21.4%
- Cost	8.7%	13.8%	5.9%	9.7%	10.2%
- Overcrowding of healthcare facility	4.3%	0.0%	0.0%	6.5%	1.9%
Approaches being used for cooling the house this summer					
- Cooler	4.3%	1.1%	3.9%	9.7%	3.7%
- Ceiling fan	56.5%	63.2%	70.6%	87.1%	67.0%
- Table fan	4.3%	14.9%	15.7%	19.4%	13.5%
- Shades and shutters	6.5%	6.9%	11.8%	0.0%	48.4%
- Trees and plants	2.2%	0.0%	3.9%	12.9%	22.6%
- Not doing anything different	41.3%	28.7%	15.7%	9.7%	25.6%
Changes being done to housing structure during summer					
- Straw on the roof	2.2%	5.7%	9.8%	3.2%	5.6%
- Covering the floor	0.0%	1.1%	5.9%	0.0%	1.9%
- Putting wet cloth on door or windows	2.2%	3.4%	3.9%	3.2%	3.3%
- Shifting the kitchen outside the house	10.9%	6.9%	5.9%	3.2%	7.0%
- Nothing specifically done	69.6%	70.1%	66.7%	77.4%	70.2%
Usual clothing material during summer – Women					
- Cotton	2.2%	6.9%	7.8%	9.7%	6.5%
- Cotton mix	6.5%	1.1%	9.8%	6.5%	4.7%
- Tericot	91.3%	88.5%	82.4%	80.6%	86.5%
Usual clothing material during summer – Men					
- Cotton	4.3%	8.0%	5.9%	19.4%	8.4%
- Cotton mix	6.5%	2.3%	9.8%	3.2%	5.1%
- Light weight cloths	0.0%	0.0%	0.0%	3.2%	.5%
- Tericot	87.0%	86.2%	84.3%	71.0%	83.7%

Summary of sources of information on heat and HRI					
- At least one reliable source	43.5%	51.7%	58.8%	61.3%	53.0%
- Word of mouth	21.7%	25.3%	25.5%	12.9%	22.8%
- No information	34.8%	23.0%	15.7%	25.8%	24.2%
Use of protective clothing during transit – Men					
- Hat or cap	54.3%	66.7%	60.8%	83.9%	65.1%
- Scarf	2.2%	1.1%	0.0%	0.0%	0.9%
- Towel (gamcha)	60.9%	70.1%	72.5%	58.1%	67.0%
- Handkerchief	19.6%	21.8%	27.5%	9.7%	13.0%
Use of protective clothing during transit – Women					
- Hat or cap	0.0%	1.1%	0.0%	3.2%	0.9%
- Scarf	97.8%	96.6%	100.0%	100.0%	98.1%
- Towel (gamcha)	2.2%	0.0%	0.0%	0.0%	0.5%

Table 15: Coping strategies

Coping strategies	Odds ratio	Low CI	Upper CI	P-value
HH electricity access				
- Yes				
- No	1.39	0.91	2.13	0.132
Presence of cross-ventilation in all rooms				
- Yes				
- No	1.18	0.86	1.62	0.317
- No windows	1.69	1.18	2.42	0.004
Cooling methods at home during summer				
- Using at least one approach to cool home	0.67	0.51	0.88	0.004
- None (baseline)				
For population exposed for more than 90 minutes during peak heat hours:				
Wearing light coloured clothing				
- Always				
- Sometimes	0.50	0.29	0.89	0.017
- Never	0.33	0.15	0.73	0.006
Covering the head				
- Always				
- Sometimes	0.66	0.39	1.12	0.122
- Never	0.67	0.22	2.03	0.483
Wearing sun-coat				
- Always				
- Sometimes	0.43	0.14	1.34	0.146
- Never	0.55	0.18	1.68	0.301

Taking a break				
- Always				
- Sometimes	0.59	0.28	1.27	0.180
- Never	1.53	0.38	6.25	0.561
Seeking shade				
- Always				
- Sometimes	0.88	0.39	2.00	0.772
- Never	1.24	0.28	5.44	0.789