Vulnerability Assessment of Households in Colombo to Heat Stress

This material is based on work supported by the Asia-Pacific Network for Global Change Research (APN). This document is an outcome of the survey on heat stress vulnerability assessment in Colombo Municipal Council jointly conducted by the Slycan Trust, Sri Lanka & Integrated Research and Action for Development (IRADe), India.

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1 Overview

1.1 Climate change, Heat waves, and heat stress

Over the last century, global temperatures have risen by approximately 0.8 to 1.3°C compared to pre-industrial times, mostly as a result of human greenhouse gas emissions. Temperatures are projected to rise even further and cause serious climatic changes across the world, including extreme weather events, loss of biodiversity and ecosystem functionality, and sea level rise (IPCC,2021/2022).

IPCC further states that heat waves are projected to become more frequent, intense, and long lasting in many parts of the world, making it even more important to develop effective strategies for managing heat stress and reducing the risk of heat-related illnesses and deaths. Heat waves often occur during the summer months and can be accompanied by high humidity, making it difficult for the body to cool down and leading to heat stress. Studies denote that climate change is one of the primary drivers of the escalating frequency, intensity, and duration of heat waves around the world. As global temperatures continue to rise due to the buildup of greenhouse gases in the atmosphere, heat waves are becoming more frequent and severe, posing a significant risk to human health, ecosystems, and infrastructure.

Apart from these short- and long-term impacts, the increase in temperature itself can negatively affect human health and wellbeing via a variety of mechanisms, including heat stress, heat exhaustion and heat stroke, chronic dehydration, an increase in vector-borne infections, and malnutrition. It is now beyond doubt that global warming has increased the number of heat waves experienced around the world. The adverse impacts of climate change and heat waves on weather patterns, crops, and livestock have been demonstrated and researched extensively (Pagani et al. 2017). In particular, outdoor industries such as road and building construction, agriculture, mining, and fishing are vulnerable to heat diseases and rising temperatures (Nilsson and Kjellstrom, 2010).

1.2 Heat stress impacts: Specific focus on Sri Lanka

South Asia is recognized as a high-risk region for climate impacts due to a combination of factors including its climate and geography, a large and growing population, rapid urbanization, gaps in health infrastructure, resource scarcity, and reliance on agricultural livelihoods. Similar to other regions, annual average temperatures in South Asia have exhibited a clear and significant rising trend. Southeast India, Western Sri Lanka, Northern Pakistan, and Eastern Nepal have had annual temperature increases of 1.0°C to 1.5°C over the past few decades (Mani et al., 2018). The

Intergovernmental Panel on Climate Change (IPCC) estimates that the South Asian region's average annual temperature could rise by 2°C by the middle of the 21st century, compared to the 20th century average.

Sri Lanka is particularly vulnerable to the impacts of climate change-driven heat stress due to its tropical climate and location near the equator. The rise in temperatures within a country can have detrimental effects on people, ecosystems, and the economy. The level of risk linked to heat stress impacts is determined by the intensity of the natural hazard and the degree of vulnerability of humans and/or the environment. Moreover, factors such as socioeconomic and demographic conditions affect a population's susceptibility to heat stress, in addition to climate. The interplay of these factors can result in an increased likelihood of exposure to heat-related dangers.

2 Study Area

2.1 About Colombo Municipal Council

Colombo Municipal Council (CMC) is located at 6°56'04"N 79°50'34"E on the west coast, just south of the Kelani River. It is a principal port on the Indian Ocean. It is situated on the west coast of the island, close to the Greater Colombo area, which includes Sri Jayewardenepura Kotte.

From a geographical viewpoint, the Colombo city region has been defined as the Colombo district area, including the Municipal Council (CMC). The Colombo Municipal Council area (CMC) and its adjacent municipalities 'Dehiwala-Mount Lavinia' and 'Sri Jayewardenepura Kotte' are designated the Colombo Core Area (CCA). The city consists of six districts for its administrative purposes. These districts are further divided into 47 Colombo Municipal Council (CMC) wards for their administrative purpose.

Colombo is the commercial capital and the most populous city in Sri Lanka. It is the island's financial centre and a popular tourist destination. Colombo is the most densely populated city in Sri Lanka with 13364 persons/Km2 while the country's average population density is 325 persons/Km2 (Ariyawansa, 2009). According to the Colombo Municipal Council, Colombo has a total population of 555,031. The total population of Colombo accounts for approximately 13% of the total population of the country. Furthermore, the city region has a transient population twice as large as the resident population.

Table-1: Colombo city, Demography (Source: Colombo Municipal Council)

Socio-economic characteristics	
Population	555,031 (as per 2011 census)
Total area	37 Km^2
Density	8,664 persons per sq. km.
Slum Population	177,791 & 44,448 HHs (55%)[1]

Table 2 – Survey locations in Colombo City

Survey locations in Colombo City		
No	Surveyed Hotspots	Ward Number
1	Sir James Pieris Mawatha	23
2	Slave Island	21
3	Mattakkuliya	1
4	Modara	2
5	Kotahena	7
6	Hunupitiya	23

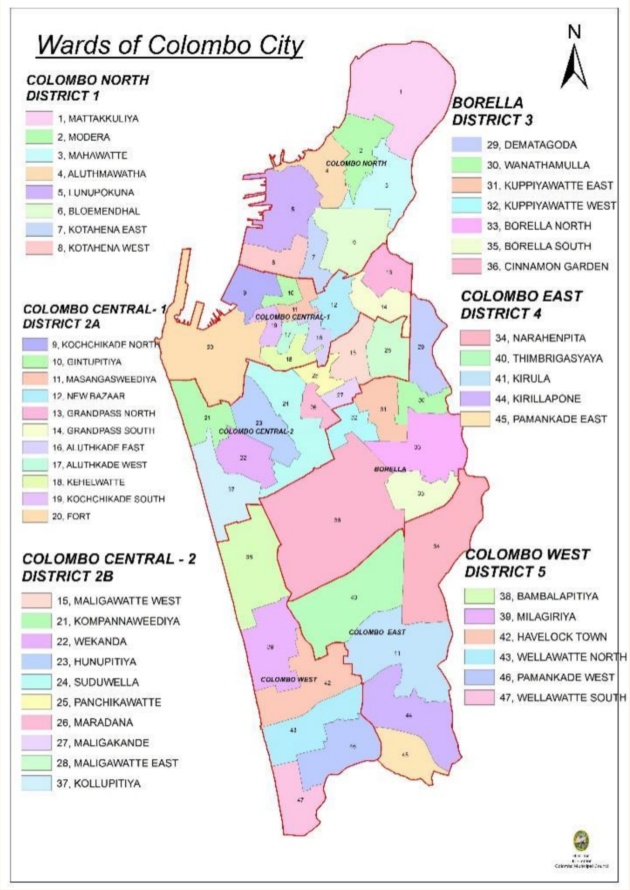

Figure 1. Ward Map of Colombo city

2.2 Selection of Participants

In order to identify the vulnerable populations, economically disadvantaged groups, women, children, and elderly, as well as working individuals such as construction workers, factory workers, transportation workers, sweepers, labours, and vendors, were considered. Vulnerability mapping was carried out by taking into account the overlapping layers of identified vulnerable areas and sections. To measure the susceptibility to heat stress, comprehensive household surveys were conducted in the city, with 50 households participating in the study.

2.3 Survey design and data collection

The survey assessed the impact of heat stress on health, work productivity, and livelihood in a sample size of 50 HHs. The surveys were initiated after the pilot surveys. Structured interviews were carried out at the household level. The investigators collected the data by going door to door and helping the identified groups respond where required.

During the survey, the impact of extreme heat events on the health, work productivity, and livelihoods of the vulnerable population was assessed by utilizing a comprehensive index of compounding factors that worsen the effects of the climate. The index encompasses nine sectors and multiple sub-sectors, including services that are crucial during heatwaves, as listed in the table.

Table 3 – Sectors and sub sectors of the structured interviews

No	Sectors	Sub Sectors
1	Sanitation	Type of toilet
		Individual toilets
2	Water	Water source
		Frequency water supply
		Water bill
3	Electricity	Electricity cut-off
		Electricity bill
4	Health	Access to health facilities
		Distance hospital
		Heat stress symptoms
5	Transportation	Mode of Transportation
		Distance travelled
6	Housing	Year of Occupancy
		Number of rooms
		Type of house
		Floor type
		Roof type
		Wall type
		Number of Windows
		Wall color
7	Cooking	Cooking place
8	Awareness	Heat stress awareness
		Awareness about use of medical facilities
		Awareness about availability of medical measures

3.0 Results

3.1 Household Information

3.1.1 Ownership:

Table 4 – House ownership

House Ownership			
Colombo City	No	Yes	Total
Absolute Number	8	42	50
Percentage distribution (Within Options)	16%	84%	100%

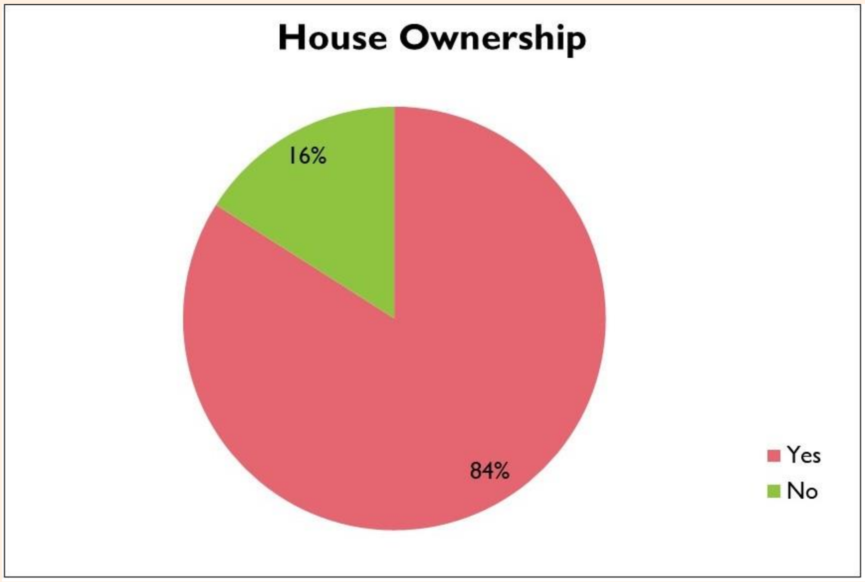

Figure 2 – House ownership

In the survey conducted it was observed that majority (around 84%) of the respondents possess house ownership while 16% of them weren't. These results suggest a majority inclination towards the positive response, indicating a prevailing trend in the studied population. House ownership can also play a role in the level of heat stress experienced by individuals. Homeowners may have more control over the design and maintenance of their homes, including the installation of air conditioning and insulation systems, which can help to mitigate the effects of heat stress. Conversely, renters may have less control over the maintenance and upkeep of their homes, and may be less likely to invest in cooling systems or make structural changes to combat heat stress. However, it is important to note that the relationship between house ownership and heat stress is complex and multifaceted, and can be influenced by a variety of socioeconomic, demographic, and environmental factors.

3.1.2 Total number of rooms

Table 5 – Number of rooms

Number of rooms				
	1 Room	**2 Rooms**	**3 Rooms**	**4 Rooms**
Absolute Numbers	12	26	8	4
Percentage distribution	24%	52%	16%	8%

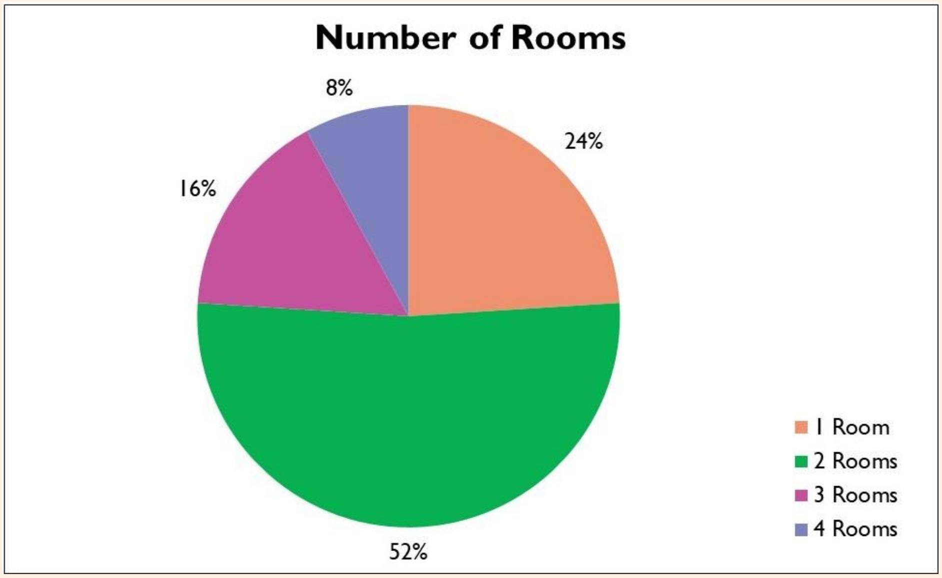

Figure 3 – Number of rooms

The number of rooms in a house can potentially impact the level of heat stress experienced by its occupants. Houses with fewer rooms may be more susceptible to heat stress, as the limited space can lead to higher indoor temperatures and less opportunity for airflow.

The findings suggest that majority of houses has either two rooms (52%) or one room (24%) with fewer households with three rooms (16%) and four rooms (8%).

Smaller houses may lack adequate insulation or cooling systems, further exacerbating the effects of heat stress. Conversely, larger houses with more rooms may be better equipped to combat heat stress, as they may have better insulation, air conditioning, and ventilation systems in place. However, it should be noted that the specific factors contributing to heat stress in a given household can vary widely and are dependent on a multitude of factors beyond the number of rooms, such as geographic location, climate, and building materials.

Figure 4 –Houses with adequate insulation

3.1.3 Type of Housing structure, Floor material, wall material and roof material

Table 6 – Type of house

Type of House			
	Single house in separate land	**Interconnected houses**	**Total**
Absolute Numbers	37	13	50
Percentage distribution	74%	26%	100%

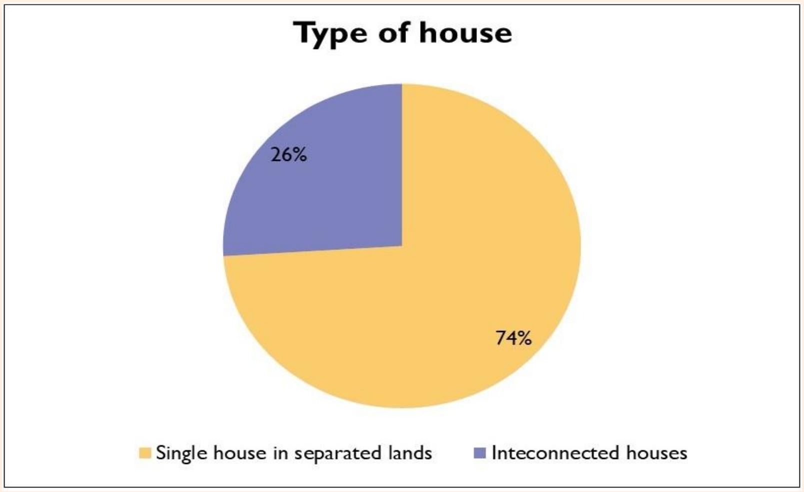

Figure 5 – Type of house

Table 7 - Type of house wall

Type of House Wall					
	No walls	**Natural**	**Cement/Concrete**	**HI/Metal**	**Wood/ Thin sheet**
Absolute Numbers	0	0	48	1	1
Percentage distribution	0%	0%	96%	2%	2%

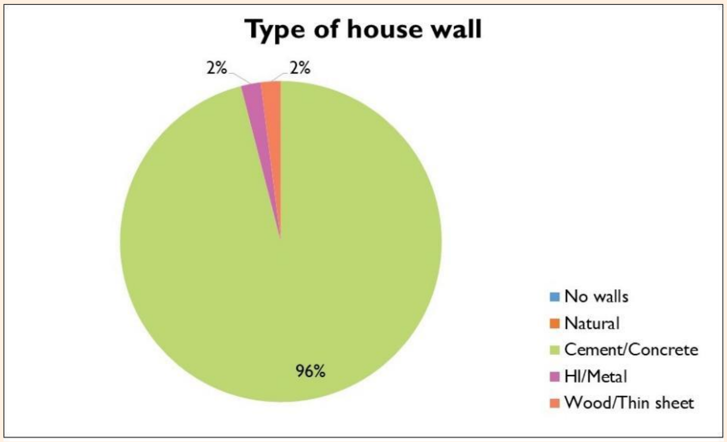

Figure 6 – Type of house wall

Table 8 – Material of the roof

Material of the roof			
	Asbestos sheets	**Thin metal sheet**	**Concrete**
Absolute Numbers	37	3	10
Percentage distribution	74%	6%	20%

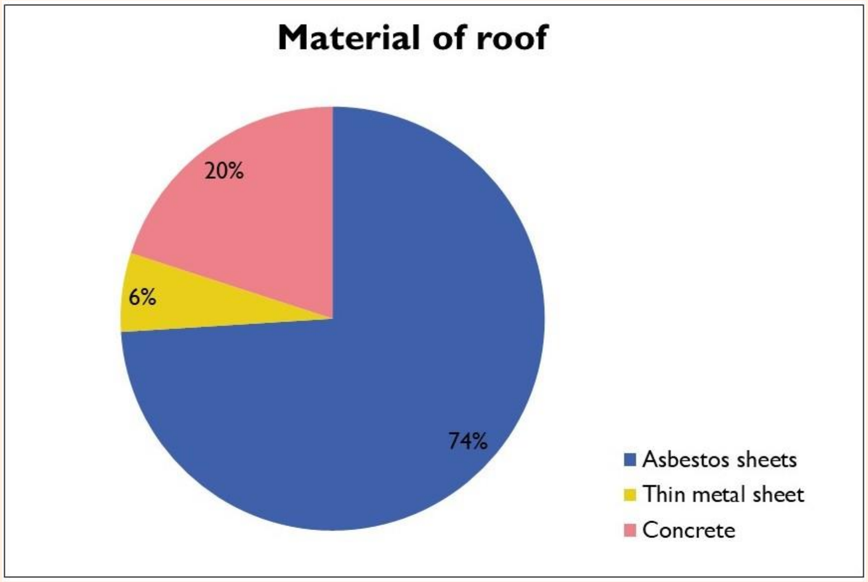

Figure 7 – Material of the roof

Results indicate that 74% of the respondents reported living in single houses, while 26% reported living in interconnected houses. These findings provide an insight into the housing preferences and choices of the study population. Moreover, the research findings indicate that almost 96% of the participants reported having house walls made of cement or concrete, while the remaining 4% reported having walls made of either HI/metal or wood/thin sheet, with each category accounting for 2%. Furthermore, upon examining the material composition of the roofs in the surveyed households, it was found that 74% of the roofs were constructed with asbestos sheets, while 20% were made of concrete and 6% were composed of thin metal sheets.

Figure 8 – Material of the roof

The type of house, wall type, and roofing material can collectively impact the level of heat stress experienced by occupants. For instance, houses with high ceilings, large windows, or that face direct sunlight may be more susceptible to heat stress. If combined with thin metal or wood sheet walls, and a roofing material that has low thermal mass such as asbestos sheets, the heat transfer into the house can be faster, causing higher indoor temperatures and worsening heat stress. Conversely, houses with thick walls made of materials such as brick or stone, and efficient insulation, may be better able to regulate indoor temperatures and reduce the impact of heat stress. Roofs made of materials with high thermal mass, such as concrete, can also help to absorb and release heat slowly, and further mitigating the effects of heat stress. Additionally, the effectiveness of cooling systems, location, and individual behaviors and preferences can all influence the relationship between type of house, wall type, roofing material and heat stress. Overall, understanding the interplay between these factors is important in designing houses that are better equipped to reduce the impact of heat stress.

3.1.4 Number of Windows, exterior wall paints

Table 9 – Number of in the house

Number of Windows in house					
	No Window	**1 Window**	**2 Windows**	**3 Windows**	**4 Windows**
Absolute Numbers	1	11	24	10	4
Percentage distribution	2%	22%	48%	20%	8%

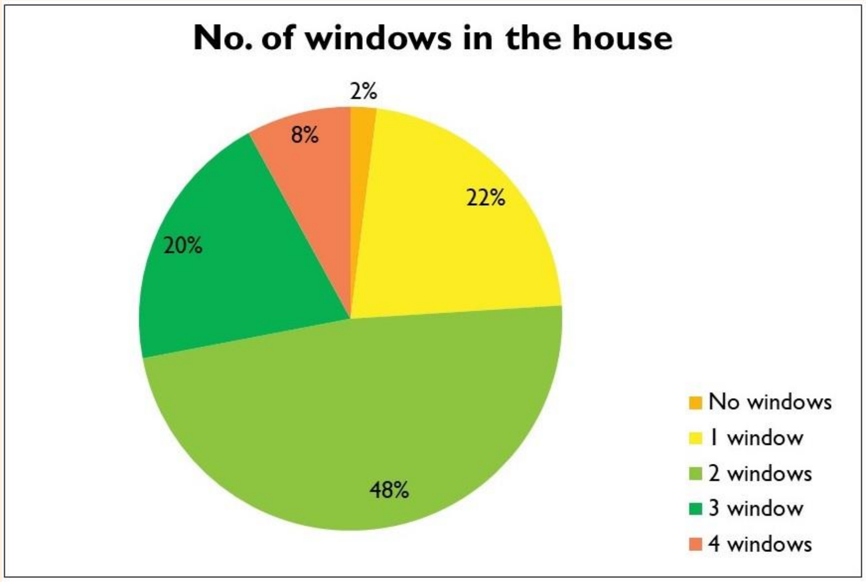

Figure 9 – Number of windows in the house

Table 10 – Exterior wall paint color

Exterior wall paint		
	Light Color	**Dark Color**
Absolute Numbers	41	9
Percentage distribution	82%	18%

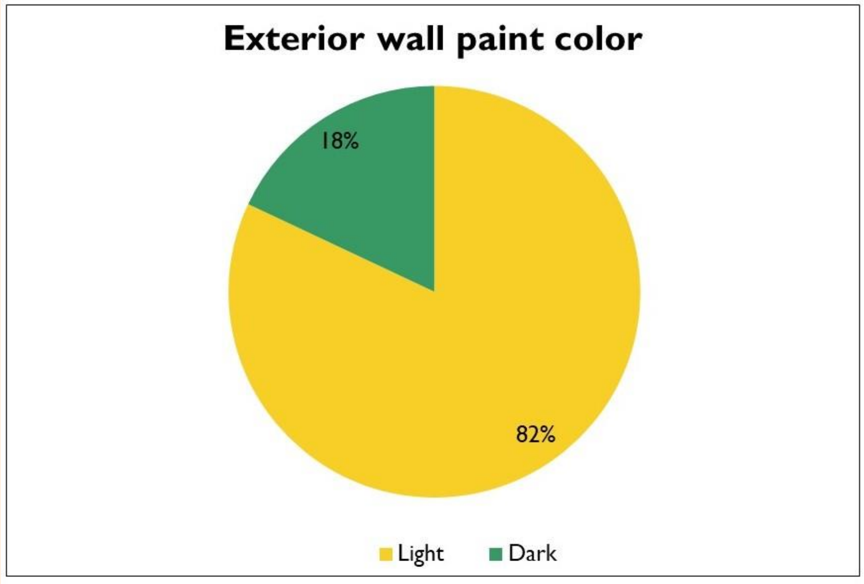

Figure 10 – Exterior wall paint color

The research findings indicate that the majority of households surveyed, accounting for 42%, had two windows, followed by 22% with one window, 20% with three windows, 8% with four windows, and 2% with no windows. Moreover, it was found that 82% of the households surveyed had light-colored exterior walls, while only 18% had dark-colored walls.

The number of windows in a house can also impact the level of heat stress experienced by its occupants. Houses with more windows may allow more heat to enter, especially if the windows face direct sunlight, resulting in increased indoor temperatures and heat stress. Conversely, houses with fewer windows or those with windows that are shaded or protected by exterior shading devices may be better able to regulate indoor temperatures and reduce heat stress. This could also influenced by the orientation and location of the house.

Such influence can be catalyzed by the (paint) colors of the exterior wall. Light-colored walls tend to reflect more sunlight and heat, resulting in lower heat absorption and reduced indoor temperatures, which can help to mitigate heat stress. In contrast, dark-colored walls tend to absorb more sunlight and heat, resulting in higher heat transfer and increased indoor temperatures, which can worsen heat stress. Therefore, houses with light-colored walls may be better equipped to reduce the impact of heat stress, especially if combined with other heat reduction strategies, such as insulation or shading devices.

3.2 Cooking

3.2.1 Cooking place

Table 11 – Cooking place

Cooking Place			
	In the house	**Outdoors**	**Total**
Absolute Numbers	44	6	50
Percentage distribution	88%	12%	100%

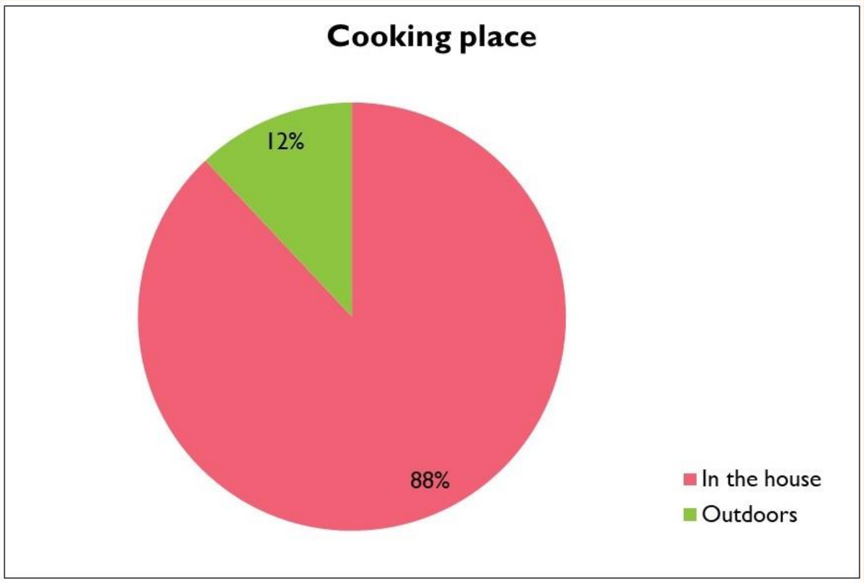

Figure 11 – Cooking place

The results show that 88% of the survey participants reported cooking inside their house, while 12% cook outdoors. The location of the kitchen in a house can also impact the level of heat stress experienced by its occupants. Kitchens located indoors can generate heat from cooking appliances, such as ovens and stoves, which can increase indoor temperatures and contribute to heat stress. Kitchens located outdoors or in separate structures, can help to reduce the amount of heat generated inside the house and mitigate heat stress. Additionally, the ventilation and cooling systems in the kitchen can also play a role in reducing heat stress. Proper ventilation can help to remove heat and humidity generated during cooking, while efficient cooling systems can regulate indoor temperatures and reduce heat stress.

3.3 Sanitation

3.3.1 Access to toilet

Table 12 – Shared toilet facilities

Shared Toilet			
	No	**Yes**	**Total**
Absolute Numbers	50	0	50
Percentage distribution	100%	0%	100%

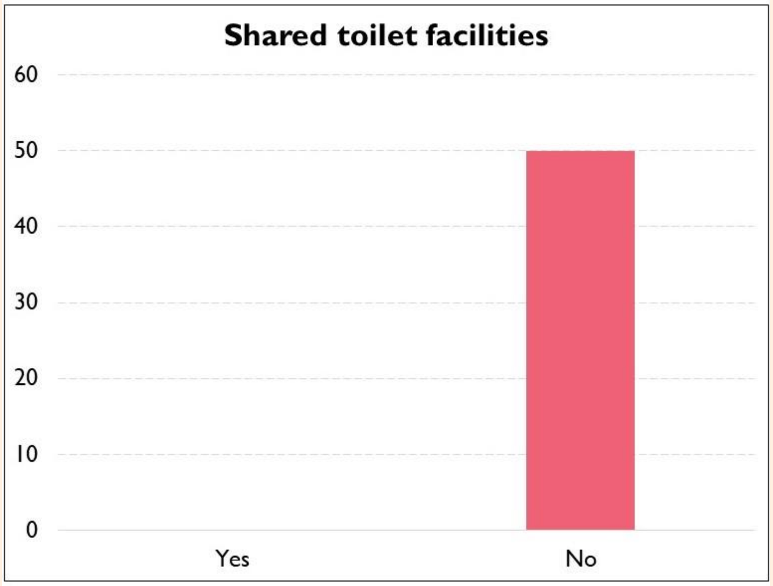

Figure 12 – Shared toilet facilities

According to the survey results, all respondents reported that they do not share toilets with other households. In other words, this implies that all the respondents have their own private toilet. Sanitation can have an indirect impact on heat stress, particularly in urban areas where access to adequate sanitation facilities is essential. Poor sanitation practices can lead to the accumulation of waste and stagnant water, which can create breeding grounds for mosquitoes and other insects that can transmit diseases such as malaria and dengue fever. These diseases can increase the risk of heat stress by causing fever and dehydration. In addition, inadequate sanitation can contribute to poor air quality and unpleasant odors, which can exacerbate heat stress and other health issues. However, it should be noted that sanitation do not have a direct influence on heat stress but lack of sanitary facilities could accelerate the heat stress impacts.

Therefore, proper sanitation practices, including the provision of adequate toilet facilities and waste management systems, can help to reduce the risk of heat stress in urban areas.

3.4 Water

3.4.1 Access to water supply

Table 13 – Access to water supply

Access to Water Supply				
	Piped water	**Public taps**	**Dug well**	**Total**
Absolute No.	46	3	1	50
Percentage	92%	6%	2%	100%

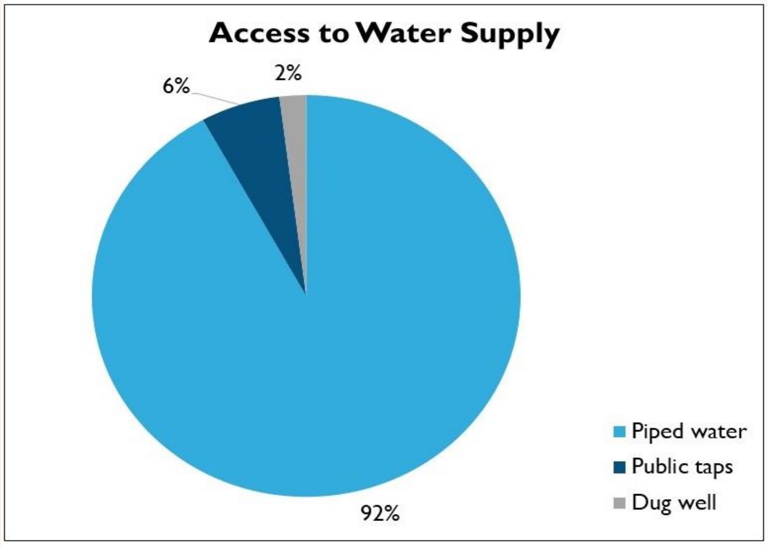

Figure 13 – Access to water supply

Out of all the people who participated, 92% have their own water supply through pipes, while a smaller percentage, only 6% and 2%, get their water from public taps or dug wells, respectively. The results provide an overview of the distribution of water supply sources among the respondents.

The source of water supply and its access can have an impact on various aspects of life, including physical health, agriculture, biodiversity, and infrastructure. During hotter months it is likely to witness a decline/deficiency in water sources and this could lead to drops in agricultural yield, risk food security and lack of water for domestic use particularly in the urban areas. Moreover, the competition for water resources between irrigation and domestic or industrial use can exacerbate water scarcity and limit access to safe and affordable water, further increasing vulnerability to heat stress.

3.4.2 Average water bill

Table 14 – Average monthly water bill

Average monthly water bill (LKR)					
	500 -1000	**1000 - 1500**	**1500 - 2000**	**Above 2000**	**No idea**
Absolute No.	34	9	3	1	3
Percentage	68%	18%	6%	2%	6%

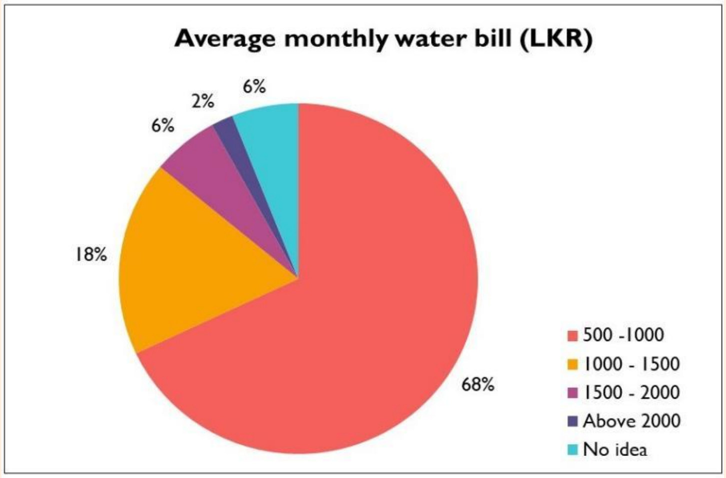

Figure 14 – Average monthly water bill

Among the surveyed individuals 68% of the participants pay somewhere between Rs. 500-1000 per month for their water bill. 18% of participants pay a monthly bill between Rs. 1000-1500. Only a small proportion of the participants pay more than Rs. 1500 for their monthly water bill, with 6% of them paying between Rs. 1500-2000 and 2% paying more than Rs. 2000. Additionally, 6% of the participants didn't know how much their water bill was. The results show that most of them pay a moderate amount, while a small proportion pay a higher amount or have no idea how much they pay.

For instance, during hot weather conditions, people may consume more water to stay hydrated and cool, which can lead to higher water bills. Inadequate access to safe and affordable water supply may also limit people's ability to cope with heat stress, particularly for those who cannot afford to pay for water or have limited options for water supply.

Moreover, high water bills may cause financial stress and affect people's ability to afford other necessities such as adequate housing, food, and healthcare, which can worsen the health impacts of heat stress. Therefore, it is important to consider the energy and water implications of irrigation practices when developing strategies to address heat stress and climate change.

3.5 Electricity

3.5.1 Electricity supply, and frequency of power cuts

Table 15 – Electricity supply

Electricity supply			
	No	**Yes**	**Total**
Absolute No.	0	50	50
Percentage	0	100%	100%

Table 16 – Power cuts

Power cuts			
	No	**Yes**	**Total**
Absolute No.	10	40	50
Percentage	20%	80%	100%

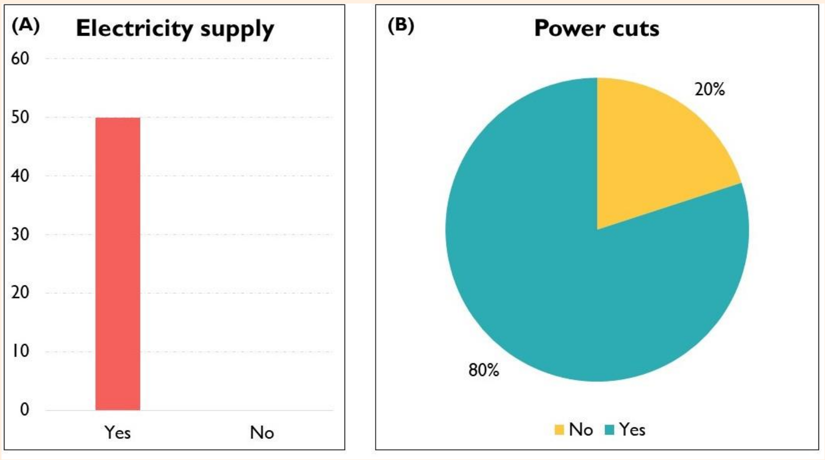

Figure 15 – Electricity supply and power cuts

Results of the survey shows that all the participants have access to electricity supply. When asked about how often they experience power cuts, about 80% of the participants said they do experience power cuts, while the remaining participants said they do not experience power cuts.

3.5.2 Electricity bill

Table 17 – Electricity bill

Electricity bill (LKR)					
	Below 999	**1000 - 1999**	**2000 - 2999**	**3000 -3999**	**Above 4000**
Absolute No.	18	21	8	2	1
Percentage	36%	42%	16%	4%	2%

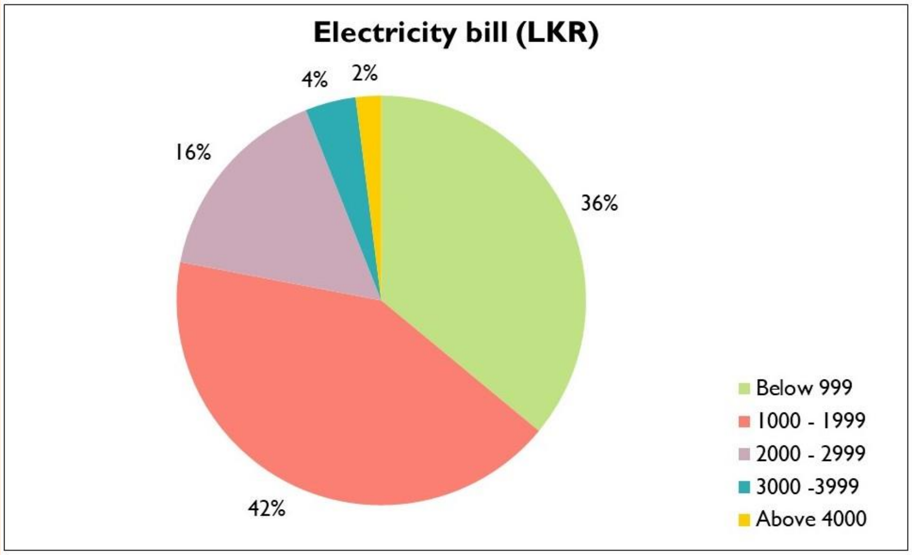

Figure 16 – Electricity bill

Of the individuals who were surveyed, most of them received their electricity bills in the range of Rs. 1000-1999, while 36% of them received bills below Rs. 999. This means that a large proportion of individuals paid electricity bills within the range of Rs. 1000-1999, while a smaller proportion received bills below Rs. 999. 16% of the participants, mentioned that they receive their electricity bill between Rs. 2000-2999, 4% of them receive their bill within the range Rs. 3000-3999 and 2% above Rs.4000.

3.5.3 Increase in the monthly electricity bill amount compared to cooler seasons

Table 18 - Increase in the monthly electricity bill amount compared to cooler seasons

Increase in the monthly electricity bill amount compared to cooler seasons (LKR)				
	Below 499	**500 - 999**	**1000 - 1499**	**Above 1500**
Absolute No.	32	15	1	2
Percentage	64%	30%	2%	4%

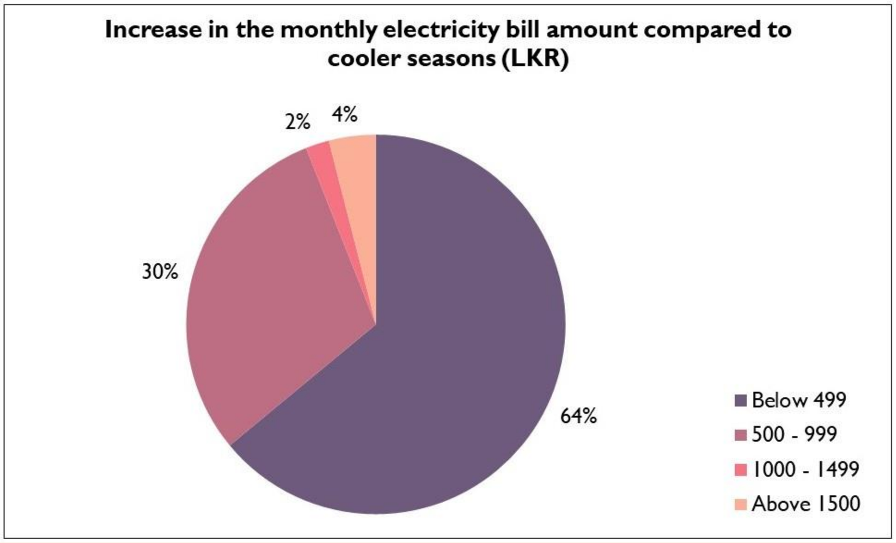

Figure 17 - Increase in the monthly electricity bill amount compared to cooler seasons

Most of the participants mentioned that their electricity bill has been increased in the hotter seasons rather than the cooler ones. 64% of the participants mentioned that the increase was below Rs. 499 followed by 30% of them between Rs. 500 - Rs.999. Fewer participants stated that they have a bill raise more than Rs. 1000; with 2% within the range of Rs. 1000 – Rs. 1499 and 4% received a bill raise more than Rs. 1500.

During hot weather, people may use air conditioning or fans to stay cool, which can lead to higher energy bills. High energy bills can cause financial stress for households, particularly those on low incomes or with limited financial resources. Financial stress, in turn, can contribute to poor mental and physical health, including exacerbating the impacts of heat stress.

Moreover, it should be noted that energy poverty - the inability to afford adequate heating, cooling, or lighting - can increase vulnerability to heat stress. People who cannot afford to run air conditioning or fans may be at higher risk of heat-related illnesses and death during extreme heat events. Similarly, poor-quality housing or inadequate insulation can increase the need for cooling during hot weather and drive-up energy bills.

3.6 Health

3.6.1 Mapping the high heat period

Table 19 - Heat stress months

Heat stress months						
	Jan	**Feb**	**Mar**	**April**	**May**	**June**
Absolute No.	13	14	40	46	11	1
Percentage	26%	28%	80%	92%	22%	2%

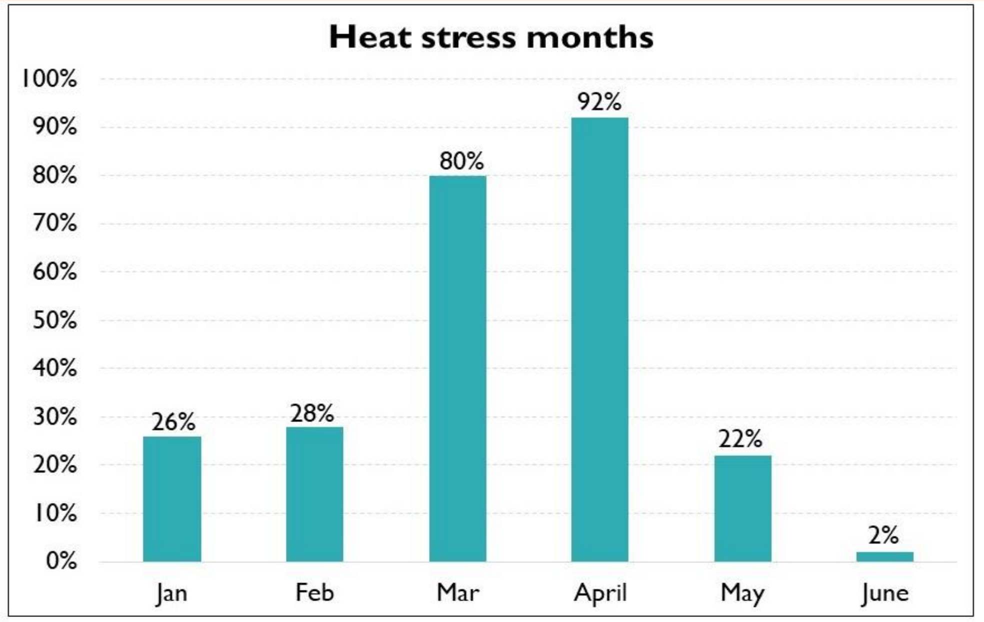

Figure 18 – Heat stress months

During the survey, majority of the respondents (92%) stated that April is the hottest month of all followed by March (80%). Fewer respondents pointed out that February (28%), January (26%) and May (22%) are comparatively hotter months. Only 2% of them mentioned that June is a hottest one.

The hotter months of the year are often associated with amplified incidents of heat stress impacts on human health. This is because as temperatures rise, the human body is exposed to more heat, which can lead to a variety of health problems. During the hotter months, the body's ability to regulate its temperature may be compromised, leading to dehydration, heat exhaustion, and heat stroke. Additionally, hot and humid conditions can exacerbate existing health problems, such as cardiovascular and respiratory issues.

3.6.2 Household reporting heat stress symptoms

Table 20 – HH level symptoms

HH level symptoms						
	Heat Rash	**Dehydration**	**Heat Cramps**	**Sweating**	**Headache**	**No response**
Absolute No.	22	20	15	36	27	4
Percentage	44%	40%	30%	72%	54%	8%

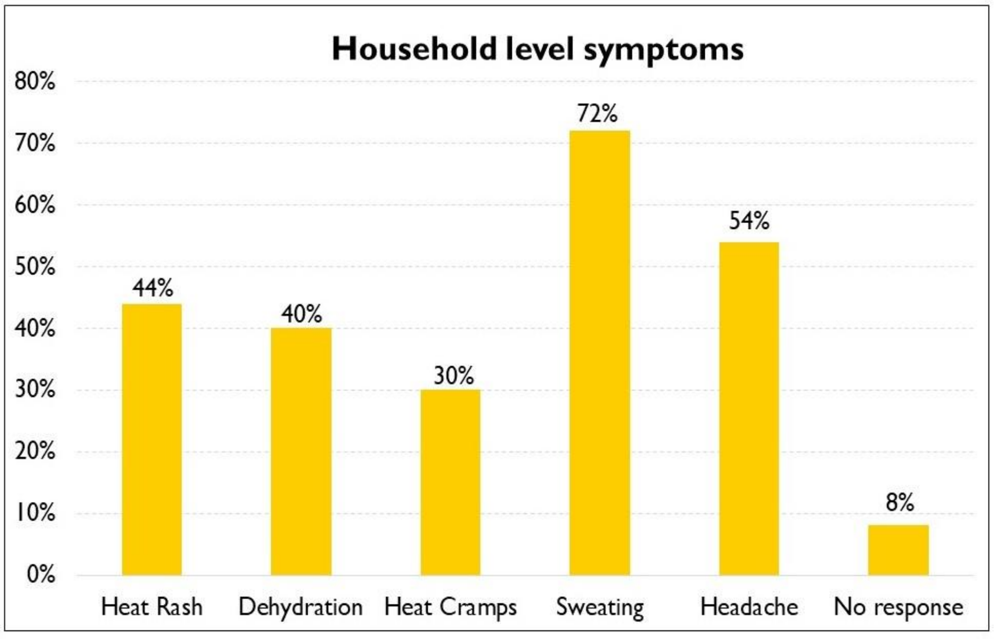

Figure 19 – HH level symptoms

When inquired about the health impacts due to heat stress issues across household levels, 72% of the respondents stated that they experience sweating and 54% experience headache. Moreover, heat rash (44%), dehydration (40%) and heat cramps (30%) were also observed during hotter months. Few respondents (8%) were left with no responses to heat stress impacts.

The severity of heat stress impacts also depends on factors such as age, physical fitness, and access to cooling measures such as air conditioning. Elderly individuals, young children, and those with preexisting health conditions may be particularly vulnerable to the negative effects of heat stress.

To reduce the health impacts of heat stress, it is important to stay cool and hydrated during hot weather. This can include staying indoors during the hottest parts of the day, drinking plenty of water, wearing loose and light-colored clothing, and using fans or air conditioning to cool down. It is also important to check on vulnerable individuals as well as those with preexisting health conditions, during periods of high heat.

3.6.3 Health facility

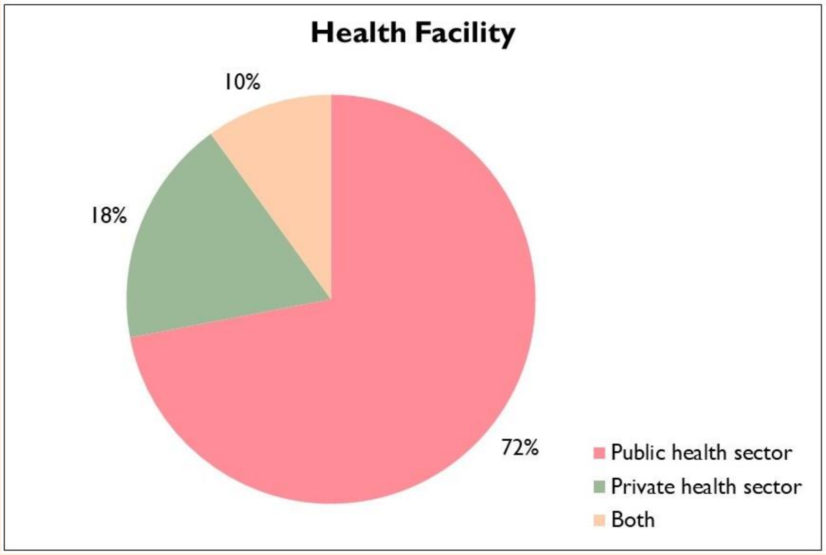

Figure 20– Health facility

Of the entire group of participants, it was observable that 72% of the participants have access to public health sectors while 18% of them has access to private health sector. 10% of the respondents have access to both.

Access to healthcare facilities can play an important role in mitigating the impact of heat stress on human health. During periods of extreme heat, individuals who experience symptoms of heat-related illnesses such as dehydration, heat exhaustion, or heat stroke may require medical attention. The availability of healthcare facilities and trained medical professionals can help ensure prompt treatment and reduce the risk of serious health complications or even death. Additionally, healthcare facilities can provide information on preventative measures to reduce the risk of heat stress, such as staying hydrated and avoiding prolonged exposure to high temperatures.

Furthermore, certain populations such as the elderly, children, and those with pre-existing medical conditions may be more vulnerable to the negative impacts of heat stress. In these cases, access to specialized medical care may be critical in managing and preventing heat stress-related illnesses. In areas prone to heat waves or other extreme heat events, it is important for healthcare facilities to be prepared and equipped to handle an influx of patients experiencing heat stress symptoms. This includes having adequate staffing levels, medical equipment, and supplies, as well as plans in place for emergency situations.

3.6.4 Distance from nearest health center

Table 21 - Distance for nearest health center

Distance for nearest health center					
	Below 14 minutes	**15-24 minutes**	**25-34 minutes**	**35-44 minutes**	**Above 45 minutes**
Public health facility	11	19	12	6	2
Private health facility	17	18	8	7	0

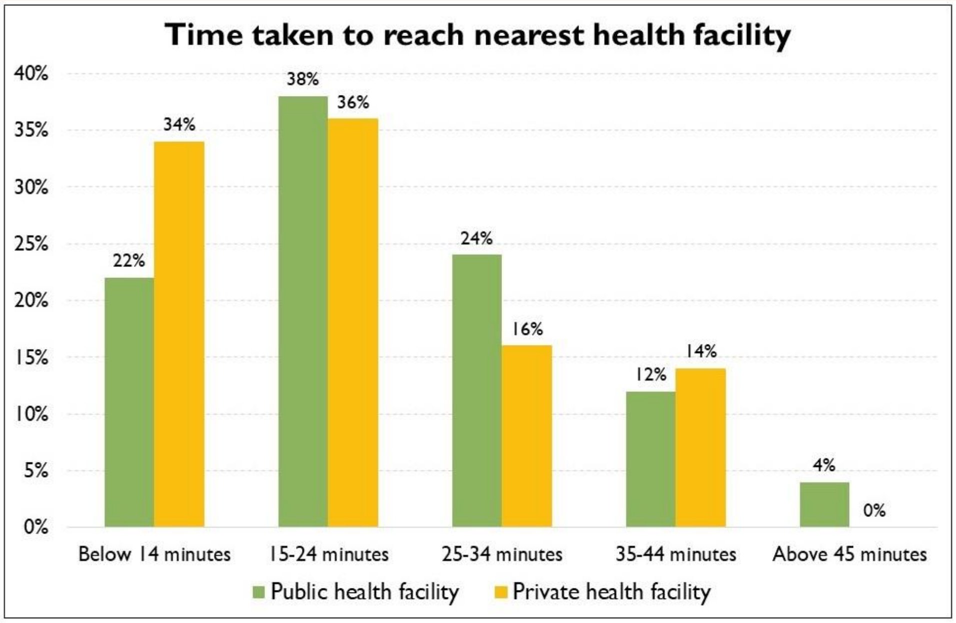

Figure 21 - Distance for nearest health center

According to the survey results, 22% of public health facilities and 34% of private health facilities are accessible within 14 minutes, while 38% of public and 36% of private health facilities take between 15-24 minutes to reach. Furthermore, 24% of public and 16% of private health facilities take between 25-34 minutes to reach, and 12% of public and 14% of private health facilities take between 35-44 minutes. Only 4% of public health facilities take more than 45 minutes to reach.

When people are exposed to extreme heat, they may experience various health problems that require medical attention. If they have to travel long distances to reach health care facilities, it can delay their treatment and worsen their health condition. Additionally, traveling in hot weather can also cause additional heat stress and increase the risk of health problems. Therefore, it is important to ensure that health care facilities are easily accessible to the public, especially during the hot months when the risk of heat stress impacts is high. Hence it is vital to have closer medical facilities specifically for vulnerable groups.

3.6.5 Gender-wise differential impacts of heat

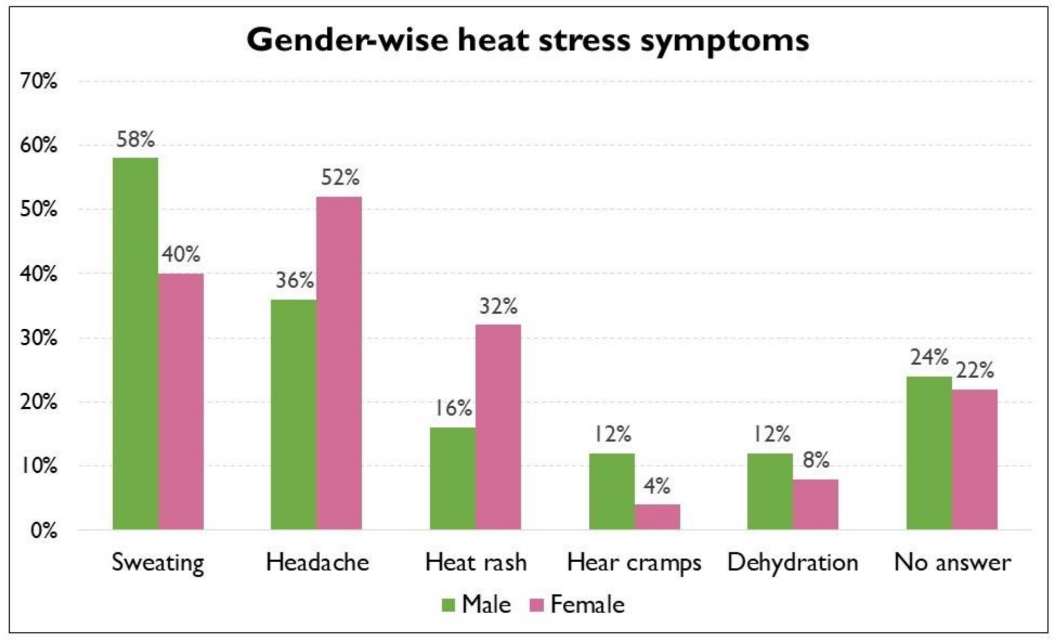

Figure 22 – Gender-wise heat stress symptoms

When examining the effects of heat stress on health in different genders, it was found that the majority of men are likely to experience sweating (58%), headache (36%), and heat rash (16%). On the other hand, most women are prone to headache (52%), sweating (40%), and heat rash (32%). On contrary only a smaller percentage of men (12%) and women (4%) have experienced heat cramps, while fewer men (12%) and women (8%) have experienced dehydration.

Accordingly, males are more likely to experience sweating, headache, and heat rash, while females are more likely to experience headache, sweating, and heat rash. Additionally, the percentage of males who experience heat cramps and dehydration is higher than that of females. These differences in health impacts may be due to differences in physiological factors such as body composition, hormonal differences, and outdoor activities.

3.7 Transportation

3.7.1 Methods used for transportation

Table 22 – Methods use for transportation

Methods used for transportation							
	On foot	Bicycle	Moter Bicycle	Car	Public Transport	Rickshaw/ Three wheel	Others
Absolute No.	10	5	6	0	15	5	9
Percentage	20%	10%	12%	0%	30%	10%	18%

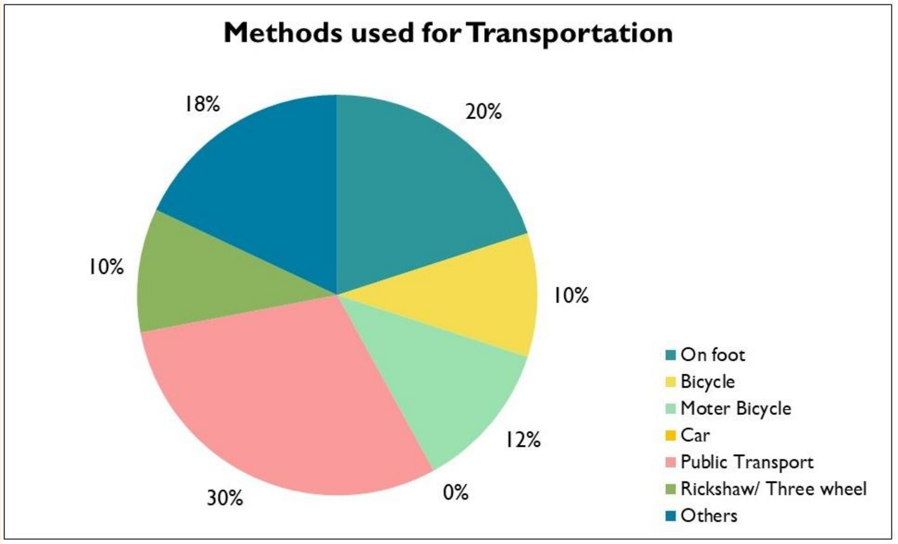

Figure 23 – Methods used for transportation

The survey asked people about the way they travel every day and the participants gave multiple answers. The results showed that 30% of the participants use public transportation like buses, 20% of them travel by foot, 12% use motorcycles, and 10% each use three-wheelers and bicycles for their daily commute.

The method used for transportation can have an impact on heat stress. In general, modes of transportation that require physical exertion such as cycling, walking, and manual rickshaw pulling can increase the risk of heat stress. This is because physical exertion leads to increased metabolic heat production, which can elevate body temperature and increase the risk of heat-related illnesses. On the other hand, modes of transportation that involve air conditioning, such as cars and buses, can help regulate body temperature and reduce the risk of heat stress.

Therefore, it is important to consider the method of transportation when assessing the risk of heat stress in individuals.

3.7.2 Total distance travelled

Table 23 – Distance travelled to work

Distance travelled to work (KM)					
	Below 5	**6-15**	**16-25**	**More than 25**	**Others**
Absolute No.	20	12	7	1	10
Percentage	40%	24%	14%	2%	20%

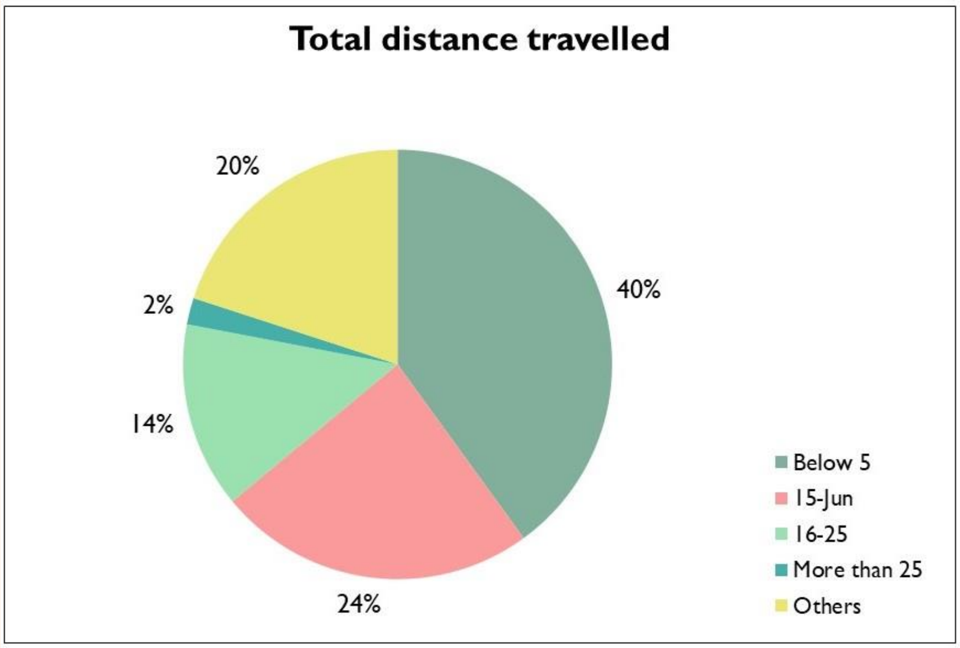

Figure 24 – *Distance travelled to work*

The survey asked the respondents about how far they travel on a regular day. Most of the respondents travel less than 5 kilometers, which is a short distance. About 24% of the respondents travel between 6 and 15 kilometers, which is a medium distance. Only 14% of them travel between 16-25 kilometers, which is a long distance. Very few respondents travel more than 25 kilometers.

The distance travelled on a daily routine can have an impact on heat stress. Longer distances travelled on foot or by non-air-conditioned modes of transportation, such as bicycles or manual rickshaws, can increase the risk of heat stress. This is because the longer the time spent under the sun, the greater the exposure to high temperatures and humidity levels, leading to an increase in metabolic heat production and elevated body temperature. Additionally, longer distances travelled on foot or by non-air-conditioned modes of transportation can also increase physical exertion, further increasing the risk of heat-related illnesses. Therefore, it is important to consider the distance travelled on a daily routine when assessing the risk of heat stress in individuals.

3.8 Impact on Livelihoods

3.8.1 Avg. Monthly Income

Table 24 - Avg. Monthly Income

	10,000–19,999	**20,000–29,999**	**30,000–39,999**	**40,000–49,999**	**More then 50,000**	**No response**
Absolute No.	2	4	13	7	8	16
Percentage	4%	8%	26%	14%	16%	32%

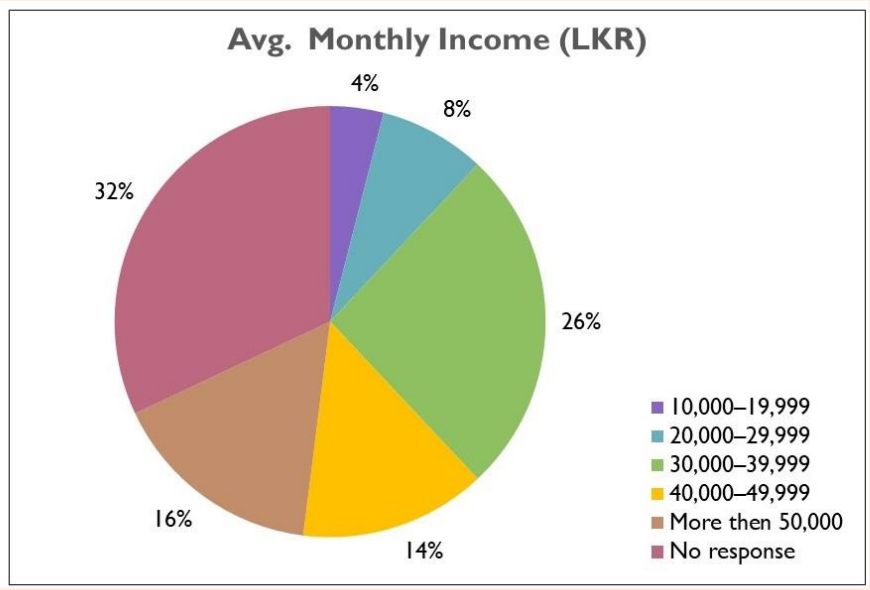

Figure 25 - - Avg. Monthly Income

The pie chart shows the distribution of average monthly income of the respondents. The data indicates that the largest percentage of respondents (26%) have an average monthly income in the range of LKR 30,000 to 39,999. The second largest group (16%) earns more than LKR 50,000 per month. The third largest group (14%) has an average monthly income in the range of LKR 40,000 to 49,999. The fourth largest group (8%) earns between LKR 20,000 to 29,999 per month, while the smallest group (4%) has an average monthly income in the range of LKR 10,000 to 19,999.

3.8.2 Average productivity loss

Table 25 - Average productivity loss

	No absence	1-2 days	3-4 days	5-7 days	More than a week
Absolute No.	34	7	3	5	1
Percentage	68%	14%	6%	10%	2%

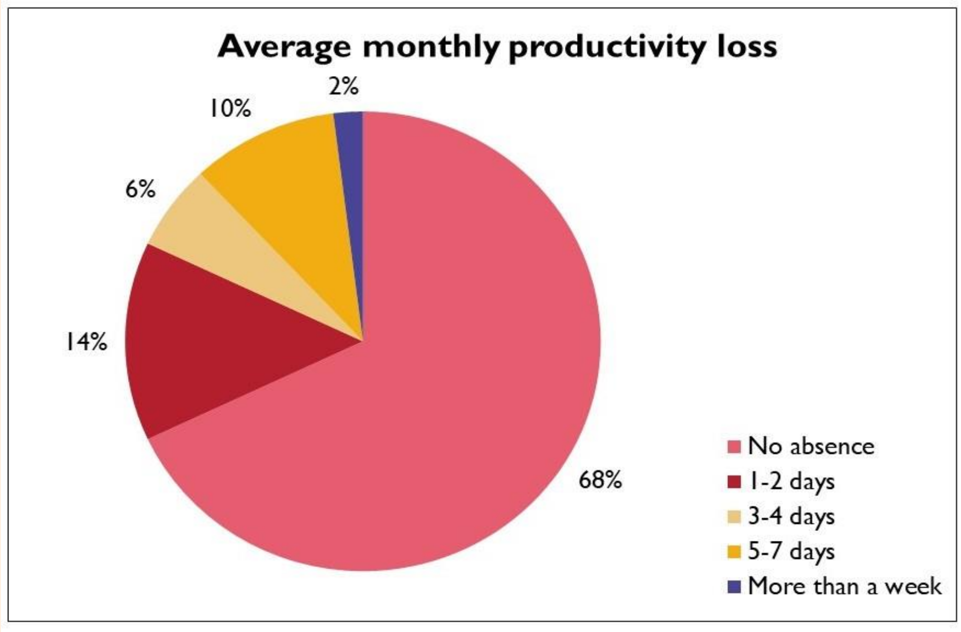

Figure 26 - Average productivity loss

The data presented pertains to average monthly productivity loss due to excess heat, in the form of the number of days taken off by employees. The results indicate that the majority of employees (68%) did not experience any absence due to excess heat in a month. However, 14% of employees took 1-2 days off, and 6% took 3-4 days off due to heat. Furthermore, 10% of employees took 5-7 days off, while only 2% of employees reported an absence of more than a week. The findings suggest that a significant percentage of employees experienced a productivity loss due to excess heat, which may have implications for employers, particularly in industries that require outdoor.

3.8.3 Gender wise productivity loss

Table 26 - Gender wise productivity loss

		No absence	1-2 days	3-4 days	5-7 days	More than a week
Male	**Absolute No.**	24	5	3	3	1
	Percentage	66.66%	13.9%	8.33%	8.33%	2.77%

		No absence	1-2 days	3-4 days	5-7 days	More than a week
Female	**Absolute No.**	10	2	0	2	0
	Percentage	71.42%	14.28%	0%	14.28%	0%

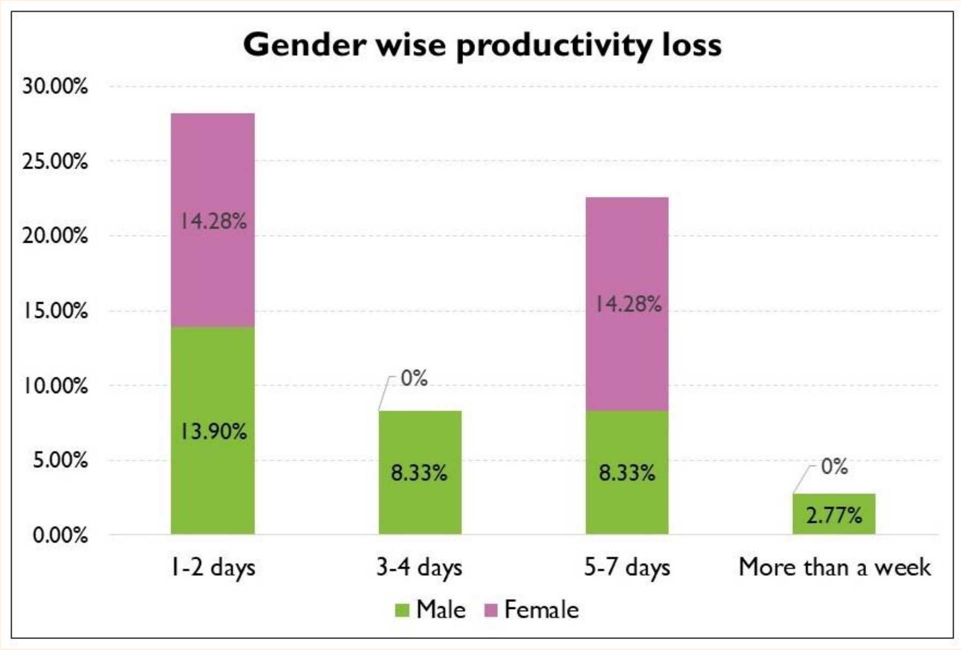

Figure 27 - Gender wise productivity loss

According to the data, males tend to experience greater wage loss due to productivity loss compared to females. This could be due to various reasons related to heat stress. Furthermore, the majority of both males and females experience productivity loss in 1-2 days per month.

3.9 Adaptation

3.9.1 Coping with heat related discomfort at home

Table 27 – Methods to combat heat at home

	Absolute No.	Percentage
Drinking water	23	46%
Comfortable clothes	10	20%
Avoid going outside	15	30%
Sleeping	6	12%
Use fans	3	6%
Eat balance diet	1	2%
No idea	5	10%

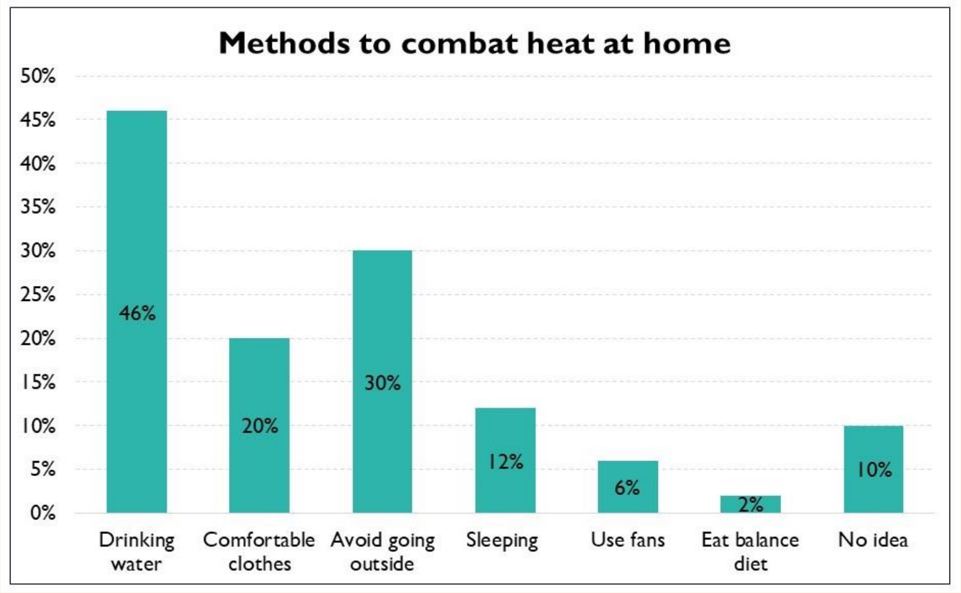

Figure 28 – Methods to combat heat at home

According to the bar chart, the most popular method to combat heat at home is by drinking water, with 46% of respondents choosing this option. This is likely because staying hydrated helps regulate body temperature and prevents dehydration in hot weather. The second most popular method is wearing comfortable clothes, with 20% of respondents choosing this option. Avoiding going outside is the third most popular method, with 30% of respondents choosing this option. This may involve staying indoors during the hottest parts of the day or minimizing outdoor activities during heatwaves. Sleeping (12%) and using fans (6%) are less common methods, while only 2% of respondents chose eating a balanced diet as a method to combat heat at home.

3.9.2 Coping with heat related discomfort at work

Table 28 – Methods to combat heat at work

	Absolute No.	Percentage
Wearing hats	5	10%
Drinking water	10	20%
Using fans, AC, Cooler	8	16%
Comfortable clothes	3	6%
Other	9	18%

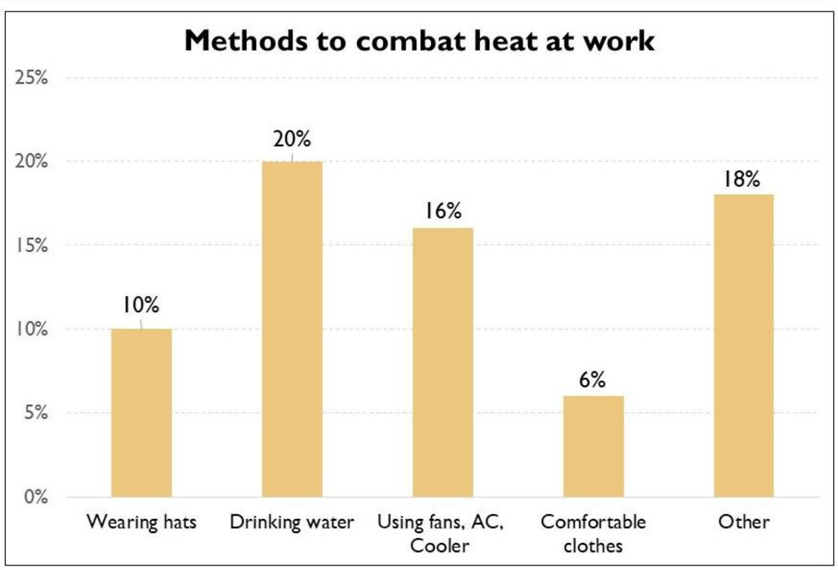

Figure 29 – Methods to combat heat at work

According to the bar chart, there are a variety of methods that people use to combat heat at work place. The most popular method, chosen by 20% of respondents, is drinking water. Another common method is wearing comfortable clothes, which was chosen by only 6% of respondents. wearing hats is a more popular method than comfortable clothes, with 10% of respondents choosing this option. Using fans, air conditioning units, or coolers is also a popular way to combat heat at work, with 16% of respondents choosing this option.

3.10 Preferred communication strategies

3.10.1 Access to information on heat stress

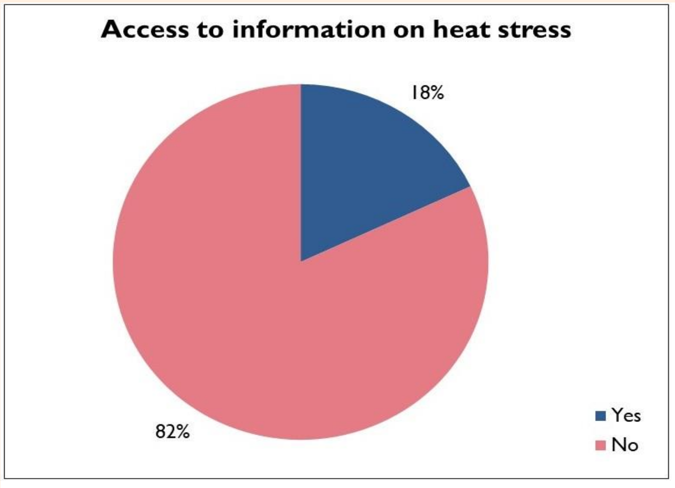

Figure 30 - Access to information on heat stress

According to the data, only 18% of the individuals surveyed reported having access to information on heat stress, while the remaining 82% did not have such access. This suggests a potential knowledge gap that could negatively impact the health and safety of individuals working in environments that expose them to high temperatures.

3.10.2 Use of social media to access heat wave information

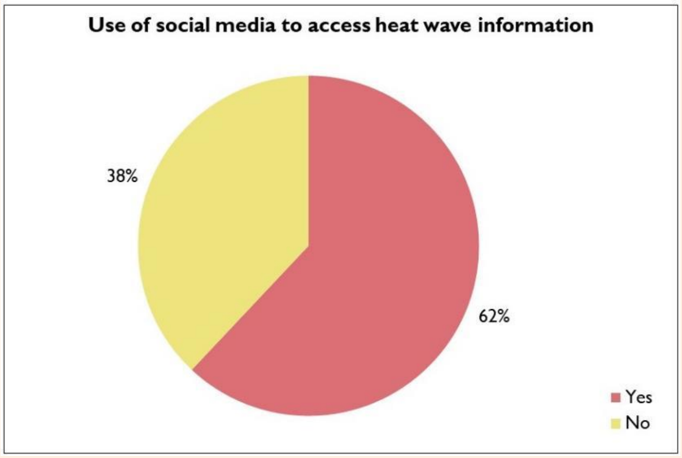

Figure 31 - Use of social media to access heat wave information

According to the data, 62% of individuals use social media to access information about heat waves, while 38% do not. This indicates a significant portion of the population relies on social media as a source of information during heat wave events. With the increasing prevalence of social media in modern society, it is likely that this trend will continue to grow. However, it is important to note that not all individuals have access to social media, and thus alternative methods of disseminating heat wave information should also be considered to ensure that all individuals are informed and prepared for extreme weather events.

3.10.3 Information sharing on heat wave

Table 29 - Information sharing on heat wave

	Absolute No.	**Percentage**
Through tv/news	36	64%
Through news papers	10	20%
Through radio	4	8%
Through CMC officers	2	4%
Through neighbors	7	14%
Through other sources	1	2%
No response	7	14%

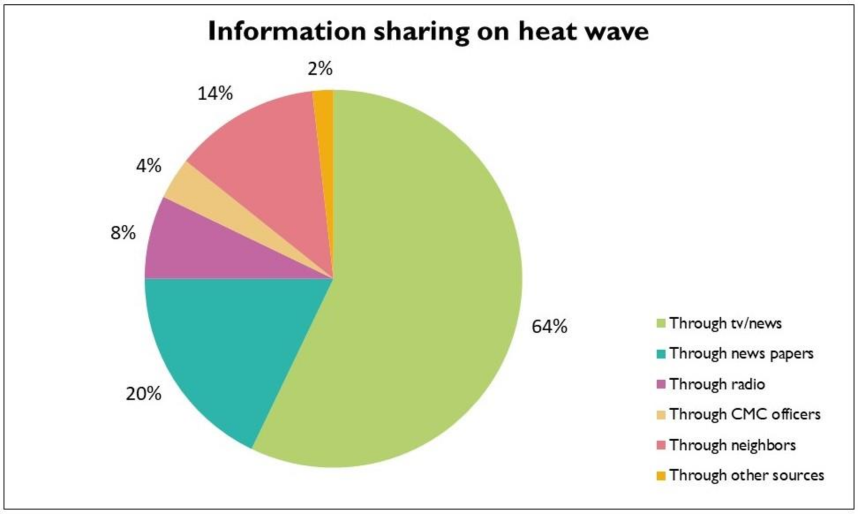

Figure 32 - Information sharing on heat wave

According to the data, the majority of individuals (64%) access information about heat stress through television and news. Newspapers are also a common source of information, with 20% of respondents reporting that they obtain heat stress information through this medium. Radio is a less frequently utilized source of information, with only 8% of individuals indicating that they rely on this platform for updates about heat stress. Only 4% of individuals rely on communication from community management CMC officers for information about heat stress. Interestingly, 14% of individuals obtain heat stress information from their neighbors, highlighting the potential for informal communication networks to play a role in disseminating important health information. Only 2% of individuals report obtaining heat stress information from other sources.

4.0 Conclusion

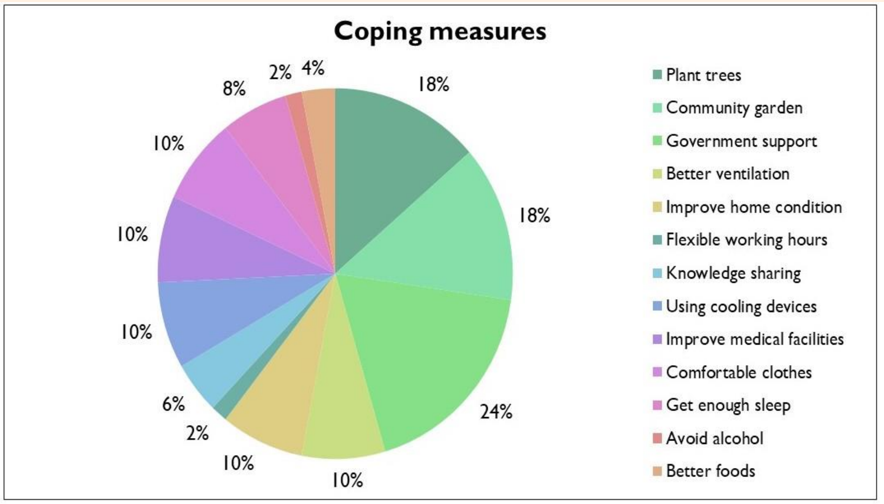

Figure 33 – Coping Measures for heat wave

The survey results highlight the importance of government support as a critical measure for building heat stress resilience. With 24% of respondents identifying it as the most effective strategy, it suggests that government policies and programs can play a vital role in helping communities adapt to extreme heat. Such initiatives can range from increasing access to air-conditioned public spaces, providing financial support for home improvements that enhance indoor cooling, and developing public education campaigns to raise awareness about the risks of heat stress and how to prevent it.

Planting trees and establishing community gardens were also identified as important strategies for building resilience to heat stress, with 18% of respondents suggesting that these measures could help to reduce the impact of extreme heat. Green spaces like parks and gardens can provide shade and help to lower temperatures, which can have a significant impact on reducing heat stress in urban areas.

In addition, the survey respondents recognized the importance of personal actions that can help mitigate the effects of heat stress, such as improving home conditions and ventilation, using cooling devices, and wearing comfortable clothing. While these measures were cited by a smaller percentage of respondents, they are nonetheless essential actions that individuals can take to protect themselves from heat stress.

Overall, the survey findings suggest that building heat stress resilience requires a multi-faceted approach that involves not only government support but also community-based efforts and personal actions aimed at reducing exposure to extreme heat. By implementing these measures, individuals and communities can build their resilience to heat stress and protect themselves from the adverse health effects of extreme heat.

5.0 References

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Vulnerability Assessment of Households in Colombo to Heat Stress

For More Details Contact:

mayantha@slycantrust.org

r.magotra@irade.org