Volume 3, Issue 5, 2025

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

ANALYZING HEALTH RISK ASSESSMENT OF EXTREME WEATHER CONDITIONS IN KARACHI

Saeeda Anjum Buriro[*1], Dharti Shahnawaz Thebo[2], Madiha Beg[3]

[1,2]*Department of Zoology, University of Sindh Jamshoro.*
[3]*Assistant Professor Department of Public Health SZABIST University, Karachi*

[*1]buriro.saeeda@gmail.com

DOI: https://doi.org/10.5281/zenodo.16153440

Keywords
Extreme weather, Health Care, Urban Flooding, Heatwaves, Public Health, Climate Change

Article History
Received: 05 April, 2025
Accepted: 03 July, 2025
Published: 19 July, 2025

Corresponding Author: *
Saeeda Anjum Buriro

Abstract

This study analyzes health concerns that extreme weather, especially heat waves and flooding in cities, pose to vulnerable urban population in Karachi. The focus of the study is to look at the kind, frequency, and severity of health effects caused by extreme weather incidents caused by climate change, as well as to find areas where local coping and public health responses are lacking. The study employed quantitative research methodology and focused on adults (18 and older) who lived in four high-risk Districts of Karachi areas: Korangi, Lyari, Malir, and Orangi Town. A structured questionnaire was administered among N=200 participants who were literate in English language by using purposive sampling who had all been directly exposed to extreme weather conditions because of their job nature. For quantification of the data SPSS (Version 24) was used to ensure reliable results. Study used descriptive statistics (means, frequencies, and percentages) to analyze the reported health outcomes. There were two main findings: first, a lot of people of all ages, but especially older adults, reported getting sick from the heat (for example, dehydration and heatstroke). Second, after urban flooding, lower-income households were much more likely to get sick from waterborne diseases (for example, diarrhea, skin infections, and dengue). The results show that problems with infrastructure, like not having enough drainage, not being able to get clean water easily, and having intermittent electricity, make the health effects of extreme weather worse. The results of the study reveal climate change is a big threat to public health in Karachi's urban population. It is recommended better urban planning, localized early warning systems, and healthcare services that can handle climate change.

INTRODUCTION

In 2019, there were 396 catastrophes globally that resulted in 11,755 fatalities, impacted 95 million individuals, and incurred costs approaching US$130 billion. Asia experienced the highest impact, accounting for 40% of the occurrences, 45% of the fatalities, and 74% of the total individuals affected. Floods and storms constituted 68% of the global population affected. Anthropogenic greenhouse gas emissions, land use alterations, and other activities affecting the global energy equilibrium are modifying the frequency and severity of numerous extreme weather and climate phenomena, with certain regions witnessing an uptick in heat waves, floods, and droughts. Climate change is increasingly influencing events, including wildfires.

Risks associated with extreme weather and climate events stem from the convergence of physical hazards (e.g., wind and rain), the degree of exposure to these

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

hazards, the susceptibility of individuals and groups, and the ability to prepare for, manage, and recover from such extreme occurrences.

Climate change is significantly influencing extreme weather patterns worldwide. Record-setting heat waves, heavy rainfall, severe flooding, extended droughts, and catastrophic wildfires are increasingly common and intense, occurring at a pace more rapid than expected (Witze, 2022). 2023 has been officially recognized as the warmest year on record (World Meteorological Organization, 2024). Extreme weather events have presented numerous health risks to humans, including an increase in heatstroke, respiratory and cardiovascular diseases, renal dysfunction, undernutrition stemming from food insecurity, and mental health issues (Palinkas and Wong, 2020; Romanello et al., 2023; Don et al., 2024). Climate change has been recognized as the foremost health challenge of the 21st century (Watts et al., 2015). However, even with ambitious emission reduction efforts to achieve the 1.5 C threshold, the increasing trend of extreme weather events caused by climate change cannot be reversed in the near future. Moreover, it is possible that the present increase in global temperature has already surpassed 1.5 °C (McCulloch et al., 2024). The detrimental health effects of extreme weather events are anticipated to escalate catastrophically within decades due to ongoing climate change (Costello et al., 2023; Lüthi et al., 2023; Zhao et al., 2025). From 1991 to 2000, the average yearly heat-related mortality among individuals over 65 years of age rose by 85% in the period from 2013 to 2022 (Romanello et al., 2023). The increase in health hazards due to climate change highlights the critical necessity for robust and comprehensive adaptation methods to mitigate effects on human life.

In contrast to adaptation strategies in other domains, addressing health risks from extreme weather events frequently entails intricate social, economic, and medical considerations, necessitating multi-sectoral coordination and the involvement of several stakeholders (Cai et al., 2021). It requires the collaborative efforts of governmental bodies, community organizations, healthcare systems, enterprises, and individuals (Ebi & Burton, 2008). Consequently, it is imperative to devise thorough adaptation strategies for distinct actors individually, ensuring that these strategies are adapted to match the distinctive demands and skills of each entity. This will guarantee an efficient response to the health threats presented by climate change and protect public health and welfare.

Recognizing extensive adaptation options accessible to diverse stakeholders is essential for policymakers to formulate proactive adaptation plans to tackle health risks associated with extreme weather events. Nevertheless, current research on adaptation measures primarily concentrates on the agricultural sector (Aryal et al., 2020) and sea level rise (Bailles et al., 2020), with insufficient focus on health hazards associated with climate change. Recent research on health risk adaptation strategies primarily focusses on cataloguing the advancements of national adaptation initiatives (Ji et al., 2023), delineating the adaptation strategies employed by healthcare systems (Lugten & Hariharan, 2022), and assessing the efficacy of particular adaptation strategies, such as urban tree canopy (Iungman et al., 2023), vegetated roofs, cool pavements, and cool facades (He et al., 2022). Insufficient research has thoroughly examined adaptations to mitigate health effects associated with extreme weather events in the context of climate change in Karachi. Moreover, current research often neglects to distinguish among the numerous entities tasked with executing adaptation measures, so limiting the actual applicability and efficacy of their conclusions.

This study offers realistic and thorough recommendations to assist various stakeholders in executing comprehensive strategies to successfully mitigate the health hazards associated with extreme weather occurrences.

Research Questions

1. What are the most commonly reported health conditions associated with extreme weather events (heatwaves and urban flooding) among residents of high-risk urban areas in Karachi?
2. How do socio-demographic factors such as age, income, and education influence the likelihood of experiencing climate-related health issues in vulnerable communities?
3. To what extent do residents of climate-vulnerable areas in Karachi have access to healthcare services

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

and perceive governmental preparedness during extreme weather events?

Literature Review

Climate change has caused extreme weather events to happen more often in cities all over the world. Karachi, the biggest metropolis in Pakistan, is no different. Its high population density, unplanned urban growth, lack of healthcare infrastructure, and income and social inequality make it especially exposed to the health risks that come with extreme weather, such as heat waves, urban flooding, and poor air quality (Ali & Khan, 2020). This study looks at the current research on health risk assessment in Karachi during extreme weather and finds areas where more research is needed and where interventions can be focused.

Urban Vulnerability and Climate Change

Karachi's location and fast growth as a city make it more vulnerable to climate-related risks. The Pakistan Meteorological Department (PMD) says that average temperatures in Karachi have been rising consistently over the past two decades. The city has also been having more frequent and powerful heatwaves (PMD, 2021). The 2020 monsoon season also caused catastrophic floods in cities, which forced people to move, spread diseases, and made it hard to get essential amenities (Rehman et al., 2022). Urban areas, especially informal settlements, typically don't have infrastructure that can adapt to harsh weather, including stormwater drainage. This makes the health effects of extreme weather worse.

How Heat Waves Affect Health in Karachi

Extreme weather phenomena like heatwaves are among of the deadliest. Karachi has been hit especially hard by them. There were more than 1,200 deaths during the 2015 heatwave, mostly from heatstroke and dehydration (Saquib et al., 2018). The elderly, outdoor workers, and people who live in slums were among the most affected groups. Shahid et al. (2019) found that a lack of knowledge, limited access to cooling equipment, and poor emergency response systems all had a big role in the high death rate.

Studies have also found a link between heat stress and more people going to the hospital for heart and lung problems (Ahmed et al., 2021). High humidity levels, when combined with high temperatures, also make it harder for the body to cool down by sweating, which raises the risk of heat-related illnesses (WHO, 2020).

Diseases That Spread Through Water and Insects Because of Flooding In Cities

When it floods in Karachi, the water typically stays still, which makes it a good place for mosquitoes to reproduce and spreads diseases like dengue and malaria (Khan & Jahan, 2020). Karachi saw one of the worst increases in dengue incidence in recent years after heavy rain in 2020. Floodwater also makes drinking water dirty, which makes diarrhea, cholera, and hepatitis A and E more common (UN-Habitat, 2021).

Raza et al. (2022) found that hospitals in low-lying regions of Karachi saw a 40% increase in gastroenterological and dermatological disorders after the flooding. Because there aren't any early warning systems or coordinated public health measures, it has often taken longer to treat people who have been afflicted.

The Risks to Breathing and Air Quality

Bad weather in Karachi has also been connected to worse air quality. After the monsoon season, there is more particulate matter (PM2.5 and PM10) in the air because to the buildup of trash and debris. This has a big impact on respiratory health (Iqbal et al., 2020). In addition, temperature inversions in the winter keep pollutants near to the ground, making asthma and chronic bronchitis worse, especially in youngsters and the elderly.

The problem is made worse by car pollution, industrial activity, and burning trash in the open. The Sindh Environmental Protection Agency (SEPA) says that living in cities like Karachi with bad air quality for a long time could shorten your life by 2 to 3 years (SEPA, 2021).

Ways to Assess Risk and Policy Gaps

There hasn't been much use of health risk assessment (HRA) tools in Pakistan. When they are used, they generally don't have enough detail about space and don't include signs of socio-economic vulnerability. In places like Dhaka and Mumbai,

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Integrated Climate Risk Assessment (ICRA) models have been useful for predicting health outcomes and deciding which measures are most important (Lal et al., 2021). However, Karachi still needs to make tools that are specific to the area that connect environmental data with public health records and social indices.

Pakistan's National Climate Change Policy (2012) has some general rules for getting ready for disasters, but it doesn't do anything to protect the health of people in urban coastal cities like Karachi (GoP, 2012). There are still not many ways to effectively put into place heat-health action plans, flood-resistant infrastructure, and early warning systems.

Climate Change: Heatwaves impacts

Heatwaves may compromise the operational capacity of hospitals, including medical apparatus and pharmaceutical storage, and adversely impact the thermal comfort of hospital facilities for patients and personnel. Structural design aimed at fulfilling additional hospital criteria may undermine thermal regulation, for instance, due to inadequate heating system management techniques or safety standards that limit window openings (Ebi, 2011). Contemporary or transient structures may exhibit inferior heat control compared to older edifices (Flynn, 1996). Evidence regarding the effects of extreme heat in facilities such as care homes is limited; however, certain case studies indicate issues related to inadequately adapted equipment, structural design, and care practices, along with a lack of awareness among designers and managers about the necessity of heat management and the avoidance of cold-related risks. Further investigation is required to ascertain the magnitude of these issues, particularly as mortality risks during heatwaves are significantly elevated for elderly individuals in care facilities (Galea, Aherns & Karpati, 2005). The influence of excessive heat on the broader networks of constructed infrastructure and utilities that underpin healthcare systems is generally negligible, considering the extreme temperature levels recorded thus far in the Pakistan (GOP, 2012).

Impacts of Flooding

Flood hazards exhibit local variability, contingent upon flood risk zones and return intervals. Evidence from European nations, including the UK, indicates that the effects on physical infrastructures supporting health services encompass inundated health facilities (occasionally necessitating patient evacuation), disruptions to power and water supplies, security and accessibility of patient records, interruptions to ambulance services, and continuity of outreach and community care. Extensive infrastructure systems may exhibit a certain tolerance for localized flooding. Electricity substations in the UK must be resilient to floods up to a depth of 300 mm (Oven et al., 2017). Nonetheless, flooding below this depth may disrupt service access and delivery and regions at heightened risk in certain areas of the UK have populations that are especially prone to requiring health services (WHO, 2002).

Methodology

This study uses a quantitative, cross-sectional survey research design to look at the health concerns that extreme weather poses to vulnerable metropolitan regions of Karachi. The quantitative method lets the researcher gather data that can be measured, find trends, and do statistical analysis to find links between factors like the number of extreme weather events, their effects on health, and the vulnerability of different groups of people.

Population and Sample of the Study

The target market is those who live in poor urban regions of Karachi that are notorious for having bad weather, like heat waves, floods, and bad air quality. Some of these areas are Korangi, Orangi Town, Lyari, and Baldia Town, which are low-income and have a lot of people living there. Stratified random sampling was used to choose a sample of 200 people from different districts to make sure that all areas were represented. Each stratum was based on how vulnerable the environment was (for example, areas that are likely to flood or be damaged by a heat wave). There were 50 participants from each area, which kept the representation equal and made it possible to compare districts.

The study takes place in four very susceptible metropolitan areas of Karachi that are notorious for being exposed to extreme weather conditions such heat waves, urban flooding, and bad air quality. Korangi, Orangi Town, Lyari, and Malir are some of

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

these regions. They are heavily inhabited and have bad housing, bad infrastructure, and restricted access to healthcare.

The target demographic is people who live in these areas and are 18 years old or older. They have lived there for at least the past five years, which makes them more likely to have seen how extreme weather events affect health.

A total of 200 participants were selected using purposive sampling, a non-probability sampling technique used to select individuals who meet specific criteria relevant to the study's objectives. The criteria for inclusion were: People who have lived through extreme weather events like heat waves or floods People who have said that variations in the weather have caused them health problems, such as heatstroke, respiratory ailments, or waterborne diseases. People who live in low-income, high-density neighborhoods and don't have frequent access to health care.

We put the data into SPSS (Version 26) so we could do statistical analysis. The following methods were used: Using descriptive statistics (such frequencies, percentages, and averages) to sum up the characteristics of the participants and the patterns of exposure and health outcomes Cross-tabulation and chi-square testing to look at the links between demographic characteristics (such age and wealth) and reported health concerns.

Using logistic regression analysis to find factors that can predict certain health outcomes, such respiratory disease or disorders associated to heat. The quantitative technique made it possible to fully evaluate how vulnerable people's health is and how well they can deal with bad weather.

Table 1: Demographic Characteristics of Participants

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	102	51.0
	Female	98	49.0
Age Group (in years)	18–30	54	27.0
	31–45	68	34.0
	46–60	50	25.0
	61 and above	28	14.0
Education Level	No formal education	42	21.0
	Primary	58	29.0
	Secondary	64	32.0
	Tertiary (college/university)	36	18.0
Monthly Income	Less than PKR 20,000	74	37.0
	PKR 20,001–40,000	82	41.0
	PKR 40,001–60,000	32	16.0
	Above PKR 60,000	12	6.0
Area of Residence	Korangi	50	25.0
	Orangi Town	50	25.0
	Lyari	50	25.0
	Malir	50	25.0

Table 1 shows the demographic information for the 200 people who were chosen from four very dangerous districts of Karachi: Korangi, Orangi Town, Lyari, and Malir. There were 102 men (51.0%) and 98 women (49.0%) in the sample,

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

which means that the gender distribution was almost even.

The age distribution showed that the biggest group of people who took part (34.0%) were between 31 and 45 years old. The next biggest group (27.0%) were between 18 and 30 years old, then 46 and 60 years old (25.0%), and finally 61 years old and up (14.0%). This spectrum includes adults at different phases of life, which guarantees a variety of views on health vulnerabilities.

In terms of education, 21.0% of those who answered said they had no formal education, while 29.0% said they had finished primary school. The most frequent degree of education was secondary school (32.0%), while 18.0% had tertiary school. This shows that people had different levels of literacy and may have had different levels of health awareness and ability to adjust.

The monthly income of the people who answered the survey showed that most of them were low-income. About 37% of them made less than PKR 20,000, and 41% made between PKR 20,001 and 40,000. Only 6.0% made more than PKR 60,000, which shows that most of the participants were quite economically vulnerable.

There were 50 people (25.0%) from each of the four chosen areas, thus the participants were evenly spread out. This fair portrayal made it possible to compare different urban areas that all had to deal with extreme weather.

In general, the demographic profile shows that the population is socio-economically challenged and vulnerable to climate change, with a wide range of ages and educational backgrounds. These traits are very important for figuring out their health risks and how they change their behavior when there are extreme weather events in Karachi.

Table 2: Descriptive Statistics of Responses on Health Risk Assessment

It No.	Item Description	Mean (M)	S D (SD)
1	I have experienced extreme heat during the past three years.	4.35	0.72
2	I have experienced urban flooding in my area.	4.12	0.89
3	I am aware of the health risks related to heatwaves.	3.98	1.02
4	I suffer from dehydration during heatwaves.	3.87	0.95
5	I or a family member experienced illness after flooding.	3.76	1.10
6	My area lacks proper drainage, which increases flood risk.	4.40	0.68
7	There is frequent power outage during extreme heat periods.	4.55	0.62
8	I have access to clean drinking water during emergencies.	2.85	1.21
9	I can access medical care during extreme weather conditions.	2.94	1.09
10	I feel physically weak or unwell during heatwaves.	3.90	0.84
11	Flooding has disrupted my daily life (work, travel, education).	4.05	0.93
12	I use any preventive measures during heatwaves (e.g., staying indoors, hydration).	3.65	1.03
13	My family has suffered from waterborne diseases post-flood.	3.72	1.07
14	I believe the government provides effective health support during such events.	2.48	1.19
15	I have received early warning messages about weather events.	2.96	1.11
16	I understand how to respond to a heatwave or flood warning.	3.15	1.04
17	I suffer from breathing problems during extreme heat or poor air quality.	3.82	0.88
18	I consider extreme weather as a serious health threat to my community.	4.25	0.76
19	I rely on local community support during climate-related emergencies.	3.52	1.10
20	My area needs better planning and healthcare access for extreme weather events.	4.48	0.69

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

It No.	Item Description	Mean (M)	S D (SD)

Table 2 shows the descriptive statistics for 20 items that asked participants about their experiences, views, and coping reactions to health hazards from extreme weather in Karachi. We used a 5-point Likert scale to record responses (1 = Strongly Disagree to 5 = Strongly Agree). The results show that people feel quite exposed and vulnerable, and they are also very worried about the quality of infrastructure and services.

A lot of the people who took part said they had been through harsh weather situations a lot. The statement "I have experienced extreme heat during the past three years" had a mean (M) of 4.35 (SD = 0.72), and the statement "There is frequent power outage during extreme heat periods" had the most agreement (M = 4.55, SD = 0.62). These data show how common heat-related problems are in the daily lives of people in Karachi.

Urban floods also turned out to be a big environmental stressor. The items "I have experienced urban flooding in my area" (M = 4.12, SD = 0.89) and "My area lacks proper drainage" (M = 4.40, SD = 0.68) show that residents are quite vulnerable because of problems with infrastructure. Also, "Flooding has disrupted my daily life" (M = 4.05, SD = 0.93) shows how flooding can have a big impact on transportation, jobs, and schools.

There were also clear effects on health. People who took part agreed that extreme weather has an influence on their physical health. For example, they said, "I feel physically weak or unwell during heatwaves" (M = 3.90, SD = 0.84) and "I suffer from dehydration during heatwaves" (M = 3.87, SD = 0.95). In the same way, people said they had health problems after the flood, like waterborne diseases. For example, "My family has suffered from waterborne diseases post-flood" (M = 3.72, SD = 1.07).

Even though there was a lot of risk and exposure, replies about getting help from institutions and resources were low. For example, "I have access to clean drinking water during emergencies" (M = 2.85, SD = 1.21) and "I can access medical care during extreme weather conditions" (M = 2.94, SD = 1.09) show that there are gaps in basic services. Also, people didn't think the government was ready or good at communicating; "I believe the government provides effective health support during such events" got the lowest average score (M = 2.48, SD = 1.19).

Interestingly, the people who took part showed a moderate level of awareness and adaptability. Items like "I know about the health risks of heatwaves" (M = 3.98, SD = 1.02) and "I take steps to protect myself during heatwaves" (M = 3.65, SD = 1.03) show that people know about the risks, but they may not always act on that information because of systemic barriers. There was also a lot of agreement on the statement "My area needs better planning and healthcare access for extreme weather events" (M = 4.48, SD = 0.69). This shows that there is a great need for stronger disaster preparedness, urban planning, and healthcare infrastructure.

Overall, the results show that people who live in vulnerable parts of Karachi are very aware of and affected by extreme weather, but they don't have enough access to services and support networks. These results show how important it is to quickly build infrastructure, set up early warning systems, and target public health programs in cities that are vulnerable to climate change.

Table 3: Frequency and Percentage of Reported Health Symptoms During Extreme Weather (N = 200)

Health Symptom	Frequency (n)	Percentage (%)
Dehydration	138	69.0
Skin infections (e.g., rashes)	94	47.0
Diarrhea/Gastroenteritis	110	55.0
Breathing difficulties	126	63.0

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Health Symptom	Frequency (n)	Percentage (%)
Heatstroke/Heat exhaustion	102	51.0
Dengue/Malaria (post-flood)	88	44.0
No reported symptoms	32	16.0

Table 3 shows how often and what proportion of participants reported health problems during extreme weather events including heat waves and urban flooding. Dehydration was the most common health problem mentioned, with 69.0% (n = 138) of respondents saying they had it. Breathing problems came in second, with 63.0% (n = 126) saying they had them, and diarrhea or gastroenteritis came in third, with 55.0% (n = 110) saying they had them. More over half of the people who took part (51.0%, n = 102) said they had heatstroke or heat exhaustion, and 47.0% (n = 94) said they had skin illnesses such rashes or irritations.

Additionally, 44.0% (n = 88) of the people who answered said they had gotten vector-borne diseases like dengue or malaria after floods in cities. It's interesting that 16.0% (n = 32) of the participants said they didn't have any health problems during extreme weather occurrences. This suggests that certain people or the environment are more resilient than others.

Overall, the results show that heat- and flood-related health problems are a big problem, which makes it even more important to quickly provide targeted public health services and climate-adaptive healthcare services to vulnerable urban groups in Karachi.

Discussion

The results of this study show that a lot of people in Karachi's most vulnerable metropolitan areas get sick from heat and water. These results are in line with earlier studies that showed the city is prone to extreme weather, including repeated heat waves and flooding in the metropolis (Shahid et al., 2019; Saquib et al., 2018). This study is different because it looks at risk in a specific way utilizing data from low-income, high-density neighborhoods that are generally left out of national catastrophe risk frameworks. This study uses a purposive sample technique to find people who have experienced health stress caused by climate change. The results can be used to help plan for urban resilience in Karachi at the district level.

The study also shows that socio-economic status has a big impact on both exposure to and the ability to respond to health concerns associated to climate change. People with lower incomes said they had trouble getting clean water, drainage systems that didn't work well, and healthcare services that weren't good enough. These things made the effects of flooding and heatwaves worse. These results support other research from around the world that shows how poverty and informal housing make climate change worse (Watts et al., 2021; IPCC, 2022). The report also indicates that people don't think the government is ready for emergencies, and many people don't trust health interventions or early warning systems. This insight shows that there is a big gap between what policymakers want to do and what is actually happening on the ground. This calls for focused, community-based health and infrastructure improvements.

This study contributes to the expanding body of climate-health literature by establishing a context-specific health risk assessment framework for a Global South megacity. A few studies have looked at how vulnerable Pakistan is to climate change in general (Ali & Khan, 2020; Rehman et al., 2022), but not many have utilized numbers to look at how it affects health in informal settlements on the outskirts of cities, where infrastructure failure is most severe. The results show how important it is for Karachi's public health strategy and city government to include climate resilience. The results also support the creation of early warning systems that can be adapted to local conditions, better health care delivery, and urban design that takes climate into account. So, this study gives people who work at the crossroads of climate change, urban development, and public health a solid, practical, and evidence-based framework to build on.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Conclusion

This study aimed to find out what health risks extreme weather, especially heat waves and urban flooding, pose to the most climate-vulnerable neighborhoods of Karachi. The study successfully captured the localized experiences, health outcomes, and risk perceptions of communities that are often left out of broader policy conversations by employing a quantitative research design and purposeful sampling of 200 participants from four highly populated and low-income urban areas. The organised questionnaire gave real-world proof of how often health problems happen, how much exposure people have, how well they can cope, and what they think are deficiencies in infrastructure and health service delivery.

The results show that dehydration, breathing problems, stomach infections, and heatstroke are some of the most common health problems in Karachi that are related to harsh weather. These hazards are made much worse by bad drainage systems, unpredictable access to clean drinking water, and power outages that happen a lot during heat waves. The study also indicated that socioeconomic vulnerabilities, such as low income, poor education, and lack of access to health services, are highly linked to worse health outcomes. One of the most important new things our research found is that there is a lack of faith in how well the government is prepared for and responds to emergencies. our shows that there is a gap between public health policy and what happens in the actual world.

The study suggests that communities should come up with their own ways to adapt to climate change. These might include setting up localized early warning systems, providing mobile health services during extreme weather events, and making infrastructure changes that focus on drainage, availability of water, and reliable energy. In addition, Karachi's urban governance and public health planning frameworks need to include climate-health modules as soon as possible. Future study should build on this by using longitudinal or mixed method approaches to look at how patterns of susceptibility change over time. Overall, this study gives a solid and evidence-based basis for targeted actions and policy changes to preserve health in Karachi as climate concerns develop.

REFERENCES:

Ahmed, S., Khan, M. A., & Tariq, R. (2021). Heatwave morbidity patterns in urban Pakistan: A case study of Karachi. Journal of Environmental Health Research, 30(4), 289–301.

Ali, M., & Khan, M. T. (2020). Climate change vulnerability assessment of urban sectors in Karachi. Urban Climate, 34, 100683.

Ali, S., Li, D., Congbin, F., & Khan, F. (2017). Twenty-first century climatic and hydrological changes over Upper Indus Basin of Pakistan. Global and Planetary Change, 147, 181–195. https://doi.org/10.1016/j.gloplacha.2016.11.007.

Aryal, J. P., Sapkota, T. B., Rahut, D. B., Krupnik, T. J., Shahrin, S., Jat, M. L., & Stirling, C. M. (2020). Major climate risks and adaptation strategies of smallholder farmers in coastal Bangladesh. Environmental Management, 66(1), 105-120.

Baills, A., Garcin, M., & Bulteau, T. (2020). Assessment of selected climate change adaptation measures for coastal areas. Ocean & Coastal Management, 185, 105059.

Cai, W., Zhang, C., Suen, H. P., Ai, S., Bai, Y., Bao, J., ... & Gong, P. (2021). The 2020 China report of the Lancet Countdown on health and climate change. The Lancet Public Health, 6(1), e64-e81.

Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). SAGE Publications.

Costello, A., Romanello, M., Hartinger, S., Gordon-Strachan, G., Huq, S., Gong, P., ... & Montgomery, H. (2023). Climate change threatens our health and survival within decades. The Lancet, 401(10371), 85-87.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Don, A., Seidel, F., Leifeld, J., Kätterer, T., Martin, M., Pellerin, S., ... & Chenu, C. (2024). Reply letter to Munoz et al.' on the importance of time in carbon sequestration in soils and climate change mitigation'—Keep carbon sequestration terminologies consistent and functional. Global Change Biology, 30(3), e17230.

Ebi, K. L. (2011). Resilience to the health risks of extreme weather events in a changing climate in the United States. International journal of environmental research and public health, 8(12), 4582-4595.

Ebi, K. L., & Burton, I. (2008). Identifying practical adaptation options: an approach to address climate change-related health risks. Environmental Science & Policy, 11(4), 359-369.

Flynn, B. C. (1996). Healthy cities: toward worldwide health promotion. Annual review of public health, 17(1), 299-309.

Galea, S., Ahern, J., & Karpati, A. (2005). A model of underlying socioeconomic vulnerability in human populations: evidence from variability in population health and implications for public health. Social science & medicine, 60(11), 2417-2430.

Government of Pakistan (GoP). (2012). National Climate Change Policy. Ministry of Climate Change.

He, C., Kim, H., Hashizume, M., Lee, W., Honda, Y., Kim, S. E., ... & Kan, H. (2022). The effects of night-time warming on mortality burden under future climate change scenarios: a modelling study. The Lancet Planetary Health, 6(8), e648-e657.

Khan, J., & Sayyed, M. R. G. (2019). A spatiotemporal analysis of urban flooding in Karachi and its impact on the urban poor. Journal of Environmental Management, 248, 109-237. https://doi.org/10.1016/j.jenvman.2019.109237.

Iqbal, M., Akhtar, M., & Shaikh, M. (2020). Health impacts of ambient air pollution in Karachi: A review of recent evidence. Pakistan Journal of Public Health, 10(2), 34–39.

IPCC. (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (H.-O. Pörtner et al., Eds.). Cambridge University Press.

Ji, J. S. (2024). China's health national adaptation plan for climate change: action framework 2024–2030. The Lancet Regional Health–Western Pacific, 52.

Khan, A., & Jahan, F. (2020). Urban flooding and health crises: An emerging challenge for Karachi. Pakistan Journal of Medical Sciences, 36(5), 1120–1125.

Lal, P., Mazumder, A., & Taneja, D. (2021). Climate-based health risk assessments in South Asian cities: A comparative analysis. Environmental Risk Management Journal, 19(2), 105–120.

Lugten, E., & Hariharan, N. (2022). Strengthening health systems for climate adaptation and health security: key considerations for policy and programming. Health security, 20(5), 435-439.

Iungman, T., Khomenko, S., Barboza, E. P., Cirach, M., Gonçalves, K., Petrone, P., ... & Nieuwenhuijsen, M. (2024). The impact of urban configuration types on urban heat islands, air pollution, CO2 emissions, and mortality in Europe: a data science approach. The Lancet Planetary Health, 8(7), e489-e505.

Lüthi, S. (2023). The Heat is on-Impacts of Heat & Wildfires in a Rapidly Changing Climate (Doctoral dissertation, ETH Zurich).

McCulloch, M. T., Winter, A., Sherman, C. E., & Trotter, J. A. (2024). 300 years of sclerosponge thermometry shows global warming has exceeded 1.5 C. Nature Climate Change, 14(2), 171-177.

Mirza, M. M. Q. (2011). Climate change, flooding in South Asia and implications. Regional Environmental Change, 11(1), 95–107. https://doi.org/10.1007/s10113-010-0184-7.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Oven, K. J., Curtis, S. E., Reaney, S., Riva, M., Stewart, M. G., Ohlemüller, R., ... & Holden, R. (2012). Climate change and health and social care: Defining future hazard, vulnerability and risk for infrastructure systems supporting older people's health care in England. Applied Geography, 33, 16-24.

Pakistan Meteorological Department (PMD). (2021). Climate Summary of Pakistan. PMD Annual Report.

Palinkas, L. A., & Wong, M. (2020). Global climate change and mental health. Current opinion in psychology, 32, 12-16.

Raza, S., Baloch, M., & Karim, S. (2022). Flood-related public health emergencies in Karachi: Lessons from recent events. Asia-Pacific Journal of Public Health, 34(1), 98–106.

Rahman, A., Khan, M. A., & Ahmad, M. (2015). Urban flooding and health risk in Karachi, Pakistan. International Journal of Disaster Risk Reduction, 12, 122–129. https://doi.org/10.1016/j.ijdrr.2014.12.002

Rehman, A., Urooj, S., & Shah, N. (2022). Impacts of urban flooding on public health: A study from Karachi. Environmental Hazards, 21(2), 134–149.

Romanello, M., Di Napoli, C., Drummond, P., Green, C., Kennard, H., Lampard, P., ... & Costello, A. (2022). The 2022 report of the Lancet Countdown on health and climate change: health at the mercy of fossil fuels. The Lancet, 400(10363), 1619-1654.

Romanello, M., Di Napoli, C., Drummond, P., Green, C., Kennard, H., Lampard, P., ... & Costello, A. (2022). The 2022 report of the Lancet Countdown on health and climate change: health at the mercy of fossil fuels. The Lancet, 400(10363), 1619-1654.

Saquib, S., Rahman, A., & Farooq, S. (2018). An assessment of the 2015 Karachi heatwave and lessons learned. Disaster Medicine and Public Health Preparedness, 12(5), 610–616.

SEPA. (2021). Annual Environmental Quality Report 2020–21. Sindh Environmental Protection Agency.

Shahid, S., Alamgir, M., & Nawaz, N. (2019). Risk and vulnerability of heatwaves in urban areas: A case study of Karachi. Climate Risk Management, 24, 100-117. https://doi.org/10.1016/j.crm.2019.100217.

UN-Habitat. (2021). Urban Resilience Profile: Karachi. UN-Habitat Pakistan.

World Health Organization (WHO). (2020). Heat and health in cities: WHO guidance for urban health resilience.

World Health Organization. (2002). Floods: climate change and adaptation strategies for human health: report on a WHO meeting: London, United Kingdom, 30 June–2 July 2002. In Floods: climate change and adaptation strategies for human health: report on a WHO meeting: London, United Kingdom, 30 June–2 July 2002.

Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Beagley, J., Belesova, K., ... & Costello, A. (2021). The 2021 report of the Lancet Countdown on health and climate change: Code red for a healthy future. The Lancet, 398(10311), 1619–1662. https://doi.org/10.1016/S0140-6736(21)01787-6

Witze, A. (2022). Russia's war in Ukraine forces Arctic climate projects to pivot. Nature, 607(7919), 432-432.

Zhao, G., Yu, B., An, R., Wu, Y., & Zhao, Z. (2021). Energy system transformations and carbon emission mitigation for China to achieve global 2 C climate target. Journal of Environmental Management, 292, 112721