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Knowledge And Perception of Climate Change Impacts on Health Among Staff of Sindh Integrated Emergency and Health Services in Karachi, Pakistan

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Abstract

Objectives:

To assess knowledge and perceptions of climate change impacts on health among clinical and non-clinical staff of the Sindh Integrated Emergency and Health Services (SIEHS) in Karachi, Pakistan.

Methods:

A cross-sectional study was conducted among 218 staff members of Sindh Integrated Emergency and Health Services (SIEHS) using a structured Knowledge, Attitudes, and Practices questionnaire adapted from the United Nations Development Programme climate awareness survey. Data were collected through an online self-administered questionnaire. Descriptive statistics, independent t-tests, ANOVA, and Spearman correlation were applied.

Results:

Participants demonstrated moderate overall knowledge and perceptions of climate change and its health impacts. Statistically significant differences in knowledge and perception scores were observed across age groups, departments, education levels, and years of experience ($p < 0.05$). Emergency Medical Department staff and participants with higher education levels showed significantly higher scores. A weak but statistically significant positive correlation was identified between knowledge and perception scores ($r = 0.195$, $p = 0.004$).

Conclusion:

Although SIEHS staff demonstrate moderate awareness of climate-related health risks, gaps remain in perceived preparedness and institutional readiness. Targeted climate-health training and structured preparedness programmes may help strengthen workforce response capacity in climate-vulnerable urban settings.

Introduction

Climate change refers to long-term alterations in temperature, precipitation, and weather patterns, primarily driven by human activities such as the burning of fossil fuels, deforestation, and industrial processes (Nations, 2025). These activities release greenhouse gases (GHGs) like carbon dioxide and methane into the atmosphere, leading to climate change that causes extreme weather events, directly influencing human health, particularly vulnerable populations. (Nations, 2025).

Climate change (CC) is considered one of the major factors influencing human health and illness in a variety of ways. However, there are certain elements that result in exacerbating the impact of climate change on health, including age, inadequate economic resources, and geographical location. (Prevention, 2024). The vulnerable populations are at an increased risk of health complication including respiratory diseases, cardiopulmonary illnesses, vector-borne diseases, water-borne diseases and mental health challenges due to climatic hazards. (Hira Tariq, 2025)

Low- and Middle-income countries are primarily exposed to major climatic events because of their inadequate adaptive capacity concerning integrated healthcare systems and infrastructure. Forecasts suggest that between 2030 and 2050, climate change could lead to an estimated 250,000 more deaths each year from causes such as undernutrition, malaria, diarrheal diseases, and heat stress. The health impacts of climate change are particularly severe in low and middle-income countries (LMICs) where healthcare systems are often under-resourced. (WHO, 2023)

The National Disaster Management Authority (NDMA) ranked Pakistan among eighth most vulnerable nations globally. It further states that Pakistan is expected to experience a rise of about 5.3 degrees Celsius in temperature, which is higher than the global average of 3.7 degrees Celsius (URAANpakistan, 2024). Moreover, Climate change exacerbates the threat to areas with mountain ranges, comprising a large volume of fresh water. Floods of 2022 reported approximately 12,000 injuries, 8 million displacements and 1739 deaths (reliefweb, 2022). Furthermore, the patterns from 2022 floods highlighted 7,000 cholera cases and 4,500 dengue infections in Sindh alone, while due to collapsed sanitation system and poor infrastructure, an increase in acute fever, malaria, diarrhoeal, and skin infections across multiple flood-affected regions, including Sindh, southern Punjab and Khyber Pakhtunkhwa were reported. While the reports of 2024 floods suggests that Khyber Pakhtunkhwa (KP) and Baluchistan provinces of Pakistan were primarily affected and resulted in causing 117 fatalities and 139 injuries with extensive damage reported, including 464 schools, over 5,800 houses and more than 700 livestock nationwide (reliefweb, 2024). A study revealed that previous flood crises in Pakistan showcased critical disruption in antenatal care, chronic disease management, and childhood immunization services. Pregnant and lactating women were mainly exposed to disrupted maternal care, while adolescent girls experienced trauma and gender-based violence due to the absence of gender sensitive sanitation and psychosocial services (Ayesha Fahim, 2025).

Healthcare professionals are categorized among the most reliable and authoritative sources of health information. According to a study, the healthcare workforce believes that climate change adversely impacts human health and endorse their responsibility to advocate for health policies (Antonio Miguel Caraballo-Betancort, 2025). A study conducted among Emergency specialist showcased that most participants recognised a relationship between climate change and health and believed it would impact both their own and their patients' health (Elzarie Theron, 2025). Similarly, another study suggests that most of the public health professionals considered climate change as a public health issue but lacked information, expertise, and resources to address and combat climate hazards, hence emphasizing the

role of healthcare professionals to work on adapting and mitigating strategies for climate change effects. (Antonio Miguel Caraballo-Betancort, 2025).

Awareness and perceptions regarding health impacts of climate change play a crucial role in understanding and shaping perceived risks, encouraging preventive behaviours, and strengthening climate adaptive policies (John Kotcher, 2021). The World Health Organization emphasizes that educating individuals is essential for climate preparedness, behaviour adaptation and reducing greenhouse gas emissions. Individuals who acknowledge climate change as an immediate health risk tend to practice preventive and protective behaviours and support relevant policies (John Kotcher, 2021). However, the most evidence emerges from high-income nations, highlighting limited research from Pakistan. Understanding the Knowledge and perceptions of frontline workers, nonclinical staff is therefore critical for more targeted interventions, enhancing preparedness, and supporting policies for climate-vulnerable nations. (Antonio Miguel Caraballo-Betancort, 2025). In Pakistan, particularly among staff of Sindh Integrated Emergency and Health Services in Karachi, there is a notable gap in the literature regarding how healthcare and emergency respondents perceive climate change and its influence on health practices, underscoring the need for context-specific assessment.

Rationale of the Study

Despite Karachi being a metropolitan city is highly susceptible to climate-related health illnesses, including natural disasters and climate-sensitive diseases. The frontline emergency and healthcare workforce at Sindh Integrated Emergency and Health Services is considered essential to respond to these challenges effectively. The lack of trainings on climate change impact on health, insufficient resources and lack of adequate interventions limit their capacity to effectively manage climate health risks. Gaps in knowledge and perceptions related to climate change impacts on health among Sindh Integrated Emergency and Health Services staff to inform targeted trainings and climate-sensitive responsive health interventions.

Aim of the Study

This study aims to assess knowledge and measure the perceptions of climate change impacts on health among staff of Sindh Integrated Emergency and Health Services (SIEHS). It specifically focuses on frontline health and emergency worker as well as the administrative staff, examining their roles in identifying and responding to climate-related health diseases as well as evaluating the institution's preparedness of SIEHS to address health risks associated with climate change.

Research Question

What is the Knowledge and Perceptions of Climate Change Impacts on Health among staff of Sindh Integrated Emergency and Health Services in Karachi, Pakistan?

Research Objectives:

1. To assess knowledge and perceptions of climate change impacts on health among staff of Sindh Integrated Emergency and Health Services.

Operational Definitions:

Climate Change: Climate change refers to significant and lasting changes in the Earth's temperatures and weather patterns. These changes can be from natural causes (such as large volcanic activity) or from human activities.

Health Illness: A state of complete physical, mental, and social well-being and not merely the absence of disease, or infirmity. (WHO 1946).

Emergency Respondents: According to the World Health Organization, Emergency respondents are highly skilled teams to support their communities' immediate needs. It includes Emergency Medical Teams (EMTs), composed of doctors, paramedics, and logistical experts, are crucial responders in crises.

Preparedness: The knowledge and capacities developed by governments, response and recovery organizations, communities, and individuals to effectively anticipate, respond to, and recover from the impacts of likely, imminent, or current disasters.

Literature Review

According to the occupational health literature, climate change adversely impacts the health of workers by exposing them to extreme heat. The highest risk of heat-related illness and mortality is reported to be in workers in agriculture, forestry, fishing, hunting, and construction, which highlights that there is awareness of the risks associated with climate in some occupational groups, but that due to exposure, they are vulnerable. (Nambi Ndugga, 2023)

Research on healthcare providers demonstrates that the majority of them acknowledge climate change as a risk to patient health and are interested in participating in the corresponding discussions. But one of the perceived barriers is perceived lack of time, competing priorities, and limited knowledge, which hinder regular communication with patients, which suggests an awareness-practical disjunction. (Tess Wiskel, 2024)

Studies carried out on medical and health sciences students reveal high awareness and little knowledge of climate change and its effects on health. Information is mostly obtained through the internet and social media; less usage of scientific journals and formal curricula is mentioned. Though students believe that climate change is a future challenge to the health of patients, a lack of adequate exposure in the curriculum reduces their readiness to deal with its effects in clinical environments. Research into environmental sustainability knowledge indicates that awareness is moderately high, but there is low understanding, and no stable behaviour is taken in terms of sustainability. (J Irlam, 2023)

The students are aware of the sustainability concept and are not clear about how it applies to health care, which is a weakness in health curricula concerning environmental health and sustainability. According to population-based studies conducted in Canada, there is concern regarding the health effects of climate change, but it depends on the gender, education, and political orientation. Selective perceptions regarding the health risks were expressed by the respondents who were more interested in water, food, and air quality than mental health or infectious diseases (Nora Casson, 2023)

On the same note, a German population survey revealed that there was high recognition of climate change and its health, yet people believe that other people are more affected than they are, thereby displaying cognitive distancing and that there is a need to better communicate risks (Katharina van Baal, 2023)

The study, conducted in UK, showed that people who had personal or local experience with flooding and air pollution had reported far greater concern and more negative views of health effects of climate phenomenon, which implies that the experience of living environment has a strong influence on the perception and awareness. (Hilary Graham, 2022).

A study conducted in rural Nigeria showed that there is poor knowledge and good attitude to climate change and thus the need to engage in persistent health promotion and dissemination of information to vulnerable communities (Esther O Asekun-Olarinmoye, 2014)

Similarly, research conducted in Lusaka Province found that there are significant gaps in stakeholder knowledge, especially concerning indirect health effects. Even though the importance of health-related risks posed by climate change is acknowledged, the need to conduct research and education at a local level is evident. (Mwale, 2025)

Lastly, local public health departments in the United States were assessed and either did not possess expertise, staffing and funds or harboured a low institutional priority regarding climate change because of its perceived as an increasing public health issue. This is indicative of structural knowledge and capacity void in the systems of public health.(Edward W. Maibach 2008)

Conceptual Framework:

The conceptual framework was adapted from published climate change and health impact models (e.g., NSW Health framework), with modifications made to suit the objectives of the present study.

This conceptual frame is adapted and modified from existing climate change and health models that briefly explain the conceptual route through which climate-related health illnesses are caused. The original framework showcases direct and indirect climatic exposures leading to mental and physical health outcomes, with vulnerability acting as a modifying factor.

In order to incorporate this framework, according to this study, the framework has been modified to be consistent with the research objectives and target population. The adapted model highlights knowledge

and perceptions of climate change impacts on health. This study focuses on climatic hazards, including extreme weather events such as heatwaves, pollution, flood all of these hazards are considered as health-related exposures, the outcome of interest includes staff perceptions related to it.

Sociodemographic and professional characteristics, including education, role within the Sindh Integrated Emergency and Health Services, years of experience, and prior training, are considered contextual factors that may influence knowledge and perceptions.

This adapted framework provides a structured approach to understanding how SIEHS staff perceive the link between climate change and health, while remaining within the scope of a cross-sectional assessment of knowledge and perception

METHODS

Study Design:

A Cross-sectional study design was used in this study to assess knowledge and measure perceptions of climate change impacts on health among staff of Sindh Integrated Emergency and Health Services. The data was collected in two phases. The data was collected using a structured and modified questionnaire named the Knowledge, Attitudes, and Practices (KAP) survey, adapted from the UNDP climate change awareness survey. A cross-sectional approach helped to collect the data at a single point in time.

Study Setting

This study was carried out at two major headquarters of Sindh Integrated Emergency and Health Services (SIEHS) in Karachi, Pakistan. Rescue 1122 Headquarters, Gulshan-e-Iqbal was the first site for data collection comprising of two key departments, Emergency Medical Department and Communication and Command Control Centre (CCC), while the second site is located at Central office, PECHS block 6, Siehs office, where the department of Teletabeeb, Research Development and Education (RDE) and Monitoring, Evaluation, Accountability and Learning (MEAL) departments are stationed.

Study Population

The study population comprised of Staff working across various departments of Sindh Integrated Emergency and Health Services. These consist of the Emergency Medical Department (Pre-hospital and ambulance care), the communication and command and control centre (emergency call handling and dispatch coordination), and the Research, Development and Education (RDE) Department (Performance monitoring and quality assurance). The accessible population comprised all staff members currently stationed in Karachi and those who were present at the time of data collection and provided informed consent.

Eligibility Criteria:

Inclusion Criteria:

- Employee currently stationed at any department of Sindh Integrated Emergency and Health Services in Karachi.
- Belong to any unit of Sindh Integrated Emergency and Health Services.
- Have at least 6 months of job experience to ensure exposure to emergency and rescue operations.
- Willing to provide informed consent and available during the study period.

Exclusion Criteria:

- Staff on leave or temporarily absent during data collection.
- Retired, resigned, or transferred employees no longer associated with SIEHS.
- Staff from other cities or regions outside Karachi.

Sampling Strategy

Sampling

Quantitative data were collected using convenience sampling. This approach was employed because the questionnaire was disseminated through office channels, and participants who responded voluntarily were included in the study.

Sampling Technique

The Mixed approach (Census + Random sampling) is used to ensure differences in department sizes. Due to the unequal size of departments, a mixed sampling approach was carried out. All staff from smaller departments (≤10 members) were included (census), while participants from larger departments (>10 members) were selected using simple random sampling to ensure representativeness and feasibility.

Sample Size

The sample size for this study was initially calculated using a single-population proportion formula with a 95% confidence level, 5% margin of error, an assumed proportion of 50%, and a 10% anticipated non-response rate. Although the calculated minimum sample was larger, practical constraints during field data collection limited recruitment. Ultimately, 218 participants were successfully enrolled and included in the final analysis. Prior to the main data collection, a pilot study involving 10 participants was conducted to assess the clarity, reliability, and feasibility of the study instrument. Data from the pilot testing were excluded from the final analysis. All eligible participants who provided informed consent during the study period were included.

Recruitment Procedure:

The recruitment process was initiated after approval from the Ethical Review Committee (ERC) and Institutional Review Board (IRB) of the Shaheed Zulfiqar Ali Bhutto University of science and Technology (SZABIST). The data was collected between October 2025 and December 2025. Participants were recruited using a nonprobability convenience sampling technique. Eligible participants were staff members of the Sindh Integrated Emergency (SIEHS) working in Karachi. Data were collected at a single point in time through an online survey. The survey link was disseminated through official institutional channels and WhatsApp groups following administrative approval. All participants provided electronic informed consent before participation. A subset of respondents from the same sample voluntarily participated in the qualitative component of the study. Participation was entirely voluntary, and confidentiality and anonymity were ensured.

Data Collection

A self-administered and modified questionnaire comprising 30 closed-ended questions was developed in English and Urdu and then pretested among 12 participants for non-selected staff for assessing content validity, appropriateness, and comprehensibility of the questions. The data was collected through an online Google form. The edited questionnaire was administered by the principal investigator to the 218 participating staff at two different headquarters of Sindh Integrated Emergency and Health Services from December 1st to January 1st. The questionnaire consists of five sections, including socio-demographic information, general knowledge and awareness, experience & observations, perceptions of risk & priorities, health impacts of climate change and training, guidelines & institutional readiness.

Data Collection Tools

Quantitative Data Collection Tool

The quantitative data was collected through a structured, validated questionnaire known as the Knowledge, Attitudes, and Practices (KAP) survey adapted from the UNDP climate change awareness survey, to assess knowledge and measure climate change impacts on health. The five-point Likert scale was used, consisting of 30 closed ended questions covering five sections including socio-demographic information, general knowledge and awareness, experience & observations, perceptions of risk & priorities, health impacts of climate change and training, guidelines & institutional readiness. These sections aim to assess the knowledge regarding climate change impacts on health among SIEHS staff. Evaluation for positive statements: (1) Strongly disagree, (2) Disagree, (3) Neither (4) Agree, (5) Strongly agree, while evaluation for negative statements: (5) Strongly disagree, (4) Disagree, (3) Neither (2) Agree, (1) Strongly agree were used.

Tool Validity:

The Knowledge, Attitudes, and Practices (KAP) survey is a validated tool based on the UNDP climate change awareness survey. The UNDP KAP Survey on Climate change awareness developed the tool's content and construct validity through expert review. However, it has not been previously applied in

Pakistan; it provided a useful structural framework for developing our questionnaire on climate change knowledge and perceptions. The tool was adaptively modified to reflect local climate change issues in Pakistan. In this study, the instrument was carefully reviewed by the principal investigator for the content relevance and clarity of the language of the tool. This study involving human participants was conducted in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

RESULTS

Table1: Participant's Demographic Characteristics

The study sample comprised a total of 218 participants for the quantitative phase, as shown in Table 1. Out of 218 participants, 139(63.8%) were females, and 79(26.2%) were males. The age distribution reported that 73 (33.49 %) participants were between 18 and 27, 107 (49.08 %) were between 28 and 37 years of age, 32 (14.68 %) were between 38 and 47 years, and 6 (2.75 %) were above 48 years and above of age. The majority of participants were from the Emergency Medical Department, accounting for 110 (50.46 %), 96 (44.04%) were from the Communication and Command and Control Centre, and 34 (11.3%) were from Monitoring, Evaluation, Accountability and Learning (MEAL), followed by 10 (4.59%) and 2 (0.92%) Teletabeeb and Research, Development, and Education Department (RDE), respectively.

The maximum number of participants, 86 (39.45%), had a bachelor's level of education. 47 (21.56%) held a diploma. Respondents with an MS/MPhil included 10 (4.59%). 24 (11.01%) had a secondary level of education. Participants with a primary level of education included 51 (23.39%).

Regarding years of experience, 39 (17.89%) have less than 1 year, 95 (43.58%) have 1–3 years, 45 (20.64%) have 4–6 years, and 39 (17.89%) have more than 6 years in the Sindh Integrated Emergency and Health Services.

Table 1 Table 1Participant's Demographic Characteristics

Demographic Characteristics	Categories	Frequency (Percentage) n (%)
Age	18–27 years	73 (33.49 %)
	28–37 years	107 (49.08 %)
	38–47 years	32 (14.68 %)
	48–57 years	6 (2.75 %)
Gender	Female	139(63.8%)
	Male	79 (26.2%)
Department	Emergency Medical Department	110 (50.46 %)
	Communication and Command and Control Centre	96 (44.04%)
	Research, Development, and Education Department (RDE)	2 (0.92%)
	Teletabeeb	10 (4.59%)
	Monitoring, Evaluation, Accountability, and Learning (MEAL)	34 (11.3%)
Education Level	Primary	51(23.39%)
	Secondary	24 (11.01%)
	MS/MPhil	86 (39.45%)
	Diploma	10 (4.59%)
	PhD and above	47 (21.56%)
Years of Experience	Less than 1 year	39 (17.89%)
	1–3 years	95 (43.58%)
	4–6 years	45 (20.64%)
	More than 6 years	39 (17.89%)

Table 2 Participants Demographic Characteristics

The comparison of UNDP KAP survey on climate change awareness and its sub-scales scores based on the Socio-Demographic characteristics of participants is shown in Tables 1 and 2, respectively. Analysis showed that age (F: 2.69, p=0.04), Department of SIEHS staff (*F:* 13.48, p=0.000), Educational Level of participants (F:5.41, p=0.0004) and years of experience at Sindh Integrated Emergency and Health Services (F: 3.95, p=0.0091) had a significant impact on knowledge of SIEHS staff.

Anova results showed a statistically significant difference in Knowledge scores among different age groups (F: 2.69, p=0.04), showing age as an influencing factor on Knowledge Levels. The score of knowledge regarding climate change impacts on health was higher among those aged between 28 and 37 (12.84± 2.95) and 38 and 47 (13± 4.09) as compared to other age groups. According to the post-Hoc comparison, participants aged 28-37 and 38-47 scored significantly higher than other groups ($p<0.05$).

A statistically significant difference was observed in the Knowledge scores based on the departments participants belonged to (F: 13.48, p=0.000). According to the results, the knowledge scores related to climate change were high among the Emergency Medical Department (164.36±16.20) as compared to other departments. Analysis further revealed a statistically significant difference in the scores of all other departments. A statistical difference in the Communication and Command and Control Centre was significant (165.48±9.17), and participants from Research, Development, and Education (158.69±15.86) had more knowledge of climate change impacts on health. Similarly, the Teletabeeb department had knowledge scores of (155.87±15.77), and the Department of Monitoring, Evaluation, Accountability and Learning (MEAL) had knowledge scores of (162.88±18.06).

The mean knowledge score varied significantly across educational levels. Participants with a bachelor's degree demonstrated the highest mean knowledge score (13.42±3.27), followed by those with an MS/M.Phil. degree (13.8±3.55), participants with a Diploma reported (12.59±3.55) mean scores. While participants holding a secondary degree showcased (13.13±4.09). The lowest mean score was observed among participants with primary education (12.51±3.94). The differences in knowledge scores across educational categories were statistically significant ($p < 0.001$).

The mean knowledge scores increased with years of professional experience. Participants with more than 6 years of experience reported the highest mean knowledge score (13.67± 4.05), followed by those with participants with less than 1 year of experience (13.39±2.62), while the lowest mean score was observed among participants with 1-3 years of experience (12.72±3.64) and participants with years of experience between 4-6 years (12.76±3.84). The findings showed statistically significant results.

The demographic variable gender did not show a statistically significant difference in knowledge scores between male and female participants. In addition, no significant difference was observed in overall

knowledge scores related to the impacts of climate change on health across gender categories, suggesting that gender was not significantly associated with variations in knowledge or perceptions ($p > 0.05$).

Table 2 Distribution of Knowledge Scores Among Participants by Demographic Characteristics

Characteristics	Categories	Mean (SD) Total Knowledge	p-value	Statistics
Age	18–27 years	12.84± 2.95	p=0.04*	*F: 2.69*
	28–37 years	13.17± 3.87		
	38–47 years	13± 4.09		
	48–57 years	12.5 ± 3.83		
Gender	Male	13.00±3.67	p=0.874	t: −0.1586
	Female	13.18±1.99		
Department	Emergency Medical Department	164.36±16.20	p=0.000*	*F: 13.48*
	Communication and Command and Control Centre	165.48±9.17		
	Research, Development, and Education Department (RDE)	158.69±15.86		
	Teletabeeb	155.87±15.77		
	Monitoring, Evaluation, Accountability, and Learning (MEAL)	162.88±18.06		
Education Level	Primary	12.51±3.94	p= 0.0004*	*F: 5.41*
	Secondary	13.13±4.09		
	Bachelors	13.42±3.27		
	MS/MPHIL			
	Diploma	12.59±3.55		
Years of Experience	Less than 1 year	13.39±2.62	p=0.0091*	*F: 3.95*
	1–3 years	12.72±3.64		
	4–6 years	12.76±3.84		

More than 6 years	13.67± 4.05

Table3: Distribution of Perceptions Scores Among Participants by Demographic Characteristics

The mean perception scores differed across participants' demographic and professional characteristics (Table X). Age was significantly associated with perception scores ($F = 2.82$, $p = 0.03$), with the highest scores observed among participants aged 18–27 years (9.07±2.47) and the lowest among those aged 48–57 years (7.00±3.83).

Significant differences were found in perception scores across departments ($F = 13.48$, $p < 0.001$). Participants from the Emergency Medical Department had the highest mean score (9.03±2.33), while lower scores were observed in other departments. (Note: Some department data appear inconsistent and may require verification).

Education level also showed a significant association with perception scores ($F = 7.27$, $p < 0.001$). Participants with Bachelor's (9.21±2.20) and MS/MPhil degrees (8.40±2.07) had higher scores compared to those with Primary (7.71±2.58) or Secondary education (6.71±2.16). Diploma holders scored 8.89±2.47.

Finally, years of experience were significantly associated with perception scores ($F = 3.70$, $p = 0.01$). Participants with less than 1 year of experience had the highest scores (9.62±2.14), followed by those with more than 6 years (8.49±2.52), 4–6 years (8.27±2.28), and 1–3 years of experience (8.11±2.57). These results indicate that age, department, education level, and years of experience significantly influence perception scores among participants, whereas gender does not.

Gender was not significantly associated with perception scores ($t = -0.9686$, $p = 0.333$); males had a mean score of 8.43±2.51, while females scored 9.18±1.66.

Table 3 Distribution of Perception Scores Among Participants by Demographic Characteristics

Characteristics	Categories	Mean (SD) Total GDPBS	p-value	Statistics
Age	18–27 years	9.07±2.47	**p=0.03***	***F: 2.82***
	28–37 years	8.32±2.63		
	38–47 years	7.94±1.81		
	48–57 years	7± 3.83		
Gender	Male	8.43±2.51	p=0.333	t: -0.9686
	Female	9.18±1.66		
Department	Emergency Medical Department	9.03±2.33	**p=0.000***	***F: 13.48***
	Communication and Command and Control Centre	7.68±2.51		
	Research, Development, and Education Department (RDE)	±15.86		
	Teletabeeb	155.87±15.77		
	Monitoring, Evaluation, Accountability, and Learning (MEAL)	162.88±18.06		
Education Level	Primary	7.71±2.58	**p= 0.000***	*F: 7.27*
	Secondary	6.71± 2.16		
	Bachelors	9.21±2.20		
	MS/MPHIL	8.4±2.07		
	Diploma	8.89±2.47		
Years of Experience	Less than 1 year	9.62± 2.14	**P= 0.01***	*F: 3.70*
	1–3 years	8.11± 2.57		
	4–6 years	8.27±2.28		
	More than 6 years	8.49± 2.52		

Table 4: Correlation between knowledge and perception scores regarding climate change impacts on health

Spearman's correlation analysis showed a **statistically significant weak positive relationship** between knowledge and perception scores regarding climate change impacts on health (r = 0.195, p = 0.004), based on responses from 218 participants.

Table 4 Correlation between knowledge and perception scores regarding climate change impacts on health

Variable 1	Variable 2	r	p-value	N
Knowledge	Perceptions	r=0.195	**p=0.004***	N=218

Study Strengths

This study has several strengths. Firstly, to our knowledge, this study is one of the first quantitative studies conducted among clinical and non-clinical staff, aiming to assess the knowledge and perceptions regarding Climate Change impacts of health among Sindh Integrated Emergency and Health Services staff, which is an emerging topic to address the knowledge and perceptions gap among front-line professionals in high-risk areas of Karachi, Pakistan. The quantitative data allowed us to understand the level of Knowledge and perceptions among SIEHS staff.

Secondly, the participation of diverse staff from different departments of Sindh Integrated Emergency and Health Services enhanced the generalizability. The findings from the study could serve as a potential implication and guide for policymakers, particularly in the healthcare and education sectors, can use the findings from this study to design and implement targeted interventions that improve the knowledge, preparedness, and response of SIEHS staff regarding the health impacts of climate change, ultimately contributing to the physical, mental, and social well-being of the communities they serve..

Study Limitations

This study has some limitations. Its cross-sectional design prevents establishing causal relationships, and data were self-reported, which may be affected by recall or social desirability bias. The sample was limited to SIEHS staff, which may reduce generalizability to other regions or emergency services. Additionally, qualitative insights were not collected, which could have provided a deeper understanding of staff perceptions.

Recommendations

It is recommended that targeted training programs be implemented to improve SIEHS staff knowledge of climate change and its health impacts. Policies should integrate climate-related health risks into emergency response planning, and future research should include qualitative and longitudinal studies to

better understand staff perceptions and preparedness. Expanding the study to other regions would also enhance generalizability.

Here is a short, high-quality, journal-ready Discussion section (concise, integrated, scholarly, and literature-linked) suitable for manuscripts with word limits. It maintains academic rigor, compares findings with other studies, and is formatted as one coherent section.

DISCUSSION

This study provides one of the first quantitative assessments of knowledge and perceptions regarding the health impacts of climate change among both clinical and non-clinical staff of Sindh Integrated Emergency and Health Services (SIEHS) in Karachi, Pakistan. Conducted in a highly climate-vulnerable urban context, the study addresses a critical research gap by examining climate–health awareness among frontline emergency and health professionals who play a central role in disaster response and population health protection.

The findings indicate that SIEHS staff possess moderate overall knowledge and perceptions of climate change and its health consequences, with awareness of key risks such as heat-related illnesses, respiratory diseases, vector- and water-borne infections, and psychological distress during disasters. These results are consistent with international studies among healthcare professionals in high-income and low- and middle-income countries, which similarly report moderate to high climate–health awareness but uneven preparedness and institutional integration (Kotcher et al., 2021; Wiskel et al., 2024; Caraballo-Betancort et al., 2025; Hira Tariq et al., 2025).

Significant differences in knowledge and perception scores across age, department, education level, and years of experience reflect structural and professional inequalities in access to climate–health exposure and training. Higher knowledge among Emergency Medical Department and Communication and Command and Control Centre staff aligns with evidence that frontline exposure to climate-related emergencies strengthens climate–health understanding (Kang et al., 2023; Theron et al., 2025). Similarly, the association between higher education and greater knowledge supports findings from China and South Africa, where formal education enhances climate literacy but does not ensure operational preparedness (Yang et al., 2018; Irlam et al., 2023).

Higher perception scores among younger staff and frontline emergency workers mirror international research showing that direct experience with environmental hazards and generational exposure to climate discourse increase perceived health risks (Graham et al., 2022; Casson et al., 2023; van Baal et al., 2023). The higher perception among newly employed staff likely reflects recent academic exposure to climate change content, consistent with findings from studies among health students and early-career professionals (Yang et al., 2018; Irlam et al., 2023).

The weak but significant correlation between knowledge and perception highlights a critical knowledge–perception gap, indicating that increased awareness does not necessarily translate into stronger risk perception or preparedness. This pattern is widely documented in climate–health literature and underscores the limitations of information-based training alone (Maibach et al., 2008; Kotcher et al., 2021; Wiskel et al., 2024).

Overall, these findings emphasize the need for structured climate–health training, experiential learning, and institutional integration of climate resilience frameworks within emergency health systems. Strengthening intersectoral collaboration between healthcare services, disaster management authorities, and environmental agencies is essential for building climate-resilient health systems and protecting vulnerable urban populations. Despite being limited to a single institution, this study provides critical baseline evidence for Pakistan and contributes to the limited literature on climate–health awareness in emergency service systems in low- and middle-income countries.

Conclusion

This study highlights that SIEHS staff possess varying levels of knowledge and perceptions regarding the health impacts of climate change, with notable gaps in awareness and preparedness. Strengthening staff capacity through targeted training, integrating climate-related health risks into emergency response protocols, and fostering intersectoral collaboration are essential to enhance resilience and ensure effective community health protection. Addressing these gaps will not only improve the readiness of emergency health services but also contribute to safeguarding the physical, mental, and social well-being of the populations they serve in the face of climate-related challenges.

Abbreviations

SZABIST- Shaheed Zulfiqar Ali Bhutto University of Science and Technology

SIEHS- Sindh Integrated Emergency and Health Services

GHGs - Greenhouse gases

CC- Climate Change

LMICs- Low and Middle-Income Countries

NDMA- National Disaster Management Authority

WHO- World Health Organization

EMTs- Emergency Medical Teams

CCC- Communication and Command Control Centre

RDE- Research Development and Education

MEAL- Monitoring, Evaluation, Accountability and Learning

KAP- Knowledge, Attitudes, and Practices

UNDP- United Nations Development Programme

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Ethical Review Committee and Institutional Review Board of Shaheed Zulfiqar Ali Bhutto Institute of Science and Technology (SZABIST), Karachi, Pakistan.
All participants provided electronic informed consent prior to participation.
The study was conducted in accordance with the Declaration of Helsinki and relevant institutional guidelines.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Shehzeen Niaz conceived the study, developed the methodology, conducted analysis and drafted the manuscript. Rabiya Javed contributed to data collection and manuscript preparation. Suleman Otho supervised the study and critically reviewed the manuscript. All authors read and approved the final manuscript.

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Not Applicable

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Figures

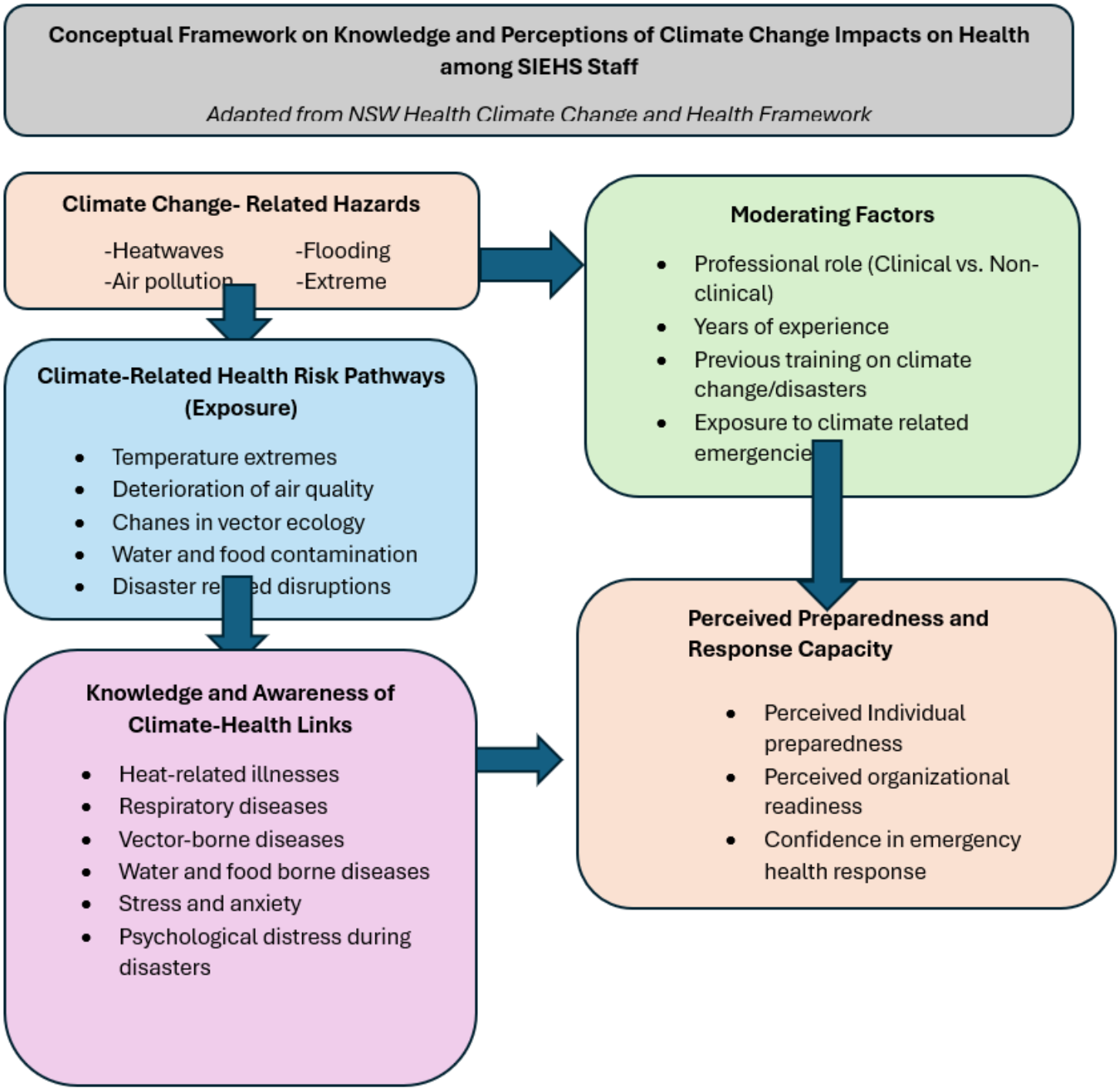


Figure 1

Unnumbered image in **Literature Review** section.

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