

A CROSS-SECTIONAL STUDY OF PERCEPTION AND KNOWLEDGE OF ASSOCIATION OF OUTBREAK OF INFECTIONS AND CLIMATE CHANGE AMONG PUBLIC HEALTH AND MEDICINE STUDENTS

Original Research

Tasneem Munir^{1*}, Rabia Zulfiqar^{2*}, Tahseen Mubarik³, Shekh Mohammad Mostafa⁴, Sm.Ashik Faysal⁵

¹Surgical technologist, Lahore General Hospital, Pakistan.

²Student, Certificate of Medical Teaching, Department of Community Medicine, King Edward Medical University, Lahore, Pakistan.

³Teaching faculty/Public health Nursing Supervisor, College of Nursing, DHQ Mianwali, Pakistan.

⁴Medical officer, OSD, Directorate General of Health Services, Moakhali, Dhaka, Bangladesh.

⁵Public Health Specialist (MPH), Department of Public Health, North South University, Dhaka Bangladesh.

Corresponding Author: Tasneem Munir, Surgical technologist, Lahore General Hospital, Pakistan. tasneemmunir786@gmail.com
Rabia Zulfiqar, Student, Certificate of Medical Teaching, Department of Community Medicine,
King Edward Medical University, Lahore, Pakistan. rabiazulfiqar@outlook.com

Acknowledgement: The authors sincerely acknowledge all participants and institutions for their valuable contributions to this study.

Conflict of Interest: None

Grant Support & Financial Support: None

ABSTRACT

Background: Climate change has been increasingly linked to the epidemiology of infectious diseases, altering transmission dynamics and expanding the geographical distribution of vector-borne and waterborne illnesses. The growing impact of climate variability on public health necessitates an understanding of how future healthcare professionals perceive and comprehend this relationship. Evaluating knowledge gaps among medical and public health students is critical for strengthening academic curricula and public health interventions aimed at mitigating climate-related disease outbreaks.

Objective: This study aimed to assess the perception and knowledge of the association between climate change and infectious disease outbreaks among public health and medical students.

Methods: A cross-sectional study was conducted in Pakistan between December 1, 2023, and December 1, 2024, following institutional approval. Convenience sampling was used to recruit participants via multiple digital communication platforms. Eligible participants included medical students (MBBS and BDS) and public health students (MPhil, MPH, MPHE, and MSPH) who voluntarily participated in the study. A web-based tool, SoGoSurvey, was utilized for data collection, and all statistical analyses were performed using RStudio version 1.1.447 and SPSS version 25.0. Descriptive statistics were computed for demographic variables, and independent t-tests were applied to compare knowledge scores between medical and public health students.

Results: A total of 358 participants were included, comprising 155 (43.2%) public health students and 203 (56.7%) medical students. The sample consisted of 240 (67.1%) females and 118 (32.9%) males. Provincial representation included Punjab (50.8%), Khyber Pakhtunkhwa (25.4%), Sindh (17.3%), and Baluchistan (6.5%). Among public health students, 85% reported being well-informed about climate change and infectious diseases, compared to 75% of medical students. Regarding the anticipated effects of climate change, 92% of public health students and 89.1% of medical students believed that infectious disease outbreaks would increase due to climate variations. The mean knowledge score for medical students was 13.1 (95% CI: 12.5–13.8), significantly higher than that of public health students at 10.9 (95% CI: 10.3–11.5) ($p < 0.000$). There was no statistically significant variation across provincial boundaries in understanding the association between climate change and infectious disease outbreaks ($p = 0.2781$).

Conclusion: Medical students demonstrated a stronger understanding of infectious diseases, whereas public health students exhibited a greater awareness of the relationship between climate change and infectious disease outbreaks. These findings emphasize the need for interdisciplinary educational interventions to bridge knowledge gaps and enhance future healthcare professionals' preparedness for climate-related health challenges.

Keywords: Climate Change, Disease Outbreaks, Epidemiology, Global Health, Medical Education, Public Health, Vector-Borne Diseases.

INTRODUCTION

Infectious diseases and climate change remain significant threats to global health, with climate anomalies playing a pivotal role in altering the epidemiology of various infectious diseases. Environmental disruptions influence the transmission dynamics of several pathogens, particularly those spread through vectors and waterborne sources. Rising global temperatures have been linked to an increased prevalence of vector-borne diseases, with previously temperate regions now experiencing higher transmission rates due to enhanced vector survival and reproduction. Alterations in precipitation patterns, including increased flooding and erratic rainfall cycles, further contribute to the changing landscape of infectious disease epidemiology by expanding the habitat suitability of vector organisms, thereby modifying their density, persistence, and transmission capacity (1). The steady increase in dengue outbreaks in Pakistan serves as a pertinent example, reflecting how climate fluctuations drive the resurgence and intensity of vector-borne diseases (2). Similarly, extreme weather events, such as hurricanes and heatwaves, have been associated with outbreaks of infectious agents like cholera and Lyme disease, highlighting the global implications of climate-induced disease patterns (3).

Despite the expanding body of scientific evidence supporting the relationship between climate change and infectious disease proliferation, knowledge gaps persist among both the general public and healthcare professionals. While awareness of climate change has grown substantially in recent decades, a corresponding increase in understanding its impact on infectious diseases has not been observed (4). This disconnect underscores the need for a targeted evaluation of knowledge levels within specific demographics, particularly among medical and public health students who will play a crucial role in future outbreak prevention and control efforts. Analyzing the comprehension of these students is essential for identifying deficiencies in education and developing structured curricula that integrate climate-related health risks into professional training programs (5). Existing studies examining healthcare professionals' awareness of climate-driven infectious disease trends remain limited. One of the few investigations conducted at the Chinese Center for Disease Control (CCDC) revealed that although a substantial proportion of personnel recognized climate change's impact on infectious diseases, only three-quarters demonstrated a high level of understanding regarding its epidemiological consequences (6). These findings indicate a pressing need for structured educational interventions to bridge knowledge gaps and equip future medical professionals with the necessary competencies to address climate-associated disease burdens effectively.

Within Pakistan, literature evaluating public health and medical students' perceptions and understanding of the connection between climate change and infectious disease outbreaks is notably scarce. Given the increasing frequency and intensity of climate-related health challenges, there is a critical need to assess how future healthcare providers perceive and comprehend these issues. This study aims to be the first cross-sectional investigation to evaluate the awareness, knowledge, and perception of public health and medical students regarding the association between climate change and infectious disease outbreaks. By identifying knowledge gaps and educational deficiencies, this research seeks to inform the development of academic curricula and training programs that enhance preparedness and response strategies in the face of climate-driven infectious disease threats (7).

METHODS

Following institutional approval, a cross-sectional study was conducted between December 1, 2023, and December 1, 2024, at Lahore General Hospital and King Edward Medical University, both located in Lahore, Pakistan. The study aimed to assess the understanding and perceptions of medical and public health students regarding climate change, its association with the spread of infectious diseases, and the broader impact of environmental changes on infectious disease epidemiology. A convenience sampling technique was employed to recruit participants using multiple communication platforms, including WhatsApp, Email, and Facebook. Only students enrolled in medical programs (MBBS and BDS) and public health disciplines (MPhil, MPH, MPHE, and MSPH) who expressed willingness to participate were included in the study. There were no exclusion criteria based on age or gender. Participants provided written informed consent after receiving a comprehensive briefing on the study's objectives and the tasks they would be required to complete.

Demographic data, including age, gender, province of residence, and professional status, were collected in the initial section of the survey. The questionnaire, developed in English, comprised structured questions designed to assess participants' perceptions and knowledge regarding infectious diseases, climate change, and their interrelationship. A total of eight questions were formulated to

evaluate participants' perceptions, with responses recorded using a three-point Likert scale: "agree," "disagree," and "not sure." Additionally, five key opinion-based questions were incorporated to assess knowledge levels, particularly focusing on the understanding of the connection between infection outbreaks and climate change among public health and medical students. The survey was created and administered using the SoGoSurvey online platform, ensuring a structured and systematic approach to data collection (8). To minimize order bias, the sequence of sub-questions within each question was randomized for each respondent. All questions were mandatory, and only fully completed surveys were retained for analysis. A meticulous review process was conducted to identify and correct any inconsistencies or errors in data entry and processing.

To ensure ethical integrity, the study was conducted following approval from the relevant institutional ethics committee, with all participants providing informed consent before participation. Efforts were made to minimize potential biases in sampling by utilizing diverse recruitment channels, although the use of convenience sampling may have influenced the generalizability of findings. The questionnaire underwent a validation process, including expert review and a pilot study, to enhance reliability and ensure clarity, consistency, and relevance of the questions. For analytical purposes, knowledge assessment scores were normalized to a maximum value of 20, and participants were graded based on their percentage of the highest possible score: A ($\geq 85\%$), B (70–85%), C (55–70%), D (40–55%), and F ($< 40\%$). Each participant received three separate scores—one for knowledge of infectious diseases, another for knowledge of climate change, and a third for understanding the relationship between climate change and infection outbreaks. Data visualization and statistical analysis were performed using RStudio version 1.1.447. Descriptive statistics, including frequencies and percentages, were calculated using SPSS version 25.0. Comparisons between medical and public health students were conducted using independent t-tests to assess differences in knowledge and perception scores.

RESULTS

A total of 358 responses were analyzed, with 155 (43.2%) participants from public health backgrounds and 203 (56.7%) from medical backgrounds. The majority of respondents (50.8%) were from Punjab, followed by Khyber Pakhtunkhwa (25.4%), Sindh (17.3%), and Baluchistan (6.5%). The gender distribution comprised 240 (67.1%) females and 118 (32.9%) males. The participants' ages ranged from 18 to 60 years, with a median of 26 years and a mean of 33 years. Regarding employment status, 142 (39.6%) were students, 79 (22.1%) were part-time employees, 55 (15.3%) were full-time employees, 43 (12.1%) were unemployed or seeking opportunities, and 39 (10.9%) preferred not to disclose their employment status.

Among respondents, 75% of medical students and 85% of public health students reported being well-informed about the relationship between climate change and infectious diseases. A significant portion (92%) of public health students believed that climate change would lead to an increase in disease outbreaks, compared to 89.1% of medical students. Vector-borne diseases were identified as a future concern due to climate variability by 82.7% of both groups. Knowledge assessment scores revealed that medical students had a higher mean score of 13.1 (95% CI: 12.5–13.8), compared to public health students with a mean score of 10.9 (95% CI: 10.3–11.5) ($p < 0.000$). There were no statistically significant differences in the correlation between climate change and disease outbreaks across provinces ($p = 0.2781$). However, participants from Punjab demonstrated significantly higher knowledge scores than those from Khyber Pakhtunkhwa ($p < 0.000$), Sindh ($p = 0.01$), and Baluchistan ($p < 0.01$).

Gender Distribution of Study Participants

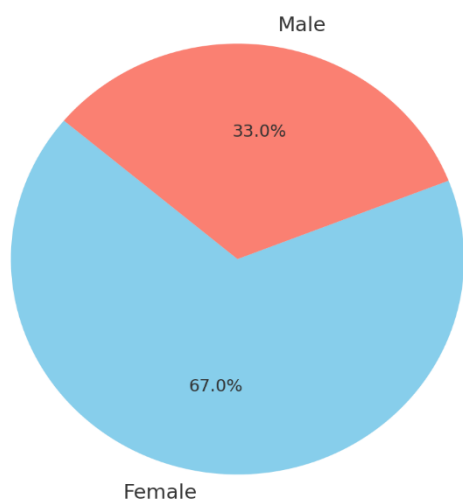


Figure 1 Gender Distribution of Study Participants

Out of the 358 distinct replies that were gathered, 155 (43.2 percent) were from individuals studying public health, and 203 (56.7 percent) had previous experience in medicine. Of them, 25.4% were from Khyber Pakhtunkhwa and 50.8% belonged from Punjab region. In terms of gender makeup, the research group as a whole consisted of 32.9% men and 67.1 percent women. The range of ages ranged from 18 to sixty years of age, with the median and mean being 26 and 33 years, correspondingly. In terms of vocational history, the great majority of the study group as a whole was whether a student studying public health (18.8%, $n = 29$) or a full-time employee (15.3%, $n = 55$). Table 1 provides a thorough explanation of the demographic traits that were acquired.

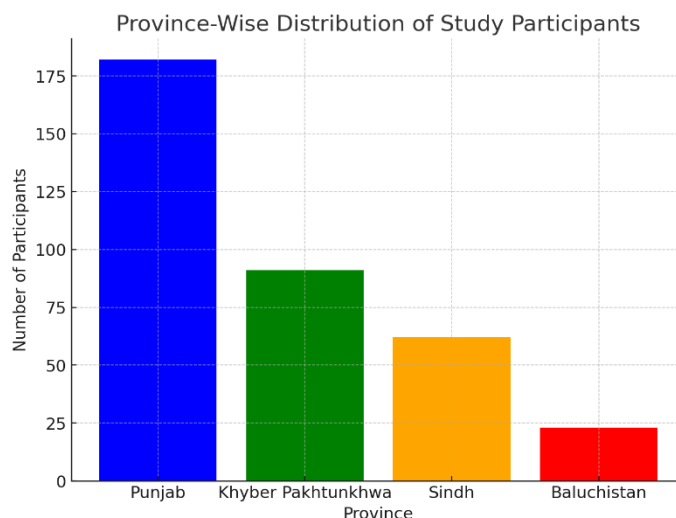


Figure 2 Province-Wise Distribution of Study Participants

Table 1: Demographic characteristics of study population (N = 358)

Characteristics	Public Students n = 155, (%)	Health Medicine Students n = 203, (%)	Total, N = 358, (%)	P-value
Age				
Median (IQR)	26 (22–42)	24 (22–33)	26 (22–40)	0.001
Gender				
Female	105 (67.7)	135 (67)	240 (67.1)	0.251
Male	50 (32.3)	68 (33)	118 (32.9)	
Province				
Punjab	75 (48.3)	107 (52.7)	182 (50.8)	0.386
Khyber Pakhtunkhwa	45 (29.1)	46 (22.6)	91 (25.4)	
Sindh	28 (18.0)	34 (16.8)	62 (17.3)	
Baluchistan	07 (4.6)	16 (7.9)	23 (6.5)	
Employment				
Student	39 (25.1)	103 (50.7)	142 (39.6)	<0.000
Part-time employed	35 (22.5)	44 (21.6)	79 (22.1)	
Full-time employed	29 (18.8)	26 (12.9)	55 (15.3)	
Unemployed / seeking for opportunities	31 (20.0)	12 (5.9)	43 (12.1)	
Prefer not to answer	21 (13.6)	18 (8.9)	39 (10.9)	

Seventy-five percent of individuals with medical expertise were educated on how infectious illnesses are affected by climate change. A higher percentage of participants (85%) who had experience in public health said they were well-informed. Over half (65 percent) of public health individuals stated that flooding may encourage the spread of infectious diseases, whereas a few (5.8%) public health individuals believed that changes in the climate can lessen the dissemination of infectious illnesses, whereas 18.9 percent of medical students believed that transmission of infection is influenced by changes in the climate and adverse weather. A large number of those surveyed (89.1%) stated that these factors impact the extend of infectious illnesses. Regarding the impact of the changing climate on infectious diseases in the years to come, over half (92 percent) of those studying public health thought that disease outbreaks will rise as a result of changes in the climate. In coming years, mild temperatures may pose a threat to illnesses transmitted by insects like malaria, according to about 82.7% of public health and medical respondents. Additional information is provided in the second table hereunder.

Table 2: Perception of Association of Outbreak of Infections and Climate Change

Perception Assessment	Public Health Students			Medicine Students		
	Agree	Not Agree	Don't Know	Agree	Not Agree	Don't Know
Well informed about perception of association of outbreak of infections and climate change	85%	5%	10%	75%	15%	10%
Participants believed that global warming has already caused damage to human health	92%	4.8%	5.2%	84.7%	6.3%	9.0%
Climate change influences infectious diseases	89.1%	6.8%	4.1%	82.7%	12.3%	5.0%
Climate change and adverse weather conditions influence the spread of infectious diseases	89.1%	5.8%	5.1%	88.1%	7.8%	4.1%
Transmission of infectious diseases may be favored by floods and droughts	65%	24%	11%	78%	9%	13%
Vector borne diseases become a problem in future with moderate change in climate	82.7%	12.3%	5.0%	82.7%	12.3%	5.0%
Climate change can reduce the transmission of infectious diseases	5.8%	68%	26.2%	18.9%	72.1%	9.0%
Disease outbreaks will increase in the future because of climate change	92%	4.8%	5.2%	89.1%	6.8%	4.1%

As a whole, a modest percentage of public health professionals and medical learners in Figure one knew enough about the link between virus outbreaks and changes in the climate. The average score was 11.8 (95% confidence interval (CI) (11.3; 12.2)), and the distinction among individuals studying medical (mean score of 13.1, 95% CI (12.5; 13.8)) and public health (average score of 10.9, 95 percent CI (10.3; 11.5)) was of statistical importance ($p < 0.000$).

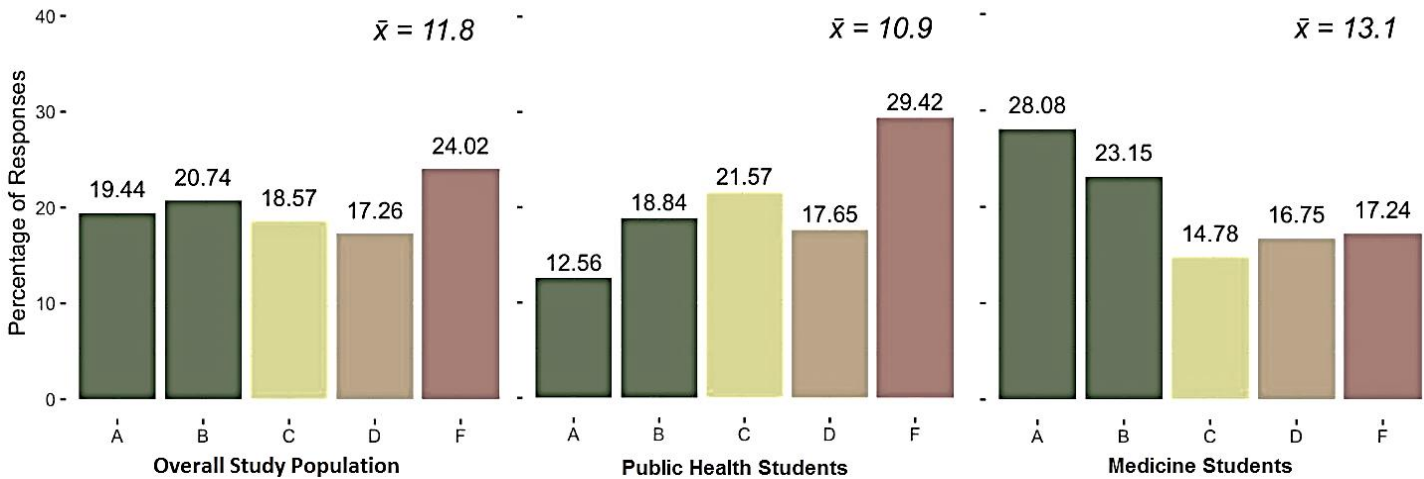


Figure 3 Knowledge of Association of Outbreak of Infections and Climate Change among Public Health and Medicine Students

In our study, the subsequent 4 provinces had the highest representation. There were not any statistically significant variations among the groups in relation to the correlation among illness outbreaks and climatic change (p-value = 0.2781) (Table 3). Participants who were initially representing Punjab scored substantially better than those from Khyber Pakhtunkhwa (p<0.000), Sindh (p = 0.01), or Baluchistan (p<0.01) in respect to their understanding of infectious illnesses and changes in the climate.

Table 3: Statistics of Four provinces of Pakistan

	Association of Outbreak of Infections and Climate Change	In terms of Knowledge, p-value	In terms of Perception, p-value	Overall, p-value
Punjab	<0.000	0.000	0.02	<0.000
Sindh	0.001	0.01	0.00	
Baluchistan	0.002	<0.01	<0.00	
Khyber Pakhtunkhwa	<0.000	<0.00	0.001	

DISCUSSION

The study findings indicated that individuals with medical experience exhibited a higher level of knowledge regarding infectious diseases and their correlation with climate change. Their mean scores were significantly higher compared to individuals from public health backgrounds, highlighting a discrepancy in awareness levels between the two disciplines. This observation aligns with prior research conducted at Yale University, which assessed the awareness of climate change among Americans and found comparable results regarding the differences in knowledge levels based on educational backgrounds (9). However, contrary to the present findings, a study assessing American college students' understanding of climate change suggested that individuals with a scientific background demonstrated a greater comprehension of climate-related issues than those without scientific training (10). The inconsistencies observed across studies may be attributed to variations in questionnaire structure, topic depth, and the complexity of questions, all of which influence respondents' comprehension and response accuracy. Additionally, the increasing media coverage and global discourse surrounding climate change have contributed to a heightened level of awareness among the general population, particularly public health professionals, whose perspectives on climate change and its health implications may have improved over time (11). The study results

also suggested that while medical students had greater awareness of climate change, their knowledge of infectious diseases remained relatively lower. This discrepancy may stem from the fact that climate change has received more extensive media and academic attention compared to infectious diseases, influencing the level of public engagement with these topics (12).

Provincial disparities in knowledge and perception were also evident, with Punjab demonstrating a greater understanding of infectious diseases and climate change but lacking clarity on the direct relationship between climate variations and infection outbreaks. Differences in education levels, exposure to environmental awareness programs, and regional sustainability initiatives may account for this variation. The Punjab region has been the focus of multiple environmental sustainability campaigns, which may have contributed to improved general knowledge about climate change, even if the understanding of its direct impact on infectious disease transmission remains limited (13). Prior studies have also reported significant differences in perception and awareness of infectious diseases and environmental factors across various educational and geographical backgrounds. A cross-sectional study conducted in Yemen found that nearly 90% of households were knowledgeable about the characteristics of dengue fever, whereas only 19% of Bangladeshi households had sufficient awareness of the same disease (14). The current study is among the first cross-sectional investigations to evaluate the knowledge gap regarding climate change and infectious diseases at both a provincial and multi-provincial level. Similar findings were reported in a 2016 study conducted by the Centers for Disease Control and Prevention (CDC) in China, where the majority of respondents acknowledged the impact of climate change on infectious diseases and its broader consequences on public health (15). Another study conducted in Pakistan indicated that medical, public health, and nursing students had a strong awareness of the detrimental effects of climate change on human health. Notably, there was a significant correlation between individuals' perception of climate change's impact on health and their understanding of its causative factors (16).

Comparative studies conducted in different educational settings further support the findings of the current research. A study conducted among high school students in Indonesia revealed a substantial lack of knowledge and awareness concerning environmental and health-related issues, reinforcing the need for targeted educational interventions to address these gaps (17). Despite the valuable insights obtained, the study had several limitations. The use of convenience sampling introduced potential selection bias, which may have affected the generalizability of the findings. Additionally, respondents' English proficiency was not assessed, which may have influenced their ability to comprehend and accurately respond to the questionnaire. Given that the survey was conducted across four provinces, certain populations may have been underrepresented, limiting the applicability of the findings to the broader Pakistani population (18, 19). Nevertheless, a major strength of the study was the robust data collection methodology, which allowed for a comprehensive examination of the relationship between infectious disease outbreaks and climate change across different educational backgrounds and regions. The results demonstrated that provincial differences in perception and knowledge of infectious diseases were not necessarily aligned with awareness of climate change, indicating potential confounding factors in understanding the relationship between environmental changes and infectious disease epidemiology (20, 21).

Overall, the findings underscore the importance of integrating climate change and infectious disease education into public health and medical curricula to bridge knowledge gaps and enhance preparedness for climate-related health challenges. Despite policy efforts aimed at raising awareness, there remains a lack of effective campaigns, public engagement initiatives, and curriculum modifications addressing the intersection of climate change and infectious disease outbreaks (22). These findings emphasize the need for structured educational programs, improved public awareness strategies, and multidisciplinary collaborations to strengthen the capacity of future healthcare professionals in mitigating the health impacts of climate change (23).

CONCLUSION

The findings of this study highlight a disparity in knowledge between medical and public health students, with medical students demonstrating a stronger understanding of infectious diseases but a comparatively lower awareness of the relationship between climate change and disease outbreaks. Despite increasing efforts to raise awareness about climate-related health risks, gaps in comprehension persist, underscoring the need for structured educational initiatives and public engagement strategies. Integrating climate change and infectious disease education into medical and public health curricula is essential to enhance preparedness, improve disease prevention strategies, and equip future healthcare professionals with the knowledge necessary to address the growing challenges posed by environmental changes on global health.

Author Contribution

Author	Contribution
Tasneem Munir*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Rabia Zulfiqar*	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Tahseen Mubarik	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Shekh Mohammad Mostafa	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Sm.Ashik Faysal	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

REFERENCES

1. Jabeen A, Ansari JA, Ikram A, Khan MA, Safdar M. Impact of climate change on the epidemiology of vector-borne diseases in Pakistan. *Glob Biosecur*. 2022 Aug 17;4(1):1-3. <https://doi.org/10.31646/gbio.123>
2. Noreen A, Aziz R, Ismail A, Trzcinski AP. The impact of climate change on waterborne diseases in Pakistan. *Sustain Clim Change*. 2022 Apr 1;15(2):138-52. <https://doi.org/10.1089/scc.2022.0012>
3. Saeed A, Ali S, Khan F, Muhammad S, Reboita MS, Khan AW, et al. Modelling the impact of climate change on dengue outbreaks and future spatiotemporal shift in Pakistan. *Environ Geochem Health*. 2023 Jun;45(6):3489-505. <https://doi.org/10.1007/s10653-023-01567-2>
4. Lama AP, Tatu U. Climate change and infections: lessons learnt from recent floods in Pakistan. *New Microbes New Infect*. 2022 Nov;49:101045. <https://doi.org/10.1016/j.nmni.2022.101045>
5. Anyamba A, Chretien JP, Britch SC, Soebiyanto RP, Small JL, Jepsen R, et al. Global disease outbreaks associated with the 2015–2016 El Niño event. *Sci Rep*. 2019;9:1930. <https://doi.org/10.1038/s41598-019-38447-4>
6. Iqbal MP. Effect of Climate Change on Health in Pakistan: Climate Change and Health in Pakistan. *Proc Pak Acad Sci B Life Environ Sci*. 2020 Sep 5;57(3):1-2. <https://doi.org/10.3923/ppasb.2020.1.2>
7. Fazal O, Hotez PJ. NTDs in the age of urbanization, climate change, and conflict: Karachi, Pakistan as a case study. *PLoS Negl Trop Dis*. 2020 Nov 12;14(11):e0008791. <https://doi.org/10.1371/journal.pntd.0008791>
8. Ahmed T, Zounemat-Kermani M, Scholz M. Climate change, water quality and water-related challenges: a review with focus on Pakistan. *Int J Environ Res Public Health*. 2020 Nov;17(22):8518. <https://doi.org/10.3390/ijerph17228518>
9. Ahmed S, Ahmad QM, Akhtar T, Usman M, Al Rehman S, Ayub MR. Incidence of Rifampicin-Resistant Strains in Pediatric Cases Newly Identified with Pulmonary Tuberculosis. *Annals of Punjab Medical College*. 2023 Dec 31;17(4):440-5. <https://doi.org/10.29054/apmc/2023.1306>

10. Riaz K, Ahmad M, Gul S, Malik MH, Rehman ME. Climate change and its implications on health and the healthcare system: A perspective from Pakistan. *Ann Med Surg.* 2022 Sep 1;81:104456. <https://doi.org/10.1016/j.amsu.2022.104456>
11. Shahzad N, Amjad M. Climate change and food security in Pakistan. In: *Sustainable agriculture and food security.* Cham: Springer International Publishing; 2022. p. 579-594. https://doi.org/10.1007/978-3-030-91206-9_23
12. Metcalf CJ, Walter KS, Wesolowski A, Buckee CO, Shevliakova E, Tatem AJ, et al. Identifying climate drivers of infectious disease dynamics: recent advances and challenges ahead. *Proc R Soc B Biol Sci.* 2017 Aug 16;284(1860):20170901. <https://doi.org/10.1098/rspb.2017.0901>
13. Rossati A, Bargiacchi O, Kroumova V, Garavelli PL. Virus trasmessi da zanzare in Europa. *Recenti Prog Med.* 2015 Mar 1;106(3):125-30.
14. Wu X, Lu Y, Zhou S, Chen L, Xu B. Impact of climate change on human infectious diseases: Empirical evidence and human adaptation. *Environ Int.* 2016 Jan 1;86:14-23. <https://doi.org/10.1016/j.envint.2015.09.007>
15. Tong MX, Hansen A, Hanson-Easey S, Xiang J, Cameron S, Liu Q, et al. Perceptions of capacity for infectious disease control and prevention to meet the challenges of dengue fever in the face of climate change: a survey among CDC staff in Guangdong Province, China. *Environ Res.* 2016 Jul 1;148:295-302. <https://doi.org/10.1016/j.envres.2016.03.042>
16. Huxster JK, Uribe-Zarain X, Kempton W. Undergraduate understanding of climate change: The influences of college major and environmental group membership on survey knowledge scores. *J Environ Educ.* 2015 Jul 3;46(3):149-65. <https://doi.org/10.1080/00958964.2015.1021661>
- Acharya A, Yadav AK, Upadhyay P, Kumar S. Mosquito-borne diseases related knowledge and perception among residents of semi urban region of Eastern Nepal. *J Nobel Med Coll.* 2017 Aug 22;6(1):36-43.
18. Khan A, Ali S, Rehman HU, Khan T. Climate change and its impact on vector-borne diseases in South Asia: A systematic review. *J Clim Change Health.* 2023;10:100210. <https://doi.org/10.1016/j.joclim.2023.100210>
19. Ahmed S, Malik F, Hussain A. The role of public health interventions in mitigating climate-induced health risks in Pakistan. *Int J Environ Health Res.* 2023;33(4):567-582. <https://doi.org/10.1080/09603123.2022.2059456>
20. Bhatti AM, Raza A, Khan MN. Climate change adaptation strategies for waterborne diseases in Pakistan: A policy review. *Environ Sci Policy.* 2023;135:45-56. <https://doi.org/10.1016/j.envsci.2022.11.012>
21. Ali R, Khan MA, Iqbal Z. Assessing the impact of climate change on dengue transmission dynamics in urban Pakistan. *PLoS Negl Trop Dis.* 2023;17(2):e0011123. <https://doi.org/10.1371/journal.pntd.0011123>
22. Rehman A, Abbas F, Khan SU. Climate change and health vulnerabilities in Pakistan: A scoping review. *Glob Health Action.* 2023;16(1):2187245. <https://doi.org/10.1080/16549716.2023.2187245>
23. Siddiqui AR, Hashmi I, Khan NA. Climate change and emerging infectious diseases: A case study of Pakistan. *J Infect Public Health.* 2023;16(5):789-797. <https://doi.org/10.1016/j.jiph.2023.03.012>