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Mortality Associated with Priority Diseases in Flood-Affected Areas Using District Health Information System (DHIS2) During September–December 2022: Pakistan Experience

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Abstract

Objectives: To quantify the burden of communicable diseases and characterize the most reported infections during public health emergency of floods in Pakistan.

Methods: The study's design is a descriptive trend analysis. The study utilized the disease data reported to District Health Information System (DHIS2) for the 12 most frequently reported priority diseases under the Integrated Disease Surveillance and Response (IDSR) system in Pakistan.

Results: In total, there were 1,532,963 suspected cases during August to December 2022 in flood-affected districts (n = 75) across Pakistan; Sindh Province reported the highest number of cases (n = 692,673) from 23 districts, followed by Khyber Pakhtunkhwa (KP) (n = 568,682) from 17 districts, Balochistan (n = 167,215) from 32 districts, and Punjab (n = 104,393) from 3 districts. High positivity was reported for malaria (79,622/201,901; 39.4%), followed by acute diarrhea (non-cholera) (23/62; 37.1%), hepatitis A and E (47/252; 18.7%), and dengue (603/3245; 18.6%). The crude mortality rate was 11.9 per 10 000 population (1824/1,532,963 [deaths/cases]).

Conclusion: The study identified acute respiratory infection, acute diarrhea, malaria, and skin diseases as the most prevalent diseases. This suggests that preparedness efforts and interventions targeting these diseases should be prioritized in future flood response plans. The study highlights the importance of strengthening the IDSR as a Disease Early Warning System through the implementation of the DHIS2.

Flooding can be devastating at the microeconomic and macroeconomic levels and a serious public health problem. Food insecurity, shelter, and health provision are among the urgent needs of affected people.[1] Flooding is the leading cause of death from natural disaster worldwide, causing around US $700 billion of damage and an average of 6000 deaths worldwide annually.[1,2] Half of flood-related fatalities occur in Asia, which has been the most flood-affected region in the last 25 floods.[2,3] The impact of flooding in Asia is likely to rise further, due to rapid urbanization and changes in land use, a lack of preparedness efforts and government regulation, and a high concentration of marginalized or poor populations.[4] The geography of South Asia and its hydro-meteorological factors make it the most flood-prone place in the world.[5] Pakistan is ranked as the fifth most vulnerable country to long-term climate change and contributes one-fifth of global flood-related deaths.[6,7] High intensity rainfall of short duration, inadequate drainage capacity of rivers, unplanned reservoir regulations, and failure of flood control structures are the main reasons for flooding in Pakistan.

The great flood of 2010 killed over 1700 people and adversely affected 14 to 20 million people. It damaged or destroyed nearly 1.1 million homes and 436 health care facilities.[8] Furthermore, the flooding caused US $9.7 billion in damage in more than 46 districts, lasting nearly 6 months.[9] The unprecedented impact on the rural economy, affecting livestock, agriculture crops, animal sheds, fertilizers, personal seed stock, machinery, forestry, and fishery, caused a loss of 80% of

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Table 1. Distribution of disease notifications from September to December 2022, provinces of Pakistan

Diseases	KP	South Punjab	Sindh	Balochistan	Total
ARI	236 523	24	171 391	40 338	448 276
Acute diarrhea	153 784	71 248	94 920	20 833	340 785
Malaria	59 218	2586	94 298	32 405	188 507
Skin diseases	49 967	23 756	51 661	6775	132 159
Eye diseases	22 121	4077	21 847	3058	51 103
Injuries	20 685	1174	0	0	21 859
Typhoid	7192	79	6380	2820	16 471
AWD	9031	78	2054	3120	14 283
Dengue	5383	69	3025	429	8906
Acute jaundice	2871	0	491	46	3408
Snake bite	0	3	481	75	559
Others	1907	1299	246 125	57 316	306 647
Total	**568 682**	**104 393**	**692 673**	**167 215**	**1 532 963**

food reserves.[10] In subsequent flooding, around 360 people died in September 2021, and, in September 2012, 100 people died and thousands of homes were destroyed. The 2013 flood caused a loss of 80 lives. Further flooding occurred in Pakistan in 2014 and 2021. The flood of 2022 severely affected most areas of Pakistan.[11,12] Torrential rainfall caused massive flooding across Pakistan, affecting more than 33 million people, displacing 5.4 million from their homes[13] and causing an estimated 1554 deaths nationwide; 647 children lost their lives while 4006 children were reported to be injured.[13]

Waterborne infections, such as cholera, have been the most frequently reported health issues in areas devastated by the 2022 flood. Flood-related breakdown of water disposal and water filtration systems is a major cause of diarrheal disease. Crowding and increased fecal-oral transmission of gastrointestinal pathogens also increase the risk of outbreaks in displaced persons camps. Other infections of public health concern may occur. Direct contact with contaminated water can cause skin and eye infections.

The objective of this study is to assess the burden of communicable diseases associated with the 2022 flooding, through epidemiological analysis of the most frequently reported diseases.

Methods

The 2022 flooding had a major impact on all 4 provinces of Pakistan, as well as some parts of Azad Jammu and Kashmir (AJK) and Gilgit-Baltistan, affecting a total of 75 districts between September and December 2022.

This study is based on a descriptive trend analysis of data captured by Pakistan's Integrated Disease Surveillance and Response (IDSR) system, based on the District Health Information System version 2 (DHIS 2) platform, hosted and maintained by the Pakistan National Institute of Health (https://DHIS2.org/). DHIS 2 is an open-source web-based platform for the collection, management, visualization, and analysis of data, which is developed by the University of Oslo with donor funding. It was used to capture numbers of disease notifications of the 12 most prevalent diseases in the 2022 flooding (https://dhis2.org/pakistan-flood-response/), positive tests for dengue, malaria, hepatitis A and E and cholera deaths, and patients admitted to hospitals; NIH in collaboration with UKHSA also conducted trainings in Islamabad Capital Territory, Balochistan, and Sindh. Deaths associated with flooding reported to the National Flood Response Coordination and Control (NFRCC) were also incorporated into DHIS 2. IDSR data in DHIS 2 also flowed to the Emergency Disease Surveillance System (EDSS), an additional surveillance system introduced in a collaboration between the National Institute of Health (NIH) and the World Health Organization.

Time trends and geographical distribution of suspected diseases from all 4 provinces are presented. Additional data captured on age, gender, and cause of death in Sindh and Balochistan allowed the calculation of group-specific mortality rates; the case fatality rate (CFR) represents the proportion of cases that eventually die from a disease. To assess the CFR, we divided the number of known deaths by the number of confirmed cases. Data analysis was done using IBM SPSS version 26 (IBM Corp, Armonk, NY), R Studio, and Microsoft Excel.

The study was approved by the ethical review committee of the National Institute of Health, Islamabad, Pakistan.

Results

Distribution of Suspected Cases Reported

During September 1 to March 31, 2022, 75 districts (with a population of 32.9 million) across 4 provinces of Pakistan reported 1 532 963 notifications of suspected infectious disease to the IDSR system. Sindh Province reported the greatest number of notifications (n = 692 673) from 23 districts, followed by Khyber Pakhtunkhwa (KP) (n = 568 682) from 17 districts, Balochistan (n = 167 215) from 32 districts, and Punjab (n = 104 393) from 3 districts.

The most frequently notified conditions from flood-affected areas were acute respiratory infection (ARI), acute non-cholera diarrhea (AD), malaria, skin diseases, eye infections, injuries, typhoid, acute watery diarrhea/suspected cholera (AWD), dengue, acute jaundice followed by snake bites. KP reported the greatest number of ARI and AD cases, and Sindh reported the greatest number of malaria and skin disease cases (Table 1).

Suspected cases of ARI, AWD, AD, skin disease, eye disease, and malaria in flood-affected areas were reported between September 1 and December 31, 2022. The greatest number of cases (n = 16 984) was reported for AD on September 8, 2022. The number of daily reported cases for skin disease was greatest (n = 19 748) on September 9, 2022. Reported ARI cases were greatest (n = 4547) on October 10, 2022. Daily reported cases for AWD

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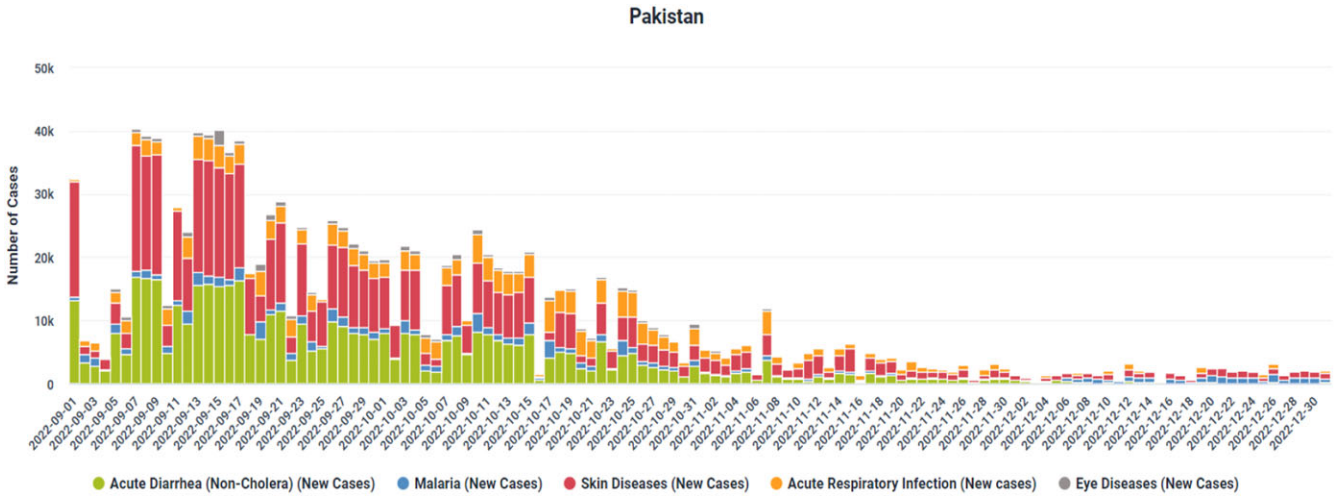

Figure 1. Daily reported numbers of disease notifications from flood-affected areas from September–December 2022.

were greatest (n = 2825) on November 5, 2022. A single spike (n = 2301) for eye disease was reported on September 15, 2022. The greatest number of reported malaria cases (n = 2920) was high on October 10, 2022. Conclusively, there were 2 spikes in the combined trend of all diseases: first spike at AD (n = 12 500) on September 8, 2022, and the second spike at skin disease on September 9, 2022 (Figure 1).

Cases of acute respiratory infection increased gradually between September 1 and October 15, with the greatest number of cases (n = 4974) reported on October 22. The trend of reported cases declined after October 28 with a possible second peak on November 18 (n = 3975). Acute diarrhea cases were at the highest level in September 2022 and gradually decreased during October to November (Figure 2).

Distribution of Positive Cases Reported

Sindh and Balochistan tested samples for dengue (n = 3246), malaria (n = 201 901), hepatitis A and E (n = 252), and cholera (n = 62). In total, 62 tests were performed for cholera, in which 23 samples were positive. Among 3245 tests conducted for dengue fever, 18.6% tested positive (n = 603). Among 252 tests conducted for hepatitis A and E, 18.7% were positive (n = 47). Furthermore, among 201 901 tests conducted for malaria, 39.4% were positive. High positivity rate was reported for malaria (0.394), followed by cholera (0.371), hepatitis A and E (0.187), and dengue (0.186).

Distribution of Deaths Reported

Overall, 1824 deaths were reported between October 3, 2022, and January 1, 2023, with the greatest number of deaths reported in the first week of October. The greatest number of deaths was reported from Sindh (n = 1141).

The leading cause of deaths was poor maternal health and its outcomes, which led to the greatest mortality number (n = 591) followed by malaria (n = 336), AD (n = 109), ARI (n = 105), typhoid fever (n = 45), dengue fever (n = 42), AWD (n = 41), eye diseases (n = 40), acute viral hepatitis (A and E) (n = 38), snake bite (n = 25), and skin diseases (n = 14), with 438 deaths from other causes. Deaths from malaria were consistently high throughout October and November then rose sharply to peak in the first week of December (n = 135), with most deaths that week reported from Balochistan. Deaths from AD and ARI were both highest in October then declined rapidly. Reported deaths from ARI peaked (n = 55) in the first week of October and deaths from AD peaked in mid to late October (Figure 3).

More deaths were reported in women than men. Among women, 59% (591/1010) of reported deaths were related to maternal health, with the second highest number of deaths in cases with malaria. For men, the highest reported deaths were in cases with malaria: 67% (174/259).

Discussion

This is the first study in Pakistan to describe trends in diseases related to the 2022 flooding, such as cholera, malaria, acute respiratory disease, skin disease, and diarrhea, based on national surveillance system data; 1 532 963 disease notifications related to the 2022 flooding in Pakistan were reported in our study. Our data suggest that Sindh Province reported the greatest number of disease notifications among all provinces in Pakistan. There is a high probability of stagnant water in Sindh Province, in the Indus River plain, when waterways such as streams and river are damaged; in 2022, most flat areas of Sindh were submerged in water. Damage to the Sindh sewage and irrigation system increased the risk of diarrheal diseases; stagnant water on a massive scale caused a surge in insect populations resulting in increased vector-borne diseases.[11] Sindh reported more malaria notifications than any other province in this study, and study findings also indicated the same results. Sindh lost most of its infrastructure and had the greatest number of displaced persons. The dire situation in refugee camps further complicates the public health situation in Sindh, which reported a greater number of flood-related diseases than any other province.

KP was the second province that reported the highest number of notifications (n = 568 682), which contribute to 37.1% of total disease notifications during the study. The cooler and more humid climate of KP Province makes it a unique region within Pakistan. Unlike other provinces in Pakistan, KP reported the greatest number of disease notifications of AD and ARI. Geographically, a greater part of KP Province is mountainous, whereas the districts with the worst impact were in the plain. Underground water sources, springs, and rivers, the main sources of drinking water in

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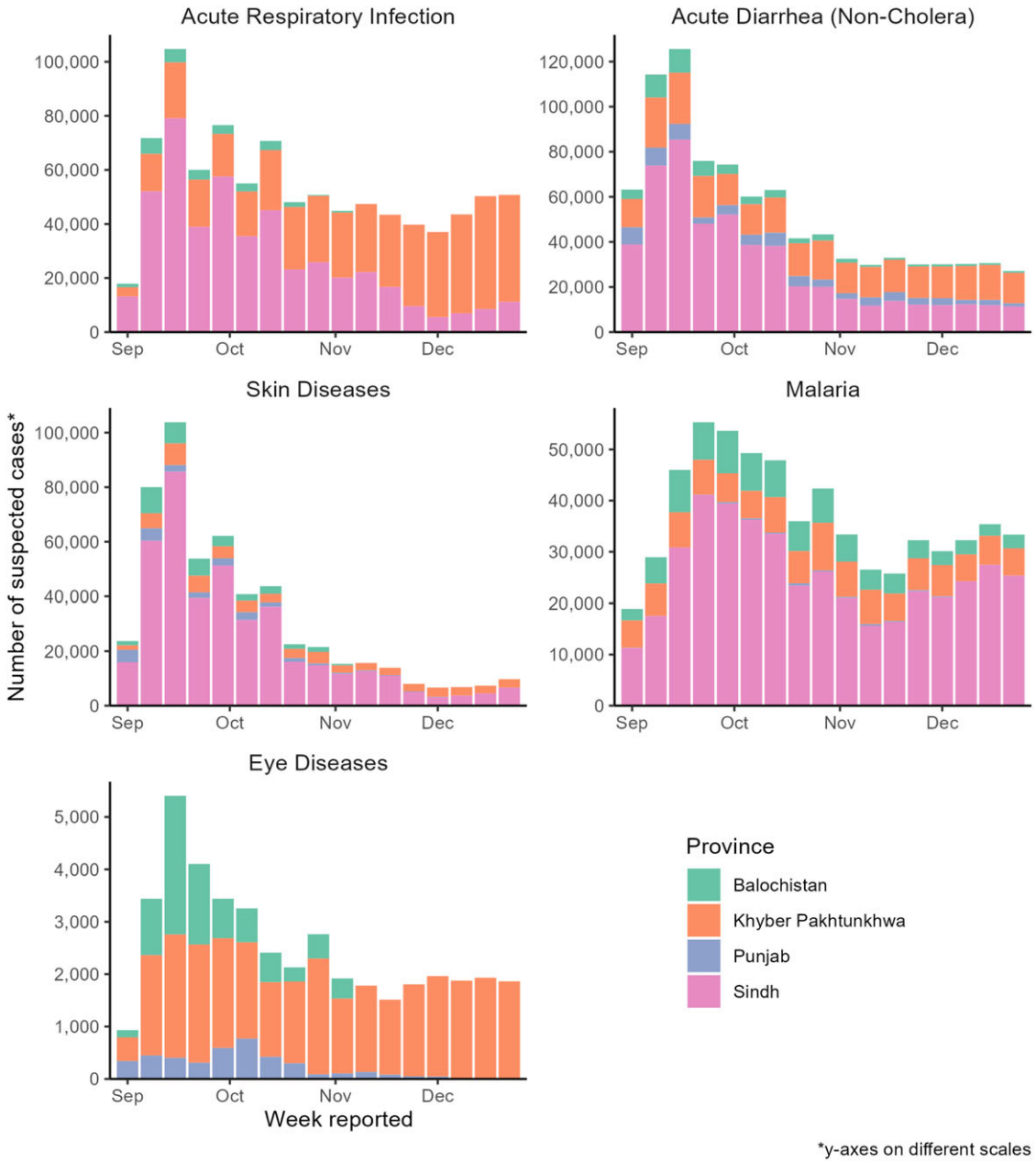

Figure 2. Weekly number of suspected cases of the 5 most highly reported conditions from flood-affected areas from September–December 2022, by province.

KP, were contaminated in the 2022 flooding, causing a surge of acute diarrhea.[12] The government declared a diarrhea outbreak in KP due to the high number of notifications during this study.[13] The lack of infrastructure and destruction of health care system further complicated the diarrhea outbreak in KP. The cooler climate and overcrowding in affected districts of KP increased the risk of ARI, with KP reporting a greater number of ARI notifications (n = 236 523) than any other province in Pakistan. Of the total flood-affected population in Pakistan, 13.2% lived in KP.

Of the total flood-affected population in Pakistan (the largest flood-affected population after Sindh), 27.9% were in Balochistan. Balochistan reported the third greatest number of disease notifications (n = 167 215): 10.9% of total disease notifications in our study. The most prevalent diseases in Balochistan were ARI, AD, and malaria. The 2022 flood had a major impact on the already weak health care system of Balochistan, resulting in a more complicated public health situation than in any other region in Pakistan. Of the total flood-affected population, 14.7% were in South Punjab, which reported 6.8% of all disease notifications in Pakistan. In our study, AD and skin diseases were most prevalent in South Punjab. South Punjab is a plain region that uses a canal system for irrigation of crops. The flooding severely damaged several canal systems, including a sewage system, which caused a spike of AD during this study. Our study has shown that the 2022 flooding significantly increased the risk of diarrheal diseases in all provinces, with notifications highest in KP Province, followed by Sindh, South Punjab, and Balochistan. The lack of clean drinking water and poor sanitation were the main contributors that increased health risk.[14] Other studies in India and Bangladesh have reported a high prevalence of acute diarrhea in flood-affected regions.[15,16]

Acute respiratory infection was most reported in KP, followed by Sindh and Balochistan; no data were available for South Punjab.

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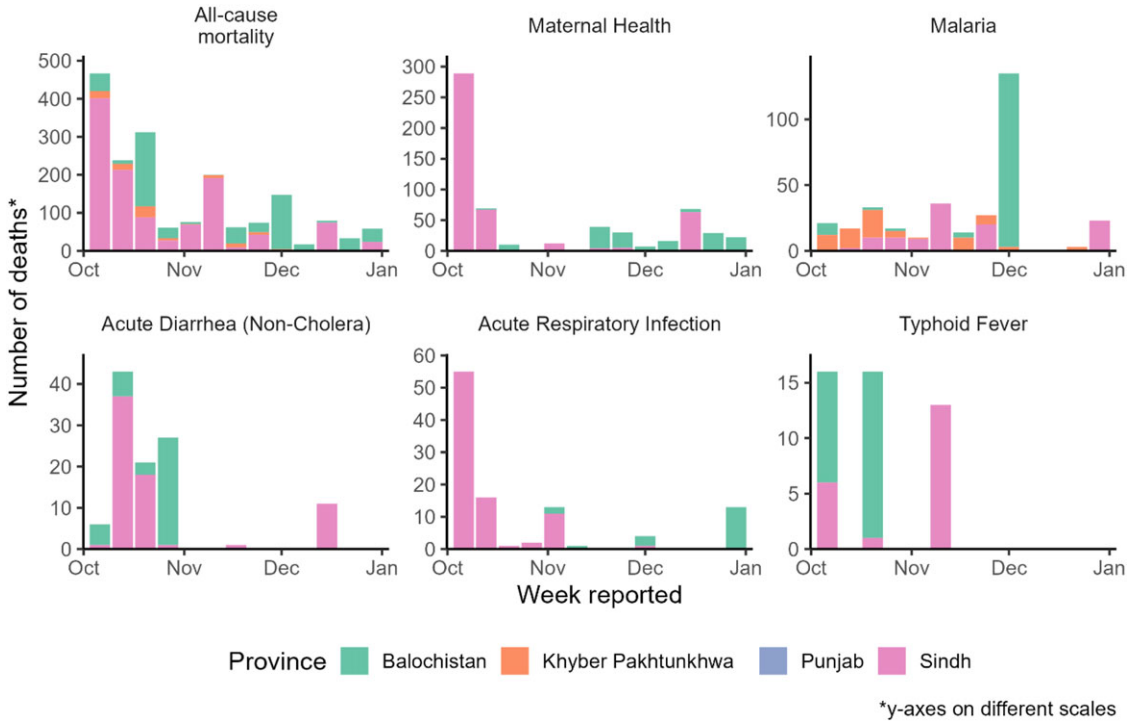

Figure 3. Weekly number of reported deaths from all causes and from the 5 most highly reported suspected causes of death in flood-affected areas by province, October–December 2022.

ARI are more commonly found in flood-affected areas due to the overcrowded conditions present in refugee camps and first aid centers, which provide a suitable environment for the disease to spread. Individuals who are infected with ARI are in close proximity to uninfected individuals, leading to direct contact and the spread of the disease. Previous studies have shown that there is a strong association between ARI and overcrowding in flood-affected areas.[17,18] Our study has revealed that acute diarrhea exhibits similar trends, with the highest number of disease notifications being reported in the Sindh Province of Pakistan. This province was particularly impacted, more so than any other province in the country.[19] However, ARI-reported cases remain consistent throughout the flood timeline, unlike other diseases. This study indicates that, during the flood in Pakistan, most suspected cases were related to skin diseases. However, when examining provincial variation, the highest number of skin-related infections was reported in Sindh Province, followed by KP, South Punjab, and Balochistan. Initially, there was a significant surge in the number of skin disease cases reported, but this trend gradually decreased over time. The primary causes of skin disease in flood-affected areas are likely to be humidity and prolonged contact with contaminated water.[20] During the fall season of 2022, a change in weather led to a decrease in humidity and less contact with contaminated water, which resulted in a gradual decline in skin disease cases. Our data indicate that there was a significant surge in malaria cases following the 2022 flood in Pakistan. Malaria was found to be most prevalent in Sindh Province, followed by KP, Balochistan, and South Punjab. The abundance of stagnant water and a favorable climate for mosquitoes made Sindh Province particularly susceptible to a potential malaria epidemic. KP also had a favorable environment for mosquito-borne malaria.[21] Stagnant water covering large areas of the Sindh and KP plains increased the mosquito population, which contributed to the surge in malaria cases and raised serious concerns for public health departments.[22] Similar studies have previously indicated an association between flooding and a surge in malarial cases.[23–26]

We encountered data constraints due to widespread infrastructure damage. In several locations, the health care system experienced a collapse, further exacerbating our limitations in obtaining comprehensive data. During the initial days, data were being received in Excel files. However, within a short span, we transitioned to utilizing DHIS2 and conducted comprehensive training sessions for staff nationwide. This facilitated the uniform uploading of data onto a centralized dashboard for streamlined management.

Throughout the flood period, we received daily updates of invaluable data. This information played a crucial role in strategically planning and prioritizing disease management efforts for flood-affected individuals, ensuring timely provisions of essential supplies such as medicines, malaria kits, testing kits, and so forth.

A well-coordinated disaster preparedness and response system is crucial for minimizing the impact of disasters and ensuring an effective and timely response. Such a system should be organized at various levels, involving local, regional, and national authorities. Defining specific roles and responsibilities is important for each stakeholder at various levels, including government agencies, non-governmental organizations (NGOs), community groups, and private sector with broader health initiatives, such as maternal and child health programs, to maximize impact and resources. Implementation of IDSR and maintenance of robust early warning systems to provide communities with timely alerts regarding impending flood events are essential. Furthermore, developing

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countries require technology systems, especially in remote areas, for communication and warnings. Global grants from the UN and aid organizations can be utilized to increase the availability of medical staff specifically dedicated to addressing maternal health issues for women in camps.

Conclusion

Our study aimed to characterize the impact of the 2022 flood in Pakistan by providing a descriptive analysis of the flood-borne diseases prevalent in the affected regions. Our data suggest that diseases such as ARI, acute diarrhea, skin diseases, and malaria are the most prevalent across 4 provinces, which are consistent with studies conducted in other Asian regions that share similar geological characteristics.

Limited information exists regarding the risk factors for flood-related deaths. However, our study indicates that women appear to be more at risk than men. Additionally, our research shows that the majority of deaths caused by drowning in homes are reported among the older adult population, which is consistent with findings from other studies.

While controlled studies have indicated an increased risk of death during the period of flooding, our findings also suggest a delayed increase in deaths, which has also been observed in other studies.

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Competing interests. None.

References

1. **The International Disaster Database**. Centre for Research on the Epidemiology of Disasters; 2019.
2. **Jonkman SN, Kelman I.** An analysis of the causes and circumstances of flood disaster deaths. *Disasters.* 2005;29(1):75-97.
3. **Jonkman SN.** Global perspectives on loss of human life caused by floods. *Nat Hazards.* 2005;34(2):151-175.
4. **Berz G**, ed. Flood disasters: lessons from the past—worries for the future. Proceedings of the Institution of Civil Engineers–Water and Maritime Engineering. Thomas Telford Ltd.; 2000.
5. **Shah SMH, Mustaffa Z, Teo FY, *et al.*** A review of the flood hazard and risk management in the South Asian Region, particularly Pakistan. *Sci Afr.* 2020;10:e00651.
6. **The ND-GAIN Country Index**. Prevention Web. 2015. Accessed April 30, 2024. https://www.preventionweb.net/publication/nd-gain-index
7. **Eckstein D,, Künzel V, Schäfer L**. The global climate risk index 2021. Bonn: Germanwatch. 2021.
8. **Kirsch TD, Wadhwani C, Sauer L, *et al.*** Impact of the 2010 Pakistan floods on rural and urban populations at six months. *PLoS Curr.* 2012;4: e4fdfb212d2432.
9. **Fao**. Realizing the right to adequate food to end hunger and malnutrition in all its forms, Knowledge Repository. 1970. Accessed April 30, 2024. https://openknowledge.fao.org/items/8a31c581-1dc9-4bbf-9631-c153f081f41f
10. **Polastro RNA, Steen N, Zafar F.** Inter-agency real time evaluation of the humanitarian response to Pakistan's 2010 flood crisis. 2010. Accessed April 30, 2024. https://phkh.nhsrc.pk/sites/default/files/2019-07/Inter Agency RTE of Humanitarian Response to 2010 Flood Crisis 2011.pdf
11. **Warraich H, Zaidi AK, Patel K.** Floods in Pakistan: a public health crisis. *Bull World Health Organ.* 2011;89:236-237.
12. Peoples Dispatch. Major cholera outbreak in Pakistan's Balochistan claims several lives, Peoples Dispatch. 2022. Accessed 30 April 2024. https://peoplesdispatch.org/2022/07/20/major-cholera-outbreak-in-pakistans-balochistan-claims-several-lives/
13. **UNICEF Pakistan Humanitarian Situation Report no. 9**. End of year 2022 - Pakistan (2023) ReliefWeb. Accessed 30 April 2024. Available at: UNICEF Pakistan Humanitarian Situation Report No. 9_ End of Year 2022 - Pakistan_ReliefWeb.
14. **Shrestha B, Theerathavaj MS, Thaweboon S, Thaweboon B.** In vitro antimicrobial effects of grape seed extract on peri-implantitis microflora in craniofacial implants. *Asian Pac J Trop Biomed.* 2012;2(10):822-825.
15. **Kawoosa VM, Bhargava A, Katakam A, Sharma M.** Floods in Pakistan. Reuters [Website]. Published September 1, 2022. Accessed May 1, 2024. https://www.reuters.com/graphics/PAKISTAN-WEATHER/FLOODS/akpezbzxgvr/
16. **"Emergency Disease Surveillance System (EDSS)"** Training Conducted at District DG Khan, Punjab. LinkedIn. Published 2022. Accessed 30 April 2024. https://phb.nih.org.pk/
17. **Qamar K, Nchasi G, Mirha HT, *et al.*** Water sanitation problem in Pakistan: a review on disease prevalence, strategies for treatment and prevention. *Ann Med Surg.* 2022:104709. Published 2022 Sep 16.
18. **Joshi P, Kaushal S, Aribam BS, *et al.*** Recurrent floods and prevalence of diarrhea among under five children: observations from Bahraich District, Uttar Pradesh, India. *Glob Health Action.* 2011;4(1):6355.
19. **Milojevic A, Armstrong B, Hashizume M, *et al.*** Health effects of flooding in rural Bangladesh. *Epidemiology.* 2012(1):107-115.
20. **Kumar SG, Majumdar A, Kumar V, *et al.*** Prevalence of acute respiratory infection among under-five children in urban and rural areas of Puducherry, India. *J Nat Sci Biol Med.* 2015;6(1):3.
21. **Islam M, Sultana ZZ, Iqbal A, *et al.*** Effect of in-house crowding on childhood hospital admissions for acute respiratory infection: a matched case–control study in Bangladesh. *Int J Infect Dis.* 2021;105: 639-645.
22. **Sindh Flood Emergency Rehabilitation Project**. The World Bank. Published 2022. https://www.worldbank.org/en/news/factsheet/2022/12/19/factsheet-sindh-flood-emergency-rehabilitation-project. Accessed May 1, 2024.
23. **Bandino JP, Hang A, Norton SA.** The infectious and noninfectious dermatological consequences of flooding: a field manual for the responding provider. *Am J Clin Dermatol.* 2015;16(5):399-424.
24. **Ali N, Noreen S, Khan K, Wahid S.** Population dynamics of mosquitoes and malaria vector incrimination in district Charsadda, Khyber Pakhtunkhwa (KP) Pakistan. *Acta Trop.* 2015;141:25-31.
25. **Arshad T, Wajahat A, Jabeen A, Ali SH.** Malaria and dengue outbreaks during a national disaster in Pakistan: a rising concern for public health. *J Glob Health.* 2022;12:03076.
26. **Birley M.** An historical review of malaria, kala-azar and filariasis in Bangladesh in relation to the Flood Action Plan. *Ann Trop Med Parasitol.* 1993;87(4):319-334.

https://doi.org/10.1017/dmp.2024.77 Published online by Cambridge University Press