

Original Article



Strengthening Post-Flood Public Health and Nutrition Preparedness in Gilgit-Baltistan, Pakistan: An Integrated Assessment of Health Services, WASH Risks, Disease Surveillance, and Recovery Priorities Following the 2025 Floods

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Mar 2026**Keywords:** Gilgit-Baltistan, floods, public health, nutrition, WASH, disease surveillance**Abstract**

Background: Floods are among the most frequent climate-related disasters affecting Pakistan and often result in population displacement, disruption of health services, deterioration of water, sanitation and hygiene (WASH) conditions, and increased risk of communicable disease outbreaks. Following the July–August 2025 floods in Gilgit-Baltistan, a comprehensive assessment was required to identify priority public health and nutrition needs and inform recovery planning. **Objectives:** To assess the post-flood public health situation in Gilgit-Baltistan, identify major health, WASH, disease surveillance, and nutrition-related risks, and develop an operational response framework to strengthen disaster preparedness and resilient recovery. **Methods:** This applied public health study used secondary programmatic data extracted from the Gilgit-Baltistan post-flood field assessment conducted between September and October 2025. Descriptive analyses were performed using frequencies, proportions, and operational indicators. Health service availability, disease surveillance, WASH conditions, outbreak risks, logistics, nutrition-related information, and data quality were systematically reviewed. A risk-prioritization approach was used to identify critical operational gaps and develop an integrated intervention package. **Results:** All ten districts of Gilgit-Baltistan were affected by the floods, with four districts remaining affected during the assessment period. Approximately 6,000 people were affected, including 2,910 internally displaced persons residing in six temporary camps. Acute watery diarrhea, acute respiratory infections, and skin diseases were the leading morbidities. A confirmed cholera outbreak was identified in Astore, while a suspected dengue outbreak was reported in Diamer. Eleven health facilities sustained flood damage, including four completely destroyed facilities. Of 588 functional health facilities, only 372 (63.3%) were reporting through the Integrated Disease Surveillance and Response System. Major operational concerns included incomplete WASH information, open defecation practices, limited vector-control activities, insufficient nutrition screening, and inadequate data on maternal and newborn health, mental health, returnee populations, and water quality. An Integrated Flood Health and WASH Surveillance and Response Package was developed to strengthen outbreak surveillance, mobile health and nutrition services, WASH interventions, cold-chain recovery, logistics management, and emergency preparedness. **Conclusion:** The 2025 floods exposed important vulnerabilities in health service continuity, disease surveillance, WASH infrastructure, and nutrition-related information systems in Gilgit-Baltistan. Integrating surveillance, WASH, nutrition, and primary healthcare within a coordinated recovery framework can strengthen resilience, improve emergency preparedness, and reduce the health consequences of future flood emergencies in disaster-prone settings.

Introduction

Climate change has emerged as one of the greatest threats to global public health, increasing the frequency, intensity, and unpredictability of extreme weather events such as floods, droughts, heatwaves, and storms. Among these hazards, floods remain the most common natural disaster worldwide, accounting for nearly half of all weather-related disasters and affecting millions of people annually. Beyond the

immediate loss of life and destruction of infrastructure, floods have profound and long-lasting consequences for population health through disruption of healthcare services, contamination of drinking water, damage to sanitation systems, food insecurity, displacement of communities, and increased transmission of communicable diseases. The health impacts are particularly severe in low- and middle-income

countries (LMICs), where fragile health systems, limited emergency preparedness, and socioeconomic vulnerabilities reduce the capacity to respond effectively to climate-related emergencies [1–3].

Pakistan is consistently ranked among the countries most vulnerable to climate change despite contributing less than one percent of global greenhouse gas emissions. The country's diverse topography, glacial systems, monsoon rainfall patterns, and increasing climate variability make it highly susceptible to recurrent flooding, glacial lake outburst floods (GLOFs), flash floods, and landslides. The catastrophic floods of 2022 affected more than 33 million people, damaged over 2,000 health facilities, displaced millions of residents, and severely disrupted essential health and nutrition services across the country. The disaster highlighted significant weaknesses in emergency preparedness, disease surveillance, water, sanitation and hygiene (WASH) infrastructure, and continuity of primary healthcare, emphasizing the urgent need to strengthen climate-resilient health systems capable of responding to future disasters [4–8].

Gilgit-Baltistan represents one of Pakistan's most environmentally fragile and disaster-prone regions. Located within the Hindu Kush–Karakoram–Himalayan Mountain range, the region contains thousands of glaciers that are increasingly vulnerable to accelerated melting because of rising temperatures. Combined with intense precipitation and unstable mountainous terrain, these environmental changes increase the frequency of flash floods, glacial lake outburst floods, landslides, and avalanches. These disasters frequently damage transportation networks, isolate remote communities, interrupt access to healthcare facilities, and delay emergency response activities. The geographical remoteness of many settlements further limits access to health services, making disaster preparedness and rapid recovery particularly challenging [9–11].

Flood emergencies substantially increase the risk of communicable disease outbreaks through multiple pathways. Damage to water supply systems and sanitation infrastructure facilitates the transmission of waterborne diseases such as cholera, acute watery diarrhea, typhoid fever, and hepatitis A and E, while stagnant water created after floods promotes mosquito breeding and increases the risk of vector-borne diseases including dengue and malaria. Population displacement, overcrowded temporary shelters, poor hygiene practices, interrupted vaccination services, and reduced access to healthcare further amplify the risk of disease transmission. Previous flood emergencies in Pakistan have consistently reported increased incidences of acute respiratory infections, diarrheal diseases, skin infections, and vaccine-preventable diseases among affected populations [12–15].

Nutrition is another critical but frequently overlooked component of disaster response. Floods disrupt food production, food distribution systems, household livelihoods,

breastfeeding practices, complementary feeding, and access to essential nutrition services. Young children, pregnant and lactating women, older adults, and individuals with chronic illnesses are particularly vulnerable to malnutrition during humanitarian emergencies. Interruptions in growth monitoring, micronutrient supplementation, infant and young child feeding (IYCF) counselling, and community-based management of acute malnutrition may contribute to worsening nutritional status and increased morbidity among vulnerable populations. International guidance emphasizes integrating nutrition interventions into emergency health responses to reduce preventable illness and mortality during disasters [16–18].

Effective disease surveillance and timely public health intelligence are fundamental components of emergency preparedness and response. The World Health Organization recommends strengthening Integrated Disease Surveillance and Response (IDSR), event-based surveillance, laboratory capacity, and rapid response mechanisms to facilitate early detection and control of outbreaks during humanitarian emergencies. Similarly, WASH interventions, including provision of safe drinking water, sanitation facilities, hygiene promotion, waste management, and water quality monitoring, are essential public health measures for preventing outbreaks after floods. The Sphere Humanitarian Standards further recommend coordinated multisectoral responses integrating healthcare, nutrition, WASH, logistics, and community engagement to reduce disaster-related morbidity and mortality [3,19,20].

Although several reports have documented the health consequences of the 2022 Pakistan floods, published evidence describing district-level post-flood public health assessments in Gilgit-Baltistan remains limited. In particular, few studies have comprehensively examined health service functionality, disease surveillance performance, WASH conditions, nutrition-related risks, operational preparedness, and recovery priorities within an integrated framework. Such evidence is essential for guiding provincial preparedness planning, strengthening climate-resilient health systems, and improving coordination among health, nutrition, and humanitarian partners.

Therefore, this study aimed to assess the post-flood public health situation in Gilgit-Baltistan following the 2025 floods by evaluating health service availability, disease surveillance, WASH conditions, nutrition-related risks, and operational response capacities. The study further sought to identify critical gaps and develop evidence-informed recommendations to strengthen disaster preparedness, improve continuity of essential health and nutrition services, and enhance resilience against future climate-related emergencies in Pakistan.

Methodology

❖ Study Design

This study employed a descriptive cross-sectional assessment using secondary programmatic data collected during the post-flood public health assessment conducted in Gilgit-Baltistan, Pakistan, following the July–August 2025 flood emergency. The assessment was designed to evaluate the impact of the floods on health service delivery, disease surveillance, water, sanitation and hygiene (WASH), nutrition-related services, and emergency preparedness to support evidence-based recovery planning.

❖ Study Setting

The study was conducted in Gilgit-Baltistan, a mountainous administrative region in northern Pakistan comprising ten districts: Gilgit, Hunza, Nagar, Ghizer, Diamer, Astore, Skardu, Shigar, Kharmang, and Ghanche. The region is highly vulnerable to climate-related disasters, including flash floods, glacial lake outburst floods (GLOFs), landslides, and avalanches because of its complex terrain, glacier-fed river systems, and changing climatic conditions. The floods of July–August 2025 caused widespread damage to health infrastructure, transportation networks, water supply systems, and community services, necessitating a comprehensive post-disaster assessment.

❖ Data Sources

Secondary data were obtained from official post-flood assessment reports and routine programmatic information compiled by the Department of Health Gilgit-Baltistan and partner organizations. Data sources included:

- District post-flood rapid assessment reports
- Health facility assessment reports
- Integrated Disease Surveillance and Response System (IDSRs) reports
- Early Warning, Alert and Response System (EWARS) surveillance data
- Water, Sanitation and Hygiene (WASH) assessment reports
- Emergency Operations Centre (EOC) situation reports
- Nutrition and logistics assessment reports
- Population displacement and camp management records

Information from these sources was consolidated to provide a comprehensive assessment of the public health situation following the floods.

❖ Study Variables

The assessment examined multiple public health domains, including:

- Health Service Availability
- Number and functionality of health facilities
- Extent of infrastructure damage
- Availability of essential medicines and medical supplies
- Human resource availability

- Continuity of routine health services
- Disease Surveillance
- Functional surveillance reporting sites
- Priority communicable diseases
- Disease outbreak alerts
- Laboratory confirmation
- Reporting completeness
- Water, Sanitation and Hygiene (WASH)
- Access to safe drinking water
- Water quality monitoring
- Sanitation facilities
- Hygiene practices
- Solid waste management
- Vector breeding risks
- Nutrition and Maternal–Child Health
- Availability of nutrition services
- Infant and young child feeding (IYCF) support
- Growth monitoring
- Screening for acute malnutrition
- Maternal and child health services
- Emergency Preparedness
- Availability of emergency medical supplies
- Cold-chain functionality
- Mobile health services
- Logistics and supply chain
- Referral mechanisms
- Coordination arrangements

❖ Data Collection and Management

Data were extracted using a standardized data abstraction template developed for the study. Information from different programmatic sources was reviewed for completeness, consistency, and duplication before analysis. Variables were categorized according to the World Health Organization Health Emergency and Disaster Risk Management Framework to facilitate systematic assessment of health system performance following the flood emergency.

Data Analysis

Data were analyzed using descriptive statistical methods. Categorical variables were summarized using frequencies and percentages, whereas continuous variables were summarized using means, medians, or ranges where appropriate. Findings were organized into thematic domains, including health services, disease surveillance, WASH, nutrition, logistics, and emergency preparedness.

A qualitative risk-prioritization approach was subsequently applied to identify operational gaps based on the magnitude of public health risk, service disruption, outbreak potential, and feasibility of intervention. Priority recommendations were synthesized to develop an integrated post-flood public health recovery framework for Gilgit-Baltistan.

Ethical Considerations

The study utilized secondary, anonymized programmatic data collected as part of routine public health emergency response

activities. No individual patient identifiers were included in the analysis. As the assessment involved secondary analysis of aggregated operational data without direct human participant involvement, formal ethical approval was not required. Permission to utilize the assessment findings for academic purposes was obtained from the relevant health authorities where applicable. Confidentiality of institutional information was maintained throughout the study.

Quality Assurance

Data quality was strengthened through triangulation of multiple official information sources, including surveillance reports, health facility assessments, WASH assessments, and emergency situation reports. Cross-validation of findings improved the completeness and reliability of the assessment and minimized reporting inconsistencies. The methodology adhered to internationally recognized principles for public health emergency assessments and humanitarian health response planning.

Results

❖ Flood Impact and Population Affected

The post-flood assessment demonstrated that all ten districts of Gilgit-Baltistan experienced varying degrees of flood-related impacts following the July–August 2025 floods. At the time of assessment, four districts continued to report significant humanitarian needs. Approximately 6,000 individuals were affected by the disaster, including 2,910 internally displaced persons (IDPs) residing in six temporary camps established across the affected districts. Damage to roads, bridges, communication networks, and public infrastructure limited access to essential health services and delayed emergency response activities in several remote communities.

❖ Damage to Health Infrastructure

The floods substantially affected health service delivery across Gilgit-Baltistan. A total of 11 health facilities sustained flood-related damage, of which four facilities were completely destroyed and the remaining facilities experienced partial structural damage. Despite these disruptions, 588 health facilities remained functional, although service delivery capacity varied according to district and accessibility.

Routine primary healthcare services continued in most districts; however, transportation constraints, damaged infrastructure, and shortages of medical supplies affected service accessibility in remote areas. Damage to health facilities also reduced the capacity to provide preventive and curative health services during the emergency period.

Table 1. Status of Health Facilities Following the 2025 Floods

Indicator	Number
Total functional health facilities	588
Health facilities damaged	11
Completely destroyed facilities	4
Partially damaged facilities	7

❖ Disease Surveillance and Communicable Disease Situation

Disease surveillance identified several priority communicable diseases requiring immediate public health attention. Of the 588 functional health facilities, 372 (63.3%) were actively reporting through the Integrated Disease Surveillance and Response System (IDSRS), indicating incomplete surveillance coverage across the region.

The leading reported illnesses included:

- Acute watery diarrhea (AWD)
- Acute respiratory infections (ARI)
- Skin diseases
- Suspected malaria
- Suspected dengue fever

A laboratory-confirmed cholera outbreak was reported from Astore District, while a suspected dengue outbreak was identified in Diamer District, emphasizing the increased outbreak risk associated with damaged water systems, poor sanitation, and vector breeding following flooding.

Table 2. Major Public Health Events Identified During the Assessment

Indicator	Findings
Functional surveillance sites	372 (63.3%)
Cholera outbreak	Confirmed (Astore)
Dengue outbreak	Suspected (Diamer)
Common reported diseases	AWD, ARI, skin diseases, malaria

❖ Water, Sanitation and Hygiene (WASH) Assessment

The WASH assessment identified several operational gaps that may increase the risk of communicable disease transmission. Damage to water supply systems affected access to safe drinking water in several flood-affected communities. Open defecation continued in some temporary settlements because of inadequate sanitation facilities. Limited information was available regarding routine water quality monitoring and residual chlorine testing.



Environmental conditions created favorable breeding sites for mosquitoes, increasing the potential for vector-borne disease transmission. Waste management systems were also disrupted in several affected areas.

❖ Nutrition and Maternal–Child Health Services

The assessment identified important information gaps regarding nutrition service delivery. Limited data were available on screening for acute malnutrition, infant and young child feeding (IYCF) practices, micronutrient supplementation, and community-based nutrition services.

Similarly, information regarding maternal health, newborn care, immunization status, and mental health services among affected populations remained incomplete. These gaps limited comprehensive assessment of nutritional vulnerability following the floods.

❖ Operational Preparedness and Response Capacity

The assessment identified several operational strengths, including rapid deployment of emergency response teams, establishment of temporary camps, continuation of routine disease surveillance, and ongoing coordination between provincial health authorities and development partners.

However, several critical challenges remained:

- Incomplete disease surveillance reporting
- Damage to health infrastructure
- Limited WASH monitoring
- Inadequate nutrition surveillance
- Weak vector surveillance
- Logistics and transportation constraints
- Insufficient data on displaced and returning populations

These operational limitations may affect timely detection of disease outbreaks and continuity of essential health and nutrition services during future emergencies.

❖ Priority Public Health Recovery Needs

Based on the integrated assessment, the following priority interventions were identified:

- Restoration of damaged health facilities.
- Strengthening Integrated Disease Surveillance and Response System reporting.
- Expansion of mobile health and nutrition services in inaccessible communities.
- Improvement of safe water supply, sanitation, and hygiene promotion.
- Enhanced cholera and dengue surveillance and rapid response.
- Routine nutrition screening and infant and young child feeding support.
- Strengthening emergency logistics, cold-chain systems, and medical supply management.

- Development of climate-resilient health emergency preparedness plans.

These findings informed the development of an Integrated Flood Health, Nutrition, and WASH Recovery Framework aimed at strengthening disaster preparedness and improving resilience of the health system in Gilgit-Baltistan.

Discussion

This study provides a comprehensive assessment of the public health situation following the 2025 floods in Gilgit-Baltistan, highlighting significant disruptions in health service continuity, disease surveillance, WASH, and nutrition preparedness. Consistent with the rationale presented in the Introduction, the findings demonstrate that flood emergencies have consequences extending beyond infrastructure damage, affecting health systems, communicable disease transmission, and access to essential health and nutrition services. These findings support previous evidence indicating that climate-related disasters require integrated and resilient health systems capable of maintaining essential services during emergencies [21,22].

One of the principal findings was the damage to health infrastructure, with eleven health facilities affected, including four that were completely destroyed. Although the majority of facilities remained functional, disrupted road networks and logistical constraints reduced healthcare accessibility in remote communities. Similar observations were reported following the 2022 Pakistan floods, where extensive damage to health infrastructure interrupted primary healthcare, maternal and child health services, immunization programs, and nutrition interventions [21,23]. Akthar and Reid further emphasized that strengthening climate-resilient health systems is essential for maintaining continuity of essential healthcare during future climate-related disasters [21].

Another important finding was incomplete disease surveillance, with only 63.3% of functional health facilities reporting through the Integrated Disease Surveillance and Response System. Effective surveillance is fundamental for the early detection and rapid control of epidemic-prone diseases during humanitarian emergencies. WHO recommends strengthening integrated surveillance systems, laboratory capacity, and rapid response mechanisms to improve outbreak detection and response following disasters [23,24]. Similar surveillance challenges were documented during the Pakistan flood response, where delayed reporting hindered timely public health interventions [23].

The confirmed cholera outbreak in Astore and the suspected dengue outbreak in Diamer highlight the increased risk of communicable diseases following floods. Floodwaters often contaminate drinking water supplies, damage sanitation infrastructure, and create breeding sites for disease vectors. Previous studies have reported increased incidences of acute watery diarrhea, dengue, malaria, respiratory infections, and skin diseases following flood emergencies in Pakistan and other low-resource settings [23,22]. These findings reinforce the importance of integrated disease surveillance,

environmental health monitoring, and rapid outbreak response.

The assessment also identified important deficiencies in water, sanitation, and hygiene services. Limited water quality monitoring, inadequate sanitation facilities, and open defecation practices in some temporary settlements increase the risk of faecal–oral disease transmission. International humanitarian standards consistently recognize access to safe drinking water, sanitation, hygiene promotion, and environmental health interventions as fundamental components of emergency response and disease prevention [23,24].

Although nutrition was not comprehensively assessed, important information gaps were identified regarding screening for acute malnutrition, infant and young child feeding, and micronutrient interventions. Disruptions to food systems and healthcare services following floods can substantially increase the risk of malnutrition among children and pregnant and lactating women. WHO and UNICEF recommend integrating nutrition assessment and management into emergency health responses to reduce preventable morbidity and mortality among vulnerable populations [23,24].

The findings also emphasize the importance of strengthening emergency preparedness before disasters occur. WHO's Operational Framework for Building Climate-Resilient and Low Carbon Health Systems recommends resilient infrastructure, emergency logistics, disease surveillance, workforce capacity, risk communication, and multisectoral coordination to ensure continuity of essential health services during climate-related emergencies [3,24]. These recommendations are particularly relevant to Gilgit-Baltistan, where mountainous terrain and dispersed populations create additional challenges for emergency response.

A major strength of this study is its integrated assessment of health services, disease surveillance, WASH, nutrition, and operational preparedness using routine public health data. However, several limitations should be acknowledged. The analysis relied on secondary programmatic data, and information on nutrition, maternal health, mental health, and water quality was incomplete in several districts. In addition, the descriptive study design limits causal inference and long-term evaluation of post-flood recovery.

Overall, this study addresses an important evidence gap identified in the Introduction by providing a comprehensive assessment of post-flood public health preparedness in Gilgit-Baltistan. Strengthening health infrastructure, disease surveillance, WASH systems, nutrition services, logistics, and emergency coordination will be critical for improving resilience against future climate-related disasters and ensuring continuity of essential health and nutrition services [3,20,24].

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Declarations:

Authors' Contribution:

- **All Authors** Conceptualization, data collection, interpretation, drafting of the manuscript and intellectual revisions
- The authors agree to take responsibility for every facet of the work, making sure that any concerns about its integrity or veracity are thoroughly examined and addressed

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