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Evaluating Environmental and Public Health Hazards of Urban Flooding: Clinical Consequences and Considerations

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Abstract

Urban flooding poses a significant threat to environmental integrity and public health, particularly in rapidly expanding regions of Nigeria. This study evaluates the environmental contamination, clinical consequences, and psychosocial impacts of urban flooding across six districts—Gwarinpa, Lokogoma, and Lugbe in Abuja, and Yola North, Demsa, and Numan in Adamawa State—selected for their history of seasonal flooding, population density, and strategic urban importance. A mixed-methods approach was employed, combining environmental sampling, clinical data collection, and household surveys. Water and soil samples were analyzed for microbial contamination (*E. coli*), pH, turbidity, and heavy metals (lead, mercury, cadmium) in line with WHO standards, while clinical data from health facilities were used to assess the prevalence of flood-related illnesses, including diarrhea, skin infections, and respiratory symptoms. Mental health outcomes were evaluated through structured surveys administered to 300 residents, focusing on anxiety and post-traumatic stress disorder (PTSD). Results revealed elevated levels of *E. coli* and heavy metals in flood-affected

zones, with Lokogoma and Yola North recording the highest contamination, and these districts also reporting the highest incidence of waterborne diseases and respiratory conditions. Mental health symptoms were prevalent across all districts, with more than 50% of respondents in Lokogoma and Demsa reporting signs of anxiety and PTSD, while healthcare facilities in Lugbe and Numan experienced disruptions in chronic disease management and medication access, underscoring systemic vulnerabilities. In conclusion, urban flooding in Abuja and Adamawa has profound environmental and public health implications, and the findings highlight the need for integrated flood management strategies, including infrastructure upgrades, environmental monitoring, healthcare system strengthening, and mental health integration. Tailored interventions across these districts are essential to mitigate future risks and build community resilience in the face of climate-induced disasters.

Keywords: Urban Flooding; Environmental Contamination; Public Health Impacts; Mental Health Outcomes; Abuja; Adamawa State; Climate-Induced Disasters

INTRODUCTION

Urban flooding has emerged as a pressing global concern, particularly in the context of rapid urbanization and climate change. Defined as the inundation of land in densely populated areas due to excessive rainfall, inadequate drainage systems, or rising water bodies, urban flooding disrupts infrastructure, displaces populations, and poses significant environmental and health risks (Jha et al., 2012). Unlike rural flooding, urban flooding is exacerbated by impervious surfaces such as concrete and asphalt, which prevent natural water absorption and increase runoff. As cities expand, the loss of green spaces and wetlands further diminishes their capacity to manage stormwater, making urban areas increasingly vulnerable to flood events.

The environmental consequences of urban flooding are multifaceted. Floodwaters often carry a toxic mix of pollutants, including industrial waste, sewage, and hazardous chemicals, which contaminate soil and water sources (Douglas et al., 2008). These pollutants not only degrade ecosystems but also pose long-term risks to human health. For instance, stagnant floodwaters become breeding grounds for disease vectors such as mosquitoes and rodents, increasing the risk of vector-borne diseases like malaria and

leptospirosis (WHO, 2017). Moreover, the destruction of vegetation and erosion of topsoil during floods contribute to biodiversity loss and reduced ecological resilience.

From a public health perspective, urban flooding can trigger a cascade of health emergencies. Waterborne diseases such as cholera, typhoid, and hepatitis A often surge in the aftermath of floods due to contaminated drinking water and poor sanitation (Ahern et al., 2005). Respiratory infections and skin conditions also become prevalent as people are exposed to mold-infested environments and polluted water. Vulnerable populations, including children, the elderly, and those with pre-existing health conditions—are disproportionately affected, often lacking access to timely medical care and clean water.

The mental health impact of urban flooding is equally significant but often overlooked. Displacement, loss of property, and trauma from flood events contribute to increased rates of anxiety, depression, and post-traumatic stress disorder (PTSD) among affected populations (Reacher et al., 2004). These psychological effects can persist long after the physical damage has been repaired, underscoring the need for integrated mental health services in disaster response frameworks. In many cases, the breakdown of social networks and community support systems further exacerbates mental health challenges.

Clinically, urban flooding presents unique challenges for healthcare systems. Hospitals and clinics may be inundated or rendered inaccessible, while the demand for emergency care surges. Medical professionals must be equipped to manage a wide range of flood-related conditions, from acute injuries and infections to chronic disease exacerbations and mental health crises (Few et al., 2004). Preventive measures such as vaccination campaigns, distribution of clean water, and public health education are essential to mitigate the clinical burden of floods.

In conclusion, urban flooding is not merely an environmental issue, it is a complex public health emergency with profound clinical implications. Addressing this challenge requires a multidisciplinary approach that integrates urban planning, environmental management, public health preparedness, and clinical care. As climate change continues to intensify extreme weather events, proactive strategies are essential to safeguard urban populations and build resilient healthcare systems.

Environmental Hazards of Urban Flooding

Urban flooding introduces a complex array of environmental hazards, many of which stem from the contamination of water sources by industrial waste and untreated

sewage. The results from Table 1 reveal alarmingly high levels of *Escherichia coli* (E. coli) in floodwaters across all three study locations—Gwarinpa (180 CFU/100ml), Lokogoma (220 CFU/100ml), and Lugbe (160 CFU/100ml)—far exceeding the World Health Organization's (WHO) permissible limit of 0 CFU/100ml for drinking water (WHO, 2017). This indicates significant fecal contamination, likely due to the overflow of septic systems and open defecation areas during flooding. The presence of such pathogens in water sources increases the risk of waterborne diseases like cholera, typhoid, and dysentery, particularly in communities with limited access to clean water and sanitation infrastructure (Ahern et al., 2005).

In addition to microbial contamination, floodwater often mobilizes heavy metals and hydrocarbons from industrial zones, roads, and waste dumps. The study's findings show that lead concentrations in floodwaters reached up to 0.15 mg/L in Lokogoma—15 times higher than the WHO guideline of 0.01 mg/L. Mercury levels also exceeded safe thresholds, with Lokogoma again recording the highest concentration at 0.04 mg/L. These toxic substances can persist in the environment long after floodwaters recede, seeping into groundwater and accumulating in the food chain (Douglas et al., 2008). Table 2 further supports this concern, with soil samples from all three locations showing elevated levels of lead and cadmium, particularly in Lokogoma and Gwarinpa. Chronic exposure to these metals is associated with neurological disorders, kidney damage, and developmental issues in children (Few et al., 2004).

Beyond chemical and microbial hazards, urban flooding significantly disrupts local ecosystems. The physical force of floodwater contributes to soil erosion, stripping away nutrient-rich topsoil and destabilizing the foundations of buildings and roads. Vegetation loss, as observed in the surveyed areas, reduces natural water absorption and exacerbates future flood risks. Moreover, the accumulation of stagnant water creates ideal breeding grounds for mosquitoes, increasing the incidence of vector-borne diseases such as malaria and dengue fever (WHO, 2017). Rodent populations also thrive in post-flood environments, further elevating the risk of leptospirosis and other zoonotic infections. These ecological disturbances not only threaten biodiversity but also compromise the resilience of urban environments to future climate shocks (Reacher et al., 2004).

The cumulative impact of these environmental hazards is a degraded urban landscape that poses long-term risks to public health and safety. The correlation between

environmental contamination and clinical outcomes is evident in the study's results: Lokogoma, which recorded the highest levels of water and soil pollutants, also experienced the most significant health burden, including 150 cases of diarrhea and the highest prevalence of anxiety and PTSD symptoms. These findings underscore the urgent need for integrated flood management strategies that address both infrastructural vulnerabilities and environmental health risks. Sustainable urban planning, improved waste management, and community-based monitoring are essential to mitigate the cascading effects of urban flooding on both ecosystems and human well-being (Jha et al., 2012).

Urban flooding poses serious public health risks, including outbreaks of infectious diseases, respiratory and skin infections, and long-term mental health consequences. These impacts are especially severe in densely populated and poorly serviced areas.

Public Health Risks of Urban Flooding

Urban flooding creates ideal conditions for the spread of infectious diseases, particularly in regions with inadequate sanitation and limited access to clean water. Floodwater often mixes with sewage and waste, contaminating drinking sources and increasing the risk of waterborne diseases such as cholera, typhoid fever, hepatitis A, and leptospirosis (Paterson et al., 2018). In Nigeria, post-flood outbreaks of cholera have been documented in displaced communities, where overcrowding and poor hygiene exacerbate transmission (Adesola et al., 2024). Leptospirosis, a bacterial infection transmitted through contact with water contaminated by rodent urine, is also a growing concern in urban slums affected by flooding.

Respiratory and skin infections are another major consequence of urban flooding. Prolonged exposure to polluted water and damp environments leads to dermatological conditions such as fungal infections, dermatitis, and cellulitis, especially among children and the elderly. Additionally, mold growth in flooded homes contributes to respiratory illnesses like asthma, bronchitis, and allergic reactions (Health Guide NG, 2025). These conditions are worsened by poor ventilation and the lack of access to healthcare services, particularly in informal settlements where flood damage often goes unrepaired for months.

The mental health toll of flooding is profound and often underreported. Displacement, loss of property, and the trauma of surviving a flood event contribute to elevated rates of anxiety, depression, and post-traumatic stress disorder (PTSD). In the 2022 flood crisis in Nigeria, many affected individuals reported sleep disturbances,

emotional numbness, and persistent fear of future flooding (Adesola et al., 2024). These psychological effects are compounded by the breakdown of social networks and the stress of rebuilding lives with limited resources. Mental health support is rarely integrated into disaster response, leaving survivors without adequate care.

Flooding also disrupts the management of chronic diseases and access to essential medications. Patients with conditions such as diabetes, hypertension, and HIV/AIDS often lose their medications during displacement or face barriers to reaching healthcare facilities. This interruption in care can lead to complications, hospitalization, and increased mortality, especially among vulnerable populations. Moreover, healthcare infrastructure itself may be damaged or overwhelmed, reducing the system's capacity to respond to both acute and chronic health needs (Paterson et al., 2018).

In summary, the public health risks of urban flooding are multifaceted and far-reaching. Immediate threats include infectious disease outbreaks and environmental exposure, while long-term consequences affect mental health and chronic disease management. Addressing these risks requires a coordinated public health strategy that includes emergency medical response, disease surveillance, mental health services, and infrastructure resilience. Without such measures, urban flooding will continue to pose a serious threat to population health in vulnerable regions.

Clinical Implications of Urban Flooding

Urban flooding presents a multifaceted challenge to healthcare systems, necessitating rapid mobilization of resources and adaptive clinical strategies. The immediate aftermath of flooding typically sees a surge in patients presenting with injuries such as lacerations, fractures, and soft tissue infections sustained during evacuation or from contact with debris and contaminated water (Paterson et al., 2018). Hospitals and clinics in flood-prone areas must be equipped to handle increased caseloads, often under compromised conditions due to infrastructure damage or power outages. Emergency departments should prioritize **triage systems** that can efficiently assess and manage acute injuries, dehydration, and infectious diseases to prevent complications and fatalities.

One of the most critical clinical responses to urban flooding is the management of waterborne and vector-borne diseases. As demonstrated in the study, there was a marked increase in cases of diarrhea, skin infections, and respiratory illnesses in flood-affected districts. These conditions require prompt diagnosis and treatment to prevent outbreaks.

Clinicians must be prepared to administer oral rehydration therapy, antibiotics, and antifungal medications, particularly in resource-limited settings where laboratory diagnostics may be unavailable. Additionally, the use of mobile clinics and temporary health posts can help reach displaced populations and reduce the burden on central hospitals (WHO, 2017).

Preventive healthcare measures are equally vital in mitigating the clinical impact of flooding. Vaccination campaigns targeting diseases such as hepatitis A and typhoid fever should be prioritized in high-risk zones, especially where sanitation infrastructure is compromised. The administration of prophylactic antibiotics for leptospirosis is recommended for individuals exposed to floodwaters, particularly in areas with known rodent infestations (Ahern et al., 2005). Public health authorities must also ensure the availability of clean drinking water, water purification tablets, and hygiene kits to reduce the risk of disease transmission.

Mental health care is an often overlooked but essential component of flood response. The psychological toll of displacement, property loss, and trauma can lead to anxiety, depression, and post-traumatic stress disorder (PTSD). The study's findings revealed that over 50% of respondents in Lokogoma reported anxiety symptoms, with significant levels of PTSD and sleep disturbances across all surveyed districts. Integrating mental health services into emergency response frameworks—including counseling, psychosocial support, and community outreach—can help address these needs. Training healthcare workers in psychological first aid and establishing referral pathways for specialized care are critical steps toward holistic recovery (Reacher et al., 2004).

In conclusion, the clinical implications of urban flooding extend beyond immediate injuries to encompass a broad spectrum of health concerns, including infectious diseases, chronic illness management, and mental health. A proactive and integrated healthcare response is essential to mitigate these impacts. This includes strengthening hospital preparedness, ensuring vaccine availability, deploying mobile health units, and embedding mental health services into disaster response plans. As climate change increases the frequency and severity of urban flooding, healthcare systems must evolve to meet the complex demands of affected populations.

MATERIALS AND METHODS

This study was conducted in six strategically selected districts across two Nigerian states: Gwarinpa, Lokogoma, and Lugbe in the Federal Capital Territory (Abuja), and Yola North, Demsa, and Numan in Adamawa State. Gwarinpa, Lokogoma, and Lugbe are prominent urban districts within Abuja, known for their residential density and infrastructural development. While drainage systems in these areas are generally functional, rapid urban expansion and increased impermeable surfaces have heightened their vulnerability to flash flooding. Similarly, Yola North—home to the state capital of Adamawa—and its neighboring districts Demsa and Numan are urban centers with growing populations and evolving infrastructure. These locations were selected due to their documented exposure to seasonal flooding and their significance in regional health and environmental planning (Adesola et al., 2024; Nana, 2025).

A mixed-methods approach was adopted to comprehensively assess the environmental and public health impacts of urban flooding. Environmental sampling involved the collection of water and soil specimens from flood-affected zones in each district. Water samples were analyzed for microbial contamination (E. coli), pH, turbidity, and heavy metals including lead and mercury, following WHO standards for potable water (WHO, 2017). Soil samples were tested for lead, cadmium, and total bacterial load. Clinical data were gathered from primary and secondary health facilities, focusing on flood-related illnesses such as diarrhea, skin infections, and respiratory conditions. Additionally, structured household surveys were administered to 300 residents across the six districts to evaluate mental health outcomes, particularly symptoms of anxiety and post-traumatic stress disorder (PTSD), using validated screening instruments (Reacher et al., 2004).

Quantitative data were analyzed using SPSS version 26. Descriptive statistics were used to summarize contamination levels and disease prevalence, while inferential tests such as chi-square and one-way ANOVA were applied to assess differences across districts. Ethical approval was obtained from relevant health authorities, and informed consent was secured from all survey participants. The integration of environmental, clinical, and psychosocial data provided a robust framework for understanding the multifaceted risks associated with urban flooding in both federal and state capital regions of Nigeria (Few et al., 2004).

Urban Flooding Impact Questionnaire

Study Title: Evaluating Environmental and Public Health Hazards of Urban Flooding in Abuja and Adamawa, Nigeria

Confidentiality Notice: All responses will be kept confidential and used solely for academic research purposes.

Section A: Demographic Information

Age: _____

Gender: ☐ Male ☐ Female ☐ Other

Marital Status: ☐ Single ☐ Married ☐ Widowed ☐ Divorced

Occupation: _____

District of Residence: ☐ Gwarinpa ☐ Lokogoma ☐ Lugbe ☐ Yola North ☐ Demsa ☐ Numan

Duration of residence in this district: ☐ <1 year ☐ 1–5 years ☐ >5 years

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Section B: Environmental Exposure

Have you experienced flooding in your area in the past 12 months? ☐ Yes ☐ No

If yes, how many times? ☐ Once ☐ 2–3 times ☐ More than 3 times

Did floodwater enter your home or compound? ☐ Yes ☐ No

Were you exposed to floodwater directly (e.g., walking, cleaning, wading)? ☐ Yes ☐ No

Did you notice unusual smells, colors, or debris in the floodwater? ☐ Yes ☐ No

Were you aware of any industrial or sewage waste mixing with floodwater? ☐ Yes ☐ No

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Section C: Health Outcomes

Have you or any household members experienced the following after the flood? (Check all that apply)

☐ Diarrhea

☐ Skin infections (e.g., rashes, boils)

☐ Respiratory symptoms (e.g., coughing, wheezing)

☐ Fever

☐ Eye irritation

Did you seek medical treatment for any of the above conditions? ☐ Yes ☐ No

Was your local health facility accessible during the flood period? ☐ Yes ☐ No

Were you able to access clean drinking water during and after the flood? ☐ Yes ☐ No

Do you or any household members have a chronic illness (e.g.Diabetes, hypertension, HIV)? ☐ Yes ☐ No

Was your access to medication or follow-up care disrupted by the flood? ☐ Yes ☐ No

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Section D: Mental Health and Psychosocial Impact

Since the flood, have you experienced any of the following? (Check all that apply)

☐ Difficulty sleeping

☐ Persistent anxiety or fear

☐ Sadness or depression

☐ Flashbacks or nightmares

☐ Avoidance of flood-related areas or memories

Did you receive any form of psychological support or counseling? ☐ Yes ☐ No

Would you be willing to participate in community-based mental health programs? ☐ Yes ☐ No

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Section E: Community Response and Preparedness

Were you warned about the flood? ☐ Yes ☐ No

Did your community have any emergency response or evacuation plan? ☐ Yes ☐ No

What support did you receive during or after the flood? (Check all that apply)

☐ Food aid

☐ Medical assistance

☐ Temporary shelter

☐ Clean water

☐ None

What do you think should be prioritized to reduce flood-related health risks in your area?

Any additional comments or suggestions?

Case Study: Abuja's 2025 Urban Flood Crisis

In July 2025, Abuja experienced one of its most severe urban flood events in recent history, triggered by prolonged rainfall and blocked drainage systems. The districts of Gwarinpa, Lokogoma, and Lugbe were among the hardest hit, with hundreds of homes submerged and thousands of residents displaced. The flooding disrupted transportation, overwhelmed local infrastructure, and exposed critical gaps in urban planning and emergency response. These districts, known for rapid development and poor drainage, became focal points for assessing the environmental and public health consequences of urban flooding (Nana, 2025; Agu, 2025).

Environmental sampling revealed significant contamination across all three districts. Water samples from Lokogoma showed the highest levels of *E. coli* (220 CFU/100ml), lead (0.15 mg/L), and mercury (0.04 mg/L), far exceeding WHO safety thresholds (WHO, 2017). Soil samples also indicated elevated levels of lead and cadmium, particularly in Gwarinpa and Lokogoma. These findings suggest that floodwater mobilized pollutants from industrial zones, waste dumps, and septic systems, creating toxic conditions that persisted long after the flood receded. The environmental degradation in these areas mirrors patterns observed in other rapidly urbanizing Nigerian cities (Afeonkhai, 2025).

Clinically, the flood led to a surge in waterborne and skin-related illnesses. Lokogoma recorded 150 cases of diarrhea, 95 skin infections, and 75 respiratory illnesses—more than any other district in Abuja. Gwarinpa and Lugbe also reported significant disease burdens, with over 250 combined cases of diarrhea and skin infections. These outcomes reflect the direct impact of contaminated water and poor sanitation on public health. Health centers in these districts struggled to meet demand, with reports of medication shortages and overcrowded waiting areas. The situation highlighted the need for emergency preparedness and resource allocation in urban healthcare systems (Adesola et al., 2024).

Mental health outcomes were equally concerning. Household surveys revealed that 55% of respondents in Lokogoma experienced anxiety symptoms, while 50% in Lugbe and

42% in Gwarinpa reported sleep disturbances and signs of PTSD. Many residents described emotional numbness, persistent fear of future flooding, and difficulty coping with property loss. Despite these findings, mental health services remained limited, with few facilities offering counseling or psychosocial support. The psychological toll of the flood underscores the importance of integrating mental health care into disaster response frameworks (Reacher et al., 2004).

The Abuja flood crisis of 2025 serves as a stark reminder of the intersection between urbanization, environmental management, and public health. The results from Gwarinpa, Lokogoma, and Lugbe demonstrate the urgent need for flood-resilient infrastructure, environmental monitoring, and healthcare system strengthening. Tailored interventions—such as improved drainage, vaccination campaigns, and mental health outreach—can significantly reduce the health burden of future flood events. As Abuja continues to grow, proactive planning and cross-sector collaboration will be essential to protect its residents from climate-induced disasters.

Case Study: Adamawa, Nigeria's 2025 Flood Crisis

In 2025, Adamawa State in northeastern Nigeria experienced one of the most catastrophic flood events in its history, triggered by prolonged rainfall and overflow from the Benue River. The disaster affected over 3 million residents across key local government areas such as Yola North, Demsa, and Numan. Entire communities were submerged, forcing mass evacuations and displacing thousands into temporary shelters. The scale of destruction overwhelmed local authorities and exposed critical gaps in disaster preparedness and public health infrastructure (Adesola et al., 2024).

One of the most immediate consequences of the flood was a sharp increase in waterborne diseases among displaced populations. With sanitation systems compromised and clean water sources contaminated, outbreaks of cholera, typhoid fever, and hepatitis A were reported within days. In camps set up for internally displaced persons (IDPs), overcrowding and poor hygiene conditions accelerated the spread of these infections. Health workers in Yola reported treating hundreds of cases of acute diarrhea and dehydration, particularly among children under five (Health Guide NG, 2025). The lack of access to safe drinking water and the breakdown of waste disposal systems created a public health emergency that persisted for weeks.

Healthcare facilities across Adamawa State faced immense pressure during the flood crisis, with many struggling to manage the sudden surge in patient volume. Clinics in Demsa and Numan, despite being part of the state's expanding healthcare network, reported critical shortages of antibiotics, intravenous fluids, and essential vaccines. The flooding also disrupted key infrastructure, damaging roads and power lines—which hindered access to affected communities and delayed emergency response efforts. Timely intervention by state and local authorities helped stabilize the situation, while mobile health units deployed by non-governmental organizations provided much-needed temporary relief. However, the overwhelming demand far exceeded available resources, underscoring the fragility of regional healthcare systems in the face of climate-related disasters and the urgent need for investment in resilient, adaptive infrastructure (WHO, 2017).

Beyond the immediate health impacts, the flood led to long-term displacement that exacerbated mental health challenges and disrupted chronic disease management. Many families lost their homes, livelihoods, and access to routine medical care. Patients with conditions such as diabetes, hypertension, and HIV/AIDS were unable to refill prescriptions or attend follow-up appointments, leading to complications and hospitalizations. Mental health symptoms—including anxiety, depression, and post-traumatic stress disorder (PTSD)—were widespread among survivors. In interviews conducted by local health workers, displaced individuals described persistent fear, insomnia, and emotional numbness. Yet mental health services remained scarce, with few trained professionals available to provide counseling or psychosocial support (Reacher et al., 2004).

RESULTS

Table 1: Water Quality Parameters in Flood-Affected Areas

Location	E. coli (CFU/100ml)	pH	Turbidity (NTU)	Lead (mg/L)
Gwarinpa	180	6.2	45	0.12
Lokogoma	220	6.0	52	0.15
Lugbe	160	6.5	40	0.10
WHO Limit	0	6.5–8.5	<5	0.01

Interpretation: All sites exceeded WHO limits for microbial and heavy metal contamination.

Table 2: Soil Contamination Levels

Location	Lead (mg/kg)	Cadmium (mg/kg)	Total Bacterial Count (CFU/g)
Gwarinpa	95	2.1	1.2×10^6
Lokogoma	110	2.5	1.5×10^6
Lugbe	88	1.8	1.0×10^6
Safe Limit	<50	<1.0	—

Interpretation: Soil samples showed elevated heavy metal concentrations, posing long-term exposure risks.

Table 3: Clinical Cases Reported Post-Flood (3-Month Period)

Disease Type	Gwarinpa	Lokogoma	Lugbe	Total
Diarrhea	120	150	100	370
Skin Infections	85	95	70	250
Respiratory Illness	60	75	55	190

Interpretation: Lokogoma recorded the highest disease burden, correlating with worst water quality.

Table 4: Mental Health Outcomes from Household Survey

Symptom	Gwarinpa (%)	Lokogoma (%)	Lugbe (%)
Anxiety	42	55	38
PTSD Symptoms	28	35	25
Sleep Disturbances	50	60	45
Symptom	**Gwarinpa (%)**	**Lokogoma (%)**	**Lugbe (%)**

Interpretation: Mental health symptoms were prevalent, especially in Lokogoma, indicating psychological impact of flooding.

Table 5: Water Quality Parameters in Abuja Districts

Location	E. coli (CFU/100ml)	pH	Turbidity (NTU)	Lead (mg/L)	Mercury (mg/L)
Gwarinpa	180	6.2	45	0.12	0.03
Lokogoma	220	6.0	52	0.15	0.04
Lugbe	160	6.5	40	0.10	0.02
WHO Limit	0	6.5–8.5	<5	0.01	0.001

Table 6: Soil Contamination Levels

Location	Lead (mg/kg)	Cadmium (mg/kg)	Total Bacterial Count (CFU/g)
Gwarinpa	95	2.1	1.2×10^6
Lokogoma	110	2.5	1.5×10^6
Lugbe	88	1.8	1.0×10^6
Safe Limit	<50	<1.0	—

Table 7: Clinical Cases Reported Post-Flood (Abuja)

Disease Type	Gwarinpa	Lokogoma	Lugbe
Diarrhea	120	150	100
Skin Infections	85	95	70
Respiratory Illness	60	75	55

Table 8: Health Impact of the 2025 Adamawa Flood Crisis

Health Indicator	Yola North	Demsa	Numan	Total
Cholera Cases	210	180	160	550
Typhoid Fever Cases	130	115	95	340
Hepatitis A Cases	75	60	50	185
Diarrhea (Children <5)	320	280	250	850
Skin Infections	190	160	140	490
Respiratory Illnesses	150	130	120	400
PTSD Symptoms (Surveyed Adults)	58%	52%	49%	—
Interrupted Chronic Disease Care	420	390	360	1,170

Interpretation: Yola North recorded the highest burden across most health indicators, reflecting its dense population and proximity to flood zones. Mental health symptoms were prevalent across all districts, with over half of adults surveyed reporting PTSD-related experiences.

DISCUSSION

The results from Gwarinpa revealed elevated levels of lead (95 mg/kg) and E. coli (180 CFU/100ml), correlating with 120 reported cases of diarrhea and 85 skin infections. These findings align with the environmental concerns raised by residents in the Team 7 Neighborhood Association, who petitioned the Nigeria Centre for Disease Control (NCDC) over a persistent public health crisis linked to flooding and poor waste

management (Agu, 2025). The overlap between community-reported hazards and scientific data underscores the urgency for targeted environmental remediation and health surveillance in this district.

Lokogoma recorded the highest contamination levels across all parameters—E. coli (220 CFU/100ml), lead (110 mg/kg), and mercury (0.04 mg/L)—and correspondingly the highest disease burden: 150 diarrhea cases, 95 skin infections, and 75 respiratory illnesses. This mirrors findings from Nana (2025), who documented the consequences of rapid urbanization and poor drainage in Lokogoma Estates, emphasizing the role of unregulated development in exacerbating flood risks. The study supports the need for stricter zoning enforcement and improved sanitation infrastructure to mitigate health impacts.

Lugbe's results showed slightly lower contamination levels but still significant public health effects, including 100 diarrhea cases and 70 skin infections. Afeonkhai (2025) highlighted Lugbe's environmental challenges, including deforestation, waste mismanagement, and climate vulnerability, which contribute to recurrent flooding and disease outbreaks. The consistency between field data and published literature suggests that Lugbe's resilience depends on integrated urban planning and community-based adaptation strategies.

Yola North experienced the highest disease burden during the 2025 flood crisis, with 210 cholera cases and 320 diarrhea cases among children. This aligns with the cholera outbreak reported by Report Afrique (2024), where seven deaths and 71 hospitalizations were confirmed following flood-induced contamination of drinking water. The Joint Post-Flood Assessment by IOM (2024) further corroborates these findings, noting extensive damage to water points and sanitation facilities. These studies validate the urgent need for water safety interventions and emergency health preparedness in Yola North.

Demsa recorded 180 cholera cases and 280 diarrhea cases, with significant disruption to chronic disease care. The 2023 Rapid Needs Assessment by OCHA (2023) identified Demsa as one of the hardest-hit areas, with widespread displacement and infrastructure collapse. The overlap between our results and OCHA's assessment highlights the vulnerability of rural health systems and the importance of mobile clinics and supply chain resilience during flood emergencies.

Numan's data showed 160 cholera cases and 250 diarrhea cases, alongside 140 skin infections. Adesola et al. (2024) emphasized the long-term mental health effects and

chronic disease disruption in flood-affected communities like Numan. The consistency between clinical data and published findings reinforces the need for mental health integration and chronic care continuity in disaster response frameworks.

Recommendations

To effectively mitigate the environmental and public health risks of urban flooding across Gwarinpa, Lokogoma, Lugbe, Yola North, Demsa, and Numan, a multi-tiered strategy is essential. First, infrastructure upgrades must prioritize flood-resilient drainage systems, improved waste management, and the restoration of green spaces to reduce runoff and contamination. Regular environmental monitoring, especially of water and soil quality, should be institutionalized in high-risk zones like Lokogoma and Yola North. Healthcare facilities in flood-prone areas must be equipped with emergency supplies, including antibiotics, vaccines, and rehydration kits, while mobile clinics should be deployed to reach displaced populations during crises. Public health education campaigns focusing on hygiene, safe water practices, and early disease reporting can empower communities to reduce exposure and transmission.

Equally important is the integration of mental health services into disaster response frameworks. The psychological toll observed in Lugbe, Demsa, and Numan—marked by high rates of anxiety and PTSD—demands the deployment of trained mental health professionals and the establishment of community-based support systems. Policymakers should develop a national urban flood health response framework that includes mental health, chronic disease continuity, and emergency triage protocols. Cross-sector collaboration between government agencies, NGOs, and local communities will be vital to building resilience. By aligning environmental planning with clinical preparedness and psychosocial care, Nigeria can better protect its urban populations from the escalating threats of climate-induced flooding.

CONCLUSION

Urban flooding remains one of the most pressing environmental and public health challenges facing rapidly developing regions like Nigeria. The findings from this study, spanning both Abuja and Adamawa, reveal a consistent and alarming pattern: floodwaters carry a toxic mix of microbial pathogens, heavy metals, and industrial pollutants that contaminate water and soil, degrade ecosystems, and directly contribute to disease

outbreaks. In districts such as Lokogoma and Yola North, the correlation between environmental contamination and clinical burden was especially stark, with elevated levels of *E. coli*, lead, and mercury coinciding with spikes in diarrhea, cholera, typhoid, and hepatitis A. These results affirm the urgent need for integrated environmental monitoring and infrastructure upgrades in flood-prone urban zones.

The clinical implications of these findings are profound. Healthcare systems in Gwarinpa, Lugbe, Demsa, and Numan were overwhelmed by the surge in flood-related illnesses, ranging from acute infections to chronic disease disruptions. The lack of access to clean water, essential medications, and mental health services exacerbated the crisis, particularly among displaced populations. Mental health symptoms—such as anxiety, depression, and PTSD—were widespread, yet largely unaddressed due to limited psychosocial support. These outcomes highlight the necessity of embedding mental health care into disaster response frameworks and ensuring continuity of care for vulnerable groups during and after flood events.

This study also underscores the importance of localized, data-driven interventions. Each district exhibited unique vulnerabilities shaped by geography, infrastructure, and population density. For example, Lokogoma's unregulated urban expansion intensified its flood exposure, while Demsa's rural isolation hindered emergency response. Tailoring public health strategies to these local contexts—through targeted vaccination campaigns, mobile clinics, and community education—can significantly reduce health risks and improve resilience.

Ultimately, addressing the environmental and health hazards of urban flooding requires a multidisciplinary approach that bridges urban planning, environmental science, clinical medicine, and public health policy. Strengthening early warning systems, enforcing zoning regulations, investing in healthcare infrastructure, and fostering community engagement are critical steps toward building flood-resilient cities. As climate change continues to amplify extreme weather events, proactive and inclusive planning will be essential to safeguard the health and well-being of urban populations across Nigeria and beyond.

Conflict of Interest

The authors declare that there are no competing interests related to the content or publication of this manuscript.

Authors' Declaration

The authors certify that the research presented is entirely original and has not been published elsewhere. They assume full responsibility for the integrity and accuracy of the work, including any claims or implications arising from its content.

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