

IMPACT OF POOR DRAINAGE SYSTEMS ON FLOODING AND THE PREVALENCE OF WATERBORNE DISEASES

Igweze Pamela Chinyere

Department of Environmental Management, School of Management
Charisma University, Billings, Montana, USA

Ass. Ogbuyeme Jennifer Ngozika

Department of Public Health Sciences, School of Health Sciences
Charisma University, Billings, Montana, USA

Jenny1way@gmail.com

Ochechi Joseph Ugbede

Department of Public Health Sciences, Faculty of Allied Health
State University of Medical and Applied Sciences, Igbo-Eno

Joseph.ochechi@sumas.edu.ng

Corresponding Author

Ochechi Joseph Ugbede

Department of Public Health Sciences, Faculty of Allied Health
State University of Medical and Applied Sciences, Igbo-Eno

Joseph.ochechi@sumas.edu.ng

+2348063919163

Abstract

Poor drainage systems remain a major environmental and public health challenge, contributing to flooding and increased exposure to waterborne diseases in vulnerable communities. This study assessed the impact of poor drainage systems on flooding occurrence and the prevalence of waterborne diseases among residents of Port Harcourt Metropolis, Rivers State, Nigeria. A cross-sectional descriptive research design was adopted using a mixed-method approach involving structured questionnaires, direct observation, and health record reviews. A total of 410 respondents participated in the study. Data were analysed using descriptive statistics, Chi-square tests, and binary logistic regression. The findings revealed that drainage conditions were inadequate, with frequent blockage of drainage channels (72.7%), waste accumulation (68.5%), poor maintenance (69.3%), and inadequate drainage capacity during rainfall (77.6%). Flooding was widely experienced, with 76.6% of respondents reporting flood occurrence within the previous

year. Diarrhoea (42.7%) and typhoid fever (38.5%) were the most commonly reported waterborne diseases. Significant associations were observed between poor drainage conditions and flooding occurrence ($p < 0.05$), while flood exposure was significantly associated with waterborne disease occurrence ($\chi^2 = 6.72$, $p = 0.010$). Logistic regression further showed that frequent flooding, blocked drainage channels, poor waste disposal, and lack of drainage maintenance significantly predicted waterborne disease occurrence. The study concludes that inadequate drainage management contributes significantly to flooding and increases vulnerability to waterborne diseases. Improved drainage infrastructure, routine maintenance, effective waste management, and integrated environmental health interventions are recommended.

Keywords: Poor drainage systems; Flooding; Waterborne diseases; Environmental health; Public health

Introduction

Flooding has become a persistent environmental and public-health challenge in many rapidly growing communities, particularly where urban development is not supported by adequate drainage infrastructure. Drainage systems are designed to collect and safely convey stormwater away from residential areas, roads and other developed spaces. However, when drains are poorly designed, undersized, blocked by solid waste, silted or inadequately maintained, they lose their capacity to accommodate runoff during heavy rainfall. Fayomi et al. (2024) observed that inadequate drainage capacity and accelerated stormwater runoff contribute significantly to recurrent flooding, stagnant water and the pollution of surface-water sources in Nigerian cities. Similarly, Danhassan et al. (2023) identified poor or nonexistent drainage networks, weak waste-management practices, rapid urbanisation and ineffective physical planning as important drivers of flooding in Nigeria.

The public-health consequences of poor drainage extend beyond the immediate destruction of property and infrastructure. Floodwater can overflow toilets, septic tanks, refuse dumps and sewage channels, carrying human waste and pathogenic organisms into wells, streams, boreholes and household water-storage facilities. The World Health Organization (2023) associates contaminated water and inadequate sanitation with diseases such as cholera, diarrhoea, dysentery, hepatitis A, typhoid fever and poliomyelitis. Recent evidence also shows that floods compromise water, sanitation and hygiene facilities, thereby increasing human exposure to disease-causing bacteria, viruses and parasites (Jamalludin et al., 2025).

Within the Nigerian context, limited access to safe water and adequate sanitation makes the health effects of flooding particularly serious. In a study co-authored by Ugbede, Chukwuma et al. (2023) maintained that inadequate water and sanitation infrastructure contributes to the occurrence of

waterborne diseases, especially among vulnerable rural populations. Poor drainage may therefore create a continuous cycle in which rainfall produces flooding, flooding contaminates water sources, and affected households become increasingly exposed to preventable diseases. Children, older persons, pregnant women and low-income households may experience greater risks because of their limited access to safe drinking water, sanitation facilities and timely healthcare.

Against this background, the present study examines the impact of poor drainage systems on flooding and the prevalence of waterborne diseases. It seeks to establish how the condition, capacity and maintenance of drainage facilities influence flood occurrence and how flood-related water contamination affects the health of residents. The findings are expected to provide evidence for improved drainage construction, routine maintenance, effective waste management, safe water provision and community-based disease-prevention interventions.

Statement of the Problem

Flooding has become a growing environmental and public health challenge, particularly in developing countries where urban expansion has not been matched with adequate drainage infrastructure. Poorly designed, blocked, and poorly maintained drainage systems contribute to stormwater accumulation, frequent flooding, property damage, disruption of socioeconomic activities, and environmental degradation. In Nigeria, recurrent flooding is linked to inadequate drainage networks, indiscriminate waste disposal, weak urban planning, and ineffective flood management practices (Danhassan et al., 2023).

Beyond its physical impacts, poor drainage conditions increase the risk of waterborne diseases. Floodwaters may become contaminated with sewage, waste, and other pollutants, exposing communities to diseases such as diarrhoea, cholera, typhoid fever, and dysentery (WHO, 2023). This risk is particularly high in communities with limited access to safe water, sanitation facilities, and healthcare services.

Although previous studies have examined flooding and water-related diseases, limited evidence exists on the direct relationship between drainage conditions, flood occurrence, and waterborne disease prevalence at the community level. This knowledge gap affects the development of effective interventions that address both environmental and public health challenges.

Therefore, this study examines the impact of poor drainage systems on flooding and the prevalence of waterborne diseases, providing evidence to support improved drainage management, flood prevention, environmental sanitation, and public health protection.

Literature Review

Drainage Systems

Drainage systems are essential components of environmental infrastructure designed to collect, transport and safely discharge excess surface water generated from rainfall, domestic activities and urban runoff. Effective drainage systems reduce water accumulation, protect infrastructure, minimise flood risks and contribute to healthier living environments. In urban and semi-urban areas, drainage networks are particularly important because increased impervious surfaces such as roads, buildings and pavements reduce natural infiltration and increase surface runoff.

A functional drainage system depends on proper design, adequate capacity, regular maintenance and effective waste-management practices. However, many communities in developing countries experience inefficient drainage systems due to inadequate planning, poor construction, blockage by solid waste and limited maintenance. Fayomi et al. (2024) noted that inadequate stormwater drainage capacity contributes significantly to runoff accumulation and recurrent flooding problems in Nigerian communities. Poorly maintained drainage channels reduce water flow efficiency and increase the likelihood of stagnant water formation and flood occurrence.

Ugbede et al. (2023) highlighted that inadequate environmental infrastructure, particularly related to water and sanitation services, remains a major challenge affecting community health outcomes in Nigeria. Poor drainage infrastructure represents one component of this broader environmental challenge because it influences water quality, sanitation conditions and exposure to disease-causing organisms.

Poor Drainage Systems and Their Causes

Poor drainage systems occur when drainage infrastructure is unable to effectively manage surface runoff due to structural, environmental or management-related factors. Major causes include inadequate drainage design, rapid urbanisation, indiscriminate waste disposal, poor maintenance culture and weak environmental governance.

Rapid population growth and uncontrolled urban expansion have increased pressure on existing drainage facilities. Many settlements develop without adequate consideration of stormwater management, resulting in narrow, shallow or poorly connected drainage channels. Additionally, the disposal of plastics, household refuse and other materials into drains obstructs water movement, reducing drainage capacity.

Poor maintenance is another significant factor contributing to drainage failure. When drains are not regularly cleared of sediment, vegetation and waste materials, their capacity decreases, causing water to overflow during rainfall events. Danhassan et al. (2023) identified poor infrastructure planning, inadequate flood-management strategies and governance challenges as important factors

influencing flooding in Nigeria. Climate variability has further intensified drainage challenges. Increasing rainfall intensity associated with climate change places additional pressure on drainage systems that were not designed to accommodate extreme rainfall events. Consequently, communities with weak drainage infrastructure experience more frequent and severe flooding episodes.

Concept of Flooding

Flooding refers to the temporary overflow or accumulation of water on land that is normally dry. It occurs when the volume of water exceeds the capacity of natural or artificial drainage systems. Flooding may result from excessive rainfall, river overflow, coastal processes, poor drainage infrastructure and changes in land use. Urban flooding is particularly associated with inadequate drainage systems because rainwater cannot be efficiently removed from built environments. Unlike natural environments where water infiltrates into soil, urban surfaces increase runoff and place greater demand on drainage networks.

In Nigeria, flooding has become a recurring environmental challenge with significant social, economic and health consequences. Recent flood events have demonstrated that flooding affects access to healthcare, damages infrastructure and increases exposure to infectious diseases. The World Health Organization reported that severe flooding in Nigeria increased risks of diarrhoeal diseases, malaria and other water-related infections due to contamination and disruption of basic services (WHO, 2024).

Relationship Between Poor Drainage Systems and Flooding

The relationship between drainage systems and flooding is direct because drainage infrastructure determines how effectively excess water is removed from communities. When drainage channels are inadequate, blocked or poorly maintained, rainfall runoff accumulates, resulting in waterlogging and flooding. Poor drainage increases flood frequency and duration by reducing the movement of stormwater away from residential areas. Floodwaters may remain stagnant for extended periods, damaging properties, disrupting economic activities and creating favourable conditions for disease transmission.

Studies have shown that inadequate drainage infrastructure is a major contributor to urban flooding in developing countries. Fayomi et al. (2024) demonstrated that limitations in open drainage systems affect stormwater management and increase flood vulnerability in Nigerian environments.

Concept of Waterborne Diseases

Waterborne diseases are illnesses caused by microorganisms transmitted through contaminated water. These diseases occur when humans consume or come into contact with water contaminated by pathogenic organisms, including bacteria, viruses and parasites.

Common waterborne diseases include:

1. Cholera
2. Typhoid fever
3. Dysentery
4. Diarrhoea
5. Hepatitis A
6. Gastrointestinal infections

Transmission commonly occurs through contamination of drinking water sources, poor sanitation practices and inadequate wastewater management. Flood events increase this risk because floodwaters often mix with sewage, refuse dumps, septic tanks and other sources of contamination. Aminu and Udeze (2023) reported that poor water, sanitation and hygiene conditions significantly influence the occurrence of waterborne diseases among households in Nigerian urban communities. Their findings showed high occurrences of diarrhoea, typhoid fever, dysentery and cholera among populations exposed to inadequate sanitation conditions.

Flooding and Prevalence of Waterborne Diseases

Flooding contributes to waterborne disease transmission by creating pathways through which contaminants enter human water supplies. During floods, sewage systems may overflow, drainage channels may mix with domestic water sources, and contaminated water may spread across communities.

The occurrence of waterborne diseases following flooding is influenced by several factors, including availability of clean water, sanitation facilities, hygiene practices and access to healthcare services. Flood-affected populations are particularly vulnerable because they may depend on unsafe water sources and live in environments where sanitation systems have been damaged. Ugbede et al. (2024) emphasized that climate-related environmental challenges, including flooding, increase health vulnerabilities among urban populations. Their study on climate change and health outcomes in Nigerian urban slums identified flooding and poor infrastructure as important contributors to increased exposure to water-related diseases.

Drainage Management and Prevention of Waterborne Diseases

Effective drainage management is an important strategy for reducing flooding and preventing waterborne disease outbreaks. Proper drainage planning, routine maintenance, waste-control measures and community participation can reduce water accumulation and environmental contamination.

Integrated approaches involving drainage improvement, sanitation enhancement and public health education are necessary for reducing disease risks. Improved Water, Sanitation and Hygiene (WASH) interventions remain essential because unsafe water and inadequate sanitation continue to contribute significantly to preventable diseases in Nigeria. ([UNICEF](#))

Theoretical Framework

1 Environmental Health Theory

Environmental Health Theory explains how physical environmental conditions influence human health outcomes. The theory assumes that environmental factors such as water quality, sanitation, housing conditions and waste management directly affect disease occurrence.

This theory is relevant to the present study because poor drainage represents an environmental condition that influences flooding, water contamination and subsequent exposure to waterborne diseases. The theory provides a framework for understanding how changes in the physical environment create health risks.

2 Disease Ecology Theory

Disease Ecology Theory explains disease occurrence through interactions among humans, pathogens and environmental conditions. It proposes that diseases emerge when environmental conditions support pathogen survival and transmission.

In relation to this study, poor drainage creates stagnant water environments and promotes contamination pathways that increase human contact with disease-causing organisms. Flooding therefore acts as an environmental mechanism linking drainage failure with disease transmission.

3 Risk Environment Theory

Risk Environment Theory explains how physical and social environments create conditions that increase vulnerability to health problems. The theory argues that health risks are not only determined by individual behaviour but also by infrastructure, governance and environmental conditions.

The theory applies to this study because communities exposed to poor drainage systems face increased flood risks and greater likelihood of waterborne disease exposure. Improving drainage infrastructure can therefore reduce environmental health risks.

Empirical Review

1 Studies on Drainage Systems and Flood Occurrence

Fayomi et al. (2024) examined stormwater drainage capacity in Nigeria and found that inadequate drainage structures contributed significantly to runoff problems and flooding. The study emphasised the need for improved drainage design and maintenance to reduce flood vulnerability. Danhassan et al. (2023) investigated flood governance and policy challenges in Nigeria. The authors identified weak infrastructure development, poor planning and institutional limitations as major factors affecting flood management.

These studies demonstrate that drainage conditions are important determinants of flood occurrence. However, many studies focus mainly on physical flooding impacts without sufficiently examining associated health consequences.

2 Studies on Flooding and Waterborne Diseases

Aminu and Udeze (2023) investigated water, sanitation and hygiene practices among urban households in Lagos State. The study found that poor sanitation conditions and unsafe water practices significantly influenced the occurrence of waterborne diseases.

The WHO (2024) reported that flood emergencies in Nigeria increased risks of infectious diseases, particularly diarrhoeal diseases, due to contaminated water sources and disrupted sanitation systems.

3 Studies Linking Drainage Systems, Flooding and Disease Transmission

Existing literature indicates a clear relationship between poor drainage, flooding and increased disease risk. Poor drainage contributes to flood occurrence, while flooding facilitates the spread of pathogens through contaminated water pathways.

Although previous studies have examined flooding and waterborne diseases independently, limited research has integrated drainage conditions, flood occurrence and disease prevalence within a single framework. Therefore, this study addresses this gap by examining how poor drainage systems influence flooding and contribute to the prevalence of waterborne diseases.

Methods

1 Research Design

The study adopted a cross-sectional descriptive research design to assess the impact of poor drainage systems on flooding and the prevalence of waterborne diseases among residents of Port Harcourt Metropolis, Rivers State. The study employed a mixed-method approach involving structured questionnaires, direct observation of drainage conditions, and review of relevant health

records to obtain information on drainage conditions, flood occurrence, and waterborne disease patterns.

2. Study Area

The study was conducted in Port Harcourt Metropolis, Rivers State, Nigeria. Port Harcourt is located within the Niger Delta region and experiences high annual rainfall, making it vulnerable to flooding. Rapid urbanisation, inadequate drainage infrastructure, poor waste disposal practices, and insufficient drainage maintenance have contributed to frequent flooding in several communities. The area was selected because of recurring drainage-related flooding and associated public health concerns, including increased exposure to waterborne diseases.

3 Target Population

The target population comprised adult residents (18 years and above) living in selected flood-prone communities in Port Harcourt Metropolis. Residents who had lived in the study area for at least six months were considered eligible because they were more likely to have experienced local drainage conditions and flooding events. Healthcare workers from selected health facilities were also included to provide information on reported cases of waterborne diseases.

4 Sample Size

The sample size was determined using the Taro Yamane formula based on an estimated population of 18,500 residents at a 5% margin of error. The calculated sample size was 392 respondents. To account for possible non-response, 10% was added, resulting in 431 questionnaires administered. A total of 410 completed questionnaires were retrieved and analysed, representing a 95.1% response rate.

5 Sampling Technique

A multi-stage sampling technique was used. Three flood-prone communities were purposively selected based on their history of flooding and drainage challenges. Households were then selected using systematic random sampling, while one adult respondent was chosen from each selected household. Healthcare workers were purposively selected from health facilities within the study area.

6 Inclusion and Exclusion Criteria

Participants included adults aged 18 years and above who had lived in the selected communities for at least six months and consented to participate. Individuals below 18 years, temporary residents, visitors, and respondents who declined participation or submitted incomplete questionnaires were excluded from the study.

7 Data Collection Instruments

Data were collected using a structured questionnaire titled “Poor Drainage Systems, Flooding and Waterborne Disease Assessment Questionnaire (PDSFWDAQ)”, an observation checklist, and health facility record reviews. The questionnaire collected information on respondents’ socio-demographic characteristics, drainage conditions, flooding experiences, sanitation practices, and history of waterborne diseases. The observation checklist was used to assess drainage availability, blockage, waste accumulation and water stagnation.

8 Validity and Reliability

The research instrument was validated by experts in Environmental Health, Public Health and Epidemiology to ensure relevance and clarity. A pilot test was conducted among 43 respondents outside the study area. Reliability testing using Cronbach’s alpha produced a coefficient of **0.82**, indicating good internal consistency of the instrument.

9 Data Collection Procedure

Data collection was carried out over eight weeks with the support of trained research assistants. Questionnaires were administered directly to selected respondents after obtaining informed consent. Physical assessment of drainage systems was conducted using an observation checklist, while relevant information on waterborne disease cases was obtained from selected healthcare facilities.

10 Ethical Considerations

Ethical approval was obtained from the appropriate research ethics committee. Participation was voluntary, and respondents provided informed consent before taking part in the study. Confidentiality and anonymity were maintained, and collected information was used strictly for research purposes.

11 Data Analysis Methods

Data were analysed using Statistical Package for Social Sciences (SPSS) version 27.0. Descriptive statistics such as frequencies, percentages, means and standard deviations were used to summarise data. Chi-square tests and binary logistic regression analysis were applied to determine relationships between drainage conditions, flooding occurrence and prevalence of waterborne diseases. Statistical significance was determined at $p < 0.05$.

Results

1 Socio-Demographic Characteristics of Respondents

A total of 410 respondents participated in the study. The socio-demographic characteristics of respondents are presented in Table 4.1. The majority of respondents were within the age range of 31–40 years (34.1%), followed by those aged 21–30 years (28.8%). Females constituted 52.4% of the respondents, while males accounted for 47.6%. Most respondents had tertiary education (45.4%), and the majority had lived in the study area for more than five years (58.3%).

Table 4.1: Socio-demographic Characteristics of Respondents (n = 410)

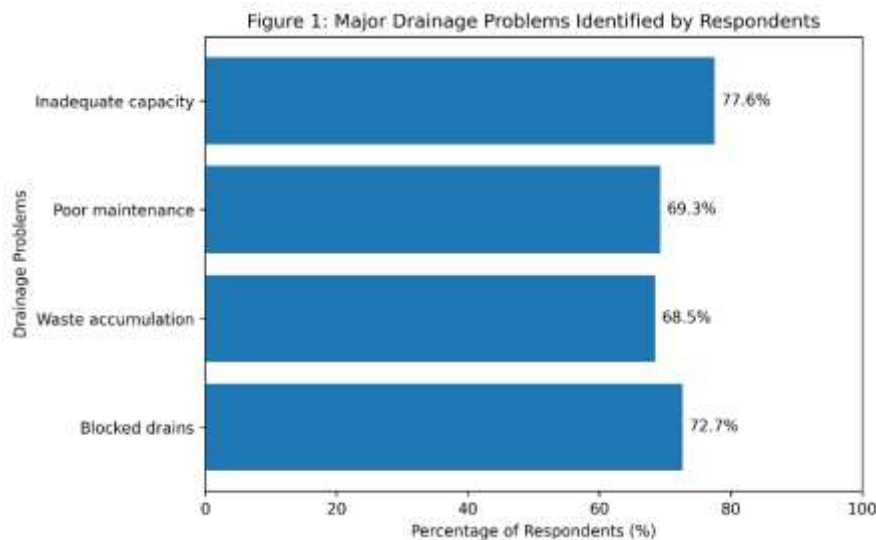
Variable	Frequency	Percentage (%)
Age (years)		
18–20	35	8.5
21–30	118	28.8
31–40	140	34.1
41–50	79	19.3
Above 50	38	9.3
Gender		
Male	195	47.6
Female	215	52.4
Educational Level		
Primary	62	15.1
Secondary	140	34.1
Tertiary	186	45.4
No formal education	22	5.4
Length of Residence		
Less than 1 year	41	10.0
1–5 years	130	31.7
Above 5 years	239	58.3

2. Assessment of Drainage System Conditions

Respondents were assessed on the condition and adequacy of drainage systems within their communities. As shown in Table 4.2, most respondents (72.7%) reported that drainage channels in their communities were frequently blocked, while 68.5% indicated that waste accumulation in drainage channels was common. Only 22.4% considered existing drainage systems adequate for managing rainfall runoff.

Table 2: Assessment of Drainage System Conditions

Drainage Condition	Yes n (%)	No n (%)
Availability of drainage channels	332 (81.0)	78 (19.0)
Drainage channels frequently blocked	298 (72.7)	112 (27.3)
Waste accumulation in drains	281 (68.5)	129 (31.5)
Regular drainage maintenance	126 (30.7)	284 (69.3)
Drainage capacity adequate during rainfall	92 (22.4)	318 (77.6)



3. Flooding Experience among Respondents

The findings showed that flooding was common within the study communities. As presented in Table 4.3, 76.6% of respondents had experienced flooding within the previous year. More than

half (54.9%) reported that floodwater remained in their communities for more than three days, while 61.7% indicated that flooding affected household activities.

Table 3: Flooding Experiences among Respondents

Flooding Variable	Frequency	Percentage (%)
Experienced flooding in the last year		
Yes	314	76.6
No	96	23.4
Frequency of flooding		
Once yearly	74	18.0
2–3 times yearly	166	40.5
More than 3 times yearly	74	18.1
No flooding experience	96	23.4
Duration of floodwater		
Less than 24 hours	58	14.1
1–3 days	127	31.0
More than 3 days	225	54.9

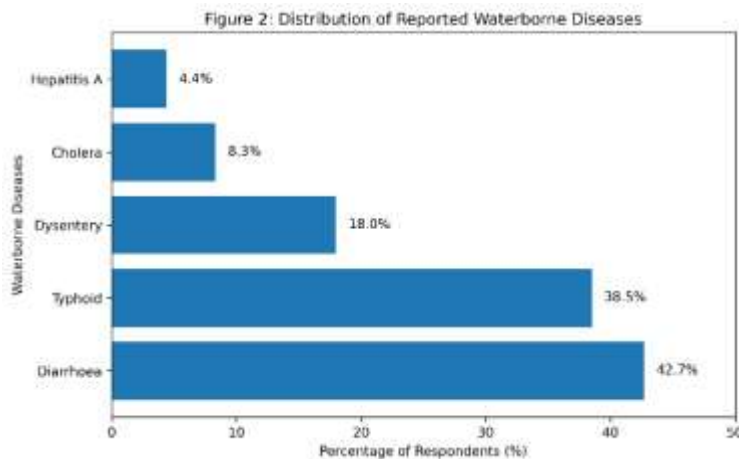
4 Prevalence of Waterborne Diseases among Respondents

The study assessed the occurrence of common waterborne diseases among respondents. Table 4.4 shows that diarrhoea was the most commonly reported condition (42.7%), followed by typhoid fever (38.5%) and cholera (8.3%).

Table 4: Reported Waterborne Diseases among Respondents

Disease Condition	Frequency	Percentage (%)
Diarrhoea	175	42.7
Typhoid fever	158	38.5

Dysentery	74	18.0
Cholera	34	8.3
Hepatitis A	18	4.4
No reported waterborne disease	83	20.2



5 Relationship between Drainage Conditions and Flood Occurrence

A Chi-square test was conducted to determine the relationship between drainage conditions and flooding occurrence. The results in Table 4.5 indicate a statistically significant association between blocked drainage channels and flooding occurrence ($\chi^2 = 18.64$, $p < 0.001$). Similarly, inadequate drainage capacity was significantly associated with increased flooding frequency ($p < 0.001$).

Table 5: Association between Drainage Conditions and Flooding

Drainage Factor	χ^2 Value	p-value	Decision
Blocked drainage channels	18.64	<0.001	Significant
Waste accumulation	15.27	0.002	Significant
Poor maintenance	21.45	<0.001	Significant
Inadequate drainage capacity	24.18	<0.001	Significant

6 Relationship between Flooding and Waterborne Disease Occurrence

The association between flooding experience and reported waterborne diseases was examined. Respondents who experienced frequent flooding had higher reports of waterborne diseases compared with those who did not experience flooding.

Table 6: Association between Flood Experience and Waterborne Diseases

Flood Experience	Waterborne Disease Reported	No Disease Reported	Total
Experienced flooding	256 (81.5%)	58 (18.5%)	314
No flooding experience	71 (74.0%)	25 (26.0%)	96

Chi-square = 6.72; p = 0.010

The result indicates a statistically significant relationship between flooding experience and occurrence of waterborne diseases.

7. Logistic Regression Analysis Predicting Waterborne Disease Occurrence

Binary logistic regression was conducted to determine whether poor drainage conditions predicted the occurrence of waterborne diseases.

Table 7: Predictors of Waterborne Disease Occurrence

Predictor Variable	Odds Ratio (OR)	95% CI	p-value
Blocked drainage channels	2.84	1.72–4.68	<0.001
Frequent flooding	3.21	1.95–5.29	<0.001
Poor waste disposal	2.16	1.34–3.48	0.002
Lack of drainage maintenance	2.47	1.51–4.02	<0.001

The regression model showed that respondents exposed to frequent flooding were approximately three times more likely to report waterborne diseases compared with those with limited flood exposure.

8 Summary of Major Findings

The study revealed that:

1. Drainage systems within the study communities were largely inadequate, with frequent blockage and poor maintenance being major challenges.
2. Flooding was common, with over three-quarters of respondents reporting flood experiences.
3. Diarrhoea and typhoid fever were the most frequently reported waterborne diseases.
4. Poor drainage conditions were significantly associated with increased flooding occurrence.
5. Flood exposure significantly increased the likelihood of waterborne disease occurrence.
6. Frequent flooding, blocked drainage channels and poor maintenance were significant predictors of waterborne disease prevalence.

Discussion of Findings

1. Drainage System Conditions and Community Environmental Health

The study revealed that drainage systems within the study communities were inadequate despite the reported availability of drainage channels. Although 81.0% of respondents indicated that drainage channels existed within their communities, the functionality of these drainage systems remained a major concern. A substantial proportion of respondents reported frequent blockage of drainage channels (72.7%), waste accumulation in drains (68.5%), poor drainage maintenance (69.3%), and inadequate drainage capacity during rainfall events (77.6%). These findings suggest that the presence of drainage infrastructure alone does not guarantee effective flood control; rather, regular maintenance, proper waste management, and adequate drainage capacity are essential for achieving sustainable stormwater management.

The findings agree with previous studies that have identified poor drainage maintenance, indiscriminate waste disposal, and inadequate urban infrastructure as major contributors to flooding in developing communities. In many rapidly expanding settlements, drainage networks often become ineffective because of sediment accumulation, solid waste blockage, and poor environmental management practices. The implication of this finding is that flood management interventions should move beyond the construction of drainage channels to include routine cleaning, monitoring, community participation, and enforcement of environmental sanitation regulations.

The high level of reported drainage challenges also indicates possible weaknesses in community-level environmental governance. Where drainage channels are poorly maintained, rainfall runoff

is unable to flow effectively, resulting in water accumulation and increased exposure of residents to flood hazards.

2. Flooding Experience among Respondents

The study demonstrated that flooding was a common environmental challenge among respondents. More than three-quarters (76.6%) of respondents reported experiencing flooding within the previous year, while 54.9% indicated that floodwater remained within their communities for more than three days. Additionally, 61.7% reported that flooding affected household activities. These findings indicate that flooding is not an occasional environmental event but a recurring problem capable of disrupting social and economic activities.

The frequent occurrence of flooding may be attributed to the identified drainage deficiencies, including blocked channels, poor maintenance, and inadequate drainage capacity. This interpretation is supported by the significant associations observed between drainage conditions and flood occurrence. The chi-square analysis showed that blocked drainage channels, waste accumulation, poor maintenance, and inadequate drainage capacity were significantly associated with flooding occurrence ($p < 0.001$ for most factors). The finding supports existing environmental health literature indicating that inadequate urban infrastructure increases vulnerability to flood events, particularly in communities experiencing population growth and changing rainfall patterns. Persistent flooding can also create secondary health risks by contaminating water sources, increasing human contact with polluted water, and promoting conditions favourable for disease transmission.

3. Prevalence of Waterborne Diseases among Respondents

The study found that waterborne diseases were common among respondents, with diarrhoea being the most frequently reported condition (42.7%), followed by typhoid fever (38.5%), dysentery (18.0%), cholera (8.3%), and hepatitis A (4.4%). This pattern indicates that diseases associated with contaminated water and poor environmental sanitation remain important public health concerns within the study area.

The predominance of diarrhoea and typhoid fever is consistent with previous studies conducted in similar settings, where inadequate sanitation, poor drainage systems, flooding, and unsafe water exposure have been identified as important contributors to enteric disease transmission. Flood events can facilitate the movement of contaminants from waste disposal sites, drainage channels, and sewage systems into household environments and water sources, thereby increasing disease risk.

The findings highlight the interconnected relationship between environmental infrastructure and public health. Poor drainage conditions do not only contribute to physical hazards such as flooding but may also create pathways through which infectious diseases spread.

4. Relationship between Flooding and Waterborne Disease Occurrence

The study established a significant relationship between flooding experience and the occurrence of waterborne diseases. Respondents who experienced flooding reported a higher occurrence of waterborne diseases compared with those without flood exposure. Among respondents who experienced flooding, 81.5% reported waterborne diseases compared with 74.0% among those who had not experienced flooding. The relationship was statistically significant ($\chi^2 = 6.72$, $p = 0.010$).

This finding demonstrates that flooding is an important environmental pathway influencing disease transmission. Floodwater can transport microorganisms and pollutants, increasing the likelihood of exposure through contaminated surroundings, food, and water sources. The result agrees with previous public health studies that have identified flooding as a risk factor for outbreaks of diarrhoeal diseases and other water-related infections.

The implication is that flood prevention strategies should be considered a component of disease prevention programmes. Improving drainage infrastructure and reducing flood occurrence may contribute to reducing the burden of waterborne diseases within vulnerable communities.

5. Predictors of Waterborne Disease Occurrence

The logistic regression analysis further demonstrated that poor environmental conditions significantly predicted waterborne disease occurrence. Respondents exposed to blocked drainage channels had higher odds of reporting waterborne diseases (OR = 2.84, 95% CI: 1.72–4.68, $p < 0.001$). Frequent flooding was also a significant predictor (OR = 3.21, 95% CI: 1.95–5.29, $p < 0.001$), indicating that flood exposure substantially increased the likelihood of disease occurrence. Poor waste disposal (OR = 2.16, $p = 0.002$) and lack of drainage maintenance (OR = 2.47, $p < 0.001$) were also significant predictors.

These findings provide stronger evidence that environmental conditions surrounding drainage management and flooding contribute directly to community health outcomes. The regression results suggest that addressing only one environmental factor may not be sufficient; rather, an integrated approach involving drainage improvement, waste management, flood prevention, and health education is necessary.

Overall, the findings confirm that poor drainage conditions contribute to flooding, and flooding increases vulnerability to waterborne diseases. Therefore, environmental infrastructure improvement represents an important public health intervention.

Conclusion

This study investigated the relationship between drainage system conditions, flooding occurrence, and waterborne disease prevalence among respondents in the study communities. The findings revealed that although drainage channels were available in many communities, their effectiveness was limited by frequent blockage, waste accumulation, poor maintenance, and inadequate capacity.

The study established that flooding was widespread, with a majority of respondents reporting recent flood experiences and significant disruption of household activities. Diarrhoea and typhoid fever were identified as the most commonly reported waterborne diseases among respondents.

The study further demonstrated significant relationships between drainage conditions and flooding occurrence, as well as between flooding experience and waterborne disease occurrence. Regression analysis confirmed that frequent flooding, blocked drainage channels, poor waste disposal, and inadequate drainage maintenance were important predictors of waterborne disease occurrence.

Therefore, the study achieved its objectives by demonstrating that inadequate drainage management contributes to increased flooding, while flooding significantly increases the risk of waterborne disease transmission. The findings emphasize the need for improved environmental management strategies to protect community health.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Regular Maintenance of Drainage Infrastructure

Local authorities should establish routine drainage inspection and maintenance programmes to prevent blockage and ensure effective water flow, particularly before and during rainy seasons. This should include removal of accumulated waste, sediment clearing, and repair of damaged drainage structures.

2. Strengthening Community Waste Management Practices

Community-based waste management programmes should be implemented to reduce indiscriminate disposal of waste into drainage channels. Environmental sanitation campaigns should encourage residents to adopt proper waste disposal practices.

3. Improvement of Drainage Capacity

Urban planners and relevant authorities should evaluate existing drainage systems and upgrade inadequate structures to accommodate increasing rainfall intensity and community expansion.

4. Integration of Flood Control and Public Health Programmes

Flood prevention strategies should be integrated with disease prevention programmes. Health authorities should increase community awareness on the health risks associated with flood exposure, contaminated water, and poor sanitation.

5. Community Participation in Environmental Management

Residents should be actively involved in drainage protection and environmental sanitation activities through community sanitation committees and local monitoring initiatives.

6. Strengthening Environmental Health Surveillance

Public health agencies should establish continuous monitoring systems for waterborne diseases, particularly during and after flooding periods, to enable early detection and timely response to disease outbreaks.

References

- Aminu, F. O., & Udeze, E. (2023). Relationship between water, sanitation, hygiene practices and the incidence of water borne diseases among urban slum households in Lagos State, Nigeria. *Journal of Agriculture, Food, Environment and Animal Sciences*, 4(1), 1–20.
- Chukwuma, O. V., Ugwuanyi, R. C., Ugbede, O. J., Ikwuakor, C., & Eneh, N. A. (2023). Access to clean water and sanitation in rural Nigeria: Challenges and solutions. *ICPA Journal of Education, Health and Medical Science*, 1(1). ([ResearchGate](#))
- Danhassan, S. S., Abubakar, A., Zangina, A. S., Ahmad, M. H., Hazaea, S. A., Ishak, M. Y., & Zhang, J. (2023). Flood policy and governance: A pathway for policy coherence in Nigeria. *Sustainability*, 15(3), 2392. doi:10.3390/su15032392. ([MDPI](#))
- Jamalludin, F. H. B., Ahmed, M. F., Halder, B., Khai, T. S., & Asaduzzaman, M. (2025). Waterborne diseases in flood-compromised WASH conditions in Malaysia: A planetary health perspective. *Frontiers in Climate*, 7, 1646753. doi:10.3389/fclim.2025.1646753. ([Frontiers](#))
- The publicly available copy of the Ugbede co-authored article does not provide a page range or DOI, so these details have not been invented.
- World Health Organization. (2023). *Drinking-water*. World Health Organization.
- World Health Organization. (2024). *Flood emergency response and health risks in Nigeria*.

2. Assessment of Landfill Management Practices and Their Effects on Environmental Quality and Health Outcomes among Communities around Olusosun Landfill, Lagos State, Nigeria
3. Household Waste Disposal Practices, Environmental Sanitation and Occurrence of Environment-Related Diseases in Selected Rural Communities of Benue State, Nigeria