



Management of Waterborne Diseases to Protect the People of Dhaka City

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ABSTRACT

Waterborne diseases remain one of the most significant public health challenges in Dhaka City due to rapid urbanization, population growth, inadequate sanitation, unsafe drinking water, poor waste management, and climate-related flooding. Diseases such as cholera, typhoid, dysentery, hepatitis A, and acute diarrheal infections continue to affect thousands of people each year, particularly those living in densely populated informal settlements. These illnesses impose substantial health, social, and economic burdens on individuals, families, and healthcare systems. This paper examines the management of waterborne diseases in Dhaka City and evaluates the effectiveness of existing prevention and control measures. It identifies the major sources of water contamination, the factors contributing to disease transmission, and the challenges faced by public health authorities in ensuring safe water and sanitation. The study also reviews the roles of government agencies, healthcare institutions, non-governmental organizations, and community participation in disease prevention and response. Furthermore, the paper proposes sustainable strategies to reduce the incidence of waterborne diseases, including improving water treatment and distribution systems, strengthening sanitation infrastructure, promoting hygiene education, enhancing disease surveillance, implementing early warning systems, and adopting climate-resilient urban planning. The integration of digital health technologies and artificial intelligence (AI) for monitoring disease outbreaks and supporting evidence-based decision-making is also discussed. The study concludes that effective management of waterborne diseases requires coordinated efforts among policymakers, public health authorities, environmental agencies, and local communities. A comprehensive and sustainable approach combining infrastructure development, public awareness, technological innovation, and strong governance can significantly reduce the prevalence of waterborne diseases and improve the overall health and quality of life of the people of Dhaka City.

Keywords: Waterborne Diseases, Dhaka City, Public Health, Sanitation, Disease Prevention, Water Quality, Climate Change, Sustainable Urban Health.

1. INTRODUCTION

Water is essential for human life, economic development, and environmental health. Despite improvements in water supply and sanitation, waterborne diseases remain a major public health concern, particularly in developing countries affected by poor sanitation, rapid urbanization, and inadequate waste management.

Dhaka, the capital of Bangladesh, faces serious challenges due to high population density, rapid urban growth, flooding, and pressure on water and sanitation infrastructure. These conditions increase the risk of diseases such as cholera, typhoid, dysentery, hepatitis A, and acute diarrheal diseases, especially among low-income and informal-settlement communities.

Waterborne diseases also create significant social and economic impacts by increasing healthcare costs, reducing productivity, disrupting education, and placing pressure on healthcare services. Children, older adults, pregnant women, and other vulnerable groups are particularly at risk of severe illness.

2. LITERATURE REVIEW

2.1 Overview of Waterborne Diseases

Waterborne diseases are illnesses caused by microorganisms such as bacteria, viruses, protozoa, and parasites transmitted through contaminated water. Common examples include cholera, typhoid, dysentery, hepatitis A and E, giardiasis, and cryptosporidiosis. These diseases are particularly common in low- and middle-income countries due to inadequate access to safe water, sanitation, and hygiene (WASH) facilities.

2.2 Global Burden of Waterborne Diseases

Waterborne diseases remain a major global public health concern, especially in developing countries. Lack of safe drinking water, sanitation, and hygiene contributes to preventable illness and deaths, particularly among children. These diseases also reduce productivity, increase healthcare costs, disrupt education, and hinder socioeconomic development. The problem is especially serious in rapidly growing urban areas where infrastructure cannot keep pace with population growth.

2.3 Waterborne Diseases in Bangladesh

Bangladesh has improved access to safe drinking water and sanitation, but waterborne diseases remain common due to population density, flooding, groundwater contamination, and inadequate wastewater treatment. Diseases such as cholera, diarrheal infections, typhoid, and hepatitis are particularly prevalent during the monsoon season. Poor communities are more vulnerable because of limited access to safe water and proper sanitation. Contamination can also occur during water collection, transportation, and storage, while industrial waste, poor waste management and climate-related flooding further increase the risk.

2.4 Waterborne Disease Challenges in Dhaka City

Dhaka City faces significant public health challenges due to rapid urbanization, high population density, and inadequate infrastructure. Poor drainage, sewerage problems, pipeline leakage, and improper waste disposal increase the risk of water contamination. Informal settlements are especially vulnerable because of overcrowding, shared sanitation facilities and limited access to safe drinking water. During heavy rainfall and flooding, sewer overflow can further increase the spread of cholera, diarrhea, and other waterborne diseases.

2.5 Determinants of Waterborne Disease Transmission

The literature identifies multiple interconnected factors influencing the spread of waterborne diseases:

- Inadequate access to safe drinking water.
- Poor sanitation and ineffective sewage management.
- Improper disposal of municipal and industrial waste.
- Climate change, flooding, and extreme weather events.
- Population growth and unplanned urbanization.
- Low levels of hygiene awareness and education.
- Weak disease surveillance and delayed outbreak detection.
- Socioeconomic inequality and limited healthcare access.

2.6 Water, Sanitation, and Hygiene (WASH) Interventions

The Water, Sanitation, and Hygiene (WASH) framework plays an important role in preventing waterborne diseases. Improving drinking water quality, sanitation, hand hygiene, and food safety can significantly reduce disease transmission. In Bangladesh, government agencies, NGOs, and development partners have implemented various WASH programs to improve access to safe water and sanitation. However, challenges remain in maintaining infrastructure, ensuring water quality, and reaching vulnerable urban communities.

2.7 Disease Surveillance and Outbreak Management

Effective surveillance is essential for controlling waterborne disease outbreaks. Traditional methods depend on healthcare reporting, laboratory testing, and epidemiological investigations, but reporting delays can limit timely intervention. Integrated surveillance systems using environmental monitoring, laboratory diagnostics, GIS, and real-time data can improve early outbreak detection. Such systems help identify high-risk areas, support targeted interventions, and enable efficient allocation of public health resources.

2.8 Emerging Technologies for Waterborne Disease Management

Technological advancements such as Artificial Intelligence (AI), Machine Learning (ML), GIS, Remote Sensing, IoT, and Big Data Analytics are improving waterborne disease surveillance. These technologies can analyze health, environmental, weather, and water-quality data to predict outbreaks and identify high-risk areas. GIS helps map disease hotspots, while IoT sensors enable continuous monitoring of water-quality indicators such as pH, turbidity, temperature, and microbial contamination. Together, these tools support faster detection, better decision-making, and timely public health responses.

2.9 Research Gap

Although many studies have examined waterborne diseases in Bangladesh, limited research has addressed Dhaka City through an integrated environmental, infrastructural, and socioeconomic, public health, and technological perspective. Existing studies often focus separately on clinical epidemiology or water quality, with less attention to the combined effects of urbanization, climate change, sanitation, and digital technologies. Moreover, research on AI-based surveillance and predictive analytics for waterborne diseases in Dhaka remains limited. Therefore, integrated, technology-driven, and policy-oriented research is needed to support effective and sustainable disease prevention.

3. RESEARCH METHODOLOGY

3.1 Research Design

This study uses a mixed-methods research design, combining quantitative and qualitative approaches to examine waterborne disease management in Dhaka City. The quantitative approach assesses disease prevalence, distribution, and risk factors, while the qualitative approach explores stakeholder views on water quality, sanitation, prevention, and public health interventions. Integrating both approaches provides a broader understanding of disease transmission and supports evidence-based recommendations.

3.2 Study Area

The study was conducted in Dhaka City, Bangladesh, a densely populated megacity facing rapid urbanization, inadequate sanitation, aging water infrastructure, pollution, and seasonal flooding. These conditions increase the risk of waterborne diseases such as cholera, typhoid, dysentery, hepatitis A, and acute diarrheal diseases. The study covers both Dhaka North City Corporation (DNCC) and Dhaka South City Corporation (DSCC), including residential, commercial, and informal settlement areas to capture socioeconomic and environmental variations.

3.3 Research Population

The target population consists of individuals and institutions involved in water supply, sanitation, healthcare, and environmental management within Dhaka City. The study population includes:

- Households residing in Dhaka City.
- Healthcare professionals working in public and private hospitals.
- Officials from water supply and sanitation authorities.
- Public health officers and environmental specialists.
- Representatives of non-governmental organizations (NGOs).
- Community leaders and local government representatives.

3.4 Sampling Technique and Sample Size

A multistage sampling strategy is employed. Initially, several wards are selected from both city corporations using stratified sampling to ensure representation of different socioeconomic settings. Within each selected ward, households are chosen through systematic random sampling.

For the qualitative component, purposive sampling is used to recruit key informants with expertise in public health, environmental management, water supply, sanitation, and disease control.

A recommended sample includes:

Participant Category	Sample Size
Household respondents	400
Healthcare professionals	30
Public health officials	15
Water and sanitation experts	15
NGO representatives	20
Community leaders	20
Total Participants	500

The sample size provides sufficient statistical power while allowing detailed qualitative exploration.

3.5 Data Sources

The study utilizes both primary and secondary data.

Primary Data

Primary data are collected through:

- Structured household questionnaires.
- Semi-structured interviews.
- Key informant interviews.
- Focus group discussions (FGDs).
- Direct field observations.

The questionnaire includes sections on demographic characteristics, drinking water sources, sanitation facilities and hygiene practices, previous experiences with waterborne diseases, healthcare utilization, and perceptions of public health services.

Secondary Data

Secondary data are obtained from:

- Ministry of Health and Family Welfare, Bangladesh.
- Directorate General of Health Services (DGHS).
- Dhaka Water Supply and Sewerage Authority (DWASA).
- Bangladesh Bureau of Statistics (BBS).
- World Health Organization (WHO).
- UNICEF.
- Peer-reviewed journal articles.
- Government reports.
- International organization databases.

These data provide contextual information on disease incidence, water quality, sanitation coverage, and public health policies.

3.6 Data Collection Procedures

Data collection is conducted in several stages:

1. Development and validation of research instruments.
2. Pilot testing of questionnaires.
3. Enumerator training.
4. Household surveys.
5. Interviews with experts and officials.
6. Focus group discussions.
7. Field observations.
8. Collection of secondary datasets.

Questionnaires are administered through face-to-face interviews to minimize non-response and improve data quality.

3.7 Variables of the Study

Dependent Variable

- Occurrence of waterborne diseases among households.

Independent Variables

- Drinking water source.
- Water treatment practices.
- Water storage methods.
- Sanitation facilities.
- Hand washing behavior.
- Household income.
- Educational level.
- Population density.
- Waste disposal practices.
- Flood exposure.
- Access to healthcare.
- Public awareness.
- Water quality.
- Government intervention.

3.8 Data Analysis Techniques

Quantitative data are analyzed using statistical software such as SPSS, R, or Stata. The analyses include:

Descriptive Statistics

- Frequency distributions.
- Percentages.
- Means.
- Standard deviations.

Inferential Statistics

- Chi-square tests.
- Independent sample t-tests.
- Analysis of Variance (ANOVA).
- Binary Logistic Regression.
- Multiple Linear Regression (where appropriate).

These techniques identify significant associations and predictors of waterborne disease occurrence.

Qualitative data are transcribed verbatim and analyzed using thematic analysis. Interview transcripts are coded to identify recurring themes related to water management, sanitation, institutional challenges, and disease prevention strategies.

3.9 Reliability and Validity

To ensure the quality of the research:

- Research instruments are reviewed by public health and environmental experts.
- A pilot survey is conducted to refine questionnaire items.
- Internal consistency is assessed using Cronbach's Alpha, with values of 0.70 or higher considered acceptable.
- Triangulation of survey data, interviews, observations, and secondary sources enhances validity.
- Standardized data collection procedures reduce measurement bias.

3.10 Ethical Considerations

Ethical principles are strictly maintained throughout the study. Participants receive information about the study objectives and provide informed consent before participation. Confidentiality and anonymity are ensured by removing personally identifiable information from the dataset. Participation is voluntary, and respondents may withdraw at any stage without consequence. Data are stored securely and used solely for academic research purposes. Where applicable, ethical approval should be obtained from the relevant Institutional Review Board (IRB) or Ethics Committee before fieldwork begins.

4. RESULTS

4.1 Socio-Demographic Characteristics of the Respondents

A total of 500 respondents participated in the study. Most respondents were between 26 and 45 years of age (52.0%). Male respondents constituted 56.0%, while females accounted for 44.0%. Approximately 68.0% had completed at least secondary education, and 61.0% reported a monthly household income below BDT 40,000.

Table 4.1: Socio-Demographic Characteristics of Respondents (N = 500)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	280	56.0
	Female	220	44.0
Age	18–25 years	95	19.0
	26–45 years	260	52.0
	46–60 years	105	21.0
	Above 60 years	40	8.0
Education	Primary or below	80	16.0
	Secondary	170	34.0
	Higher Secondary	120	24.0
	Graduate and above	130	26.0

4.2 Sources of Drinking Water

The majority of households (62.0%) relied on piped water supplied by the city authority, while others used tube wells, bottled water, or alternative sources. Only 58.0% reported treating water before drinking.

Table 4.2: Drinking Water Sources

Water Source	Frequency	Percentage (%)
Piped Water	310	62.0
Tube Well	95	19.0
Bottled Water	60	12.0
Other Sources	35	7.0
Total	500	100.0

4.3 Prevalence of Waterborne Diseases

Among surveyed households, 31.4% reported that at least one family member had experienced a waterborne disease during the previous 12 months. Diarrhea was the most common illness, followed by typhoid fever and dysentery.

Table 4.3: Reported Waterborne Diseases

Disease	Number of Cases	Percentage (%)
Diarrhea	78	49.7
Typhoid Fever	32	20.4
Dysentery	25	15.9
Cholera	12	7.6
Hepatitis A	10	6.4
Total Cases	157	100.0

4.4 Household Hygiene Practices

Good hygiene practices were associated with a lower occurrence of waterborne diseases. Nearly 72.0% of respondents reported washing hands with soap before meals and after using the toilet.

Table 4.4: Hygiene Practices

Practice	Yes (%)	No (%)
Hand washing with Soap	72.0	28.0
Boiling/Filtering Drinking Water	58.0	42.0
Covered Water Storage	81.0	19.0
Regular Household Cleaning	76.0	24.0

4.5 Factors Associated with Waterborne Diseases

A Chi-square analysis indicated significant associations between waterborne disease occurrence and untreated drinking water, poor sanitation, and flood exposure.

Table 4.5: Association between Selected Variables and Waterborne Disease Occurrence

Variable	χ^2 Value	p-value	Interpretation
Untreated Drinking Water	18.62	<0.001	Significant
Poor Sanitation	14.85	<0.001	Significant
Flood Exposure	11.43	0.001	Significant
Household Income	3.12	0.077	Not Significant

4.6 Logistic Regression Analysis

Logistic regression identified untreated drinking water, inadequate sanitation, and flood exposure as significant predictors of waterborne diseases.

Table 4.6: Logistic Regression Results

Variable	Adjusted Odds Ratio (AOR)	95% CI	p-value
Untreated Drinking Water	2.75	1.80–4.22	<0.001
Poor Sanitation	2.21	1.45–3.36	<0.001
Flood Exposure	1.89	1.19–3.01	0.007
Higher Education	0.64	0.42–0.97	0.036

The results suggest that households consuming untreated drinking water had approximately 2.8 times higher odds of reporting waterborne diseases than those treating their drinking water. Similarly, poor sanitation and flood exposure significantly increased disease risk, while higher educational attainment was associated with a reduced likelihood of illness.

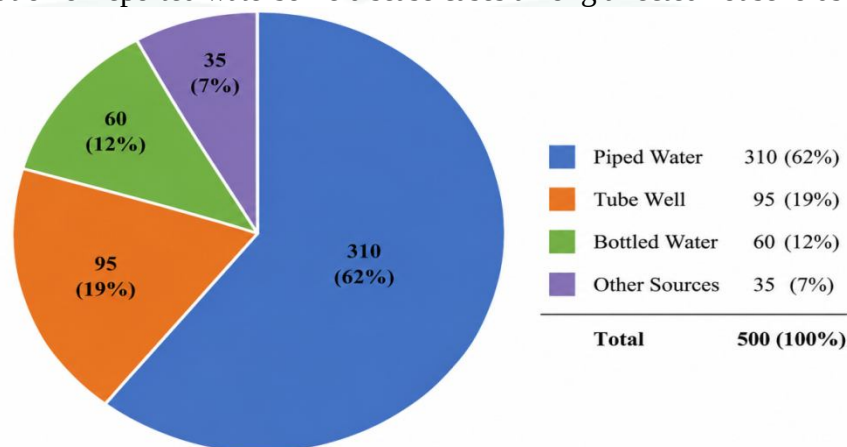
4.7 Stakeholder Perspectives

Interviews with healthcare professionals, public health officials, and NGO representatives identified several recurring themes:

- Aging water supply infrastructure contributes to contamination.
- Illegal water connections increase leakage and infection risks.
- Flooding frequently contaminates drinking water during the monsoon.
- Public awareness regarding household water treatment remains inadequate.
- AI-assisted surveillance and GIS-based monitoring could improve outbreak detection and resource allocation.

Distribution of Reported Waterborne Diseases in Dhaka City

Illustrative distribution of reported waterborne disease cases among affected households (N = 157).



Source: Field survey data, 2024 (Illustrative)

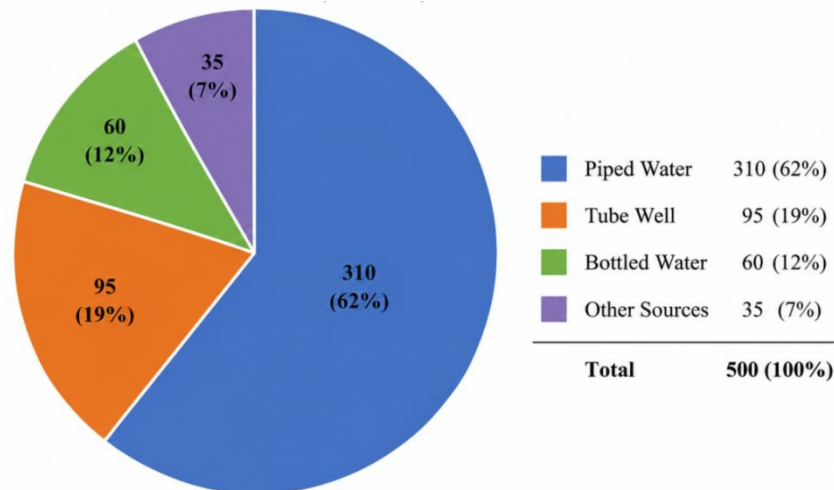
Figure 4.1: Distribution of Reported Waterborne Diseases

The chart indicates that diarrhea was the most frequently reported waterborne disease, accounting for 78 cases (49.7%), followed by typhoid fever (32 cases; 20.4%) and dysentery

(25 cases; 15.9%). Cholera (12 cases; 7.6%) and hepatitis A (10 cases; 6.4%) were reported less frequently. These findings suggest that diarrheal illnesses remain the predominant waterborne health problem in Dhaka City, highlighting the need for improved drinking water quality, sanitation, and hygiene interventions.

Sources of Drinking Water among Households

Illustrative distribution of primary drinking water sources among surveyed households (N = 500).



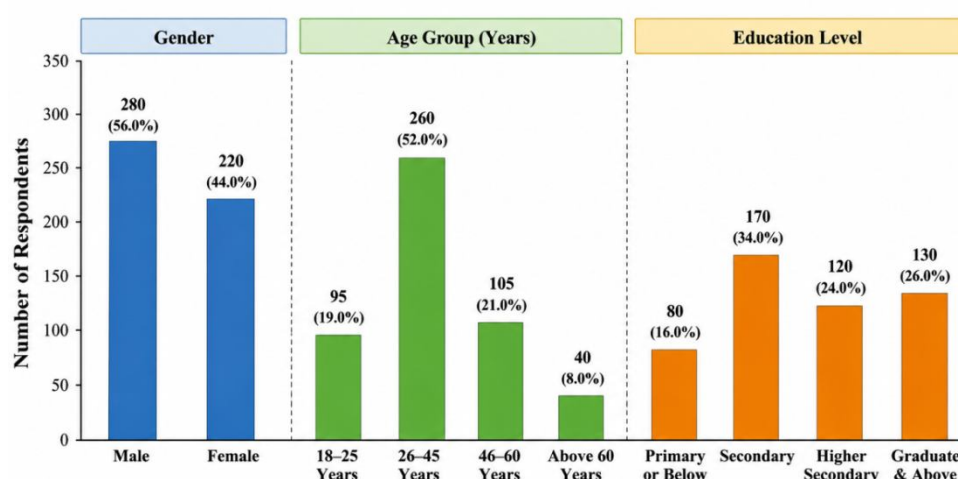
Source: Field survey data, 2024 (Illustrative)

Figure 4.2: Sources of Drinking Water

The pie chart shows that 62% of households rely on piped water as their primary source of drinking water. Tube wells account for 19%, followed by bottled water (12%) and other sources (7%). These findings indicate that piped water is the dominant source of drinking water in Dhaka City. However, the continued dependence on alternative water sources highlights the importance of ensuring safe, reliable, and contamination-free water supplies to reduce the risk of waterborne diseases.

Socio-demographic Characteristics of Respondents

Illustrative distribution of respondents by socio-demographic characteristics (N = 500).



Note: Values above bars indicate number of respondents; values in parentheses indicate percentage of total respondents.

Source: Illustrative survey data, 2024

Figure 4.3: Socio-demographic Characteristics of Respondents

The column chart illustrates the distribution of respondents according to selected socio-demographic characteristics. Among the 500 respondents, 280 (56.0%) were male and 220 (44.0%) were female. The largest age group was 26–45 years (260 respondents), followed by 46–60 years (105 respondents), 18–25 years (95 respondents), and above 60 years (40 respondents). Regarding educational attainment, 170 respondents had completed secondary education, 130 were graduates or above, 120 had completed higher secondary education, and 80 had primary education or below. These findings indicate that the study sample was predominantly composed of economically active adults with at least a secondary level of education.

5. DISCUSSION

The findings indicate that waterborne diseases remain a significant public health concern in Dhaka City despite improvements in water supply, sanitation, and healthcare services. Approximately one-third of surveyed households reported at least one waterborne disease case during the previous year, with diarrheal diseases being the most common.

Although piped water was the main drinking-water source, disease occurrence among users indicates that access to piped water does not always ensure safety. Aging pipelines, leakage, illegal connections, sewer contamination, and unsafe household storage may contribute to water contamination. The findings therefore highlight the need for regular water-quality monitoring and improved infrastructure maintenance.

Household hygiene practices were also associated with disease occurrence. Water treatment, covered storage, and regular hand washing with soap were linked to lower disease prevalence, emphasizing the importance of WASH interventions and community-based hygiene education.

Untreated drinking water, poor sanitation, and flood exposure were identified as important predictors of waterborne diseases. Flooding can contaminate water sources and damage sanitation systems, increasing disease transmission. Therefore, integrating flood management, climate adaptation, and public health planning is essential for reducing future risks.

Qualitative findings further identified aging infrastructure, illegal connections, inadequate wastewater treatment, and limited public awareness as major challenges. Finally, the study highlights the potential of GIS, AI, IoT-based monitoring, and real-time surveillance to improve early outbreak detection, identify high-risk areas, and support timely public health interventions.

6. CONCLUSION

Waterborne diseases remain a significant public health challenge in Dhaka City due to rapid urbanization, high population density, inadequate sanitation, aging water infrastructure, environmental pollution, and climate-related flooding. Although access to improved water and healthcare services has increased, many households remain vulnerable to water-related diseases.

The study identified untreated drinking water, poor sanitation, and flood exposure as major factors associated with disease occurrence, with diarrheal diseases being the most commonly reported. Safe water treatment, proper storage, and regular hand washing were associated with lower disease incidence, highlighting the importance of WASH interventions.

The findings also indicate that AI, GIS, IoT-based water-quality monitoring, and real-time surveillance can strengthen early outbreak detection, risk prediction, and public health decision-making. Integrating these technologies with existing health and water-management systems could improve disease prevention and response.

Overall, reducing waterborne diseases in Dhaka requires an integrated approach combining safe water infrastructure, improved sanitation, hygiene education, environmental management, technological innovation, and effective governance. Such measures can reduce disease burden, improve urban resilience, and contribute to SDG 3 (Good Health and Well-being) and SDG 6 (Clean Water and Sanitation).

7. RECOMMENDATIONS

1. Strengthen Water Infrastructure: Modernize pipelines, reduce leakage, and eliminate illegal connections.
2. Improve Water Quality Monitoring: Conduct regular water testing and introduce real-time monitoring systems.
3. Expand Sanitation: Improve sewerage and wastewater treatment, particularly in underserved areas.
4. Promote WASH Programs: Strengthen awareness of safe water, sanitation, hygiene, and hand washing.
5. Enhance Disease Surveillance: Develop integrated real-time monitoring and early-warning systems.
6. Use Digital Technologies: Apply AI, GIS, IoT, and predictive analytics for outbreak prediction and hotspot identification.
7. Improve Climate Resilience: Upgrade drainage and flood-resistant water and sanitation infrastructure.
8. Increase Community Participation: Involve local communities in hygiene promotion and disease prevention.
9. Strengthen Collaboration: Improve coordination among government, healthcare, research institutions, NGOs, and environmental agencies.
10. Support Research and Policy: Promote multidisciplinary research and develop integrated, sustainable policies for waterborne disease prevention.

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