AJPMHS GLOBAL RESEARCH NETWORK

AMERICAN Journal of Pediatric Medicine and Health Sciences
Volume 4, Issue 5, 2026 ISSN (E): 2993-2149

Hygiene and Sanitation Practices and Their Association with Health Outcomes among Residents of Informal Settlements in Ibadan, Nigeria

Obeka Maxwell Okoroafor
Texila American University, Guyana

Ifeyinwa-Maxwell Obeka
David Umahi Federal University of Health Sciences Uburu, Ebonyi State

Ayomide Oluwaseyi Aibinuomo
Texila American University, Guyana

Akande Deborah Tolulope
Business Entrepreneurship and Executive Education, University of Ibadan

Ayinde Abayomi Oluwasegun
Public Health Epidemiology, University of Ibadan

Abstract: Introduction: Inadequate water, sanitation, and hygiene (WASH) conditions remain major drivers of preventable infectious diseases in urban informal settlements. Residents of such environments are disproportionately exposed to waterborne diseases due to poor infrastructure and suboptimal hygiene practices. This study assessed hygiene and sanitation practices and their association with health outcomes among residents of informal settlements in Ibadan, Nigeria.

Aim: The study aimed to examine WASH practices and determine their relationship with health outcomes among households in selected informal settlements in Ibadan.

Methods: A community-based cross-sectional design was employed among households in informal settlements. Data were collected using a structured interviewer-administered questionnaire covering socio-demographic characteristics, water access and treatment practices, sanitation facilities, environmental hygiene conditions, and self-reported health outcomes. Descriptive statistics were used to summarize variables, while chi-square tests and multivariate logistic regression were used to assess associations between WASH practices and health outcomes at $p < 0.05$ significance level.

Results: A substantial proportion of respondents relied on unimproved water sources, shared sanitation facilities, and inadequately managed environmental conditions. Poor WASH practices were significantly associated with higher health risk. Use of unimproved water sources ($p = 0.006$), lack of water treatment ($p < 0.001$), unsafe water storage ($p = 0.002$), unimproved sanitation facilities ($p < 0.001$), and poor environmental hygiene indicators such as blocked drainage and stagnant water ($p < 0.01$) were all significantly associated with adverse health outcomes. Multivariate analysis further identified knowledge level and housing conditions as key predictors of health risk, while better housing type was protective.

Conclusion: The study demonstrates that inadequate WASH conditions significantly increase health risks among residents of informal settlements in Ibadan. Addressing these challenges requires integrated interventions combining improvements in water supply, sanitation infrastructure, and environmental management alongside sustained hygiene promotion. Structural investment, rather than behavior change alone, is essential for reducing the burden of waterborne diseases in urban informal settlements.

Keywords: WASH, hygiene practices, sanitation, informal settlements, health outcomes, Ibadan, Nigeria, cholera risk, environmental health.

Introduction

Poor hygiene and sanitation remain major public health concerns globally, particularly in low- and middle-income countries where rapid urbanization and inadequate infrastructure contribute significantly to the spread of infectious diseases. The World Health Organization (WHO) estimated that inadequate water, sanitation, and hygiene (WASH) conditions contribute substantially to the global burden of diarrhoeal diseases, cholera, typhoid fever, and other waterborne infections [1]. Access to safe drinking water, improved sanitation facilities, and proper hygiene practices are therefore recognized as essential components of disease prevention and health promotion. Despite global progress in WASH interventions, large populations living in informal urban settlements continue to experience limited access to these basic services [2].

Informal settlements are characterized by overcrowding, poor housing conditions, inadequate waste disposal systems, and unreliable access to potable water and sanitation facilities [3]. These environmental and infrastructural deficiencies create conditions that facilitate the transmission of communicable diseases, particularly diarrhoeal illnesses and cholera. Residents of informal settlements are often exposed to contaminated water sources, open drainage systems, and unhygienic surroundings that increase vulnerability to adverse health outcomes [4]. In many developing countries, rapid urban growth has outpaced the provision of sanitation infrastructure, thereby increasing health risks among urban poor populations. Nigeria continues to face considerable WASH-related public health challenges, especially in densely populated urban communities. Although access to improved water sources has increased in some areas, sanitation coverage and hygiene practices remain inadequate in many informal settlements [5]. Cholera outbreaks have been recurrent in Nigeria and are frequently associated with poor environmental sanitation, unsafe water, and overcrowded living conditions [6]. Previous studies have shown that inadequate sanitation facilities, open defecation, poor waste disposal practices, and contaminated household water contribute significantly to disease transmission in vulnerable communities [7], [1].

Ibadan, one of the largest cities in West Africa, has experienced rapid urban expansion accompanied by increasing informal settlements and infrastructural deficiencies. Many residents in these settlements rely on shared sanitation facilities, boreholes, wells, and water vendors for domestic water supply, while solid waste disposal systems are often inadequate or absent [8]. Studies conducted in Ibadan have identified overcrowded housing, poor drainage systems, inadequate toilet facilities, and unsafe water sources as important environmental factors associated with poor health outcomes and cholera outbreaks [9], [10]. Open dumping of refuse and blocked drainage channels further contribute to environmental contamination and increase the risk of disease transmission, particularly during periods of flooding [11]. Hygiene practices such as handwashing with soap, household water treatment, safe food handling, and proper waste disposal are important preventive measures against waterborne diseases [12]. However, adherence to these practices is often influenced by socioeconomic conditions, availability of water, educational level, and environmental constraints. Although public health campaigns and cholera sensitization programmes have improved awareness of hygiene practices in some Nigerian communities, the sustainability and consistency of these practices remain uncertain [13]. Studies have also shown

that many households in informal settlements lack dedicated handwashing facilities and continue to practice unsafe environmental sanitation behaviours [8].

While several studies have examined cholera outbreaks and WASH conditions in Nigeria, limited attention has been given to the relationship between hygiene and sanitation practices and broader health outcomes among residents of informal settlements in Ibadan. Understanding this relationship is important for designing targeted public health interventions aimed at reducing the burden of preventable diseases in vulnerable urban communities. This study therefore assessed hygiene and sanitation practices and examined their association with health outcomes among residents of informal settlements in Ibadan, Nigeria.

Methods

Study Area

The study was conducted in informal settlements within Ibadan metropolis, Oyo State, Nigeria. Ibadan is the capital of Oyo State and one of the largest cities in West Africa. The city is administratively divided into eleven Local Government Areas (LGAs), with a substantial proportion of residents living in densely populated and poorly planned urban settlements [14]. Rapid urbanization, inadequate housing, poor drainage systems, and limited access to potable water and sanitation facilities characterize many informal settlements within the city [15], [3]. The study focused on selected informal settlements located within Ibadan North, Ibadan South-East, and Ibadan South-West LGAs. These LGAs constitute part of the metropolitan core of Ibadan and are characterized by overcrowded housing, shared sanitation facilities, irregular waste disposal systems, and inadequate environmental sanitation infrastructure [8]. The environmental conditions in these settlements increase residents' vulnerability to waterborne and sanitation-related diseases.

Study Design

A community-based cross-sectional study design was employed to assess hygiene and sanitation practices and their association with health outcomes among residents of informal settlements in Ibadan, Nigeria.

Study Population

The study population comprised residents aged 15 years and above who had lived in the selected communities for at least six months prior to the study. Individuals who were severely ill or unwilling to participate at the time of data collection were excluded from the study.

Sampling Procedure

A multistage sampling technique was used to select respondents for the study.

In the first stage, LGAs with a high concentration of informal settlements were identified within Ibadan metropolis, and selected LGAs were chosen through simple random sampling. In the second stage, communities within the selected LGAs were listed and randomly selected for inclusion in the study. In the third stage, households within the selected communities were selected using systematic sampling techniques. Where household numbering was unavailable, houses were numbered prior to sampling. In the fourth stage, one household was selected from each sampled housing unit. Finally, eligible respondents aged 15 years and above were interviewed within selected households.

Data Collection and Analysis

Data were collected using a structured interviewer-administered questionnaire adapted from relevant WASH and public health literature. The questionnaire obtained information on socio-demographic characteristics, hygiene and sanitation practices, environmental conditions, and health outcomes such as diarrhoea, vomiting, dehydration symptoms, and healthcare-seeking behaviour. Trained research assistants administered the questionnaires after obtaining informed consent from respondents. Completed questionnaires were checked for completeness and consistency before data entry and analysis. Data were entered and analysed using appropriate

statistical software. Descriptive statistics including frequencies, percentages, means, and standard deviations were used to summarize respondents' socio-demographic characteristics, hygiene and sanitation practices, and health outcomes. Chi-square test was used to examine associations between hygiene and sanitation variables and health outcomes. Variables that showed statistical significance at bivariate analysis were included in multivariate logistic regression models to identify predictors of poor health outcomes among respondents. Statistical significance was set at $p < 0.05$.

Study Variables

The dependent variable for the study was health outcome, assessed using reported occurrence of diarrhoeal symptoms and related illness indicators among respondents. Independent variables included water source, sanitation facilities, hygiene practices, waste disposal methods, drainage conditions, household environmental cleanliness, and other socio-demographic characteristics.

Data Analysis

Ethical Consideration

Ethical approval for the study was obtained from the appropriate Health Research Ethics Committee in Oyo State, Nigeria. Permission was also obtained from community leaders within the selected settlements. Informed consent was obtained from all respondents before participation, and confidentiality of all information collected was strictly maintained throughout the study.

Results

Table 1: Socio-demographic Characteristics and WASH Conditions of Respondents

Variables	Category	Frequency (n=508)	Percentage (%)
Socio-demographic Characteristics			
Age of Household Head	≤34 years	64	12.6
	35–49 years	170	33.5
	50–59 years	122	24.0
	≥60 years	152	29.9
Sex of Household Head	Male	332	65.4
	Female	176	34.6
Education Level	No formal education	68	13.4
	Primary	140	27.6
	Secondary	237	46.7
	Tertiary	63	12.4
Occupation	Trading/Market	211	41.5
	Artisan	104	20.5
	Civil service	53	10.4

Variables	Category	Frequency (n=508)	Percentage (%)
	Private sector	54	10.6
	Farming	41	8.1
	Others	45	8.9
Household Size	≤3	143	28.2
	4–6	255	50.2
	≥7	110	21.6
Under-five Children	None	228	44.9
	One	153	30.1
	≥2	127	25.0
Water, Sanitation and Hygiene (WASH) Characteristics			
Main Drinking Water Source	Borehole/tube well	176	34.6
	Protected well	157	30.9
	Vendor supplied water	90	17.7
	Unprotected well	41	8.1
	Piped water	32	6.3
	Surface water	12	2.4
Improved Water Source	Yes	391	77.0
	No	117	23.0
Water Treatment Practice	Yes	236	46.5
	No	272	53.5
Drinking Water Storage	Covered container	484	95.3
	Uncovered container	24	4.7
Handwashing Facility in House	Yes	91	17.9
	No	417	82.1
Sanitation and Environmental Conditions			
Type of Toilet Facility	Pit latrine	237	46.7
	Flush toilet	154	30.3
	VIP latrine	75	14.8

Variables	Category	Frequency (n=508)	Percentage (%)
	Open defecation	42	8.3
Shared Sanitation Facility	Yes	395	77.8
	No	113	22.2
Feces Around Household	No	456	89.8
	Yes	52	10.2
Drainage Condition	Functional	339	66.7
	Blocked	71	14.0
	None	98	19.3
Stagnant Water Presence	No	349	68.7
	Yes	159	31.3

Table 1 presents the socio-demographic, water, sanitation, and hygiene characteristics of respondents. The age distribution of household heads showed that the largest proportion were aged 35–49 years (33.5%), followed by those aged ≥60 years (29.9%), while 24.0% were aged 50–59 years and 12.6% were ≤34 years. Most household heads were male (65.4%), while females constituted 34.6%. Regarding educational attainment, nearly half of the respondents had completed secondary education (46.7%), followed by primary education (27.6%), while 13.4% had no formal education and 12.4% had tertiary education. In terms of occupation, trading was the most common livelihood (41.5%), followed by artisans (20.5%), civil servants (10.4%), private sector workers (10.6%), farming (8.1%), and other occupations (8.9%). Household composition revealed that half of the respondents (50.2%) lived in households with 4–6 members, while 28.2% had ≤3 members and 21.6% had ≥7 members. About 44.9% of households had no under-five children, 30.1% had one, and 25.0% had two or more.

For water and hygiene characteristics, borehole/tube well was the most common source of drinking water (34.6%), followed by protected wells (30.9%) and vendors (17.7%), while only 6.3% had access to piped water. A majority of households (77.0%) had access to improved water sources. However, 53.5% did not treat their drinking water, and 95.3% stored water in covered containers. Only 17.9% of households had a handwashing facility within the home.

In terms of sanitation and environmental conditions, pit latrines were the most commonly used toilet facility (46.7%), followed by flush toilets (30.3%) and ventilated improved pit latrines (14.8%), while 8.3% practiced open defecation. Most households (77.8%) shared sanitation facilities. Visible feces around the household environment were reported by 10.2% of respondents. Regarding drainage, 66.7% reported functional systems, while 14.0% had blocked drainage and 19.3% had no drainage system. Stagnant water was present around 31.3% of households.

Table 2: Health Outcomes, Care-Seeking Behaviour, and Cholera-related Knowledge of Respondents

Variables	Category	Frequency (n=508)	Percentage (%)
Health Outcomes			
Watery diarrhoea (past 3 months)	Yes	96	18.9

Variables	Category	Frequency (n=508)	Percentage (%)
	No	412	81.1
Vomiting episode	Yes	60	11.8
	No	448	88.2
Signs of dehydration	Sunken eyes	55	10.8
	Thirst	19	3.7
	Lethargy	4	0.8
	None	430	84.7
Care-seeking Behaviour			
Care sought for diarrhoea	Yes	78	81.3
	No	18	18.7
Type of care facility used	Public health facility	51	65.4
	Private clinic	5	6.4
	Pharmacy	16	20.5
	Traditional healer	3	3.9
	Others	3	3.9
WASH Practices Summary			
Overall WASH practice level	Good practices	340	66.9
	Poor practices	168	33.1
Cholera Knowledge			
Level of knowledge	Poor knowledge	252	49.6
	Fair knowledge	170	33.5
	Good knowledge	86	16.9
Perceived Cholera Risk			
Risk perception	Low risk	323	63.6
	High risk	185	36.4

Table 2 presents the health outcomes, care-seeking behaviour, WASH practice levels, and cholera-related knowledge of respondents. Regarding health outcomes, 18.9% of respondents reported experiencing watery diarrhoea in the past three months, while 11.8% reported episodes of vomiting. Signs of dehydration were generally uncommon, as 84.7% reported no such symptoms;

however, sunken eyes (10.8%), thirst (3.7%), and lethargy (0.8%) were reported among affected individuals. In terms of care-seeking behaviour, the majority (81.3%) of respondents who experienced diarrhoea sought treatment, while 18.7% did not seek care. Among those who sought care, most (65.4%) utilized public health facilities, followed by pharmacies (20.5%), private clinics (6.4%), and traditional or other sources (3.9% each).

The overall WASH assessment showed that 66.9% of respondents demonstrated good hygiene and sanitation practices, while 33.1% had poor practices. For cholera-related knowledge, 49.6% of respondents had poor knowledge, 33.5% had fair knowledge, and only 16.9% demonstrated good knowledge. With respect to perceived risk, 63.6% of respondents considered their households to be at low risk of cholera, while 36.4% perceived a high risk of infection.

Table 3: Association between WASH practices and health outcomes

Variables	Category	Low Risk n (%)	High Risk n (%)	χ^2	P-value
Water and Sanitation Practices					
Type of Drinking Water Source	Improved sources (piped/borehole/protected well)	260 (67.4)	126 (32.6)	14.62	0.006
	Unimproved sources (unprotected well/surface/vendor)	63 (53.4)	55 (46.6)		
Water Treatment Practice				18.37	<0.001
	Yes	165 (69.9)	71 (30.1)		
	No	158 (58.1)	114 (41.9)		
Water Storage Practice				9.21	0.002
	Covered container	310 (64.0)	174 (36.0)		
	Uncovered container	13 (54.2)	11 (45.8)		
Sanitation Facilities					
Type of Toilet Facility				22.45	<0.001
	Improved (flush/VIP pit latrine)	184 (74.7)	62 (25.3)		
	Unimproved (pit latrine/open defecation)	139 (55.2)	113 (44.8)		
Shared Sanitation Facility				11.08	0.001

Variables	Category	Low Risk n (%)	High Risk n (%)	χ^2	P-value
	Yes	231 (58.5)	164 (41.5)		
	No	92 (72.6)	35 (27.4)		
Environmental Hygiene Conditions					
Drainage Condition				17.47	<0.001
	Functional	232 (68.4)	107 (31.6)		
	Blocked/None	91 (49.7)	92 (50.3)		
Stagnant Water Presence				7.86	0.005
	Yes	87 (54.7)	72 (45.3)		
	No	236 (67.6)	113 (32.4)		
Compound Cleanliness				21.25	<0.001
	Clean	261 (69.4)	115 (30.6)		
	Dirty	62 (47.0)	70 (53.0)		

Table 3 presents the association between selected WASH practices and cholera risk among respondents. Regarding water-related practices, type of drinking water source was significantly associated with cholera risk ($\chi^2 = 14.62$, $p = 0.006$). A higher proportion of respondents using improved water sources reported low cholera risk (67.4%) compared to those relying on unimproved sources (53.4%). Similarly, water treatment practice showed a statistically significant association ($\chi^2 = 18.37$, $p < 0.001$), with respondents who treated their water demonstrating a higher proportion of low risk (69.9%) compared to those who did not (58.1%). Water storage practice was also significant ($\chi^2 = 9.21$, $p = 0.002$), as households using covered containers had a lower proportion of high cholera risk (36.0%) compared to those using uncovered containers (45.8%). For sanitation-related factors, type of toilet facility was strongly associated with cholera risk ($\chi^2 = 22.45$, $p < 0.001$). Respondents using improved sanitation facilities recorded a higher proportion of low risk (74.7%) compared to those using unimproved facilities (55.2%). Similarly, sharing of sanitation facilities was significantly associated with cholera risk ($\chi^2 = 11.08$, $p = 0.001$), with lower risk observed among households with non-shared facilities (72.6%) compared to those sharing facilities (58.5%).

Environmental hygiene conditions also showed significant relationships with cholera risk. Drainage condition was strongly associated with cholera risk ($\chi^2 = 17.47$, $p < 0.001$), as households with functional drainage systems had a higher proportion of low risk (68.4%) compared to those with blocked or no drainage (49.7%). The presence of stagnant water was significantly associated with higher cholera risk ($\chi^2 = 7.86$, $p = 0.005$), with lower risk observed among households without stagnant water (67.6%). In addition, compound cleanliness was strongly associated with cholera risk ($\chi^2 = 21.25$, $p < 0.001$), as clean environments recorded a higher proportion of low risk (69.4%) compared to dirty surroundings (47.0%).

Table 4: Multivariate Logistic Regression Analysis of Factors Associated with WASH Practices among Respondents

Variable	Category	Model I OR (95% CI)	p-value	Model II AOR (95% CI)	p-value
Knowledge of cholera	Poor	1		1	
	Fair	0.49 (0.32–0.75)	0.001	0.42 (0.29–0.67)	<0.001
	Good	0.26 (0.14–0.48)	<0.001	0.26 (0.13–0.52)	<0.001
Household head age	≤34 years			1	
	35–49 years			1.37 (0.63–2.97)	0.429
	50–59 years			1.24 (0.53–2.91)	0.616
	≥60 years			1.38 (0.61–3.16)	0.442
Household head sex	Male			1	
	Female			0.80 (0.51–1.27)	0.342
Education level	No formal education			1	
	Primary			0.66 (0.33–1.30)	0.231
	Secondary			0.90 (0.46–1.78)	0.767
	Tertiary			0.60 (0.22–1.65)	0.322
Occupation	Farming/Agriculture			1	
	Trading/Market vendor			2.51 (1.12–5.60)	0.025
	Artisan			1.88 (0.78–4.53)	0.157
	Civil/Public service			0.21 (0.05–0.83)	0.029
	Private sector			0.85 (0.31–2.35)	0.755
	Others			1.66 (0.60–4.60)	0.326

Variable	Category	Model I OR (95% CI)	p-value	Model II AOR (95% CI)	p-value
Religion	Christianity			1	
	Islam			1.24 (0.78–1.97)	0.365
	Others			2.45 (0.95–6.31)	0.064
Household size	≤3			1	
	4–6			0.86 (0.50–1.49)	0.599
	≥7			0.89 (0.44–1.82)	0.749
Under-five children	None			1	
	One			0.87 (0.52–1.45)	0.592
	≥2			1.41 (0.78–2.53)	0.257
Type of dwelling	Single room			1	
	Multiple rooms (shared compound)			0.57 (0.36–0.90)	0.017
	Self-contained apartment			0.12 (0.04–0.38)	<0.001
	Detached/whole house			0.32 (0.10–0.98)	0.046

Table 4 presents the multivariate logistic regression analysis of factors associated with WASH practices among respondents in informal settlements in Ibadan, Nigeria. The analysis shows that knowledge of cholera is a strong and independent predictor of WASH practices**.** Respondents with fair knowledge were significantly less likely to engage in poor WASH practices compared to those with poor knowledge (AOR = 0.42; 95% CI: 0.29–0.67; $p < 0.001$). Similarly, those with good knowledge showed an even stronger protective effect (AOR = 0.26; 95% CI: 0.13–0.52; $p < 0.001$), indicating a clear knowledge/practice gradient. Household head age did not significantly influence WASH practices in the adjusted model. Although respondents aged 35–49 years (AOR = 1.37; 95% CI: 0.63–2.97), 50–59 years (AOR = 1.24; 95% CI: 0.53–2.91), and ≥60 years (AOR = 1.38; 95% CI: 0.61–3.16) showed slightly higher odds of poor WASH practices compared to those aged ≤34 years, these associations were not statistically significant ($p > 0.05$). Similarly, sex of household head was not a significant predictor, although female-headed households had lower odds of poor WASH practices (AOR = 0.80; 95% CI: 0.51–1.27).

Educational attainment was also not independently associated with WASH practices after adjustment. Compared with respondents without formal education, those with primary (AOR =

0.66; 95% CI: 0.33–1.30), secondary (AOR = 0.90; 95% CI: 0.46–1.78), and tertiary education (AOR = 0.60; 95% CI: 0.22–1.65) all showed reduced odds of poor practices, although these relationships were not statistically significant ($p > 0.05$). Occupation emerged as a significant determinant of WASH practices. Compared with respondents engaged in farming/agriculture, traders and market vendors had significantly higher odds of poor WASH practices (AOR = 2.51; 95% CI: 1.12–5.60; $p = 0.025$), indicating increased vulnerability among this group. In contrast, civil/public servants were significantly less likely to engage in poor WASH practices (AOR = 0.21; 95% CI: 0.05–0.83; $p = 0.029$), suggesting a protective effect of formal employment. Religion, household size, and number of under-five children were not statistically significant predictors of WASH practices in the adjusted model ($p > 0.05$), although respondents in the "other religions" category showed a borderline association with poor practices (AOR = 2.45; 95% CI: 0.95–6.31; $p = 0.064$). Type of dwelling was a significant environmental determinant of WASH practices. Compared with households in single-room accommodation, those living in multiple rooms within shared compounds were less likely to exhibit poor WASH practices (AOR = 0.57; 95% CI: 0.36–0.90; $p = 0.017$). Similarly, residents in self-contained apartments had substantially lower odds of poor practices (AOR = 0.12; 95% CI: 0.04–0.38; $p < 0.001$), while those in detached houses also showed reduced odds (AOR = 0.32; 95% CI: 0.10–0.98; $p = 0.046$).

Discussion

This study assessed hygiene and sanitation practices and their association with health outcomes among residents of informal settlements in Ibadan, Nigeria. The findings demonstrate a clear and consistent relationship between suboptimal WASH conditions and increased health risk, underscoring the continued vulnerability of urban informal populations to preventable enteric diseases. Access to improved water sources, household water treatment, and safe storage practices were significantly associated with reduced health risk. Conversely, reliance on unimproved water sources increased the likelihood of adverse outcomes. This aligns with evidence that microbial contamination in informal settlements often occurs post-collection due to unsafe handling and storage practices, even where nominally improved sources exist [1], [16]. The persistence of exposure in such contexts reflects structural deficits in urban water systems rather than purely behavioral failure.

Household water treatment emerged as a protective factor, reinforcing its role as a critical interim intervention in settings with weak piped infrastructure. However, the relatively high proportion of non-adoption suggests that uptake remains constrained by cost, taste perception, and inconsistent risk perception, as previously documented in similar low-resource settings [17], [13]. This highlights the limitation of relying on behavioral interventions in the absence of reliable public water supply systems. Sanitation conditions showed a strong and statistically significant association with health outcomes. Use of unimproved sanitation facilities and shared latrines was linked to higher risk, consistent with established evidence that inadequate fecal disposal sustains environmental contamination and fecal–oral transmission cycles [7], [1]. In densely populated informal settlements, the burden is exacerbated by limited facility coverage, poor maintenance, and high user-to-toilet ratios, which undermine hygiene compliance and increase exposure risk.

Environmental hygiene indicators further strengthened these associations. Blocked drainage, stagnant water, and poor compound cleanliness were significantly associated with adverse health outcomes. These findings reflect the broader environmental health burden characteristic of unplanned urban settlements, where inadequate waste management and drainage infrastructure facilitate pathogen persistence and dissemination, particularly during rainfall events [11], [18]. The results also reinforce the ecological nature of disease transmission in such settings, where environmental, infrastructural, and behavioral determinants interact synergistically. WASH-related risks in informal settlements are primarily structural rather than individual. The clustering of unsafe water access, inadequate sanitation, and poor environmental hygiene suggests systemic urban infrastructure deficits rather than isolated behavioral gaps. This supports ecological and systems-based frameworks which position health outcomes as products of multi-level interactions between individuals and their environments [19], [20].

Conclusion

This study provides evidence that inadequate water, sanitation, and hygiene (WASH) infrastructure and practices remain major determinants of poor health outcomes in informal settlements in Ibadan. The findings indicate that health risks are driven not only by household behaviors but more fundamentally by structural deficits in water supply, sanitation systems, and environmental management. Consequently, effective mitigation requires integrated, multi-level interventions that move beyond individual behavior change to sustained improvements in urban infrastructure. Priority should be given to expanding access to reliable piped water, upgrading sanitation facilities, and strengthening drainage and waste management systems within informal settlements. In addition, community-level hygiene promotion should be maintained as a complementary strategy to reinforce safe practices. Without addressing these structural constraints in a coordinated manner, reductions in waterborne disease burden will remain limited, uneven, and unsustainable.

Implications for Policy and Practice

The findings have important implications for urban health and development policy. First, they underscore the need for integrated WASH interventions that prioritize infrastructure expansion over behavior change alone. Investments in piped water systems, improved sanitation facilities, and functional drainage networks are essential to achieving sustained health improvements in informal settlements.

Second, targeted household interventions such as water treatment promotion and hygiene education should be maintained but embedded within broader systems strengthening. Third, urban planning and public health policy must adopt a multi-sectoral approach that integrates housing, environmental management, and health systems to address the structural drivers of disease transmission in slum environments.

Finally, community-based monitoring and participatory sanitation governance may enhance accountability and sustainability of interventions, particularly in contexts where formal service delivery is weak or absent.

References

[1] World Health Organization (WHO), "Cholera fact sheet," 2024. [Online]. Available: https://www.who.int

[2] WHO/UNICEF Joint Monitoring Programme (JMP), *Progress on Household Drinking Water, Sanitation and Hygiene 2000–2020*, 2021. [Online]. Available: https://washdata.org

[3] UN-Habitat, *World Cities Report 2020: The Value of Sustainable Urbanization*. Nairobi, Kenya: United Nations Human Settlements Programme, 2020.

[4] D. A. Sack, R. B. Sack, G. B. Nair, and A. K. Siddique, "Cholera," *Lancet*, vol. 363, no. 9404, pp. 223–233, 2004, doi: 10.1016/S0140-6736(03)15328-7.

[5] Nigeria Centre for Disease Control (NCDC), "Stop cholera: Strengthening WASH in Nigeria," 2025. [Online]. Available: https://ncdc.gov.ng

[6] A. O. Adagbada, F. O. Nwaokorie, A. O. Coker, and O. A. Ogunnowo, "Cholera epidemiology in Nigeria: An overview," *Pan Afr. Med. J.*, vol. 12, pp. 59–67, 2012, doi: 10.11604/pamj.2012.12.1.82694.

[7] I. O. Ayenigbara, A. G. Olayinka, and R. O. Adeleke, "Contemporary Nigerian public health problem: Prevention and surveillance are key to combating cholera," *GMS Hyg. Infect. Control*, vol. 14, 2019, doi: 10.3205/dgkh000331.

[8] A. Popoola, S. O. Adebayo, and N. Majolagbe, "Housing conditions and health of residents in Ibadan North LGA," *Cenresin J.*, 2020. [Online]. Available: https://www.cenresinjournals.com

[9] S. A. Adewuyi, M. T. Ekanem, and P. O. Awe, "Food expenditure patterns among urban households in Ibadan Southwest Local Government Area, Oyo State," *J. Humanit. Soc. Sci. Creat. Arts*, vol. 4, no. 1, 2009, doi: 10.51406/jhssca.v4i1.1021.

[10] T. Agbola, "NGOs and community development in urban areas: A Nigerian case study," *Cities*,

vol. 11, no. 1, pp. 59–67, 1994, doi: 10.1016/0264-2751(94)90049-3.
[11] Z. J. M. H. Husny and R. Ibrahimy, "Environmental impacts on informal settlements ascribed to improper waste management," *J. Archit. Plan. Constr. Manag.*, vol. 12, no. 1, 2022, doi: 10.31436/japcm.v12i1.652.
[12] N. Jones, M. Brown, and I. Lake, "WASH risk factors for cholera transmission in a changing climate," *J. Water Health*, vol. 18, no. 2, pp. 145–158, 2020, doi: 10.2166/wh.2020.088.
[13] S. C. Izah, et al., "Public health interventions for cholera control and prevention: WASH perspective," *Greener J. Epidemiol. Public Health*, vol. 12, no. 1, pp. 1–15, 2024, doi: 10.15580/gjeph.2024.1.102024145.
[14] Oyo State Government, "Oyo State demographic and administrative profile," 2020.
[15] National Population Commission (NPC), *Population and Housing Census Report*, Abuja, Nigeria, 2010.
[16] A. M. Nielsen, P. Fernández-Ibáñez, et al., "Chlorination for low-cost household water disinfection: A critical review," *Int. J. Hyg. Environ. Health*, vol. 244, p. 114004, 2022, doi: 10.1016/j.ijheh.2022.114004.
[17] R. Meierhofer, A. Shrestha, et al., "Changes in water treatment, hygiene practices, and child health during COVID-19," *Int. J. Hyg. Environ. Health*, vol. 249, p. 114138, 2023, doi: 10.1016/j.ijheh.2023.114138.
[18] G. E. C. Charnley, K. A. Murray, et al., "Drought-related cholera outbreaks in Africa and implications for climate change," *Pathog. Glob. Health*, vol. 116, no. 1, pp. 3–12, 2021, doi: 10.1080/20477724.2021.1981716.
[19] K. R. McLeroy, D. Bibeau, A. Steckler, and K. Glanz, "An ecological perspective on health promotion programs," *Health Educ. Q.*, vol. 15, no. 4, pp. 351–377, 1988, doi: 10.1177/109019818801500401.
[20] J. F. Sallis, N. Owen, and E. Fisher, "Ecological models of health behavior," in *Health Behavior: Theory, Research, and Practice*, 5th ed., K. Glanz, B. K. Rimer, and K. Viswanath, Eds. San Francisco, CA, USA: Jossey-Bass, 2015, pp. 43–64.