

Environmental and Behavioral Determinants of Community-Acquired Infections in a Peri-Urban Setting: A Cross-Sectional Study in Bokotola Neighborhood, Mbandaka, Democratic Republic of Congo

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ABSTRACT

Background: Community-acquired infections remain a persistent public health challenge, particularly in urban areas of low-income countries. In Mbandaka, Democratic Republic of Congo, the Bokotola neighborhood, characterized by its riverine location and deteriorating sanitation infrastructure, represents a hotspot of vulnerability to these diseases.

Objective: This study aimed to identify the major predisposing factors for community-acquired infections among households in Bokotola, with the goal of proposing evidence-based interventions.

Methods: A descriptive and analytical cross-sectional survey was conducted among a probabilistic sample of 400 heads of households. Data were collected using structured questionnaires and direct observation. Bivariate analysis employed Pearson's chi-square test, while multivariate logistic regression (backward stepwise method) was performed to identify independent risk factors, controlling for potential confounders.

Results: The prevalence of infectious episodes within households over the past 12 months was 70.0% (280/400). Access to essential services was critically inadequate: 75.0% of households relied on unimproved water sources, and 85.0% used non-hygienic latrines. Multivariate analysis identified three main independent determinants: lack of an operational handwashing station (aOR = 4.2; 95% CI: 1.8–9.4; $p = 0.001$), failure to treat drinking water at home (aOR = 3.85; 95% CI: 2.41–6.15; $p = 0.001$), and stagnation of wastewater or rainwater within the household plot (aOR = 2.8; 95% CI: 1.5–4.2; $p = 0.005$). Notably, home visits by community health workers showed no statistically significant association with reduced infection rates ($p = 0.320$).

Conclusion: Achieving a sustainable reduction in infectious incidence in Bokotola requires moving beyond simple awareness campaigns toward an integrated strategy that includes subsidizing inputs (water treatment products, soap), improving urban drainage, and promoting low-cost hygiene devices.

Keywords: Community-acquired infections, WASH, Mbandaka, Logistic regression, Health risk.

1. INTRODUCTION

Environmental and behaviorally mediated infectious diseases constitute a considerable burden on healthcare systems, particularly in developing countries (World Health Organization [WHO], 2022). Although the prevention of these infections relies on well-identified measures—access to

safe drinking water, adequate sanitation, and hygiene—their incidence remains elevated in many urban areas of sub-Saharan Africa. This persistence is frequently attributed to infrastructure deficits, rapid and unplanned urbanization, and socioeconomic inequalities that constrain households' capacity to adopt preventive behaviors (Wolf et al., 2018).

The Democratic Republic of Congo (DRC) exemplifies this dynamic. In Mbandaka, situated along the Congo River, the geographical configuration and insufficient urban sanitation services create an environment particularly conducive to the circulation of pathogens (Kazadi & Mbuyi, 2022). The Bokotola neighborhood epitomizes this precariousness: housing density is high, drainage systems are virtually nonexistent, and access to piped water is severely limited (Ngabu et al., 2021).

Despite repeated interventions by health authorities and international partners, morbidity indicators related to diarrheal diseases, typhoid fever, and acute respiratory infections remain concerning (Ministère de la Santé Publique de la RDC, 2023). This discrepancy between efforts expended and observed outcomes suggests that the underlying determinants of infectious transmission are poorly understood or that current strategies are inadequately calibrated to local realities.

The objective of this study was to identify, through robust statistical analysis, the independent risk factors for community-acquired infections among households in Bokotola. The findings will inform operational recommendations to optimize prevention programs and break the vicious cycle of poverty and disease.

2. METHODS

2.1. Study Design and Setting

This analytical cross-sectional study was conducted in Bokotola neighborhood, Wangata Commune, Mbandaka, the capital of Équateur Province, Democratic Republic of Congo. This area is characterized by high population density, proximity to the Congo River, and recurrent flooding and sanitation problems. Data collection occurred between June and September 2025.

2.2. Study Population, Sample Size, and Sampling Strategy

The target population comprised all households in the neighborhood. The unit of observation was the head of household or their designated representative. Sample size was calculated using the Schwartz formula for a presumed prevalence of 50% (to maximize sample size), with a 95% confidence level and a 5% margin of error. The calculation yielded a minimum of 384 participants, rounded to 400 households to account for potential refusals or incomplete questionnaires.

A two-stage probabilistic sampling strategy was employed. First, avenues (clusters) were randomly selected. Subsequently, within each avenue, systematic sampling was applied with a sampling interval determined by the total number of concessions.

2.3. Data Collection

Data were collected using a mixed-method approach:

1. **Structured questionnaire:** Administered face-to-face to respondents, capturing information on:
 - Sociodemographic profile: age, sex, education level, household size.
 - Environmental factors (WASH): water source, water treatment, latrine type, waste management, presence of stagnant water.
 - Healthcare system interactions: distance to health center, community health worker (RECO) visits, cost of care.
 - Dependent variable: occurrence of at least one case of community-acquired infection (diarrhea, typhoid fever, respiratory infection, dermatosis) within the household during the 12 months preceding the survey.
2. **Direct observation grid:** Used to validate certain declarations, particularly regarding the presence of handwashing facilities, courtyard cleanliness, and water storage practices.

2.4. Data Processing and Statistical Analysis

Data were entered in Microsoft Excel and analyzed using IBM SPSS Statistics (version 25.0). The analytical approach proceeded in three phases:

- **Descriptive analysis:** Calculation of frequencies and percentages to characterize the sample.
- **Bivariate analysis:** Pearson's chi-square test was used to evaluate the statistical association between each potential factor and infectious status.
- **Multivariate analysis:** A binary logistic regression model was constructed using a backward stepwise method to identify independent determinants of infectious morbidity while controlling for confounding factors. Variables with $p < 0.20$ in bivariate analysis were entered into the model. Statistical significance was set at $p < 0.05$. Results are expressed as adjusted Odds Ratios (aOR) with 95% confidence intervals.

2.5. Ethical Considerations

The study adhered to fundamental ethical principles. Informed consent was obtained from each participant prior to the interview. Anonymity and confidentiality of responses were guaranteed. The project received approval from the local ethics committee of ISTM/Mbandaka.

3. RESULTS

3.1. Sociodemographic Characteristics of the Sample

The final sample comprised 400 households. Table 1 presents the sociodemographic characteristics of respondents.

Table 1

Sociodemographic Characteristics of Respondents (N = 400)

Variable	Category	Frequency (n)	Percentage (%)
Age of respondent	20 – 25 years	64	16.0

Variable	Category	Frequency (n)	Percentage (%)
Sex	26 – 30 years	112	28.0
	31 – 35 years	120	30.0
	> 35 years	104	26.0
	Male	160	40.0
	Female	240	60.0
Education level	None	60	15.0
	Primary	140	35.0
	Secondary	170	42.5
	Higher/University	30	7.5
Household size	1 – 5 persons	120	30.0
	> 5 persons	280	70.0

The predominance of female respondents (60.0%) is consistent with their central role in daily household management and hygiene practices. Household size was particularly large, with 70.0% of households comprising more than five persons—a recognized factor facilitating person-to-person transmission of pathogens, particularly for respiratory infections. While 42.5% of household heads had secondary education, half (50.0%) had not progressed beyond primary education or had no formal schooling, potentially limiting the assimilation of prevention messages.

3.2. Environmental and WASH Factors

Table 2 presents the status of water, sanitation, and hygiene (WASH) infrastructure.

Table 2

Water Supply and Sanitation Status (N = 400)

Variable	Category	Frequency (n)	Percentage (%)
Water source	Improved (piped, protected well)	100	25.0
	Unimproved (open well, river)	300	75.0
Water treatment	Always	80	20.0
	Sometimes / Never	320	80.0
Latrine type	Hygienic (with slab)	60	15.0
	Non-hygienic / Open defecation	340	85.0
Waste management	Adequate (bin/pit)	90	22.5
	Inadequate (street/river)	310	77.5
Stagnant water	Present	264	66.0
	Absent	136	34.0

The WASH data reveal a situation of extreme vulnerability. The widespread use of unimproved water (75.0%) and the near-absence of water treatment (80.0%) expose households to a high risk of waterborne diseases. The low rate of access to hygienic latrines (15.0%) is a major marker of environmental fecal contamination, while inadequate waste management (77.5%) exacerbates this hazard by promoting vector accumulation. Finally, the presence of stagnant water in 66.0% of plots favors mosquito proliferation and the persistence of pathogens in the immediate environment.

3.3. Prevalence of Community-Acquired Infections

Table 3 presents the primary outcome indicator of this study.

Table 3

Prevalence of Community-Acquired Infections in the Past 12 Months (N = 400)

Infectious Status	Frequency (n)	Percentage (%)
At least one infection reported	280	70.0
No infection reported	120	30.0
Total	400	100.0

The 70.0% prevalence constitutes a major alarm signal. It indicates that community-acquired infections are not isolated incidents but an endemic condition for the vast majority of households in the neighborhood. This figure substantially exceeds generally accepted alert thresholds in urban areas, justifying the urgency of targeted action to halt transmission dynamics.

3.4. Bivariate Analysis: Significant Associations

Table 4 summarizes the results of chi-square tests evaluating the association between key variables and infectious status.

Table 4

Factors Associated with Infection Occurrence (Bivariate Analysis, N = 400)

Risk Factor	Infected Households (n, %)	Non-Infected Households (n, %)	p-value (χ^2)
Unimproved water source	240 (80.0)	60 (20.0)	< 0.001
No water treatment	212 (69.0)	96 (31.0)	0.001
Non-hygienic latrine	260 (76.4)	80 (23.6)	< 0.001
Absence of handwashing*	208 (74.0)	72 (26.0)	0.004
Presence of stagnant water	224 (84.8)	40 (15.2)	< 0.001
Recent RECO visit	68 (57.0)	52 (43.0)	0.320 (NS)

*Measured by direct observation (device absent) or negative declaration. NS: Not significant.

Bivariate analysis demonstrated a very strong statistical correlation between WASH factors and infection occurrence. Variables related to water supply, sanitation, and hand hygiene were all significantly associated with morbidity. In contrast, the association with community health worker (RECO) visits was not significant, suggesting that these interventions in their current form do not have the expected impact on risk reduction. This finding justified further investigation through multivariate analysis.

3.5. Multivariate Analysis: Independent Determinants of Infectious Risk

Table 5 presents the final logistic regression model, adjusted for sociodemographic variables (age, sex, education, household size).

Table 5

Independent Determinants of Community-Acquired Infections (Logistic Regression Model, N = 400)

Explanatory Variable	Adjusted Odds Ratio (aOR)	95% Confidence Interval	p-value
Absence of handwashing facility	4.2	[1.8 – 9.4]	0.001
No water treatment at home	3.85	[2.41 – 6.15]	0.001
Unimproved water source	3.5	[2.1 – 5.8]	0.002
Presence of stagnant water	2.8	[1.5 – 4.2]	0.005
Non-hygienic latrine	2.1	[1.35 – 3.28]	0.012
Household size (>5 persons)	1.2	[0.8 – 1.9]	0.450 (NS)

Explanatory Variable	Adjusted Odds Ratio (aOR)	95% Confidence Interval	p-value
Low education level	1.2	[0.85 – 1.70]	0.250 (NS)

NS: Not significant ($p > 0.05$)

Logistic regression allowed prioritization of risk factors. The absence of handwashing facilities emerged as the most powerful predictor (aOR = 4.2): individuals living in households without such a device had a 4.2-fold increased risk of contracting an infection. Factors related to water quality and domestic sanitation (stagnant water, latrines) also constituted major determinants. Notably, sociodemographic variables lost their significance in the multivariate model, indicating that the theoretical protective effect of higher education is overshadowed by structural precariousness and the financial impossibility of implementing adequate hygiene practices.

4. DISCUSSION

4.1. The High Prevalence: A Reflection of Systemic Crisis

The observed 70.0% prevalence is alarming and exceeds figures reported in other Congolese cities (Kakule et al., 2025). This rate places Bokotola in a situation of persistent health emergency. This massive morbidity results from the interaction of poverty, infrastructure deficits, and major environmental determinants. The proximity of the Congo River—a source of "free" but contaminated water—constitutes an epidemiological trap. Unlike areas where water is scarce and therefore carefully treated, the apparent abundance in Mbandaka may induce a false sense of security, discouraging households from investing in water treatment (Ngabu et al., 2021).

4.2. The Predominance of Fecal-Oral Peril

The absence of handwashing was the most formidable risk factor (aOR = 4.2). This result confirms the literature on the primary barrier role of this simple gesture (Curtis et al., 2011). In Bokotola, this hygiene deficit is aggravated by the lack of equipment (soap, water near latrines). Similarly, the absence of home water treatment (aOR = 3.85) renders consumption of already polluted river water directly hazardous. These findings demonstrate that infectious risk is primarily driven by the fecal-oral route.

4.3. The Domestic Environment as a Pathogen Reservoir

Stagnant water (aOR = 2.8) and non-hygienic latrines (aOR = 2.1) act as amplifiers of contamination. The clayey soil of the neighborhood and abundant rainfall promote flooding of traditional latrines, dispersing fecal matter throughout household courtyards (Mubedi et al., 2020). This environmental contamination creates a continuous transmission cycle.

4.4. The Limited Effectiveness of Community Health Workers (RECO)

The absence of a significant association between RECO visits and reduced infections ($p = 0.320$) is a crucial observation. It reveals a disconnect between communication for behavior change (CBC) and the economic realities of households. As suggested by other studies (Kabamba et al., 2022), "sterile sensitization"—unaccompanied by material support (hygiene kits, chlorine)—collides with the wall of poverty. Informing a population that they should boil water is ineffective if they cannot afford fuel.

4.5. Limitations and Potential Biases

This study has several limitations. Recall bias is inherent in self-reporting of infectious episodes. Furthermore, the cross-sectional design allows identification of associations but not formal establishment of causality. Finally, respondents may have over-reported certain practices (such as handwashing) to conform to social norms (social desirability bias). The use of a direct observation grid partially mitigated this latter bias.

5. CONCLUSION AND RECOMMENDATIONS

This research highlights the environmental and behavioral determinants of community-acquired infections in Bokotola neighborhood. The 70.0% prevalence reflects a profound health crisis. Multivariate analysis confirms that infectious risk is primarily governed by the absence of hand hygiene, consumption of untreated water, and environmental insalubrity. The limited impact of community health workers suggests that current strategies focused solely on verbal sensitization are insufficient to halt transmission in a context of structural precariousness.

To break this dynamic, we formulate the following recommendations:

1. For Urban Authorities (City Hall, Provincial Health Division):

- Secure water supply by advocating for expansion of the REGIDESO piped network to reduce dependence on the river.
- Invest in drainage infrastructure to eliminate stagnant water, identified as a major risk factor.

2. For Technical and Financial Partners (NGOs):

- Adopt an integrated intervention model systematically combining WASH kit distribution (soap, chlorine) with sensitization.
- Promote low-cost technologies, such as "Tip-Tap" handwashing devices and SanPlat slab latrines, which are easily replicable by households.

3. For Community Health Workers and Local Leaders:

- Strengthen interactive communication by organizing practical demonstrations rather than one-way lectures.
- Establish a community-based surveillance system to detect and promptly report peaks in diarrhea or typhoid fever cases.

The implementation of these actions could potentially reduce infectious risk by nearly 70%, consistent with the findings of our model, by targeting the three principal risk factors identified.

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