



Hygiene, sanitation and CBRN security in Kinshasa: between regulations and practices in the Saïo neighbourhood

Sarah Kinsona Bombile¹, Fiston Masikini Bombamu^{1,2,3}, Orcy Amogu^{1,4}, Pierre Ensole Mbongo Pasi⁵

¹Centre of Excellence for Chemical, Biological, Radiological and Nuclear Matters (CoE-CBRN), Ministry of Scientific Research and Technological Innovation, Democratic Republic of the Congo, masikinifiston@gmail.com

²Department of Environmental Management, Cardinal Malula Christian University, Kinshasa, Democratic Republic of the Congo

³Department of Public Health, John Wesley Methodist University, Kinshasa, Democratic Republic of the Congo

⁴Department of Biology, Faculty of Science, University of Kinshasa, PO Box 190, Kinshasa XI, Democratic Republic of the Congo

⁵Higher Institute of Applied Technology, Kinshasa, Democratic Republic of the Congo

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ABSTRACT

Background: Hygiene and sanitation are major determinants of public health and health security. In the working-class neighbourhoods of Kinshasa, uncontrolled urbanisation, a lack of infrastructure and a lack of awareness of regulations expose the population to high health and CBRN (chemical, biological, radiological and nuclear) risks.

Objective: To assess the quality of hygiene and sanitation, the level of awareness of regulations and the CBRN risks associated with the Saïo neighbourhood, in the municipality of Kasa-Vubu, Kinshasa.

Methods: A descriptive cross-sectional study was conducted among 165 households selected using stratified random sampling by street. Data were collected via a structured questionnaire, a direct observation checklist and semi-structured interviews. Bivariate analysis used the chi-squared test ($p < 0.05$).

Results: Hygiene and sanitation standards were poor in 58.8 per cent of households. Only 37.0 per cent practised handwashing with soap and water, 58.8 per cent engaged in fly-tipping, and 53.9 per cent discharged wastewater onto the street. Single-pit latrines were the most common (60.6 per cent), 75.2 per cent of households shared their toilets, and 76.4 per cent of facilities were unsanitary. Level of education ($p = 0.009$), employment status ($p < 0.001$) and income ($p = 0.003$) were significantly associated with sanitation quality. With regard to regulations, 82.4 per cent of households were unaware of the existence of legal provisions relating to hygiene and sanitation, and 91.5 per cent had never received any awareness-raising on CBRN risks.

Conclusion: The hygiene and sanitation situation in the Saïo neighbourhood is generally poor, exposing the population to CBRN risks. Integrated interventions, including health education, enforcement of regulations and CBRN risk management, are required.

Keywords: Kinshasa, hygiene, sanitation, regulations, CBRN risks, public health, Saïo neighbourhood.

1. Introduction

1.1. General context

Hygiene and sanitation are fundamental determinants of public health. According to the World Health Organisation (WHO, 2022), inadequate access to safe drinking water, hygiene and sanitation is responsible for at least 1.4 million preventable deaths worldwide each year, mainly due to

diarrhoeal diseases, cholera and typhoid. Poor management of human excreta, domestic wastewater and solid waste facilitates the faecal-oral transmission of numerous pathogens (Prüss-Ustün et al., 2019).

In sub-Saharan Africa, rapid and uncontrolled urbanisation exacerbates these problems. Less than 30 per cent of the region's urban population has access to safely managed sanitation services (UNICEF & WHO, 2021). The Democratic Republic of the Congo (DRC), and more specifically its capital Kinshasa, perfectly illustrates these challenges. A megacity with a population of over 15 million, Kinshasa is characterised by haphazard urban sprawl, a glaring lack of drainage and waste collection infrastructure, and poor coverage of drinking water and collective sanitation networks (Nzeza Kabuya, 2019).

1.2. Hygiene, sanitation and CBRN security: a little-known link

Beyond conventional health risks, the failure of hygiene and sanitation systems constitutes an often-overlooked vector for CBRN (Chemical, Biological, Radiological and Nuclear) risks. Indeed:

- **Biological risks:** Stagnant wastewater, fly-tipping and the presence of faecal matter encourage the proliferation of pathogenic bacteria (*Vibrio cholerae*, *Salmonella typhi*, *Shigella* spp.), viruses (poliovirus, rotavirus, hepatitis A) and parasites (roundworms, amoebae). These biological agents can be spread via runoff and aerosols, creating epidemic hotspots.
- **Chemical risks:** Poorly managed household waste contains hazardous chemicals (batteries, solvents, pesticides, expired pharmaceutical products). Its fly-tipping and open-air incineration release volatile organic compounds (VOCs), dioxins and furans, exposing the population to acute and chronic poisoning.
- **Radiological and nuclear risks:** Although less common, medical waste (low-activity radioactive sources used in nuclear medicine, smoke detectors, lightning conductors) may end up in informal waste management systems. Handling such waste without protection exposes people to ionising radiation.

The convergence of these risks makes hygiene and sanitation a matter of **global public health security**, justifying an integrated approach that includes regulation and the management of CBRN risks.

1.3. Regulatory framework in the DRC

The DRC has a legal framework governing hygiene, sanitation and CBRN risk management, but its implementation remains limited.

National legislation:

- **Constitution of the DRC (2006):** Article 53 (right to a healthy environment), Article 54 (protection against pollution and nuisances).
- **Law No. 11/009 of 9 July 2011** on fundamental principles relating to environmental protection.
- **Law No. 15/026 of 31 December 2015** on water.
- **Act No. 18/031 of 13 December 2018** on public health (hygiene and sanitation).
- **Ordinance-Law No. 23/007** amending and supplementing Law No. 11/009 on environmental protection.
- **Ordinance No. 74-345 of 28 June 1959** on Public Hygiene in Urban Areas.
- **Decree No. 16/013 of 21 April 2016** establishing the Electricity Sector Regulatory Authority (ARE).

Ratified international instruments:

- Stockholm Convention on Persistent Organic Pollutants (POPs);
- Basel Convention on the Transboundary Movement of Hazardous Wastes;
- Convention on Biological Diversity (Cartagena Protocol on Biosafety);
- Treaty on the Non-Proliferation of Nuclear Weapons (NPT);
- Chemical Weapons Convention (CWC) and Biological Weapons Convention (BWC).

International standards:

- WHO: Guidelines on Sanitation and Health (2018);
- ISO 15189: Medical laboratories — Requirements for quality and competence;

- ISO 35001: Biorisk management;
- SDG 6: Universal access to water and sanitation by 2030.

Despite this legal framework, implementation remains limited due to a lack of public awareness, insufficient monitoring mechanisms and the general public's lack of understanding of the relevant legislation.

1.4. Issues and objectives

Within the municipality of Kasa-Vubu, the Saïo neighbourhood faces major challenges in terms of environmental hygiene. Preliminary observations reveal a worrying level of unsanitary conditions: the presence of piles of fly-tipped waste, stagnant wastewater and rainwater due to a lack of functioning drains, and the shared use of sanitation facilities that are often dilapidated and unsanitary. This situation exposes the population to a high and constant health risk (Tshibangu & Mulumba, 2020).

Whilst several studies have documented the sanitation issue in Kinshasa at a macro level, specific data at the level of a neighbourhood such as Saïo – incorporating the dimensions of domestic hygiene, infrastructure, regulation and CBRN risks – remain fragmented.

Research questions:

1. What is the standard of hygiene practices and sanitation infrastructure in the Saïo neighbourhood?
2. What is the level of awareness of current regulations on hygiene and sanitation?
3. What are the CBRN risks associated with the shortcomings observed?
4. What socio-economic and environmental factors determine this quality?

General objective: To assess the quality of hygiene and sanitation, the level of awareness of regulations and the CBRN risks associated with the Saïo neighbourhood, in the municipality of Kasa-Vubu, Kinshasa.

Specific objectives:

1. To describe household hygiene practices;
2. To assess the condition and functionality of sanitation infrastructure;

3. To assess the level of knowledge and compliance with Congolese regulations;
4. To identify the CBRN risks associated with the observed shortcomings;
5. To analyse the socio-demographic and economic factors associated with the quality of hygiene and sanitation;
6. Formulate integrated recommendations.

Hypotheses:

1. The quality of hygiene and sanitation in the Saïo neighbourhood is likely to be generally poor, falling short of the minimum standards recommended by the WHO;
2. Low household income and tenant status are likely to be significantly associated with poorer quality sanitation practices and infrastructure;
3. The level of knowledge and compliance with current regulations is likely to be low;
4. Deficiencies in hygiene and sanitation would expose the population to significant CBRN risks.

2. Materials and methods

2.1. Study setting

The study was conducted in the Saïo neighbourhood, located in the commune of Kasa-Vubu, one of the twenty-four communes of the city-province of Kinshasa, DRC. The commune of Kasa-Vubu is bordered to the north by Lingwala, to the south by Ngiri-Ngiri, to the east by Limete, and to the west by Kinshasa (Gombe). It covers an area of approximately 5.4 km².

The Saïo neighbourhood is characterised by low-income housing, small plots of land (< 100 m²), houses built from semi-durable materials, and the absence of a collective sewerage system. Open drains are often blocked, and single-pit latrines are the norm. Access to drinking water is mainly via standpipes or by purchasing it from vendors.



Figure 1. Map of the Saïo neighbourhood, Kasa-Vubu municipality, Kinshasa

2.2. Type and scope of the study

This is a descriptive, cross-sectional study with an evaluative focus. Data were collected at a specific point in time (from 20 January to 20 August 2026), without longitudinal follow-up.

2.3. Study population

Target population: All households residing in the Saïo neighbourhood. A household is defined as a group of people, whether related or not, living under the same roof, sharing a meal together and recognising the authority of a head of household.

Inclusion criteria:

- Have lived in the Saïo neighbourhood for at least 6 months;
- Voluntarily agree to take part (free and informed consent);
- Have a respondent aged 18 or over.

Exclusion criteria:

- Inability to participate due to mental health issues or a severe disability;
- Absence after two attempts to visit;
- Institutions (convents, barracks, prisons).

2.4. Sampling

Survey base: A preliminary rapid census was carried out with the assistance of the neighbourhood head and street leaders to estimate the total number of plots and households.

Method: Simple random stratified sampling by street. The streets within the neighbourhood constituted the strata. In each street, a number of households proportional to its size was selected at random.

Sample size: Calculated using Fisher's formula for a proportion in a finite population:

$$n = (Z^2 \times p \times q) / d^2$$

Where $Z = 1.96$ (95% CI), $p = 0.50$, $q = 0.50$, $d = 0.08$. Thus, $n = 150$ households. With an attrition rate of 10 per cent, the final sample size was **165 households**.

2.5. Study variables

Table 1. Categories of study variables

Category	Variable	Type	Indicators / Measures
Dependent variable	Quality of hygiene and sanitation	Ordinal qualitative	Composite score: Good / Acceptable / Poor
Independent variables			
Socio-demographic	Age of the head of household	Continuous quantitative	Years
	Gender of the head of household	Qualitative, nominal	Male / Female
	Level of education	Ordinal qualitative	None / Primary / Secondary / Higher
	Household size	Discrete quantitative	Number of people
	Housing status	Nominal qualitative	Owner / Tenant

Economic	Monthly income	Ordinal qualitative	Brackets (FC)
Environmental	Drinking water source	Nominal qualitative	Tap / Standpipe / Well / Bottled water
	Waste management method	Nominal qualitative	Bins / Fly-tipping / Landfill / Incineration
	Toilet type	Nominal qualitative	Septic tank / Improved latrine / Simple pit latrine
	Number of households sharing the toilet	Discrete quantitative	Number
Regulatory	Knowledge of legal texts	Nominal qualitative	Yes / No
	Training received	Nominal qualitative	Yes / No
CBRN	Knowledge of CBRN risks	Nominal qualitative	Yes / No
	Perception of chemical risks	Ordinal qualitative	Low / Medium / High
	Perception of biological risks	Ordinal qualitative	Low / Medium / High
	Perception of radiological/nuclear risks	Ordinal qualitative	Low / Medium / High

2.6. Data collection tools

1. **Household questionnaire:** Administered face-to-face, comprising 6 sections (socio-demographic, hygiene practices, waste management, sanitation infrastructure, regulatory knowledge, perception of CBRN risks).

2. **Observation checklist:** Objective assessment of the condition of infrastructure and the immediate environment.
3. **Semi-structured interview guide:** Interviews with key informants (neighbourhood leader, hygiene officer, health centre manager, civil protection officer).

Pre-test: The tools were pre-tested with 10 households in a neighbourhood with similar characteristics (Assossa).

2.7. Conduct of the survey

- **Interviewers:** Four interviewers were recruited and trained over a two-day period.
- **Data collection:** From 20 January to 20 August 2026, with visits in the morning and late afternoon.

2.8. Data processing and analysis

- **Data entry:** EpiData 3.1, with validity checks.
- **Analysis:** SPSS 26.0.
- **Descriptive analysis:** Frequencies, percentages, means, standard deviations.
- **Bivariate analysis:** Pearson's chi-squared test (significance level $p < 0.05$).
- **Composite score:** Constructed from 5 key indicators (handwashing, type of toilet, cleanliness, waste management, wastewater disposal), scored from 0 to 2. Total score categorised into 3 classes (Poor, Acceptable, Good) according to tertiles.

2.9. Ethical considerations

- **Informed consent:** Clear and comprehensive information; signing of the consent form.
- **Anonymity and confidentiality:** Unique codes, secure data.
- **Institutional approval:** Protocol approved by the teaching committee of the Department of Public Health.

3. Results

3.1. Sociodemographic profile of the households surveyed

Table 2. Sociodemographic characteristics of household heads (N = 165)

Variable	Category	Number (n)	Percentage (%)
Gender	Male	112	67.9
	Female	53	32.1
Age (years)	< 30	28	17.0
	30–44	71	43.0
	45–59	49	29.7
	≥ 60	17	10.3
Level of education	None	11	6.7
	Primary	38	23.0
	Secondary	89	53.9
	Higher education	27	16.4
Household size	1–3 people	26	15.8
	4–6 people	78	47.3
	≥ 7 people	61	37.0
Tenure status	Homeowner	52	31.5
	Tenant	113	68.5
Monthly income (FC)	< 200,000	74	44.8

	200,000–500,000	68	41.2
	> 500,000	23	13.9

Source: Field survey, 2026.

The majority of heads of household were male (67.9 per cent), aged between 30 and 44 (43.0 per cent), and had completed secondary education (53.9 per cent). Nearly seven in ten households (68.5 per cent) were tenants. Economically, 44.8 per cent of households reported a monthly income of less than 200,000 FC.

3.2. Household hygiene practices

Table 3. Household hygiene practices (N = 165)

Variable	Category	Number (n)	Percentage (%)
Source of drinking water	Private tap REGIDESO	31	18.8
	Street hydrant	89	53.9
	Borehole/well	18	10.9
	Bagged/bottled water	27	16.4
Method of water storage	Sealed container with lid	72	43.6
	Open container	93	56.4
Hand washing	Yes, with soap and water	61	37.0
	Yes, with water only	79	47.9
	No	25	15.2
Waste management	Bins/collection	22	13.3

	Fly-tipping	97	58.8
	Landfilling	28	17.0
	Incineration	18	10.9
Wastewater disposal	Soakaway/cesspit	41	24.8
	Drainage channel	35	21.2
	Street/courtyard	89	53.9

Source: Field survey, 2026.

Only a minority of households (18.8 per cent) had a private tap. Water was stored in an uncovered container in 56.4 per cent of households. Handwashing with soap and water was practised in only 37.0 per cent of households. Illegal dumping of rubbish occurred in 58.8 per cent of households, and the discharge of wastewater into the street or courtyard in 53.9 per cent.

3.3. State of sanitation infrastructure

Table 4. Status of sanitation infrastructure (N = 165)

Variable	Category	Number (n)	Percentage (%)
Type of toilet	Flush toilet + septic tank	18	10.9
	Improved latrine	47	28.5
	Single-pit latrine	100	60.6
Shared toilets	Not shared	41	24.8
	Shared (2–3 households)	63	38.2
	Shared (≥ 4 households)	61	37.0

Cleanliness	Clean	39	23.6
	Dirty	126	76.4
Hand-washing facility	Available with soap and water	23	13.9
	Available with water only	54	32.7
	Absent	88	53.3
Drainage channels	Present and functional	31	18.8
	Present but blocked	72	43.6
	Absent	62	37.6

Source: Field survey, 2026.

Single-pit latrines were the most common type of facility (60.6 per cent). 75.2 per cent of households shared toilet facilities. Direct observation revealed that 76.4 per cent of facilities were dirty. More than half of households (53.3 per cent) had no hand-washing facilities near the toilet. Drainage channels were either absent or blocked in 81.2 per cent of households.

3.4. Overall quality of hygiene and sanitation

Table 5. Overall quality level (N = 165)

Quality level	Number (n)	Percentage (%)
Good	21	12.7
Acceptable	47	28.5
Poor	97	58.8
Total	165	100.0

Source: Field survey, 2026.

The overall quality was poor for 58.8 per cent of households. Only 12.7 per cent were of good quality.

3.5. Knowledge of regulations and awareness

Table 6. Awareness of regulations and public awareness (N = 165)

Variable	Category	Number (n)	Percentage (%)
Knowledge of legal texts	Yes	29	17.6
	No	136	82.4
Awareness of Act No. 11/009	Yes	12	7.3
	No	153	92.7
Awareness of Law No. 15/026 (water)	Yes	8	4.8
	No	157	95.2
Awareness-raising on hygiene	Yes	42	25.5
	No	123	74.5
Awareness training received on CBRN risks	Yes	14	8.5
	No	151	91.5

Source: Field survey, 2026.

The results reveal an alarming lack of awareness of the regulations: 82.4 per cent of households were unaware of the existence of legislation on hygiene and sanitation. Only 7.3 per cent were aware of Law No. 11/009 on environmental protection, and 4.8 per cent of Law No. 15/026 on water. With regard to awareness-raising, 74.5 per cent of households had

never received any awareness-raising on hygiene, and 91.5 per cent on CBRN risks.

3.6. Perception of CBRN risks

Table 7. Households' perception of CBRN risks (N = 165)

Type of risk	Perception	Number (n)	Percentage (%)
Biological risks	Low	45	27.3
	Medium	62	37.6
	High	58	35.2
Chemical risks	Low	78	47.3
	Medium	54	32.7
	High	33	20.0
Radiological/nuclear risks	Low	142	86.1
	Medium	18	10.9
	High	5	3.0

Source: Field survey, 2026.

Perceptions of CBRN risks vary by type: 35.2 per cent of households perceived a high biological risk, compared with 20.0 per cent for chemical risks and only 3.0 per cent for radiological/nuclear risks. This low perception of radiological and chemical risks contrasts with the reality of hazardous waste present in informal waste management systems.

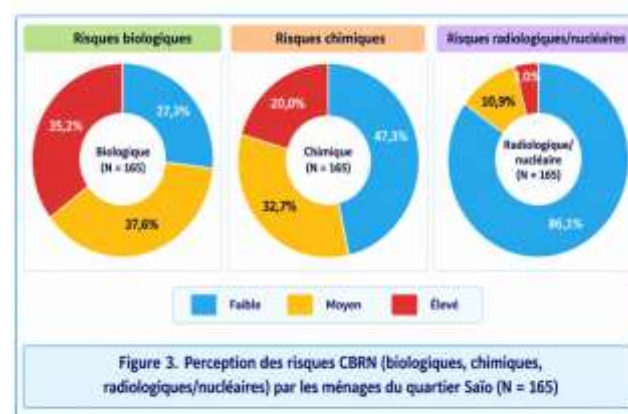


Figure 2. Households' perception of CBRN risks

Figure 2 illustrates the perception of CBRN risks among households in the Safo neighbourhood (N = 165). Biological risks are perceived as high by 35.2 per cent of households, compared with 20.0 per cent for chemical risks and only 3.0 per cent for radiological/nuclear risks. This underestimation of chemical and radiological risks contrasts with the proven presence of hazardous waste in informal waste management systems. Source: Field survey, 2026.

3.7. Factors associated with the quality of hygiene and sanitation

Table 8. Factors associated with the quality of hygiene and sanitation

Variable	Category	Good/Acceptable (%)	Poor (%)	χ^2	P-value
Level of education	None/Primary	27.5	72.5	6.84	0.009
	Secondary/Higher education	47.6	52.4		
Housing status	Homeowner	61.5	38.5	12.31	< 0.001
	Tenant	30.1	69.9		
Monthly income	< 200,000 FC	24.3	75.7	11.47	0.003

	200,000–500,000 FC	48.5	51.5		
	> 500,000 FC	65.2	34.8		
Household size	1–6 people	43.3	56.7	0.62	0.431
	≥ 7 people	37.7	62.3		
Gender of head of household	Male	42.0	58.0	0.18	0.673
	Female	39.6	60.4		
Regulatory knowledge	Yes	55.2	44.8	8.92	0.003
	No	32.4	67.6		

Source: Field survey, 2026. Significance threshold: $p < 0.05$.

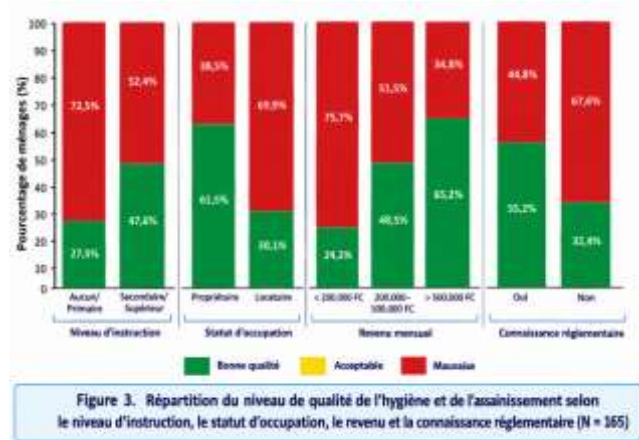


Figure 3 shows the distribution of hygiene and sanitation quality levels by educational attainment, employment status, monthly income and knowledge of regulations ($N = 165$). The stacked bars indicate the proportion of households with good/acceptable (green/yellow) or poor (red) quality. The differences are statistically significant (chi-squared test, $p < 0.05$) for all variables shown. Source: Field survey, 2026.

The bivariate analysis revealed four statistically significant associations:

- **Level of education:** A higher proportion of heads of household with secondary or higher education reported good or acceptable quality (47.6 per cent) than those with no education or primary education (27.5 per cent; $p = 0.009$).
- **Housing status:** The proportion of households with good or acceptable housing quality was twice as high amongst homeowners (61.5 per cent) as amongst tenants (30.1 per cent; $p < 0.001$).
- **Monthly income:** The higher the income, the better the quality ($p = 0.003$).
- **Knowledge of regulations:** Households familiar with the relevant legislation had better hygiene and sanitation standards (55.2% vs 32.4%; $p = 0.003$).

Neither household size ($p = 0.431$) nor the gender of the head of household ($p = 0.673$) were significantly associated.

4. Discussion

4.1. Analysis of hygiene practices

The results reveal generally inadequate hygiene practices. The rate of handwashing with soap and water (37.0 per cent) is lower than the national urban average reported by the 2013–2014 DRC Demographic and Health Survey (EDS-RDC) (approximately 45 per cent in Congolese urban areas; INS, 2014), but consistent with data from other studies conducted in working-class neighbourhoods of Kinshasa (Tshibangu & Mulumba, 2020).

The practice of fly-tipping by nearly 60 per cent of households is an alarming indicator of the failure of the municipal solid waste management system. This finding corroborates the observations of Nzeza Kabuya (2019), who highlighted that waste collection service coverage in Kinshasa did not exceed 20 per cent of households in working-class neighbourhoods.

The discharge of wastewater directly onto the street or into courtyards by more than half of households (53.9 per cent) exposes the population to constant contact with water contaminated by faecal matter. This finding confirms that wastewater management is one of the weakest links in the sanitation chain in Kinshasa's unplanned neighbourhoods (Ayebare et al., 2018).

4.2. Assessment of infrastructure quality

The prevalence of single-pit latrines (60.6 per cent) and the fact that these facilities are shared by a large majority of

households (75.2 per cent) place a large proportion of the population in the Saïo neighbourhood in the 'limited sanitation' or even 'unimproved' category according to the JMP service levels (UNICEF & WHO, 2021). Sharing toilets, particularly with more than four households, is a recognised risk factor for the transmission of diarrhoeal diseases (Jenkins & Scott, 2007).

The level of dirt observed in 76.4 per cent of sanitation facilities is an objective indicator of poor environmental hygiene. The absence of handwashing facilities near toilets in 53.3 per cent of cases is an aggravating factor, as it makes it unlikely that the most effective hygiene practice for breaking the faecal-oral transmission chain will be adopted (Luby et al., 2011).

Blocked or non-functional drains in over 80 per cent of cases partly explain the stagnation of rainwater and wastewater, creating breeding sites conducive to the proliferation of mosquitoes that transmit malaria and dengue fever.

4.3. Awareness of regulations: a critical shortfall

The results reveal an alarming lack of awareness of regulations: 82.4 per cent of households were unaware of the existence of legal provisions relating to hygiene and sanitation. This lack of knowledge is a major obstacle to improving practices, as it deprives the population of the legal tools and reference standards needed to demand a healthy environment.

This situation contrasts with the existence of a comprehensive legal framework in the DRC (Constitution, Act No. 11/009, Act No. 15/026, Order No. 74-345). The problem therefore lies less in the absence of legislation than in its lack of dissemination and enforcement. This finding is consistent with the analyses by Nzeza Kabuya (2019) and Mutombo (2020), who highlight the weakness of monitoring and enforcement mechanisms.

The significant association between regulatory knowledge and hygiene standards ($p = 0.003$) suggests that better legal information could lead to behavioural changes. This finding supports the inclusion of legal awareness modules in health education programmes.

4.4. CBRN risks associated with the observed shortcomings

Failures in hygiene and sanitation in the Saïo neighbourhood expose the population to significant CBRN risks:

Biological risks: Stagnant wastewater, fly-tipping and the presence of faecal matter create an environment conducive to the proliferation of pathogenic bacteria (*Vibrio cholerae*, *Salmonella typhi*, *Shigella* spp.), viruses (poliovirus, rotavirus, hepatitis A) and parasites (roundworms, amoebae). In recent years, the DRC has experienced outbreaks of cholera (over 71,200 cases and 2,070 deaths in 2025 according to Radio Okapi, 2026) and typhoid fever, with outbreaks often centred in neighbourhoods with poor sanitation.

Chemical risks: Poorly managed household waste contains hazardous chemicals: batteries (heavy metals: lead, cadmium, mercury), solvents, pesticides, expired pharmaceutical products and used oil. Their illegal dumping and open-air incineration release volatile organic compounds (VOCs), dioxins and furans, exposing the population to acute and chronic poisoning. Studies by Masikini (2023) on VOCs at the Bayaka market have revealed worrying levels of chemical pollution in the informal areas of Kinshasa.

Radiological and nuclear risks: Although less common, medical waste (low-activity radioactive sources used in nuclear medicine, smoke detectors, lightning conductors) can end up in informal waste management systems. Handling such waste without protection exposes people to ionising radiation. The low perception of this risk (86.1 per cent of households consider it low) contrasts with its potential danger.

The convergence of these risks makes hygiene and sanitation a matter of **global public health security**, justifying an integrated approach that includes regulation and the management of CBRN risks.

4.5. Factors associated with the quality of hygiene and sanitation

The bivariate analysis confirmed the significant influence of educational attainment, employment status, income and regulatory knowledge on the quality of hygiene and sanitation, thereby validating the research hypotheses.

The association between a higher level of education and better hygiene practices is a well-established finding in public health (Dreibelbis et al., 2013). Education promotes a better understanding of awareness messages and a keener perception of health risks.

The strong link between home ownership and better-quality infrastructure is consistent with the literature. Homeowners, who have a financial stake in their homes, are more inclined to invest in sustainable sanitary facilities (Jenkins & Scott, 2007). Conversely, tenants, who are often in a precarious

housing situation, are less motivated to invest in a home that does not belong to them.

The significant effect of income confirms the weight of economic constraints on access to a healthy environment. The poorest households are doubly disadvantaged: they live in the most unsanitary dwellings and have fewer resources to improve their living conditions (Moser, 1998).

Finally, the association between knowledge of regulations and hygiene standards ($p = 0.003$) is an original finding of this study. It suggests that the dissemination of legal texts and standards could be an effective means of improving practices.

4.6. Implications for public health and CBRN security

The poor standard of hygiene reported by nearly 59 per cent of households has direct and worrying health implications. The conditions observed — poor hand-washing practices, sharing of unsanitary toilets, stagnant wastewater and the proliferation of waste — provide a breeding ground for the transmission of numerous diseases. Children under five are the most vulnerable to diarrhoeal diseases, intestinal parasitic infections and the resulting malnutrition (Prüss-Ustün et al., 2019).

Beyond the individual health consequences, this situation places an economic burden on households and the public health system. It also poses a threat to CBRN security by facilitating the spread of biological agents, exposure to hazardous chemicals and, potentially, the handling of radiological sources.

Conclusion

The aim of this study was to assess the quality of hygiene and sanitation, the level of awareness of regulations and the CBRN risks associated with the Saïo neighbourhood in the municipality of Kasa-Vubu, Kinshasa. The results confirm an overall worrying situation in terms of hygiene and sanitation.

Summary of the main findings:

- Only 37 per cent of households practised handwashing with soap and water;
- 58.8 per cent were dumping rubbish illegally;
- 53.9 per cent discharged wastewater onto the street or into their courtyard;
- 60.6 per cent used single-pit latrines;

- 75.2 per cent shared their toilets;
- 76.4 per cent of facilities were dirty;
- 58.8 per cent of households had poor overall living standards;
- 82.4 per cent were unaware of the existence of legislation on hygiene and sanitation;
- 91.5% had never received any awareness-raising on CBRN risks.

Associated factors: Educational attainment ($p = 0.009$), employment status ($p < 0.001$), income ($p = 0.003$) and knowledge of regulations ($p = 0.003$) were significantly associated with the quality of hygiene and sanitation.

Testing of hypotheses:

- **Hypothesis 1:** Confirmed. The quality of hygiene and sanitation is generally poor and falls below WHO standards.
- **Hypothesis 2:** Confirmed. Low income and tenant status are significantly associated with poorer quality.
- **Hypothesis 3:** Confirmed. The level of knowledge and compliance with regulations is low.
- **Hypothesis 4:** Confirmed. Failures in hygiene and sanitation expose the population to significant CBRN risks.

Recommendations:

To local and urban authorities:

1. Improve solid waste collection (pre-collection, collection bins);
2. Refurbish and extend the drainage network;
3. Strengthen regulations governing sanitation in rented accommodation;
4. Facilitate access to drinking water;
5. Provide subsidies for sanitation for vulnerable households;

6. Raise awareness of the legal provisions relating to hygiene and sanitation.

For the general public:

1. Adopt essential hygiene practices (washing hands with soap);
2. Improve domestic waste management;
3. Maintain sanitation facilities;
4. Form health and hygiene committees;
5. Find out about the regulations in force.

For NGOs and technical partners:

1. Strengthen health and legal education;
2. Promote appropriate sanitation technologies;
3. Support community-led initiatives;
4. Incorporate the CBRN dimension into sanitation programmes;
5. Advocate for the inclusion of neighbourhoods in national programmes.

For national authorities (CBRN):

1. Strengthen monitoring of CBRN risks in informal settlements;
2. Develop a national hazardous waste management plan;
3. Train local stakeholders in the detection and management of CBRN risks;
4. Establish an early warning system for epidemics and CBRN incidents.

Limitations of the study: Small sample size; the self-reported nature of some information; a cross-sectional design that does not allow causal relationships to be established; absence of bacteriological and chemical analysis.

Future directions: Microbiological and chemical analyses, a longitudinal study, extension to several neighbourhoods, an in-depth qualitative study of perceptions, and a quantitative assessment of CBRN risks.

Declaration of conflict of interest

The authors declare that they have no conflict of interest relating to this study, its design, conduct, funding or publication. The results presented are the outcome of independent research and have not been subject to any influence from third parties, whether public or private organisations or technical and financial partners.

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