Research Square

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Food hygiene practices and sanitary conditions among food service establishments across three municipalities of Bukavu in the Democratic Republic of the Congo

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Abstract

Background: Safe food handling in restaurants and other food-service outlets is relevant to food utilization and public health. This study described hygiene practices and sanitation in Bukavu, Democratic Republic of the Congo, and compared three municipalities.

Methods: A cross-sectional survey and direct observation covered 85 purposively selected establishments in Bagira (30), Ibanda (25), and Kadutu (30). Frequencies and percentages were calculated; municipality differences were assessed using Pearson chi-square or Fisher exact tests for sparse tables.

Results: Protective work attire was reported by 17.6% of participants, consistent handwashing by 56.5%, and written procedures by 37.6%. Waste bins were present in 94.1% of sites, although 38.8% were near a pollution source; 83.5% had toilets. Risk awareness was reported by 86.9% of respondents with available data. Municipality differences were observed in pollution proximity, protective attire, sanitation indicators, and some hygiene practices.

Conclusions: Awareness of food-safety risks did not consistently translate into routine hygienic practices. Practical training, accessible handwashing facilities, protective attire, waste services, and proportionate municipal inspection may support safer food-service environments. These observational findings do not directly measure dietary adequacy, household food security, or microbiological contamination.

1. Introduction

Foodborne diseases remain a substantial but preventable burden on health systems and food economies. The World Health Organization burden assessment estimated hundreds of millions of illnesses and hundreds of thousands of deaths globally, with a disproportionate burden in low- and middle-income countries (2). More recent food-systems analyses emphasize that the consequences extend beyond acute morbidity to productivity, nutrition, equity and livelihoods, and that the greatest gains in food safety are likely to come from interventions that are feasible in informal and resource-constrained markets (1).

Food hygiene is especially challenging in sub-Saharan African catering and informal food-service systems because safe behavior depends on more than knowledge alone. A 2025 systematic review and meta-analysis of 42 studies involving 12,367 food handlers estimated that only about half practiced good food hygiene, with training, attitudes and medical oversight among the recurring correlates (3). A separate regional review identified persistent gaps in prerequisite hygiene programs, including personal hygiene, cleaning, cross-contamination control, waste management and temperature control, and highlighted the need for context-adapted regulation and institutional cooperation (4).

Recent empirical work in African cities also shows that food-safety behavior is shaped by the physical and organizational environment. Studies from Ethiopia and Ghana have linked hygienic practice with knowledge, experience, inspection, water availability and environmental cleanliness (6, 10); (7, 9). At the same time, qualitative evidence demonstrates that vendors may understand food-safety messages yet be unable to sustain recommended practices because of equipment costs, weak infrastructure, market conditions and regulatory constraints (5, 8). These findings support a shift from purely educational approaches toward combined behavioral, infrastructural and governance interventions. In eastern Democratic Republic of the Congo, Bakwanamaha et al. (17) documented university-community engagement in food-hygiene awareness in Beni, providing complementary evidence that awareness initiatives require sustained participation and practical support.

Bukavu provides an important setting for investigating food hygiene in urban catering. Environmental studies have documented pollution in urban rivers and challenges in municipal household-waste management (11, 12). In the Democratic Republic of the Congo, ecological research on cholera dynamics further highlights the relevance of environmental and public-health conditions (18). A microbiological investigation in Bukavu reported Salmonella enterica and Escherichia coli contamination in food and water samples, strengthening the local rationale for studying hygiene and sanitation in food-service settings (13). These earlier findings provide context; the present study did not directly test food or water samples.

Despite this environmental and microbiological evidence, comparative information remains limited on food handling, work procedures and sanitary infrastructure across Bagira, Ibanda and Kadutu. Such data can identify practical gaps in safe food utilization, one dimension of food security, without equating hygiene indicators with food availability, nutrition status or household food security.

Accordingly, this study aimed to (i) describe the sociodemographic and occupational characteristics of food handlers and operators in Bagira, Ibanda and Kadutu; (ii) characterize environmental sanitation, personal hygiene and food-handling practices; and (iii) test whether selected hygiene and sanitation indicators differed across municipalities. We hypothesized that the prevalence of key hygiene and sanitation indicators would vary significantly among the three municipalities.

2. Materials and Methods

2.1 Study design and setting

A cross-sectional field study was conducted in Bukavu, South Kivu Province, eastern Democratic Republic of the Congo, covering the municipalities of Bagira, Ibanda and Kadutu. The study follows relevant STROBE reporting principles (14). A geographical map of the three municipalities should be added if verified boundary data are available; no coordinates were available in the supplied manuscript.

2.2 Study population and sampling

The study population comprised individuals preparing or selling ready-to-eat food in formal and informal food-service establishments, including restaurants and canteens. Eighty-five accessible establishments were selected purposively, with one respondent per establishment: Bagira (30), Ibanda (25) and Kadutu (30). The sample size was determined by the number of eligible and accessible establishments reached during fieldwork rather than a formal probability-based calculation. Consequently, the results describe the participating establishments and should not be generalized statistically to all outlets in Bukavu.

2.3 Data collection and variables

Data were collected through a structured questionnaire administered face to face and complemented by direct observation of the food-service environment. The questionnaire covered sociodemographic characteristics (sex, age, education and marital status), occupational conditions (work experience, employment status, work schedule, income satisfaction and access to leave), environmental sanitation (site and surroundings cleanliness, waste-bin availability, nearby pollution sources and waste management), and food-hygiene practices (protective work attire, handwashing frequency, food sourcing, written operating procedures, dishwashing and access to toilets).

For this article, inferential analyses were restricted to variables whose categories and denominators were internally coherent in the source tables. Items with overlapping or incompletely specified response structures—such as detailed contact modes with food, some conservation categories, self-reported illness categories and detailed waste-disposal options—were not used for confirmatory inferential testing. This decision avoids treating multiple-response or subset variables as mutually exclusive outcomes.

2.4 Operational definitions

Protective work attire was defined as a positive response to use of designated work clothing/equipment. Handwashing frequency was classified as every time, occasionally or rarely, according to the original questionnaire. A written operating procedure indicated the presence of a documented procedure rather than reliance exclusively on oral practice or experience. Nearby pollution indicated observation/report of a relevant environmental pollution source near the establishment. Toilet availability referred to the presence of a toilet accessible to the establishment. Risk knowledge was based on the respondent's recorded awareness of risks associated with unsafe food; one record was missing for this item (n = 84).

2.5 Statistical analysis

Categorical variables were summarized as frequencies and percentages. Municipality-level associations were evaluated with Pearson's chi-square test when expected frequencies were adequate (all expected counts ≥ 5). For sparse contingency tables, the Fisher–Freeman–Halton extension of Fisher's exact test was estimated using fixed-margin Monte Carlo sampling (20,000 resamples; fixed random seed for reproducibility) in SciPy 1.17.0. Tests were two-sided and the significance threshold was $p < 0.05$. Tests were recalculated from the published aggregate tables; individual-level multivariable analyses were not

attempted because the source individual records were unavailable. P-values refer to exploratory, unadjusted comparisons and do not establish causality.

3. Results

3.1 Participant and occupational profile

The study included 85 respondents: 30 in Bagira, 25 in Ibanda and 30 in Kadutu. Women accounted for 49.4% of respondents and 52.9% were aged 18–34 years; 68.2% reported secondary education. Most worked full-time (91.8%). The sociodemographic and occupational indicators in Table 1 did not show statistically significant municipality-level differences.

Table 1
Sociodemographic and occupational characteristics by municipality. Values are n (%).

Characteristic	Bagira n = 30	Ibanda n = 25	Kadutu n = 30	Overall n = 85	Global test (p-value)
Sex					Pearson χ^2: p = 0.207
Female	15 (50.0)	9 (36.0)	18 (60.0)	42 (49.4)	
Male	15 (50.0)	16 (64.0)	12 (40.0)	43 (50.6)	
Age group					Fisher exact (MC): p = 0.552
18–34 years	17 (56.7)	16 (64.0)	13 (43.3)	46 (54.1)	
35–54 years	12 (40.0)	8 (32.0)	14 (46.7)	34 (40.0)	
55–64 years	1 (3.3)	1 (4.0)	3 (10.0)	5 (5.9)	
Education					Fisher exact (MC): p = 0.114
None	0	0	1 (3.3)	1 (1.2)	
Primary	4 (13.3)	1 (4.0)	8 (26.7)	13 (15.3)	
Secondary	21 (70.0)	18 (72.0)	19 (63.3)	58 (68.2)	
University	5 (16.7)	6 (24.0)	2 (6.7)	13 (15.3)	
Employment status					Fisher exact (MC): p = 0.545
Daily	0	0	1 (3.3)	1 (1.2)	
Part-time	2 (6.7)	3 (12.0)	1 (3.3)	6 (7.1)	
Full-time	28 (93.3)	22 (88.0)	28 (93.3)	78 (91.8)	
Work schedule					Fisher exact (MC): p = 0.136
Daytime	4 (13.3)	9 (36.0)	5 (16.7)	18 (21.2)	
Day + evening	25 (83.3)	16 (64.0)	25 (83.3)	66 (77.6)	
Evening only	1 (3.3)	0	0	1 (1.2)	

Notes: Pearson χ^2 = Pearson chi-square test; Fisher exact (MC) = Fisher–Freeman–Halton exact test with Monte Carlo approximation (20,000 fixed-margin samples). These exploratory p-values are unadjusted for multiple comparisons.

3.2 Environmental sanitation and infrastructure

Sanitary infrastructure differed among municipalities (Table 2). Waste bins were reported at 94.1% of establishments, while 38.8% were situated near a pollution source. Pollution proximity was highest in Kadutu (63.3%) and lowest in Ibanda (16.0%). Toilets were available in 83.5% of surveyed establishments. Site cleanliness and toilet availability also varied among municipalities.

A waste-management responsibility response was recorded for 52 establishments; among these, 63.5% reported no designated waste manager. This variable must be interpreted using its observed subset (Bagira 15, Ibanda 17, Kadutu 20), not as a prevalence estimate for all 85 establishments.

Table 2
Environmental sanitation and infrastructure indicators by municipality. Values are n (%).

Indicator	Bagira	Ibanda	Kadutu	Overall	Global test (p-value)
Site cleanliness					Fisher exact (MC): p = 0.043
Fairly clean	16 (53.3)	6 (24.0)	13 (43.3)	35 (41.2)	
Clean	14 (46.7)	16 (64.0)	17 (56.7)	47 (55.3)	
Very clean	0	3 (12.0)	0	3 (3.5)	
Waste bin available					Fisher exact (MC): p = 0.185
No	2 (6.7)	3 (12.0)	0	5 (5.9)	
Yes	28 (93.3)	22 (88.0)	30 (100.0)	80 (94.1)	
Nearby pollution source					Pearson χ^2: p = 0.001
No	20 (66.7)	21 (84.0)	11 (36.7)	52 (61.2)	
Yes	10 (33.3)	4 (16.0)	19 (63.3)	33 (38.8)	
Toilet available					Fisher exact (MC): p = 0.016
No	7 (23.3)	0	7 (23.3)	14 (16.5)	
Yes	23 (76.7)	25 (100.0)	23 (76.7)	71 (83.5)	
Waste manager (recorded subset)					Fisher exact (MC): p < 0.001
Private company	1 (6.7)	7 (41.2)	0	8 (15.4)	
Government	6 (40.0)	4 (23.5)	0	10 (19.2)	
Site owner	0	0	1 (5.0)	1 (1.9)	
Nobody	8 (53.3)	6 (35.3)	19 (95.0)	33 (63.5)	

Notes: Waste-manager figures use the available subgroup (n = 52); other variables use n = 85. Tests as defined in Table 1.

3.3 Personal hygiene, procedural controls and risk knowledge

Protective work attire was used in 17.6% of establishments, with higher reported use in Ibanda (40.0%) than in Kadutu (3.3%). Handwashing every time was reported by 56.5% of respondents. Only 37.6% reported a written operating procedure. Dishwashing after use was reported by 98.8% of respondents (Table 3).

Awareness of risks from unsafe food was reported by 86.9% of 84 respondents; one answer was missing. The exploratory Fisher exact comparison suggested a municipality-level difference ($p = 0.043$), although this borderline result is sensitive to multiple testing and sample size. Together, the observations suggest a descriptive gap between awareness and implementation of routine protective practices.

Table 3
Hygiene practices, procedural controls and risk knowledge by municipality. Values are n (%).

Indicator	Bagira	Ibanda	Kadutu	Overall	Global test (p-value)
Protective work attire					Fisher exact (MC): p = 0.002
No	26 (86.7)	15 (60.0)	29 (96.7)	70 (82.4)	
Yes	4 (13.3)	10 (40.0)	1 (3.3)	15 (17.6)	
Handwashing frequency					Fisher exact (MC): p = 0.023
Every time	18 (60.0)	18 (72.0)	12 (40.0)	48 (56.5)	
Occasionally	12 (40.0)	5 (20.0)	17 (56.7)	34 (40.0)	
Rarely	0	2 (8.0)	1 (3.3)	3 (3.5)	
Written operating procedure					Pearson χ^2: p = 0.154
No	22 (73.3)	12 (48.0)	19 (63.3)	53 (62.4)	
Yes	8 (26.7)	13 (52.0)	11 (36.7)	32 (37.6)	
Dishwashing frequency					Fisher exact (MC): p = 0.292
After use	30 (100.0)	24 (96.0)	30 (100.0)	84 (98.8)	
End of day only	0	1 (4.0)	0	1 (1.2)	
Knowledge of unsafe-food risks (n = 84)					Fisher exact (MC): p = 0.043
No	5 (16.7)	0	6 (20.7)	11 (13.1)	
Yes	25 (83.3)	25 (100.0)	23 (79.3)	73 (86.9)	

Notes: Risk-knowledge item uses n = 84 because one response was missing in Kadutu. Tests as defined in Table 1.

Source

Authors' data visualized using R version 4.4.2 (2024-10-31 ucrt) in RStudio.

Figure 2. Selected food-hygiene and sanitation indicators by municipality. Percentages use municipality-specific denominators (Bagira n = 30, Ibanda n = 25, Kadutu n = 30).

4. Discussion

The study identifies a mismatch between widespread awareness of food-related risks and inconsistent implementation of basic preventive measures. This distinction is important because knowledge alone does not ensure practical compliance. Comparable research from sub-Saharan Africa highlights training, supervision, organizational capacity and access to equipment as interrelated influences on hygiene practices (3, 4). Evidence from Beni similarly highlights the difference between food-hygiene knowledge and sustained engagement in community awareness activities, although that study involved university participants rather than food-service operators (17).

Differences between municipalities suggest that prevention cannot rely entirely on a uniform city-wide approach. Kadutu showed particular challenges related to nearby pollution and protective attire, whereas Ibanda performed better on some sanitation indicators. Local waterway-pollution and waste-management studies provide environmental context, but this survey cannot attribute those differences to specific municipal causes (11, 12).

Environmental hygiene is pertinent to food utilization and the prevention of foodborne illness. Earlier microbiological work from Bukavu found food- and water-safety concerns (13), but no food or water samples were tested in this study. Our sanitation findings therefore identify potential exposure conditions rather than confirmed contamination or attributable illness.

Personal hygiene and protective equipment showed a second important implementation gap. Protective attire was uncommon overall and highly variable among municipalities. Similar African studies report that hygienic practice is associated with environmental cleanliness, inspection, experience, training and access to enabling resources (6, 10); (7). In practice, gloves or uniforms should not be treated as substitutes for hand hygiene; instead, they are part of a package that includes handwashing facilities, clean clothing, separation of raw and cooked foods, safe storage and routine cleaning. The key implication is that compliance programs should assess whether workers have the capability and opportunity to perform the recommended behavior, not merely whether they can recall hygiene messages.

This interpretation is supported by recent intervention and qualitative research. Food vendors may improve knowledge and motivation after training, yet structural barriers such as cost, outlet infrastructure, market conditions and regulatory arrangements can prevent sustained behavior change (5, 8). Consequently, periodic classroom-style sensitization alone is unlikely to close the knowledge–practice gap observed in Bukavu. Training should be paired with affordable protective equipment, visible handwashing stations, simple written standard operating procedures, reliable waste collection and

supportive inspection. Engagement of universities and community stakeholders in sustained hygiene promotion may complement these establishment-level measures, as suggested by the Beni study (17).

The finding that written procedures were present in fewer than four in ten establishments is also operationally important. Written procedures can standardize cleaning schedules, temperature control, handling of leftovers, handwashing, waste removal and responses to contamination events. Although the present data did not show a statistically significant municipality difference for written procedures, the low overall prevalence indicates a city-wide opportunity for improvement. Simple pictorial procedures may be more feasible than complex HACCP documentation in small establishments, while larger restaurants can progressively adopt formal prerequisite programs and HACCP-based controls. Evidence from restaurant microbiological assessments indicates that structured food-safety systems can improve control, although certification alone does not eliminate the need for routine verification (15).

From a policy perspective, the results favor risk-based municipal action. Inspection resources could be prioritized toward outlets near pollution sources, sites without toilets or designated waste responsibility, and establishments lacking basic hygiene controls. At the same time, inspections should be corrective and educational rather than purely punitive, particularly in informal settings where infrastructure constraints are substantial. Governance studies of informal ready-to-eat food vending similarly emphasize the need to align formal requirements with the realities of informal food systems (16).

5. Strengths and Limitations

Combining questionnaires and direct observations across three municipalities is a useful descriptive strength. Sparse comparisons were recalculated using an exact-test approach, avoiding reliance on asymptotic chi-square tests when expected counts were too small.

The purposive cross-sectional sample does not represent all establishments in Bukavu and cannot establish causal effects. Certain measures are self-reported and could be affected by recall and social-desirability bias. No microbiological, temperature, drinking-water-quality, diet-quality or household food-security measurements were conducted. Several original variables contained overlapping categories or missing responses, and individual records were unavailable for adjusted analyses. Exploratory comparisons were not adjusted for multiple testing. Future studies should use probability sampling, direct objective measurements and more complete participant-level records.

6. Conclusions and Public-Health Implications

In the surveyed food-service establishments, high awareness of food-related risks coexisted with gaps in protective attire, consistent handwashing, written procedures and environmental sanitation. Municipality-level differences indicate potential opportunities for locally targeted improvements. These findings speak to food safety and safe food utilization, but do not demonstrate changes in dietary patterns, nutrition status or food security.

Actionable priorities include hands-on hygiene training, access to handwashing infrastructure and affordable protective clothing, clear operating procedures, reliable waste and sanitation services, and supportive risk-based inspection. Strengthening food safety at food-service outlets can complement broader healthy-diet and food-security policies, although its contribution to diet quality and food access requires separate evaluation.

Declarations

Ethical Approval and accordance

Ethical approval for this study was granted by the Interdisciplinary Centre for Ethics Research (CIRE) of the Evangelical University in Africa (UEA), Bukavu, Democratic Republic of the Congo, on 10 December 2025, under approval reference CNES 019/DPSK/322PP/2026. The study was conducted in accordance with the ethical guidelines and regulations of the approving ethics committee and applicable ethical requirements governing research involving human participants.

Consent to participate

Informed consent to participate was obtained from all 85 participants. Verification of the original database confirmed that all participants were aged 18 years or older. Participants were informed about the study objectives and procedures, the voluntary nature of participation, their right to withdraw at any time, and the confidentiality of their responses. No minors were included in the study; therefore, parental or legal guardian consent was not required.

Consent for publication

Not applicable; no identifiable participant information is reported.

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Competing interests

The authors declare no financial or non-financial competing interests.

Data availability

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

Patrick Mafikiri Bakwanamaha and Eka Nshombo Joyce: conceptualization, methodology, investigation, project administration, writing – original draft and review. Dominique Aganze Mulume, Ortence Kanyere Kazige, Irenge Mitima Honoré, Byumanine Ntabaza J. Roger, Ukweli Ndozondula Martin, Asifiwe Lwaboshi Jusine and Niyukuri Jonathan: methodology, validation and review. Sibomana Imani Caroline: conceptualization, methodology, supervision, validation and review.

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References

1. Grace D. Burden of foodborne disease in low-income and middle-income countries and opportunities for scaling food safety interventions. Food Secur. 2023;15:1475–88. https://doi.org/10.1007/s12571-023-01391-3.
2. Havelaar AH, Kirk MD, Torgerson PR, Gibb HJ, Hald T, Lake RJ, Praet N, Bellinger DC, de Silva NR, Gargouri N, Speybroeck N, Cawthorne A, Mathers C, Stein C, Angulo FJ, Devleesschauwer B. World Health Organization global estimates and regional comparisons of the burden of foodborne disease in 2010. PLoS Med. 2015;12(12):e1001923. https://doi.org/10.1371/journal.pmed.1001923.
3. Atalay YA, Gebeyehu NA, Gelaw KA. Food hygiene practice and associated factors among food handlers working in food establishments in sub-Saharan Africa: A systematic review and meta-analysis. Prim Health Care Res Dev. 2025;26:e13. https://doi.org/10.1017/S146342362500009X.
4. Tohonon AC, Ouétchéhou R, Hounsou M, Zannou O, Dabadé DS. Food hygiene in Sub-Saharan Africa: A focus on catering services. Food Control. 2025;168:110938. https://doi.org/10.1016/j.foodcont.2024.110938.
5. Adaku AA, Egyir IS, Gadegbeku C, Parry-Hanson Kunadu A, Amanor-Boadu V, Laar A. Barriers to ensuring and sustaining street food safety in a developing economy. Heliyon. 2024;10(11):e32190. https://doi.org/10.1016/j.heliyon.2024.e32190.
6. Fanta F, Azene M, Habte K, Samson H, Kebede A. Determinants of safe food handling practice among food handlers in food establishments, Yeka sub city, Addis Ababa. Ethiopia Heliyon. 2023;9(1):e12977. https://doi.org/10.1016/j.heliyon.2023.e12977.
7. Girma F, Yazew T, Bedada D, Daba A, Kuyu CG. Food hygienic practices and associated factors among street food vendors in Bishoftu town, central Ethiopia. Heliyon. 2024;10(24):e40938. https://doi.org/10.1016/j.heliyon.2024.e40938.

8. Madjdian DS, Badu D, Ilboudo V, Lallogo G, Dione VR, van Asseldonk M, Knight-Jones M, T. J. D., de Vet E. Fast food over safe food? A qualitative evaluation of a food safety training intervention for street vendors applying the COM-B model in Ouagadougou, Burkina Faso. PLoS ONE. 2024;19(11):e0313635. https://doi.org/10.1371/journal.pone.0313635.
9. Nortey AN, Amu H, Senu E, Effah A. (2024). Knowledge, attitude, and food safety practices among street food vendors at a metropolitan district in Ghana: A cross-sectional study. International Journal of Food Science, 2024, 5553942. https://doi.org/10.1155/2024/5553942
10. Werkneh AA, Tewelde MA, Gebrehiwet TA, Islam MA, Belew MT. Food safety knowledge, attitude and practices of street food vendors and associated factors in Mekelle city. North Ethiopia Heliyon. 2023;9(4):e15126. https://doi.org/10.1016/j.heliyon.2023.e15126.
11. Bisimwa AM, Amisi FM, Bamawa CM, Muhaya BB, Kankonda AB. Water quality assessment and pollution source analysis in Bukavu urban rivers of the Lake Kivu basin (Eastern Democratic Republic of Congo). Environ Sustain Indic. 2022;14:100183. https://doi.org/10.1016/j.indic.2022.100183.
12. Chuma GB, Mondo JM, Ndeko AB, Akuzibwe EM, Bagula EM, Mushagalusa GN. (2024). Quantification and valorization of compost derived from urban households' waste in Bukavu City, Eastern D.R. Congo. Discover Sustainability, 5, 102. https://doi.org/10.1007/s43621-024-00283-6
13. Okito AM, Wagacha JM, Lukhoba CW, Lina AA, Mukabana WR. Food and water safety risks from Salmonella enterica and Escherichia coli contamination in Bukavu City. Democratic Repub Congo Cureus. 2025;17(3):e79951. https://doi.org/10.7759/cureus.79951.
14. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: Guidelines for reporting observational studies. PLoS Med. 2007;4(10):e296. https://doi.org/10.1371/journal.pmed.0040296.
15. Lai H, Liu M, Tang Y, Ren F, Xu M, Guo C, Jiao X-A, Huang J. Microbiological safety assessment of restaurants and HACCP-certified kitchens in hotels: A study in eastern China. Int J Food Microbiol. 2024;425:110868. https://doi.org/10.1016/j.ijfoodmicro.2024.110868.
16. Adeosun KP, Oosterveer P, Greene M. Informal ready-to-eat food vending governance in urban Nigeria: Formal and informal lenses guiding the practice. PLoS ONE. 2023;18(7):e0288499. https://doi.org/10.1371/journal.pone.0288499.
17. Bakwanamaha PM, Mitima HI, Mulume DA, Muhiwa BM, Kanyere OK, Kasimengo AK, Mahinanda LM, Ndozondula MU, Nshombo JE, Lwaboshi JA, Ntabaza JRB, Yalala DM. (2026) Assessment of engagement of academic staff and students at the University of Beni Democratic Republic of Congo in promoting food hygiene awareness. Discover Public Health. 2026;23:1552. https://doi.org/10.1186/s12982-026-03046-y
18. Kayembe HC, Bompangue D, Linard C, Mandja B-A, Batumbo D, Matunga M, et al. Drivers of the dynamics of the spread of cholera in the Democratic Republic of the Congo, 2000–2018: An eco-epidemiological study. PLoS Negl Trop Dis. 2023;17(8):e0011597. https://doi.org/10.1371/journal.pntd.0011597.

Figures

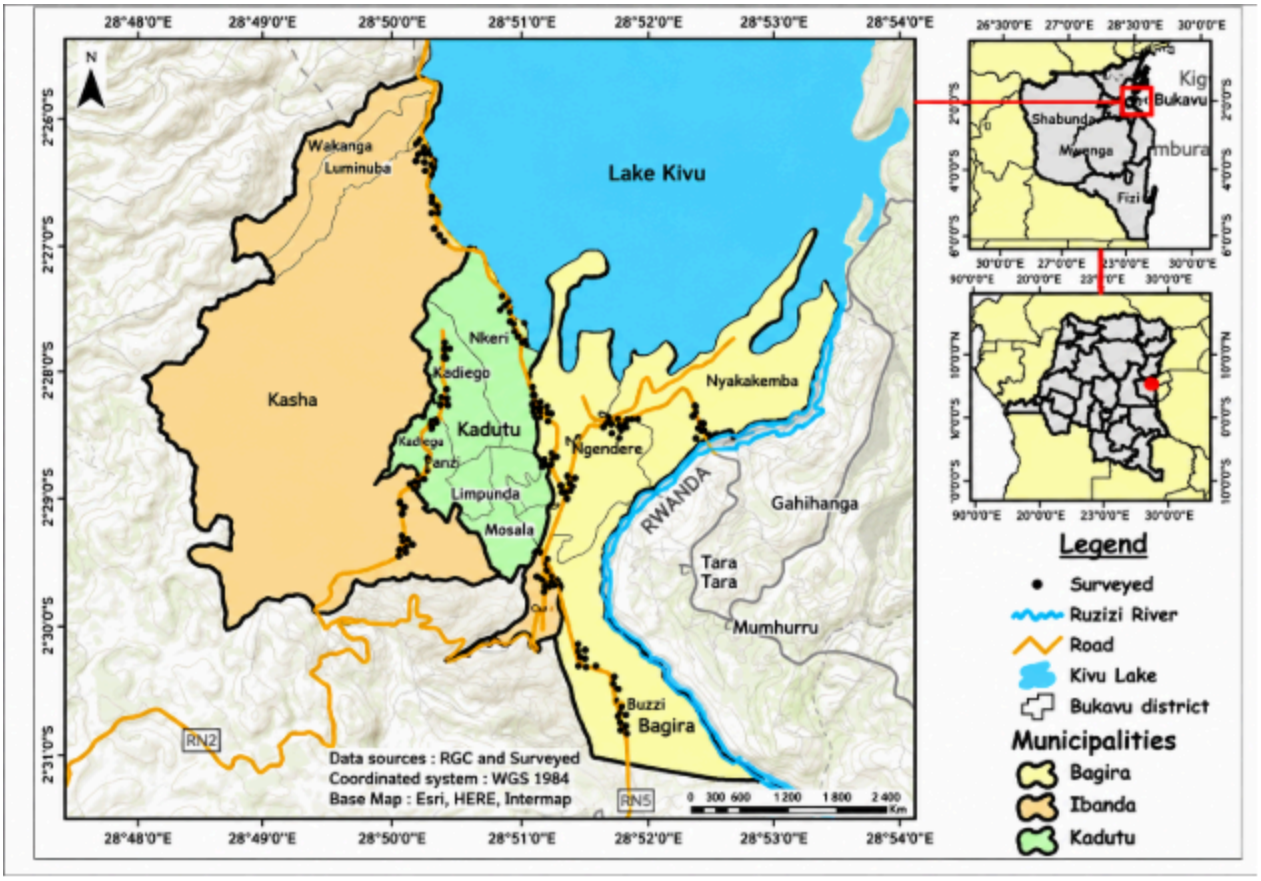


Figure 1

Geographical map of Bukavu city showing the study areas.

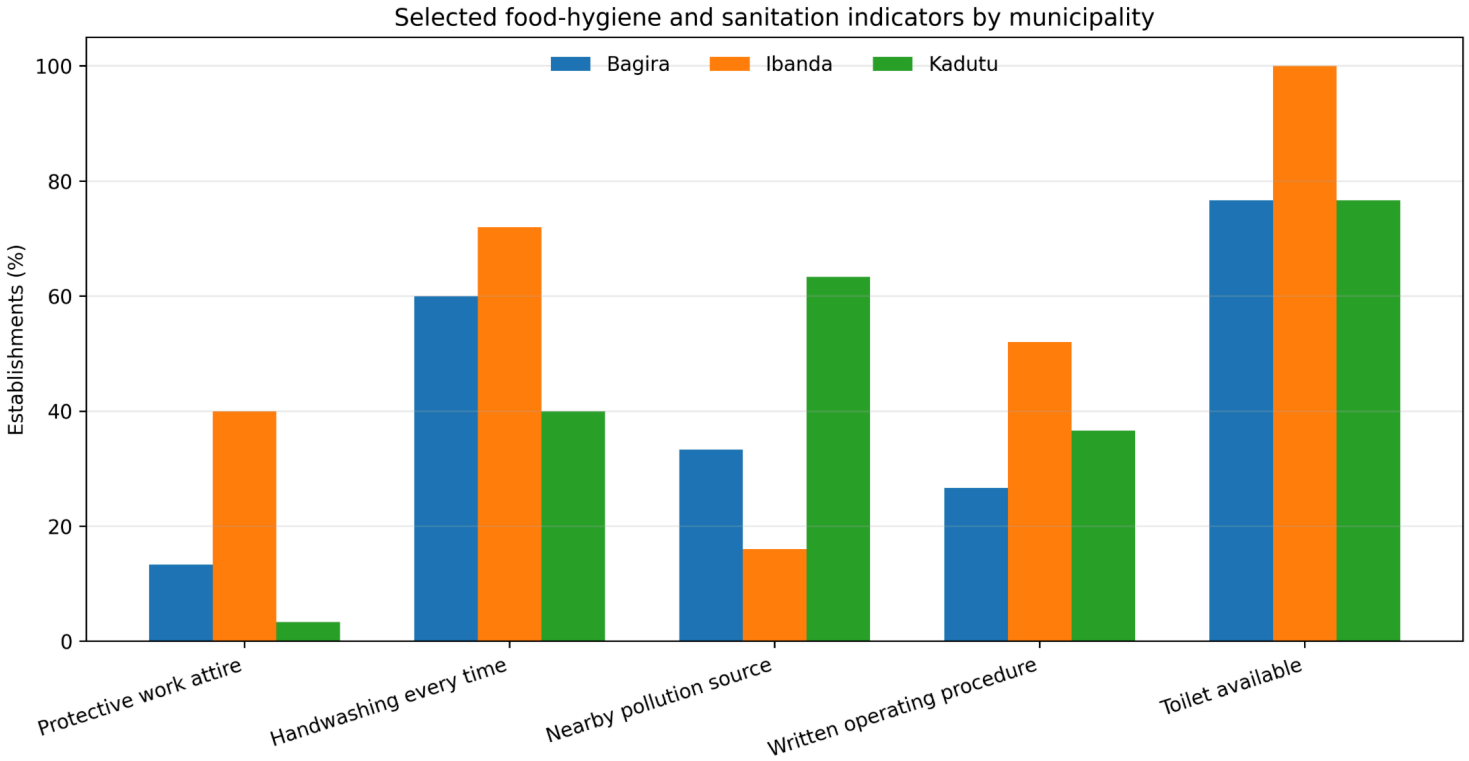


Figure 2

Selected food-hygiene and sanitation indicators by municipality. Percentages use municipality-specific denominators (Bagira n=30, Ibanda n=25, Kadutu n=30).

Source: *Authors' data visualized using R version 4.4.2 (2024-10-31 ucrt) in RStudio.*

Supplementary Files

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