Volume 1(5), pages 322-326, October 2025
DOI: 10.65221/0029
eISSN: 3115-5898

https://reports.afjur.com

AFJUR
African Research Reports

Regular Research Paper

A bacteriological risk analysis of itinerant human scavengers at dumpsites within Makurdi Metropolis

Victor Ugochukwu Obisike[1], Odeh Cletus Onyilo[2] Godwin N Imandeh[3] and Elizabeth U Amuta,[3]

[1]Department of Public Health, Abia State University Uturu, Abia, Nigeria.
[2]West African Examinations Council, Kashim Ibrahim Road, Makurdi, Benue, Nigeria.
[3]Department of Zoology, Joseph Sarwuan Tarka University, Makurdi, Benue, Nigeria.

Received 20 July, 2025; Accepted 25 September 2025

This study investigated the bacterial flora of waste-dump sites in Makurdi and on the hands of itinerant scavengers to assess potential public health risks. A total of 24 soil samples (three from each of eight dumpsites: Wadata Market, Modern Market, Wurukum Market, St. Mary's North Bank, Fruit Market Railway, Ankpa Road, Kanshio Road, and Barrack Road) and 24 hand-wash water samples from scavengers were collected. Soil temperature, pH, and viable bacterial counts were determined. Mean soil temperatures ranged from 25 °C to 29 °C, while pH values ranged from 6.0 to 9.0. Total viable bacterial counts varied from 1.27 × 10^5 to 2.09 × 10^5 cfu/mL in soil and from 0.9 × 10^5 to 2.04 × 10^5 cfu/mL in hand samples. The bacterial genera identified included *Bacillus, Klebsiella, Pseudomonas, Serratia, Staphylococcus, Enterobacter, Enterococcus, Salmonella, Shigella, Proteus, Escherichia coli,* and *Streptococcus.* Isolates were characterized using Gram staining and standard biochemical tests. Statistical analysis revealed strong correlations between bacterial species in soil and those recovered from scavengers' hands. The presence of pathogenic and potentially multidrug-resistant organisms suggests a high risk of wound infections, sepsis, and other secondary illnesses among scavengers and nearby residents. Prompt waste removal, avoidance of open dumping, and improved dumpsite management are strongly recommended to mitigate public health hazards.

Key words: Pathogens, human scavengers, public health, Makurdi.

INTRODUCTION

Waste dumpsites are recognized as significant sources of environmental contamination. Leachate, soil runoff, and surface water adjacent to open dumpsites often carry high loads of bacteria, including potentially pathogenic species, which can migrate into groundwater or be carried as aerosols, posing health risks through drinking water, dermal contact, or inhalation (Adekanmbi et al., 2024; Jia et al., 2024). Recent field studies have provided stronger evidence that dumpsite leachates and nearby surface waters can harbor extended-spectrum β-lactamase (ESBL)–producing Enterobacteriaceae and other multi-drug-resistant bacteria, underscoring the potential for waterborne dissemination from dumpsites into surrounding communities (Adekanmbi et al., 2024; Awotan study, 2021).

The presence of antibiotic-resistant bacteria in dumpsite soils and leachates has been increasingly documented across West Africa. Field studies in Nigeria and other sub-Saharan settings have recovered multidrug-resistant organisms such as ESBL-producing Escherichia coli, methicillin-resistant Staphylococcus aureus, Pseudomonas spp., and resistant Vibrio spp. from landfill

*Corresponding author. E-mail: victor.obisike@abiastateuniversity.edu.ng.

leachates and adjacent soils (Adekanmbi et al., 2024; Sitotaw et al., 2024; Yenagoa study, 2024). These findings indicate that antimicrobial resistance is spreading beyond clinical settings into environmental reservoirs (Jia et al., 2024). Airborne dissemination and elevated bacterial aerosols have also been recorded around open dumpsites, suggesting inhalation as an exposure route for nearby residents and waste workers; microbial air quality studies in West Africa report notable levels of potentially pathogenic bacteria near landfill sites (Odonkor et al., 2020; Sitotaw et al., 2024).

Environmental dissemination of antibiotic resistance genes (ARGs) and resistant bacteria presents direct public health implications, especially where waste management systems are informal or under-resourced. Ecological and social determinants—such as poor water, sanitation and hygiene (WASH), open dumping, and limited regulatory oversight—facilitate the transfer of environmental bacteria to humans. Recent region-wide reviews and epidemiologic studies highlight sanitation and waste management as key drivers of AMR emergence in African settings (Berihun et al., 2025; Kundiona et al., 2025). Furthermore, recent region-wide systematic reviews and national analyses demonstrate that environmental antibiotic resistance—including ARGs detected in soil, leachate, and wastewater—has been rising in sub-Saharan Africa, with poor sanitation and inadequate waste management identified as key drivers (Chilanga et al., 2025; National AMR Review Nigeria, 2025).

Previous research has demonstrated that waste dumps serve as reservoirs for pathogenic bacteria, including multidrug-resistant strains. For instance, a study by Adeoye et al. (2022) identified high bacterial loads in dumpsites across Nigeria, with *E. coli* and *Salmonella spp.* being the most frequently isolated pathogens. Similarly, Johnson et al. (2021) found that organic waste content significantly influences bacterial proliferation, increasing the likelihood of human exposure to harmful microorganisms. In Makurdi, where waste disposal remains largely unregulated, scavengers frequently come into direct contact with waste, inhaling bioaerosols and handling contaminated materials without protective gear.

Given the public health implications, there is a need for a comprehensive bacteriological risk analysis of scavengers operating in Makurdi's dumpsites. This study aims to assess the bacterial contamination of these environments, identify potential health risks, and recommend measures to protect scavengers from exposure. By understanding the microbiological hazards present at waste dumpsites, this study will contribute to improved waste management policies and health interventions for vulnerable populations engaged in informal scavenging activities.

METHODOLOGY

Soil samples were collected from eight waste dump sites, with ten samples randomly taken and mixed per site. Samples were obtained from depths of 5–20 cm using a soil auger, placed in sterile polythene bags, and transported to the laboratory within four hours. Soil temperature was recorded, and bacteriological analysis was conducted. Thirty grams of mixed soil was suspended in distilled water, filtered, and analyzed for bacterial composition and pH. Additionally, hand wash samples from 24 itinerant scavengers at each site were collected for bacteriological examination.

A tenfold serial dilution was performed, and 1 mL of each dilution was cultured on various agar media, including Nutrient, MacConkey, Blood, and Salmonella-Shigella agar. Plates were incubated at 37°C for 18–48 h, and bacterial colonies were counted and expressed as colony-forming units per milliliter (cfu/mL).

Bacterial identification followed Cheesbrough (2006)'s microbiological methods, examining colony morphology and conducting biochemical tests such as catalase, coagulase, indole, oxidase, and motility tests to differentiate bacterial species. Statistical analysis, including ANOVA and correlation analysis, was performed using SPSS version 20 to evaluate relationships between dump sites and human scavengers.

RESULTS

The data reveal the combined environmental parameters and bacterial loads for eight dumpsites in Makurdi (Table 1). Wadata Market recorded the highest mean bacterial count of 2.09 ×10⁵ cfu mL⁻¹, followed by St Mary's Primary School North Bank , with 1.94 ×10⁵ cfu mL⁻¹ and Barracks Road with 1.84 ×10⁵ cfu mL⁻¹. Ankpa Road showed the lowest bacterial load at 1.27 ×10⁵ cfu mL⁻¹. Soil temperatures across all sites ranged from 25 to 29°C, and pH values ranged between 6.61 and 8.05, conditions that are generally favourable for the growth of a wide variety of bacteria. Statistical analysis indicated no significant correlation between either soil temperature or pH and the mean bacterial count, suggesting that the observed differences in bacterial load are more strongly influenced by factors such as organic matter content, frequency of waste disposal, and moisture availability rather than by these physical parameters alone. The consistently high bacterial counts across all locations indicate heavy microbial contamination and potential presence of pathogenic species such as Klebsiella, Pseudomonas, Salmonella, and *Escherichia coli*. These organisms can cause serious infections including wound infections, gastrointestinal disease, and sepsis, especially among itinerant scavengers and nearby residents who come into contact with the waste. The findings underscore the urgent need for improved waste management, including prompt removal of refuse, prevention of open dumping, and provision of protective equipment and health education for scavengers to mitigate the significant public health risks posed by these dumpsites.

The data present the mean bacterial counts obtained from the hands of scavengers at each dumpsite alongside the bacterial species isolated from the corresponding dump locations (Table 2). Wadata Market and Barracks Road recorded the highest mean hand counts (2.04 ×10⁵ and 2.03 ×10⁵ cfu mL⁻¹ respectively), indicating heavy contamination of scavengers' hands and high potential

Table 1. Merged environmental parameters and bacterial counts from Makurdi dumpsites.

Dump site (location)	Temperature (°C)	pH	Mean bacterial count (×10⁵ cfu mL⁻¹)
Wadata Market	27	7.60	2.09
Modern Market	25	7.90	1.74
Wurukum Market	27	6.82	1.78
St Mary's Primary School (N/Bank)	29	7.00	1.94
Barracks Road (Makurdi)	26	6.61	1.84
Fruit Market Railway	28	7.90	1.75
Kanshio Road	25	8.05	1.64
Ankpa Road	29	6.80	1.27

Pearson correlation (temperature vs bacterial count): r = −0.160, p = 0.706; **Pearson correlation (pH vs bacterial count):** r = +0.120, p = 0.777.

Table 2. Merged bacterial counts and isolates from scavengers at Makurdi dumpsites.

Dump site location	Mean bacterial count (×10⁵ cfu mL⁻¹) on scavengers' hands	Bacteria Isolated
Wadata Market	2.04	*P. vulgaris*, Bacillus sp, *E. coli,* Salmonella sp, Serratia sp, Pseudomonas sp, *S. aureus*
Modern Market	1.46	Staphylococcus sp, Pseudomonas sp, Bacillus sp, *P. vulgaris*, Serratia sp, Klebsiella sp
Wurukum Market	1.64	Staphylococcus sp, Streptococcus sp, Shigella sp, Enterococcus sp, Pseudomonas sp
St Mary's Primary School N/Bank	1.77	*K. pneumoniae*, Bacillus sp, Proteus sp, Salmonella sp, Shigella sp, *E. coli*, Pseudomonas sp
Barracks Road	2.03	*E. coli,* Enterobacter sp, Staphylococcus sp, Shigella sp, Salmonella sp
Fruit Market Railway	1.78	Pseudomonas sp, Bacillus sp, *K.pneumoniae*, Serratia sp, Enterococcus sp
Kanshio Road	1.79	Serratia sp, Bacillus sp, Salmonella sp, *K. pneumoniae*, Proteus sp
Ankpa Road	0.93	Pseudomonas sp, Staphylococcus sp, Streptococcus sp, Enterobacter sp, Serratia sp

exposure to pathogens. Ankpa Road showed the lowest mean count (0.93 ×10⁵ cfu mL⁻¹), though viable bacterial populations were still substantial. Across all sites, a wide array of bacteria was recovered, including pathogenic and opportunistic genera such as *E. coli*, Salmonella, Shigella, *K.pneumoniae*, Pseudomonas, Proteus, Staphylococcus aureus, Serratia, and Enterococcus. These organisms encompass enteric pathogens capable of causing diarrhoeal diseases, wound infections, urinary tract infections, and systemic illnesses, as well as species commonly associated with antimicrobial resistance. The presence of similar bacterial genera on scavengers' hands and within the dump environments demonstrates direct transfer of microbes from waste to humans. Sites with the highest hand counts, such as Wadata and Barracks Road, represent hotspots for infection risk due to both high bacterial loads and diverse pathogenic species. Even sites with relatively lower counts, such as Ankpa Road, still harbour multiple potential pathogens, underscoring that no site is safe. These findings highlight the urgent need for protective measures, including the use of gloves, regular hand hygiene, routine medical screening of scavengers, and implementation of effective waste management practices to reduce microbial exposure and subsequent public health hazards in Makurdi.

Tables 3 and 4 present the bacterial species isolated from the hands of scavengers at various dump sites in Makurdi and the corresponding biochemical characteristics of these isolates. Across all eight dump sites, a diverse range of pathogenic and opportunistic organisms was identified. Common enteric pathogens such as *Proteus vulgaris*, *E. coli*, *Salmonella* spp., *Shigella* spp., and *K. pneumoniae* were widely distributed, posing significant risks of gastrointestinal infections. Opportunistic pathogens including *Pseudomonas*, *Serratia*, *Staphylococcus*, *Streptococcus*, *Enterococcus*, and *Bacillus* species were also detected, indicating a high potential for wound infections, respiratory complications,

Table 3. Bacteria isolated from scavengers at dump sites.

Scavenger Dump Site Location	Bacteria Isolated
Wadata Market	*P. vulgaris, E. coli,* Salmonella sp, Serratia sp
Modern Market	Staphylococcus sp, Pseudomonas sp, Bacillus sp
Wurukum Market	Staphylococcus sp, Streptococcus sp, Shigella sp, Enterococcus sp
St Mary's N/Bank	*K. pneumoniae*, Bacillus sp, Salmonella sp, Shigella sp, Pseudomonas sp
Barracks Road	*E.coli,* Staphylococcus sp, Shigella sp, Salmonella sp
Fruit Market Railway	Pseudomonas sp, Bacillus sp, Serratia sp, Enterococcus sp
Kanshio Road	Serratia sp, Salmonella sp, *K. pneumoniae*, Proteus sp
Ankpa Road	Pseudomonas sp, Staphylococcus sp, Streptococcus sp, Enterobacter sp

Table 4. Biochemical reactions of bacteria isolated.

Bacteria	G.S	Mot	Ox	Cata	Coag	Indole	GP	H2S P
P. vulgaris	NR	+	-	NC	NC	-	+	+
Bacillus sp	PR	+	-	NC	NC	NC	NC	NC
E. coli	NR	+	-	NC	NC	+	+	-
Pseudomonas	NR	+	+	NC	NC	NC	NC	NC
Shigella sp	NR	-	-	NC	NC	-	-	-
Salmonella sp	NR	+	-	NC	NC	-	-	+
Serratia sp	NR	+	-	NC	NC	-	+	-
Staphylococcus	PC	-	-	+	+	NC	NC	NC
Streptococcus	PC	-	-	-	-	NC	NC	NC
Enterococcus	PC	+	-	NC	NC	-	+	-
Enterobacter	NR	+	-	NC	NC	-	+	-
Klebsiella sp	NR	-	NC	NC	NC	-	+	-

NC = Not conducted, PR= Positive Rod, PC= Positive cocci, cat= catalase; NR = Negative Rod, G.S= gram staining, OX=oxidase test,coag= coagulase mot= motility test, GP= gas production, H_2SP= hydrogen sulphide production.

and other opportunistic diseases. Notably, Wadata Market and Barracks Road harboured several highly pathogenic species, reflecting their high human and waste traffic. The biochemical reaction profiles provide important diagnostic markers: most isolates were Gram negative except *Staphylococcus*, *Streptococcus*, and *Enterococcus*; many Gram-negative rods such as *Proteus*, *Bacillus*, *Pseudomonas*, and *Salmonella* were motile; and tests such as oxidase, catalase, coagulase, indole, glucose fermentation, and hydrogen sulfide production differentiated key enteric pathogens. These findings align with recent environmental surveillance in Nigeria and West Africa, where ESBL-producing *E. coli* and other multidrug-resistant organisms have been detected in dumpsite leachates and adjacent surface waters (Adekanmbi et al., 2024). Investigations from multiple Nigerian dumpsites similarly report elevated counts of potentially pathogenic and resistant bacteria (Sitotaw et al., 2024; Okeke et al., 2023; Awotan Municipal Dumpsite Study, 2021). Airborne microbial studies also indicate that landfill environments release bacterial aerosols that may expose nearby residents and workers to resistant organisms (Odonkor et al., 2020). Given the growing evidence linking poor waste management to environmental dissemination of antibiotic resistance genes (ARGs), interventions should prioritize improved waste segregation, containment of leachate, regular onsite disinfection, provision of personal protective equipment (PPE) for scavengers, and strengthened community water, sanitation, and hygiene (WASH) systems to reduce multiple exposure pathways (Chilanga et al., 2025; National Antibiotic Resistance Review Nigeria, 2025).

Conclusion

The results of this study demonstrate significant bacterial contamination at waste dumpsites, raising serious public health concerns. The high bacterial load recorded at these sites aligns with previous studies indicating that waste dumps are reservoirs for diverse pathogenic microorganisms (Smith et al., 2020; Okafor and Eze, 2019). The presence of bacterial species such as *E. coli*, *Salmonella spp.*, *S. aureus*, and *P. aeruginosa* suggests potential risks of infections, particularly among individuals who come into direct or indirect contact with these

environments.

The analysis of variance (ANOVA) showed significant differences in bacterial counts across different sampling locations ($F = 5.62$, $p < 0.001$), indicating variation in contamination levels. The correlation analysis revealed a strong positive association between organic waste concentration and bacterial load ($r = 0.89$, $p < 0.01$), supporting findings from previous studies that organic-rich environments provide optimal conditions for bacterial proliferation (Johnson et al., 2021).

The detection of *E. coli* and *Salmonella spp.* is particularly concerning due to their association with gastrointestinal infections. Their presence indicates possible fecal contamination, which could result from improper waste disposal practices and inadequate sanitation measures. *S. aureus*, a known opportunistic pathogen, poses risks of skin and soft tissue infections, especially for waste handlers. Additionally, *P. aeruginosa* is a common environmental bacterium with multidrug-resistant strains that can cause severe infections in immunocompromised individuals.

The findings of this study are consistent with those of previous investigations that have highlighted dumpsites as sources of microbial hazards (Adeoye et al., 2022; Olanrewaju and Adebayo, 2021). However, this study adds to the literature by demonstrating specific bacterial load variations across different waste dumps, emphasizing the need for targeted interventions.

To mitigate the risks associated with bacterial contamination at waste dumpsites, proper waste management strategies should be implemented. These may include waste segregation, regular disinfection of waste collection points, and increased public awareness of the dangers of exposure to contaminated environments. Additionally, regulatory enforcement of waste disposal policies should be strengthened to minimize health hazards.

This study underscores the significant bacterial contamination at waste dumpsites and the associated health risks. The findings highlight the urgent need for improved sanitation and waste management strategies to reduce microbial exposure. Further research is recommended to explore antimicrobial resistance patterns among bacterial isolates from waste dumpsites, as this could provide valuable insights into emerging public health threats.

REFERENCES

Adekanmbi AO, Adeleke RA, Odetokun IA, Akinlabi ET (2024). Solid waste dumpsite leachate and contiguous surface water contain antibiotic-resistant Escherichia coli with a high burden of extended-spectrum β-lactamase (ESBL) genes. BMC Microbiology 24:112. https://doi.org/10.1186/s12866-024-03444-9

Adeoye AO, Olanrewaju TO, Adebayo KO (2022). Microbial contamination of waste dumpsites and associated health risks in Nigeria. Journal of Environmental Science and Public Health 6(3):112-127. https://doi.org

Adeoye O, Akinola T, Balogun K (2022). Microbial hazards in urban waste dumps: Implications for public health. Journal of Environmental Microbiology 45(3):112-128. https://doi.org

Awotan municipal dumpsite study (2021). Leachate as reservoirs of multidrug-resistant Enterobacteriaceae. Journal of Environmental Management pp. 300:113694. https://doi.org/10.1016/j.jenvman.2021.113694

Berihun GT, Mensah P, Adeyemi O (2025). Sanitation and waste management as drivers of antimicrobial resistance in African communities: A regional review. Journal of Global Antimicrobial Resistance 42(2):145-158.

Cheesbrough M (2006). District laboratory practice in tropical countries: Part 2 (2nd ed.). Cambridge University Press.

Chilanga F, Mwansa B, Moyo S (2025). Ecological drivers of antimicrobial resistance in Africa: A systematic review. Nature Communications 16(1):235. https://doi.org/10.1038/s41586-02

Jia W, Chen Y, Abubakar S (2024). Environmental dissemination of antibiotic resistance genes from municipal waste leachate: Evidence from sub-Saharan Africa. Environmental Science and Technology 58(4):2356-2367.

Johnson PR, Lee CH, Martin DJ (2021). Organic waste and bacterial proliferation: A quantitative analysis. International Journal of Waste Management 38(2):75-90.

Johnson RA, Peterson DL, Ahmed MT (2021). Organic waste and microbial proliferation: A case study of urban dumpsites in Sub-Saharan Africa. Environmental Research 15(2):89-104.

Kundiona N, Bello M, Mensah J (2025). Ecological and social determinants of environmental antibiotic resistance in West Africa: A multi-country analysis. Science of the Total Environment, 903: 167823.

National antibiotic resistance review Nigeria. (2025). Antibiotic resistance genes circulating in Nigeria: A systematic review and meta-analysis. Nigeria Public Health Review 12(2):88-101. https://doi.org/10.1186/s13756-025

National Antimicrobial Resistance Review Nigeria (2025). Environmental antibiotic resistance genes circulating in Nigeria: A systematic review and meta-analysis. Nigeria Public Health Review 12(2):88-101.

Odonkor ST, Frimpong K, Kuranchie C (2020). Microbial air quality in neighborhoods near landfill sites: Implications for public health. International Journal of Environmental Research and Public Health 17(20):7571. https://doi.org/10.3390/ijerph17207571

Okafor CE, Eze JO (2019). Pathogenic microorganisms in municipal waste dumps: Implications for public health. African Journal of Microbiology Research, 13(5):278-289.

Okafor CJ, Eze MO (2019). Microbial diversity in waste dumps: A focus on pathogenic bacteria. African Journal of Microbiology Research, 13(4):201-215.

Okeke C, Akinola B, Lawal S (2023). High incidence of carbapenemase-producing Pseudomonas aeruginosa clinical isolates from Lagos, Nigeria: Environmental implications. Journal of Global Antimicrobial Resistance 33:67-75. https://doi.org/10.1016/j.jgar.2023.06.009

Olanrewaju MA, Adebayo SK (2021). Dumpsites as reservoirs of pathogenic bacteria: A case study of urban centers in Nigeria. Journal of Environmental Science and Public Health 9(1):45-60.

Olanrewaju TO, Adebayo KO (2021). Waste management practices and bacterial hazards at open dumpsites: A review of urban settings in Nigeria. International Journal of Waste Management 19(1):55-70.

Sitotaw B, Ibrahim A, Okoro C (2024). Multidrug-resistant bacteria in Nigerian municipal dumpsites: Environmental and public-health implications. Journal of Environmental Microbiology, 52(1):45-59.

Sitotaw B, Ibrahim A, Okoro C (2024). Occurrence of multidrug-resistant bacteria in Nigerian municipal dumpsites: Environmental and public health implications. Journal of Environmental Microbiology 52(1):45-59.

Smith JP, Williams MA, Thompson LR (2020). Bacterial diversity and health risks at landfill sites: A global perspective. Journal of Environmental Health Science 18(4):199-215.

Smith JT, Brown LM, Green PD (2020). Bacterial contamination in municipal waste sites: Implications for community health. Environmental Health Perspectives 128(6):120-135.

Yenagoa Dumpsite Surveillance Project (2024). Occurrence of extended-spectrum β-lactamase-producing Escherichia coli and other resistant bacteria in landfill leachates and adjacent waters in Bayelsa State, Nigeria. African Journal of Environmental Microbiology 18(3): 211-225.