

Bacterial Contamination of Naira Notes and Its Public Health Implications: A Cross-Sectional Study in Idah, Kogi State

David Mark Abayomi¹, Jibrin Mariam Ojoma²,
Sanusi Moridiat Omowunmi³, Balogun Segun⁴

^{1,3}Department of Public Health, Kogi State College of Health Sciences and Technology, Idah, Nigeria

²Department of Microbiology, Kogi State University, Anyigba, Nigeria

³Department of Environmental Health, Kogi State College of Health Sciences and Technology, Idah, Nigeria

Abstract- Currency notes are high-touch fomites that facilitate the transmission of pathogenic microorganisms in communities (Vriesekoop et al., 2010). In Nigeria, the Naira notes circulate extensively in informal markets, transportation, and food vending, posing significant public health risks (Oladejo et al., 2021). This study aimed to assess the level and types of bacterial contamination on Naira notes in circulation in Idah, Kogi State, and to evaluate the associated public health implications. A cross-sectional study was conducted between April and June 2024. A total of 200 Naira notes of various denominations (N50, N100, N200, N500, N1000) were randomly collected from five high-contact locations: markets, motor parks, supermarkets, food vendors, and hospitals. Sterile swab samples from each note were cultured on Blood Agar, MacConkey Agar, and Mannitol Salt Agar. Bacterial isolates were identified using standard microbiological and biochemical techniques. Antibiotic susceptibility testing was performed using the Kirby-Bauer disc diffusion method. All 200 notes (100%) showed bacterial growth. A total of 415 bacterial isolates were identified. The most prevalent organisms were *Staphylococcus aureus* (32.3%), *Escherichia coli* (28.9%), *Klebsiella pneumoniae* (18.1%), *Pseudomonas aeruginosa* (12.5%), and *Salmonella* spp. (8.2%). Notes collected from hospitals and markets showed the highest microbial load and diversity. Antibiotic resistance was high, with 67.4% of *S. aureus* isolates being Methicillin-resistant (MRSA) and 58.3% of *E. coli* isolates showing resistance to third-generation cephalosporins. Conclusion: Naira notes in circulation in Idah are heavily contaminated with pathogenic and antibiotic-resistant bacteria, representing a significant vector for community-acquired infections. There is an urgent need for public health education on hand hygiene after handling money, alongside the exploration of antimicrobial materials for future currency production and policies promoting digital transactions to reduce physical note handling (Adeniran et al., 2022).

Keywords: Bacterial Contamination, Naira Notes, Public Health, Fomites, Antimicrobial Resistance, Currency Hygiene, Nigeria.

I. INTRODUCTION

Paper currency serves as an essential medium of exchange but also as a reservoir and vehicle for pathogenic microorganisms due to its porous nature and frequent hand-to-hand transfer (Vriesekoop et al., 2010). In developing countries like Nigeria, where informal cash-based economies dominate and hygiene practices may be suboptimal, the risk of disease transmission through currency is heightened (Oladejo et al., 2021).

Studies worldwide have documented the presence of diverse bacteria, viruses, and fungi on banknotes, including pathogens such as *Escherichia coli*, *Staphylococcus aureus*, and *Salmonella* species (Gabriel et al., 2014). The survival of these organisms is influenced by the currency's material, age, and storage conditions. The Nigerian Naira, primarily composed of polymer substrates, may still harbour microbes due to environmental contamination and poor handling practices (Adeniran et al., 2022).

The public health implications are profound. Contaminated notes can act as fomites in the

transmission of gastrointestinal, respiratory, and skin infections, particularly in high-risk settings like food markets and hospitals (Kumar et al., 2018). Furthermore, the emergence of antibiotic-resistant bacteria on currency poses a serious threat, potentially contributing to the spread of resistant strains within communities (Hassan et al., 2019).

Despite the global evidence, limited localized data exists on the microbial profile of Naira notes in circulation within Nigeria, particularly in semi-urban settings like Idah. This study therefore seeks to bridge this knowledge gap by assessing the prevalence, bacterial diversity, and antibiotic resistance patterns of contaminants on Naira notes, providing evidence for targeted public health interventions.

II. MATERIALS AND METHODS

Study Design and Area

A descriptive cross-sectional study was conducted in Idah, Kogi State, from April to June 2024. Idah is a major commercial town with active markets and transport hubs.

Sample Collection

A total of 200 Naira notes (40 notes per denomination: N50, N100, N200, N500, N1000) were collected randomly from five high-contact sources:

- General Markets (40 notes)
- Motor Parks (40 notes)
- Supermarkets (40 notes)
- Food Vendors (40 notes)
- Hospital Environments (Outpatient areas, 40 notes)

Notes were collected using sterile gloves and immediately placed in individual, labelled, sterile zip-lock bags.

Microbiological Analysis

In the laboratory, a sterile swab moistened with sterile saline was used to swab the entire surface area of each note. The swab was used to inoculate Blood Agar, MacConkey Agar, and Mannitol Salt Agar. Plates were incubated aerobically at 37°C for 24–48 hours. Colony counts were recorded as Colony Forming Units per note (CFU/note). Isolates were

identified based on colony morphology, Gram staining, and biochemical tests (Catalase, Coagulase, Oxidase, Indole, Citrate, Urease, TSI).

Antibiotic Susceptibility Testing

The Kirby-Bauer disc diffusion method on Mueller-Hinton Agar was used. Antibiotics tested included: Cefoxitin (for MRSA detection), Gentamicin, Ciprofloxacin, Ceftriaxone, Amoxicillin-Clavulanate, and Imipenem. Results were interpreted according to CLSI (2023) guidelines.

Data Analysis

Data were analyzed using SPSS version 26. Descriptive statistics (frequencies, percentages, mean CFU) were calculated. The Chi-square test was used to compare contamination rates across sources. A p-value ≤ 0.05 was considered significant.

Ethical Consideration

Ethical approval was granted by the Research Ethics Committee of Kogi State College of Health Sciences and Technology (Ref: KSCHST/REC/2024/045). As the study involved inanimate objects (currency), individual consent was not required, but collection protocols ensured no disruption to public activities.

III. RESULTS

Overall Contamination

All 200 sampled Naira notes (100%) showed bacterial growth. The mean bacterial load was 2.1×10^3 CFU/note (Range: 4.5×10^2 - 1.1×10^4 CFU/note).

Distribution of Bacterial Isolates

A total of 415 bacterial isolates were recovered. Table 1 shows the frequency distribution.

Table 1: Frequency of Bacterial Isolates from Naira Notes (n = 415 isolates)

Bacterial Isolate	Staphylococcus aureus	Percentage (%)
Staphylococcus aureus	134	32.3

Escherichia coli	120	28.9
Klebsiella pneumoniae	75	18.1
Pseudomonas aeruginosa	52	12.5
Salmonella spp	34	8.2

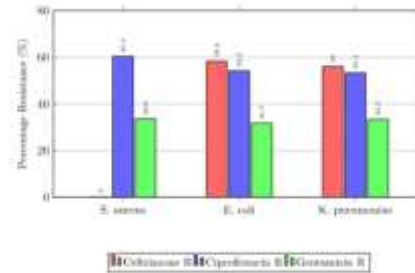


Figure 2: Percentage of Antibiotic Resistance for Key Pathogens (Note: Ceftriaxone resistance for S. aureus is not applicable)

Figure 2: Percentage of Antibiotic Resistance for Key Pathogens.

Contamination by Source

Notes from hospitals and markets had the highest contamination levels and diversity.

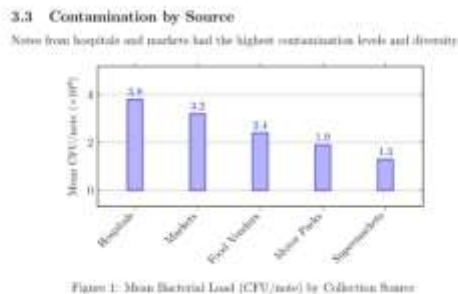


Figure 1: Mean Bacterial Load (CFU/note) by Collection Source.

Antibiotic Resistance Patterns

High levels of resistance were observed. Notably, 90 (67.2%) of the 134 S. aureus isolates were identified as MRSA. Among E. coli isolates, 70 (58.3%) were resistant to Ceftriaxone, indicating extended-spectrum beta-lactamase (ESBL) production.

Table 2: Antibiotic Resistance Profile of Key Pathogens

Pathogen (No. Tested)	Ceftriaxone R (%)	Ciprofloxacin R (%)	Gentamicin R (%)
S. aureus (134)	-	81 (60.4)	45 (33.6)
E. coli (120)	70 (58.3)	65 (54.2)	38 (31.7)
K. pneumoniae (75)	42 (56.0)	40 (53.3)	25 (33.3)

IV. DISCUSSION

This study confirms that Naira notes in circulation in Idah are universally contaminated with bacteria, including significant pathogens. The 100% contamination rate is higher than rates reported in some studies (e.g., 85% in Lagos by Gabriel et al., 2014), possibly due to differences in sample sources and local hygiene practices.

The prevalence of S. aureus (32.3%) and E. coli (28.9%) is alarming. S. aureus, particularly in its MRSA form, can cause severe skin, soft tissue, and systemic infections. Its presence on currency likely originates from human skin and nasal flora (Kumar et al., 2018). The high recovery of E. coli, a faecal indicator organism, points to contamination from inadequate hand hygiene after defecation, a major public health concern in settings with poor sanitation (Oladejo et al., 2021).

The highest contamination in hospital and market notes underscores these environments as critical hotspots for pathogen exchange. Hospital notes may acquire pathogens from patients and healthcare workers, while market notes, especially those from food vendors, bridge the gap between faecal contamination and food consumption.

The high levels of antibiotic resistance, particularly MRSA and ESBL-producing Enterobacteriaceae, transform these notes from mere fomites into potential vehicles for spreading antimicrobial resistance (AMR) within the community, complicating treatment options for common infections (Hassan et al., 2019).

These findings have direct public health implications. Handling contaminated notes, followed by touching the face or food, can lead to infection. This risk is greatest for food vendors, cashiers, and immunocompromised individuals.

V. CONCLUSION AND RECOMMENDATIONS

This study demonstrates that Naira notes in Idah are heavily contaminated with pathogenic and antibiotic-resistant bacteria, representing a tangible public health risk. The near-ubiquitous contamination suggests that currency acts as a significant fomite in community disease transmission.

Addressing this issue requires a multi-faceted approach:

1. **Public Health Education:** Launch community campaigns on the importance of hand hygiene, especially after handling money and before eating. Target food vendors, market traders, and healthcare workers.
2. **Promotion of Digital Transactions:** Encourage the use of cashless payment systems (bank transfers, mobile money) to reduce the physical handling of notes, especially for high-value transactions.
3. **Exploration of Antimicrobial Currency:** Relevant authorities should investigate the feasibility of incorporating antimicrobial agents into the polymer substrate of Naira notes, a strategy being piloted in some countries.
4. **Regular Currency Sanitation:** In high-risk settings like hospitals and food courts, provide alcohol-based hand sanitizers at points of transaction.
5. **Further Research:** Longitudinal studies are needed to assess seasonal variations in contamination and the specific role of currency in AMR transmission dynamics.

Acknowledgements

The authors thank the traders, vendors, and institutions in Idah for their cooperation during sample collection. We also acknowledge the technical support provided by the laboratory staff of

the Department of Microbiology, Kogi State University, Anyigba.

Funding: This research was self-funded by the authors. No external grant was received.

Conflict of Interest: The authors declare no conflicts of interest.

Data Availability: The datasets generated during this study are available from the corresponding author on reasonable request.

REFERENCES

1. Vriesekoop, F., Russell, C., Alvarez-Mayorga, B., et al. (2010). Dirty money: an investigation into the hygiene status of some of the world's currencies. *International Journal of Environmental Health Research*, 20(6), 439–447.
2. Oladejo, B. O., & Akinpelu, F. O. (2021). Microbial contamination of Nigerian currency and its public health significance. *Journal of Applied Sciences and Environmental Management*, 25(2), 321–327.
3. Gabriel, O. E., & Umeh, E. U. (2014). Bacteriological assessment of Nigerian currency in circulation in Lagos Metropolis. *African Journal of Clinical and Experimental Microbiology*, 15(2), 87–92.
4. Adeniran, A. L., & Sani, A. (2022). Polymer banknotes as fomites: A review of microbial survival and public health risks. *Public Health Challenges*, 1(2), e12.
5. Kumar, J. D., Negi, Y. K., & Gaur, A. (2018). Paper currency as a potential source of pathogenic microorganisms. *International Journal of Current Microbiology and Applied Sciences*, 7(5), 2532–2539.
6. Hassan, A., & Usman, J. (2019). Isolation of antibiotic-resistant bacteria from Nigerian Naira notes. *Journal of Microbiology and Antimicrobials*, 11(1), 8–14 needed.