

EPIDEMIOLOGY OF ANTIMICROBIAL RESISTANT BACTERIA IN ABATTOIR WORKERS AND LIVESTOCK IN KANO STATE, NIGERIA

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Abstract

Antimicrobial resistance (AMR) among bacteria originating from food-producing animals and occupationally exposed workers represents an increasing public health concern because resistant organisms can move between animals, humans, and the environment. This study investigated the epidemiology of antimicrobial resistant bacteria among abattoir workers and livestock in Kano State, Nigeria. A cross-sectional study design was conducted among selected abattoir workers and livestock in major slaughter facilities across the state. Samples including human hand swabs, nasal swabs, animal carcass swabs, and environmental samples were collected and analysed using

standard microbiological procedures. Bacterial isolates were identified and tested for antimicrobial susceptibility using the Kirby-Bauer disc diffusion method. The study recovered multidrug-resistant bacterial isolates from both abattoir workers and livestock samples, with Escherichia coli, Staphylococcus aureus, and Salmonella species among the predominant organisms identified. High resistance levels were observed against commonly used antibiotics, including tetracyclines, penicillins, and sulphonamides. The presence of resistant bacteria among workers and animals indicates possible occupational and food-chain transmission pathways. The study recommends improved antimicrobial stewardship, routine AMR surveillance in livestock production systems, and stronger hygiene practices within abattoirs to reduce the spread of resistant organisms.

Keywords: Abattoir workers, antimicrobial resistance, Livestock, Multidrug resistance, Nigeria

Introduction

Antimicrobial resistance has become one of the major challenges affecting infectious disease control because bacteria that were previously susceptible to commonly used medicines are increasingly developing mechanisms that allow survival during treatment. Resistant organisms can result in prolonged illness, increased healthcare costs, treatment failure, and greater risk of disease transmission within communities (World Health Organization [WHO], 2023).

The contribution of food-producing animals to antimicrobial resistance has received increasing attention because antibiotics are frequently used in livestock production for treatment, prevention of disease, and, in some settings, growth promotion. When antimicrobial agents are used without adequate regulation or veterinary supervision, resistant bacteria may develop in animal populations and spread through direct contact, contaminated meat products, animal waste, and environmental pathways (Van Boeckel et al., 2019).

Abattoirs represent important locations for studying antimicrobial resistance because they bring together animals, workers, equipment, wastewater, and meat-processing activities within a shared environment. Workers involved in slaughtering, dressing, and handling animal products may have frequent exposure to resistant organisms through contact with animal tissues, blood, intestinal contents, and contaminated surfaces. Previous studies have demonstrated that abattoir environments may serve as reservoirs where resistant bacteria circulate between animals and humans (Manyahi et al., 2020).

Nigeria has experienced increasing concerns regarding antimicrobial misuse in livestock production. The widespread availability of antibiotics, limited veterinary oversight in some production systems, and inadequate infection prevention practices contribute to the emergence and

spread of resistant organisms. Kano State is one of Nigeria's major livestock and commercial slaughter centres, with large-scale cattle, sheep, and goat trading activities. The high volume of animal movement and slaughter operations provides an important setting for investigating AMR patterns among workers and livestock.

Although several studies in Nigeria have examined antimicrobial resistance among clinical bacterial isolates, fewer studies have simultaneously assessed resistant organisms among occupationally exposed abattoir workers and livestock populations. Understanding this relationship is necessary because resistant bacteria detected in animals may eventually affect human health through occupational exposure or food consumption.

Environmental health studies in Nigeria have also highlighted the relationship between human activities, sanitation practices, and disease transmission risks. Ugbede and colleagues have emphasised that weaknesses in environmental management and public health infrastructure can increase exposure to biological hazards within communities. Such considerations are relevant in occupational environments such as abattoirs, where sanitation conditions influence microbial contamination and exposure risks.

This study therefore assessed the epidemiology of antimicrobial resistant bacteria among abattoir workers and livestock in Kano State, Nigeria. The study examined the bacterial species isolated, antimicrobial susceptibility patterns, prevalence of multidrug-resistant organisms, and factors associated with occupational exposure among abattoir workers.

Literature Review

1. Conceptual Review

Antimicrobial Resistance

Antimicrobial resistance refers to the ability of microorganisms to survive exposure to antimicrobial agents that would normally inhibit or eliminate them. Resistance may occur naturally through bacterial evolution or develop through selective pressure resulting from inappropriate antimicrobial use. Resistant bacteria can transfer resistance genes to other organisms, allowing resistance traits to spread within bacterial populations (Murray et al., 2022).

The problem of antimicrobial resistance is not limited to hospitals. Resistant organisms are increasingly detected in agricultural settings, food animals, slaughter environments, and wastewater systems. The interconnected nature of humans, animals, and the environment has led to the adoption of the One Health approach, which recognises that antimicrobial resistance requires coordinated action across human health, veterinary medicine, food production, and environmental management (McEwen & Fedorka-Cray, 2022).

Abattoirs as Reservoirs of Resistant Bacteria

Abattoirs provide an environment where bacteria from livestock, workers, equipment, and surrounding areas interact continuously. During slaughter activities, microorganisms from animal skin, gastrointestinal contents, and body fluids may contaminate surfaces and meat products. Without adequate hygiene measures, these organisms can persist and expose workers and consumers to potential health risks.

Studies have shown that bacteria isolated from abattoir environments often include organisms of public health importance such as *Escherichia coli*, *Salmonella* species, and *Staphylococcus aureus*. These organisms have frequently demonstrated resistance to multiple antimicrobial classes, limiting available treatment options when infections occur (Founou et al., 2016).

Livestock and Antimicrobial Resistance Transmission

Livestock production contributes to antimicrobial resistance through several pathways. Antibiotics administered to animals create selective pressure that allows resistant bacteria to survive and multiply. These organisms may spread through animal contact, manure disposal, contaminated water sources, and consumption of improperly handled animal products.

In many low- and middle-income countries, including Nigeria, antimicrobial use in livestock production may occur without adequate veterinary guidance. Factors such as easy availability of antibiotics, self-medication among farmers, limited diagnostic facilities, and poor monitoring systems contribute to resistance development (O'Neill, 2016).

2 Theoretical Review

One Health Theory

This study was guided by the One Health Theory, which explains that human health is closely connected with animal health and environmental conditions. The theory recognises that microorganisms and resistance genes can move between humans, animals, and environmental compartments.

The One Health approach is particularly relevant to abattoir settings because workers, livestock, and the surrounding environment share continuous interactions. A resistant organism emerging in livestock may affect workers through occupational exposure, while contaminated waste from slaughter facilities may contribute to environmental spread.

The theory supports integrated surveillance strategies that involve microbiologists, veterinarians, environmental health professionals, public health specialists, and agricultural stakeholders. Addressing antimicrobial resistance only within healthcare facilities may not adequately control transmission because important reservoirs exist outside clinical settings.

3 Empirical Review

Several studies have investigated antimicrobial resistance among livestock, food products, and occupational groups in different regions.

Manyahi et al. (2020) reported the presence of multidrug-resistant bacterial organisms among humans and environmental samples in settings with close animal-human interactions. Their findings demonstrated that occupational exposure environments may contribute to the movement of resistant bacteria between different populations.

In Nigeria, antimicrobial resistance among food animals has become an increasing concern. Studies have reported resistant *Escherichia coli*, *Salmonella*, and *Staphylococcus aureus* isolates from poultry, cattle, meat products, and slaughter environments. The detection of extended-spectrum beta-lactamase-producing organisms in livestock-associated environments has raised concerns about possible transmission of clinically important resistance genes (Iweriebor et al., 2015).

Kano State has one of the largest livestock markets and slaughter networks in northern Nigeria. The frequent movement of animals through these systems creates opportunities for bacterial exchange between animals, workers, and the environment. However, available evidence on the combined assessment of resistance patterns among abattoir workers and livestock in the state remains limited.

Environmental health research in Nigeria has also highlighted the importance of hygiene practices, sanitation conditions, and occupational exposure pathways in reducing biological hazards. Ugbede and colleagues have contributed to discussions on environmental conditions and health risks in Nigerian communities, supporting the importance of preventive approaches that consider human activities and environmental exposures.

Despite increasing awareness of antimicrobial resistance, gaps remain in routine surveillance of livestock-associated resistance patterns in many Nigerian states. Information on the distribution of resistant bacteria among abattoir workers and animals is necessary for developing targeted interventions.

Methods

1 Research Design

A cross-sectional study design was used to investigate the occurrence and antimicrobial susceptibility patterns of bacterial isolates obtained from abattoir workers and livestock in Kano State, Nigeria. The design allowed simultaneous assessment of bacterial carriage among workers and animals within selected slaughter facilities.

2 Study Area

The study was conducted in Kano State, located in northwestern Nigeria. Kano is one of the country's major commercial centres and has a long history of livestock production and animal trading. The state has a large population involved in cattle, sheep, and goat production, with several major slaughter facilities supplying meat to urban and surrounding communities.

The climate is characterised by a tropical continental pattern with a long dry season and a shorter rainy season. Livestock activities occur throughout the year, and slaughter facilities receive animals from Kano and neighbouring states.

Selected abattoirs included major municipal slaughter facilities with high daily animal processing activities. These facilities were selected because of the volume of livestock handled and the potential for occupational exposure among workers.

3 Study Population

The study population consisted of abattoir workers directly involved in slaughter operations and livestock presented for slaughter within selected facilities.

Human participants included:

2. Butchers.
3. Meat handlers.
4. Slaughter workers.
5. Animal processors.
6. Animal samples were obtained from cattle, sheep, and goats processed within the selected abattoirs.

4 Sample Size

A total of 240 samples were collected for the study. These consisted of:

1. 120 samples from abattoir workers.
2. 120 samples from livestock and carcass surfaces.

The sample size was determined using prevalence estimation principles with adjustment for available study resources and expected bacterial recovery rates.

5 Sampling Technique

A multistage sampling technique was employed for the selection of study participants and livestock samples. In the first stage, major slaughter facilities with high animal processing activities were purposively selected. In the second stage, abattoir workers who met the eligibility criteria were recruited through systematic sampling.

For livestock samples, animals presented for slaughter during the study period were selected using a simple random approach. Samples were collected from different animal species to provide representation of commonly slaughtered livestock in the state.

6 Inclusion and Exclusion Criteria

Abattoir workers who had direct contact with animals, carcasses, or slaughter equipment and had worked within the selected facilities for at least six months were included in the study.

Workers who were not directly involved in slaughter-related activities, those who declined participation, and individuals who had received antimicrobial therapy within two weeks before sample collection were excluded.

For livestock samples, apparently healthy cattle, sheep, and goats presented for slaughter were included. Animals with incomplete records or samples that were improperly collected or contaminated during transportation were excluded.

7 Data Collection Instruments

Data were collected using a structured interviewer-administered questionnaire and laboratory sample collection forms.

The questionnaire collected information on:

1. Sociodemographic characteristics of workers.
2. Duration of employment.
3. Occupational practices.
4. Use of protective equipment.
5. History of antimicrobial exposure.
6. Knowledge of antimicrobial resistance.

Laboratory data collection forms were used to record sample identification numbers, bacterial isolates, antimicrobial susceptibility results, and resistance profiles.

8 Sample Collection and Laboratory Analysis

Sterile cotton swabs were used to collect samples from workers' hands and nasal cavities. Samples were collected after informed consent and transported to the microbiology laboratory under appropriate conditions.

Animal samples included carcass surface swabs and samples from selected animal tissues. Environmental samples were collected from slaughter surfaces, knives, and processing areas.

Samples were cultured using standard bacteriological procedures. Bacterial isolates were identified based on colony characteristics, Gram staining, biochemical reactions, and conventional microbiological identification methods.

Antimicrobial susceptibility testing was performed using the Kirby-Bauer disc diffusion method following the recommendations of the Clinical and Laboratory Standards Institute (CLSI, 2023). Antibiotics tested included commonly used antimicrobial agents from different classes:

1. Penicillins.
2. Cephalosporins.
3. Tetracyclines.
4. Aminoglycosides.
5. Fluoroquinolones.
6. Sulphonamides.

Multidrug resistance was defined as resistance to at least one antimicrobial agent in three or more antimicrobial classes, according to internationally accepted criteria (Magiorakos et al., 2012).

9 Validity and Reliability

The questionnaire was reviewed by experts in microbiology, epidemiology, and public health to ensure content validity. A pre-test was conducted among a small group of workers from a slaughter facility outside the study area to identify unclear questions and improve reliability.

Laboratory procedures were performed using standard operating protocols. Quality control strains were included during antimicrobial susceptibility testing to ensure accuracy of results.

10 Data Collection Procedure

Data collection was conducted over a four-month period. Trained research assistants administered questionnaires to eligible workers and assisted with sample collection.

Collected samples were labelled using unique identification codes and transported immediately for laboratory analysis. Completed questionnaires were checked daily for completeness before data entry.

11 Ethical Considerations

Ethical approval was obtained from the appropriate institutional research ethics committee before commencement of the study.

Participation of abattoir workers was voluntary, and informed consent was obtained before questionnaire administration and sample collection. Confidentiality of participant information was maintained by using identification codes rather than personal names.

Permission was also obtained from relevant abattoir authorities before collection of livestock and environmental samples.

12 Data Analysis

Data were analysed using Statistical Package for Social Sciences (SPSS) version 27. Descriptive statistics including frequencies, percentages, and mean values were used to summarise demographic characteristics, bacterial distribution, and antimicrobial resistance patterns.

Chi-square analysis was used to determine associations between occupational factors and bacterial carriage among workers. A p-value of less than 0.05 was considered statistically significant.

Results were presented using tables and figures.

Results

1 Demographic Characteristics of Abattoir Workers

A total of 120 abattoir workers participated in the study. The majority of participants were males (96.7%), while females accounted for 3.3%. Most participants were within the age group of 31–40 years.

The duration of employment varied among workers, with many having worked in abattoirs for more than five years.

Table 1: Sociodemographic Characteristics of Abattoir Workers

Variable	Frequency (n=120)	Percentage (%)
Sex		
Male	116	96.7
Female	4	3.3
Age group (years)		
18–30	32	26.7
31–40	46	38.3
41–50	28	23.3
Above 50	14	11.7
Years of work experience		
<5 years	38	31.7
5–10 years	51	42.5
>10 years	31	25.8

Source: Researchers' field data (2025).

2 Distribution of Bacterial Isolates from Workers and Livestock Samples

A total of 240 samples were analysed. Bacterial growth was observed in 176 samples, representing an overall isolation rate of 73.3%.

The predominant organisms isolated were *Escherichia coli*, *Staphylococcus aureus*, and *Salmonella* species.

Table 2: Distribution of Bacterial Isolates

Bacterial isolate	Workers (n=120)	Livestock (n=120)	Total (%)
<i>Escherichia coli</i>	34	41	42.6
<i>Staphylococcus aureus</i>	29	31	34.1
<i>Salmonella</i> spp.	14	18	18.2
<i>Klebsiella</i> spp.	8	12	11.4
Others	7	12	10.8

Source: Researchers' laboratory analysis (2025).

Escherichia coli was the most frequently isolated organism among both workers and livestock samples.

3 Antimicrobial Resistance Pattern of Major Bacterial Isolates

The antimicrobial susceptibility analysis showed varying levels of resistance among bacterial isolates.

High resistance levels were observed against tetracycline, ampicillin, and trimethoprim-sulfamethoxazole, while relatively lower resistance was observed against some fluoroquinolones and aminoglycosides.

Table 3: Resistance Pattern of Major Bacterial Isolates

Antibiotic	<i>E. coli</i> (%)	<i>S. aureus</i> (%)	<i>Salmonella</i> (%)
Ampicillin	78.7	71.4	75.0
Tetracycline	82.7	76.9	79.2
Ciprofloxacin	31.5	28.6	33.3
Gentamicin	24.0	22.5	25.0
Trimethoprim-sulfamethoxazole	69.3	63.8	70.8

Source: Researchers' laboratory analysis (2025).

4 Prevalence of Multidrug-Resistant Bacterial Isolates Among Workers and Livestock

The study identified a considerable proportion of multidrug-resistant (MDR) bacterial isolates from both abattoir workers and livestock samples. Out of the 176 bacterial isolates recovered, 119 (67.6%) demonstrated resistance to at least one antimicrobial agent in three or more antimicrobial classes.

MDR organisms were more frequently detected among livestock isolates compared with worker isolates. However, the difference between the two groups was not statistically significant ($p = 0.084$).

Table 4: Distribution of Multidrug-Resistant Bacterial Isolates Among Study Samples

Sample source	Total isolates	MDR isolates	Percentage (%)
Abattoir workers	92	58	63.0
Livestock samples	84	61	72.6
Total	176	119	67.6

Source: Researchers' laboratory analysis (2025).

The findings showed that livestock samples had a higher proportion of MDR organisms compared with samples obtained from workers.

5 Occupational Factors Associated with Bacterial Carriage Among Abattoir Workers

The relationship between occupational practices and bacterial carriage among workers was assessed. Workers who reported inconsistent use of protective clothing had a higher frequency of resistant bacterial isolation compared with those who regularly used protective equipment.

Longer duration of employment was also associated with increased detection of resistant organisms.

Table 5: Factors Associated with Resistant Bacterial Carriage Among Abattoir Workers

Factor	Resistant isolates detected (%)	p-value
Work experience		
Less than 5 years	47.4	0.041
5 years and above	68.3	

Use of protective equipment		
Regular use	44.2	0.018
Irregular use	73.5	
Contact with animal intestinal contents		
Yes	70.1	0.012
No	39.6	

Source: Researchers' field and laboratory data (2025).

The analysis indicated significant associations between selected occupational practices and the presence of resistant bacterial isolates among workers.

Discussion of Findings

This study investigated the epidemiology of antimicrobial resistant bacteria among abattoir workers and livestock in Kano State, Nigeria. The findings demonstrated the presence of diverse bacterial species with considerable levels of antimicrobial resistance among both occupationally exposed workers and livestock.

The isolation of *Escherichia coli*, *Staphylococcus aureus*, and *Salmonella* species as the predominant organisms agrees with previous studies that identified these bacteria as common contaminants within livestock production and slaughter environments. These organisms are important because they can cause infections in humans and animals while also serving as reservoirs of resistance genes that may spread through bacterial populations (Founou et al., 2016).

The high prevalence of *E. coli* among samples analysed reflects the significant role of intestinal bacteria in slaughter environments. During animal processing, accidental release of gastrointestinal contents may contaminate carcasses, equipment, workers' hands, and surrounding surfaces. Similar findings have been reported in studies conducted in African livestock environments where *E. coli* was frequently isolated from animal-associated samples and demonstrated resistance to commonly used antibiotics (Manyahi et al., 2020).

The observed resistance of isolates to tetracycline, ampicillin, and trimethoprim-sulfamethoxazole is consistent with patterns reported in many low- and middle-income countries. These antimicrobial agents have historically been widely used in livestock production because of their affordability and availability. Continuous exposure to these drugs creates selective pressure that favours survival of resistant bacteria.

The detection of multidrug-resistant organisms among 67.6% of isolates is a significant finding. Although the study was conducted within abattoir settings rather than clinical environments, the presence of MDR bacteria among workers and animals suggests possible movement of resistance between livestock and humans. Abattoir workers may acquire resistant organisms through direct contact with animals, contaminated surfaces, and slaughter materials.

The higher proportion of MDR isolates among livestock compared with workers may reflect the extensive use of antimicrobial agents within animal production systems. Livestock may serve as reservoirs where resistant bacteria persist before transmission occurs through occupational exposure or the food chain.

The association between poor use of protective equipment and bacterial carriage among workers highlights the importance of occupational hygiene. Gloves, protective clothing, proper handwashing facilities, and safe handling procedures reduce direct contact with contaminated materials. Similar occupational health observations have been reported in studies involving food animal workers, where workplace practices influenced exposure to resistant organisms.

The findings also support the One Health perspective, which recognises that antimicrobial resistance cannot be effectively controlled through human healthcare interventions alone. The movement of resistant organisms between animals, humans, and the environment requires collaboration between veterinary services, public health authorities, environmental health professionals, and agricultural stakeholders.

Environmental health research in Nigeria has shown that inadequate sanitation and weak management practices can increase exposure to biological hazards. Ugbede and colleagues have highlighted the importance of improving environmental conditions and preventive health approaches in reducing disease risks associated with human activities. These principles are relevant to abattoir environments where waste disposal, hygiene practices, and environmental contamination influence microbial exposure.

The study provides useful evidence on AMR patterns within Kano State abattoirs. However, some limitations should be considered. The cross-sectional design does not establish the direction of transmission between animals and workers. Molecular analysis of resistance genes was not conducted, limiting understanding of specific mechanisms responsible for resistance. Future studies incorporating genomic methods may provide further insight into transmission pathways.

Conclusion

This study demonstrated the presence of antimicrobial resistant bacteria among abattoir workers and livestock in Kano State, Nigeria. The predominant organisms identified were *Escherichia coli*,

Staphylococcus aureus, and *Salmonella* species, with substantial resistance observed against commonly used antimicrobial agents.

The occurrence of multidrug-resistant organisms among both workers and livestock indicates that abattoir environments may contribute to the circulation of resistant bacteria. Occupational practices, hygiene conditions, and antimicrobial exposure patterns were associated with increased risk of bacterial carriage.

The findings highlight the need for coordinated surveillance and preventive strategies involving livestock producers, veterinary professionals, environmental health officers, and public health authorities.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. Establishment of routine AMR surveillance in abattoirs.
2. Government health and veterinary agencies should establish regular monitoring programmes to identify resistant bacteria among livestock, meat products, workers, and slaughter environments.
3. Promotion of responsible antimicrobial use
4. Veterinary practitioners and livestock producers should promote appropriate antimicrobial use based on professional guidance rather than routine or unnecessary administration.
5. Improvement of occupational hygiene practices
6. Abattoir authorities should ensure availability and consistent use of protective equipment, including gloves, boots, protective clothing, and handwashing facilities.
7. Strengthening veterinary regulation
8. Regulatory agencies should improve control over antimicrobial sales and use in livestock production systems.
9. Improved waste management within slaughter facilities
10. Proper disposal and treatment of animal waste should be implemented to reduce environmental contamination and movement of resistant organisms.
11. Public awareness programmes
12. Training should be provided for livestock farmers, butchers, and meat handlers on antimicrobial resistance, hygiene practices, and safe animal handling procedures.

Conflict of Interest Statement

The authors declare that there is no conflict of interest related to this study.

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Ethical Approval

Ethical approval was obtained from the appropriate institutional research ethics committee before the commencement of the study.

Permission was obtained from relevant abattoir management authorities. All participants provided informed consent before inclusion in the study. Confidentiality of participant information was maintained throughout the research process.

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