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Evaluation of biosecurity measures as a factor influencing antimicrobial resistance in semi-intensive poultry farms in Kinshasa

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The poultry farming sector constitutes a major pillar of food security and economic growth in several African countries. However, the persistence of various pathological conditions hampers the development of this sector, leading to substantial socio-economic and public health losses. In response to these multiple challenges, the implementation of new strategies aimed at preventing infections in poultry farms and reducing antimicrobial use is critically important. This study aimed to assess the current status of biosecurity practices as a factor influencing antimicrobial resistance in three peri-urban areas of the city of Kinshasa. Based on a survey conducted among poultry farmers, it was found that only 24% of farms had a footbath at the farm entrance, and 16% were equipped with handwashing or disinfection facilities. The presence of rodents and flies (80%), cockroaches (60%), lizards (40%), and wild birds (20%) was reported. The main diseases encountered included coccidiosis (30%), colibacillosis (28%), Newcastle disease (18%), avian pox (10%), Gumboro disease (8%), and Marek's disease (6%). Overall, the results of this study demonstrated a low level of implementation of biosecurity measures related to farm personnel, visitors, animals, as well as materials and equipment.

Keywords: Biosecurity, resistance, antimicrobial, poultry, semi-intensive, DRC

INTRODUCTION

In Africa, livestock production constitutes a fundamental pillar of food security and sustainable economic growth. However, the development of this sector remains severely constrained by the persistence of infectious diseases responsible for substantial economic and productivity losses (FAO, 2017; Ngom et al., 2024). Among these, several avian-origin diseases are classified as transboundary diseases due to their epidemic nature, high contagiousness, and transmissibility, leading to significant socioeconomic and public health impacts (Lysholm et al., 2022).

Furthermore, in poultry production systems, multiple potential sources may contribute to the introduction and dissemination of pathogenic agents, including humans, poultry, poultry feed, animal-derived products and by-products, materials and equipment, as well as rodents and other pests (Naumovska et al., 2025).

Despite the use of therapeutic measures to control some of these diseases, this approach has contributed to the emergence of antimicrobial resistance (AMR), mainly as a result of the misuse or

overuse of these agents (Otieno et al., 2023). Currently, AMR represents a growing threat to public health, particularly because food-producing animals constitute a major reservoir of drug-resistant bacteria that can be transmitted to humans, especially in sub-Saharan African countries (Ayukekbong et al., 2017; Ngom et al., 2024).

Indeed, in light of the multiple challenges posed, on the one hand, by infectious diseases and, on the other hand, by the emergence of antimicrobial resistance, the implementation of new strategies aimed at preventing infections in livestock production systems, and consequently reducing antimicrobial use, is of critical importance. Numerous studies have identified biosecurity as a key approach to limiting the transmission of pathogenic agents and reducing reliance on antimicrobials (Chisoro et al., 2023; Filippitzi et al., 2018; Dhaka et al., 2023). Furthermore, several studies have highlighted the importance of strengthening biosecurity measures to prevent disease outbreaks, safeguard poultry health, and reduce the associated economic and public health losses(Akter et al., 2025; Scott et al., 2018).

Like many regions across the African continent, biosecurity measures remain largely inadequate in poultry farms in Kinshasa. The present study aimed to assess the current status of biosecurity practices as a potential indicator of reduced antimicrobial use and their impact on the development of antimicrobial resistance (AMR).

MATERIALS AND METHODS

Study areas

This study was conducted in three peri-urban areas of the city of Kinshasa, namely Mont-Ngafula, Nsele, and Maluku.

Description of the city of Kinshasa

The city of Kinshasa covers an area of approximately 9,965 square kilometers along the southern bank of Pool Malebo and forms a vast crescent-shaped territory characterized by a relatively flat lowland landscape, with an average altitude of about 300 m. It is located between latitudes 4° and 5° South and longitudes 15° and 16°32'East.

Kinshasa is bounded:

• To the east by the provinces of Mai-Ndombe, Kwilu, and Kwango (periphery of the N’sele and Maluku municipalities);

• To the west and north by the Congo River, which constitutes a natural border with the Republic of the Congo (Brazzaville) (periphery of the Ngaliema municipality);

• To the south by Kongo Central Province (periphery of the Mont-Ngafula municipality).

For data collection, a semi-structured questionnaire was used, comprising two main indicators: the socio-professional characteristics of the farms and the biosecurity measures implemented in poultry production systems.

Study design

This was a descriptive cross-sectional study based on the assessment of biosecurity measures implemented in poultry farms as an approach to combating antimicrobial resistance (AMR).

Study population

The survey targeted poultry farmers, including farm owners and workers, in the selected poultry farms.

Sampling

A non-probabilistic sampling method was employed, using the «snowball» technique, whereby a key informant was used to identify additional study units. The choice of this sampling method was justified by the difficulty of accessing most poultry farms due to the voluntary refusal of farm managers. For convenience, the sample size was set at 50 poultry farms.

Inclusion criteria

Semi-intensive poultry farms with approximately 100 or more birds located in the study area, whose managers agreed to participate in the study.

Exclusion criteria

Farms with fewer than 100 birds and those whose managers did not provide consent to participate in the study.

Data collection

Direct interviews, lasting at least 45 minutes, were conducted. These focused on the professional profiles of the farm operators, as well as the implementation of biosecurity measures related to personnel, materials and equipment, animals, and the management of health and antimicrobial use in the farms.

Ethical consideration

Administrative authorizations were obtained from the heads of the municipal veterinary services.

Data analysis

The collected data were entered using Microsoft Excel and analyzed with the statistical software “Statix 8.0.”

RESULTS

General characteristics of respondents

The socio-demographic characteristics indicate that men were predominant (80 %) among those involved in the poultry farms surveyed. Among the respondents, 34% were aged 30-35 years, followed by those aged 23-29 years (26 %). More than half of the respondents had a university-level education (58 %), followed by those with a secondary education (38 %) (Table 1). Furthermore, the study revealed that 80 % of the farms, whether managed by owners or workers, were operated by men, 15 % by women, and 5 % under a mixed or alternating management system between men and women.

Regarding the profiles of farm operators, two main categories were identified: 22 % had professional training in animal production and health (such as animal scientists, veterinarians, or veterinary technicians), while 78 % had no professional qualifications in these fields (Table 2). Among the surveyed farms, 60 % focused on layer production, 25 % on broiler production, and 15 % practiced mixed production. The majority of farms (85%) were floor-reared, while 15 % used battery systems.

Assessment of the implementation of biosecurity measures

Biosecurity measures applied to personnel

In this study, 22 % of the farms had a veterinarian on staff; among them, only 4 out of 11 (8 %) were employed full-time, while 14 % acted as consultants or worked part-time. Only 40 % of the farms provided work clothing for employees, and 10 % had a designated changing room for staff. Furthermore, 76 % of the farms allowed visitors to enter the farm; among these visitors, 47 % were friends, 97 % were family members, 87 % were buyers, and 57.8 % were manure collectors. Additionally, 23 out of 38 farms (61 %) did not permit visitor access to the poultry houses. Among the farms that did allow access, only 2 out of 15 (13 %) provided specific clothing for entry into the poultry houses (Table 3).

In the surveyed farms, 56 % were protected by a fence; 24% had a footbath at the entrance of each poultry house, and 16% had a handwashing and/or disinfection facility at the farm entrance. Furthermore, none of the farms had a vehicle disinfection system, despite the entry of vehicles being observed in some farms (12 %). Newly acquired equipment was used directly in 29 out of 50 farms (58%), while some were subjected to disinfection (26 %) or simple cleaning (18 %). Cleaning and disinfection of the poultry houses were carried out at the beginning of the production cycle in 15 out of 50 farms (30 %), at the end of the cycle in 33 out of 50 farms (66 %), and during the cycle in 13 out of 50 farms (26 %). Among these farms, none practiced daily disinfection; 2 out of 13 (15%) performed weekly disinfection, and 11 out of 13 (85 %) carried out disinfection monthly (Table 4).

Biosecurity measures applied to animals

In 80 % of the farms, chickens or eggs were sold on the market; however, in cases of low demand, 93 % of the poultry were reintroduced into the farms. Within the farms, 76 % housed animals of different ages together in the same facility. The «all-in–all-out» production system was implemented in 56 % of the farms. In addition to chickens, 44 % of the farms raised other types of animals on the premises. Upon acquisition of a new batch, 20 out of 50 farms (40 %) mixed it with an existing batch, while 30 out of 50 farms (60 %) practiced isolation.

Regarding potentially harmful animals, 40 out of 50 farms (80 %) reported the presence of rodents and flies, 30 out of 50 farms (60 %) observed cockroaches, 20 out of 50 farms (40 %) lizards, and 10 out of 50 farms (20 %) wild birds (Table 5).

Health status in semi-intensive poultry farms in three municipalities of Kinshasa

Information provided by farm operators revealed that seven diseases were commonly observed in the poultry farms, with coccidiosis being the most prevalent (30%), followed by colibacillosis (28 %), Newcastle disease (18 %), avian pox (10%), Gumboro disease (8 %), and Marek’s disease (6 %) (Figure 1).

Occurrence of diseases in semi-intensive poultry farms in three municipalities of Kinshasa

Regarding health management, 45 out of 50 farms (90%) practiced vaccination, and 40 out of 50 farms (80 %) implemented preventive treatment for newly acquired poultry. Moreover, 35 out of 50 farms (70%) adhered to the vaccination schedule, and 23 out of 50 farms (46 %) ensured regular health monitoring.

Regarding the management of dead poultry, 18 out of 50 farms (36 %) allowed human consumption, while 15 out of 50 farms (30 %) allocated them for feeding other animals. Animal feces were used as agricultural fertilizer in 40 out of 50 farms (80 %) (Table 6).

Use of prophylactic and therapeutic drugs in semi-intensive poultry farms in Kinshasa

Regarding drug usage in the farms, sulfadiazine was used in 46 out of 50 farms (92 %), oxytetracycline in 42 out of 50 farms (84 %), chlortetracycline in 38 out of 50 farms (76 %), polymyxin E in 34 out of 50 farms (68 %), tylosin in 32 out of 50 farms (64 %), and streptomycin in 28 out of 50 farms (56 %).

The most commonly used antiparasitics were amprolium (40 out of 50 farms, 80 %) and piperazine (29 out of 50 farms, 58 %). Multivitamins were used in all surveyed farms.

Regarding vaccines, 45 out of 50 farms (90 %) used LaSota, 41 out of 50 farms (82 %) used Hitchner B1, 35 out of 50 farms (70 %) vaccinated against infectious bursal disease (IBD), and 22 out of 50 farms (44 %) vaccinated against Marek's disease (HVT, CVI988) (Table 7).

DISCUSSION

This study aimed to provide an overview of biosecurity practices as a potential indicator for reducing antimicrobial use and their impact on the development of antimicrobial resistance (AMR). As highlighted by Bouelet Ntsama et al., (2021), biosecurity is a fundamental preventive tool, serving as an effective barrier against epizootics and the resulting economic losses. Moreover, it contributes to the reduction of veterinary drug use, thereby limiting residue presence in poultry products and the emergence of antimicrobial resistance. AMR represents a significant risk for the transmission of resistant pathogens between farms, as well as between animals and humans (Bouelet Ntsama et al., 2021).

The survey results indicated that 80 % of participants were male, compared to 20 % female. Management of the poultry farms was predominantly carried out by men (80%), versus 15 % by women, and 5 % under a shared male–female management system. Participants' ages ranged from 18 to 45 years, with a mean of 30.9 ± 9.1 years. The highest level of education was university, representing 58 % of respondents. Furthermore, only 22 % of participants had received specific training in animal production and health.

A study conducted in 90 farms across three regions of Cameroon reported that 85 % of poultry farmers were men (Bouelet Ntsama et al., 2021). In Nigeria, 70 % of farmers were men, with 43 % of participants aged 31-40 years (Aderemi et al., 2023). In Bishoftu, Ethiopia, among 44 surveyed farms, 28 (63.6 %) were managed by men, 59% of whom had a university education in diverse fields, while 45% had received no formal training in poultry farm management (Ismael et al., 2021).

Furthermore, Tsegaye et al., (2023) reported that in several surveyed farms, the owners themselves managed the operations, with 68.7 % of farms under male management. The educational levels of the managers were primary (33%), secondary (34 %), and university (20 %), while 80.5 % had no formal training in poultry production.

These findings are consistent with results reported in other studies conducted across Africa. Bouelet Ntsama et al., (2021) showed that in a survey of 90 farms across three regions of Cameroon, 85 % of poultry farmers were men. Similarly, a study in Nigeria found that 70 % of poultry farm operators were male, with 43 % aged between 31 and 40 years (Aderemi et al., 2023). In Bishoftu, Ethiopia, among 44 surveyed farms, 63.6 % were managed by men, 59% of whom had a university-level education in diverse fields; additionally, 45 % of the operators had received no formal training in poultry farm management (Ismael et al., 2021).

Furthermore, Tsegaye et al., (2023) reported that in the majority of farms studied, the owners themselves managed the operations. Among them, 68.7 % were men, with educational levels of primary (33 %), secondary (34 %), and university (20 %), while 80.5 % had received no formal

training in poultry production.

The majority of the surveyed farms were focused on egg production (60 %), compared to 25 % dedicated to broiler production, while 15 % adopted a mixed system combining both egg and meat production. Similar findings were reported by Akter et al., (2025), who observed a predominance of layer farms (53 %), followed by broiler farms (37 %).

Regarding the production system, 85 % of the farms used a floor-based system, while 15 % employed a modern cage (battery) system. This predominance of the floor system is also reported in Ethiopia, where layer, broiler, and mixed farms represented 70.6 %, 13.6 %, and 15.8 %, respectively, with 95.5 % of farms using litter-based systems and only 4.1% using cages (Tsegaye et al., 2023). In Cameroon, Bouelet Ntsama et al., (2021) similarly highlighted a high proportion of deep litter farms (77.8%) compared to battery-cage systems (2.2 %), while 20 % of farms combined both systems.

Regarding biosecurity measures for workers and visitors, only 11 farms (22 %) had a veterinarian, of which 8 % were employed full-time. Among the surveyed farms, 40 % provided work clothing for employees, while only 10% had changing rooms. Visitor access was allowed in a high proportion of farms (76 %), primarily including family members (97 %), buyers (87 %), friends (47 %), and manure collectors (57.8 %). However, access to poultry houses was restricted in most farms, being permitted in only 39 % of the operations. Among these, only two farms (13 %) provided specific protective clothing for visitors before entering the poultry houses.

These results reflect a low level of implementation of biosecurity measures related to controlling human movement. In this regard, Otieno et al., (2023) reported that only 30.3 % of key stakeholders emphasized the use of protective clothing when handling poultry. Ismael et al., (2021) highlighted that human movement between farms can be a major risk factor for the transmission of avian diseases, particularly avian influenza.

Regarding biosecurity measures related to equipment and facilities, 56 % of the surveyed farms had a fence or enclosure. Footbaths at the farm entrance were observed in only 24 % of farms, while only 16 % were equipped with handwashing or disinfection facilities. Additionally, access for vehicles belonging to external persons was permitted in 12 % of the farms, although none of the farms had a vehicle disinfection system (autoclave). These results indicate insufficient implementation of material biosecurity measures.

According to Aderemi et al., (2023), regular maintenance of footbaths, systematic disinfection of equipment and tools, and quarantine of new batches are essential measures to limit the spread of infectious diseases in poultry farms. Footbaths play a significant role in reducing the transmission of contagious diseases by humans. In this regard, Ahmed et al., (2021) reported that 61 % of the farms studied were equipped with footbaths, 56 % of which contained an active disinfectant, emphasizing that their continuous use contributes to reducing the introduction of infectious agents.

Other studies have confirmed the importance of controlling movements and equipment. Akter et al., (2025) reported that vehicle access was high in both broiler (89%) and layer (83 %) farms, whereas the spraying of disinfectant on tires remained infrequent. In the same study, visitor access was largely restricted (95 %), while footbaths at farm entrances were rarely used. In Ethiopia, Ismael et al., (2021) reported that 68.2 % of farms were fenced, 90.9% had footbaths at the entrance, 70.5 % prohibited visitor access, and only 31.8 % applied proper disposal of dead birds.

Furthermore, newly acquired equipment was used immediately without prior treatment in more than half of the farms (58%), while 26% disinfected and 18 % cleaned the equipment before use. The majority of surveyed farms practiced cleaning and disinfection of poultry houses at the end of the production cycle (66 %), whereas 30 % performed these operations before the start of the cycle and 26 % during the cycle. Among the farms concerned, cleaning and disinfection were most often

conducted on a monthly basis (85 %). More intensive practices were, however, reported in some layer farms, where houses were cleaned daily or every two days, with disinfectant applied once a week (Akter et al., 2025). Appropriate and regular cleaning and disinfection methods are essential biosecurity measures, reducing environmental microbial loads below the infectious threshold and, consequently, limiting pathogen transmission within poultry farms.

Regarding biosecurity measures related to animals in poultry farms, chickens and their by-products were sold at the market in 80 % of the farms. Moreover, unsold goods were reintroduced into poultry houses in 93 % of the farms. The majority of farms (76 %) mixed chickens of different ages within the same building.

More than half of the surveyed farms (56 %) applied the “all-in–all-out” principle at the end of the production cycle. Concerning the management of new batches, 60 % of farms isolated newly acquired chicks. It is important to note, however, that day-old chicks can carry vertically transmitted pathogens, such as Mycoplasma spp., representing a significant health risk for poultry farms (Ismael et al., 2021).

Furthermore, less than half of the farms (44 %) reared other animal species alongside poultry, a practice that may increase the risk of cross-species pathogen transmission.

The presence of potentially harmful and disease-carrying animals was frequently observed in the surveyed farms, including rodents and flies (80 %), cockroaches (60 %), lizards (40 %), and wild birds (20 %). Moreover, domestic animals were reported near 58 % of the farms. Pets can serve as potential vectors, capable of carrying contaminated material from one environment to another and facilitating interspecies transmission of pathogens (Ahmed et al., 2021). These observations are consistent with those reported by Akter et al., (2025), who found wild birds accessing more than 79 % of farms, as well as the presence or infestation of rodents in 87% of the farms. The lack of effective rodent and wild bird control measures represents a major biosecurity risk, as these animals are recognized reservoirs and vectors of pathogenic microorganisms that can significantly affect poultry health (Ismael et al., 2021).

Regarding health management in poultry farms, several diseases were reported by respondents, including coccidiosis (30 %), colibacillosis (28 %), Newcastle disease (18 %), avian pox (10 %), Gumboro disease (8 %), and Marek’s disease (6 %). This diversity of pathologies reflects a high disease pressure in the studied farms. Comparable results have been observed in other African contexts. In Ethiopia, Tsegaye et al., (2023) reported a high prevalence of Newcastle disease (79.5 %), followed by Gumboro disease (54.7 %) and fowl cholera (88.5 %), highlighting the significance of infectious diseases in poultry systems with low to moderate biosecurity levels.

To prevent and control these diseases, vaccination was practiced in 90 % of the farms. The most frequently used vaccines included LaSota (90 %) and Hitchner B1 (82 %) against Newcastle disease, the infectious bursal disease (IBD) vaccine (70 %), and HVT and CVI988 vaccines against Marek’s disease (44 %). As reported by Akter et al., (2025), vaccination programs were widely implemented in poultry farms; the Newcastle disease vaccine was systematically used in the majority of farms, whereas the IBD vaccine was mainly applied in layer farms. In contrast, vaccines against other diseases, including Marek’s disease and avian pox, were rarely used (Akter et al., 2025). The limited use of vaccines against Marek’s disease and avian pox can be attributed to several factors, including farmers’ low risk perception and/or the cost of vaccines. This disparity in vaccination practices highlights existing health vulnerabilities in farms, which could favor the persistence and circulation of pathogens.

Finally, effective vaccination indirectly contributes to the reduction of antimicrobial use, as it decreases the frequency and severity of infections, thereby limiting the need for preventive or therapeutic antibiotic treatments. Strengthening vaccination programs, alongside farmer training and surveillance, is therefore essential to improve biosecurity, reduce economic losses, and

mitigate the risk of antimicrobial resistance emergence in poultry farms.

Treatment, both preventive and therapeutic, relied primarily on the use of antibiotics in 80 % of farms. The most commonly used compounds were sulfadiazine (92 %), oxytetracycline (84 %), chlortetracycline (76 %), polymyxin E (68 %), tylosin (64 %), and streptomycin (56 %). In addition, antiparasitic agents were also employed, mainly amprolium (80 %) and piperazine (58 %). Vitamins, particularly multivitamins, were administered across all surveyed farms. According to Akter et al., (2025), raising farmer awareness and improving biosecurity measures can encourage more prudent use of antibiotics. The combination of good biosecurity practices and vaccination could, in some cases, reduce the reliance on antibiotics while maintaining productivity and controlling avian diseases.

Furthermore, adherence to the vaccination schedule was observed in 70 % of the farms, while regular health monitoring was carried out in 46 % of the farms. In the event of mortality, human consumption of carcasses was reported in 36 % of farms, distribution to other animals in 3 0%, destruction in 24 %, and 10 % of farms reported discarding carcasses into the environment. Regarding the management of animal-derived waste, 80 % of farms used such waste as agricultural fertilizer, 12 % discarded it into the environment, and 8 % carried out proper disposal.

CONCLUSION

This study, which assessed biosecurity measures as a factor influencing antimicrobial resistance in semi-intensive poultry farms across three districts of Kinshasa, demonstrated that despite the partial implementation of biosecurity measures and the use of vaccination, poultry farms remain at high risk of infectious diseases, notably coccidiosis, colibacillosis, and Newcastle disease. Concurrently, the widespread use of antibiotics for both preventive and therapeutic purposes constitutes a significant risk factor for the emergence of antimicrobial resistance in poultry farms.

Based on the results obtained, the effective implementation of biosecurity measures, combined with vaccination and hygiene practices, could significantly reduce antibiotic use and limit disease transmission in poultry farms. Complementary measures to support farmers include encouraging the use of antibiotics only under veterinary prescription, establishing regular monitoring and surveillance programs for diseases and antimicrobial resistance in farms, and providing training on biosecurity, health management, and the responsible use of veterinary drugs.

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