Diseases Driving Antimicrobial Use in Commercial Poultry Production Systems in Rwanda

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Abstract: The poultry industry in Rwanda faces significant disease challenges, leading to widespread antimicrobial use (AMU) without sufficient surveillance systems to monitor antimicrobial resistance (AMR). The lack of systematic data on poultry diseases driving AMU hinders evidence-based interventions to optimize antimicrobial usage and mitigate AMR risks. This study was to provide empirical evidence of the poultry diseases driving AMU in commercial poultry production systems in Rwanda, based on one-year recall data obtained from veterinary practitioners (VPs) records. Data collection was conducted in a cross-sectional study design from 98 active VPs nationwide over a three-month study period from October to December 2024. Surveys were administered via Google Forms, which were linked to the platform's spreadsheet feature, enabling seamless export of responses into Microsoft Excel for analysis. VPs in Rwanda reported widespread poultry diseases, with infectious bronchitis (45.8%), colibacillosis (43.3%), and Marek's disease (36.0%) being the most prevalent. Prevalence of bacterial infections, including avian salmonellosis (15.7%) and fowl cholera (6.6%), remains a major concern, whereas Newcastle disease (27.7%) and Gumboro disease (1.2%) were identified as transboundary threats. Various antimicrobials were used to treat primary bacterial infections, as well as secondary bacterial infections associated with viral diseases, mycoses, and parasitic diseases. The use of therapeutic antimicrobials was strongly linked to the high rates of bacterial diseases such as colibacillosis and salmonellosis. Meanwhile, preventive treatments with anthelmintics were associated with parasitic infections like coccidiosis and helminthiasis. A variety of antimicrobials were used to treat primary bacterial infections and to address secondary complications from viral, fungal, and parasitic diseases. Rational antimicrobial use was evident, with 85.7% of the drugs demanded critically important for veterinary use. Sulfonamides (19.1%) and tetracyclines (15.7%) were the most commonly used for bacterial infections, while anthelmintics (25.8%) were primarily used for prevention. The study highlights a strong dependence on antimicrobials in Rwanda's poultry industry, largely due to high disease rates. This situation raises important concerns about antimicrobial resistance and the sustainability of the sector. To tackle these issues, it is essential to enhance disease surveillance, improve biosecurity measures, establish clear protocols for antimicrobial use, and provide training for farmers to protect food security and public health.

Keywords: *Antimicrobial, Broiler, Dual-purpose, Layers, Resistance, Veterinary practitioner*

Introduction

In Rwanda, where agriculture remains a cornerstone of the economy and a significant source of livelihood for the majority of the population, the livestock sector plays a pivotal role (MINECOFIN, 2024). However, the sector is not without challenges. Among these factors, the prevalence and impact of various animal diseases stand out as key factors influencing the widespread use of antimicrobials (AMs) both in primary and secondary bacterial infection (Manishimwe *et al.*, 2024). Understanding the dynamics of these diseases and their contributions to antimicrobial use (AMU) is essential for developing effective strategies to combat antimicrobial resistance (AMR) (Salam *et al.*, 2023). Moreover, increased AMR in livestock could result in production losses equivalent to the consumption needs of more than two billion people annually by 2050. Therefore, reliable evidence on AMU in livestock is crucial to control its usage effectively. However, few AMU data for livestock, especially poultry, are available, particularly in developing countries, including Rwanda. Furthermore, there are no standard recognized tools available, accessible, and affordable for collecting AMU data in livestock farming (Mikecz *et al.*, 2020). This was also highlighted by the Global Action Plan on AMR, in which data on AMU from lower-income countries are lacking (Mikecz *et al.*, 2020). Monitoring AMU is highly important for understanding possible areas of risk for the development of AMR. Moreover, it links to objective number four within the Global Action Plan on AMR, which is to optimize the use of antimicrobial medicines in human and animal health (WHO, 2015). AMR is already a leading cause of death globally, directly responsible for 1.2 million deaths every year.

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The Rwanda poultry industry is growing and performing well along with the population and high demand for animal protein (MINAGRI, 2024). This industry is experiencing significant growth, driven by domestic and regional market expansion and attracting both local and international investments (MINAGRI, 2024). Rwanda's poultry population has grown at an average annual rate of 9% over the past seven years, from 3.5 million in 2010 to 7.6 million in 2016. The largest segment is dual-purpose breeds at 35.0%, followed by equal shares of layers and indigenous local breeds at 25.0% each, and broilers at 15.0% of the total. Commercial poultry production systems in Rwanda comprise layers, broilers, and dual-purpose chickens. This may indicate that the poultry industry is becoming one of the emerging areas of focus in terms of AMU, with 54,454 metric tons of chicken meat and 20,211 metric tons of eggs produced in 2024 (MINAGRI, 2024).

However, many poultry farms encounter diseases such as colibacillosis, Newcastle disease, parasitic infections, and infectious bursal disease, which require extensive use of AMs to sustain this business (Mazimpaka *et al.*, 2020; Manishimwe *et al.*, 2024; Uwihanganye, 2024). This is a challenge, as Rwanda still lacks sufficient surveillance systems for AMR in the poultry industry, hindering mitigation efforts (Cyuzuzo *et al.*, 2023). As a result, the overuse and misuse of these AMs encouraged the development of microbial reservoirs both in animals and humans, especially poultry, that carry AMR determinants (Rahman *et al.*, 2022), reducing the efficiency of these medicines when most needed (Naghavi *et al.*, 2024). These poultry diseases pose significant challenges for poultry farmers in Rwanda (Uwihanganye, 2024), resulting in high mortality rates, economic losses, and negative impacts on food security and rural livelihoods (Grace *et al.*, 2024).

Despite the importance of controlling poultry diseases to optimize AMU, there is limited documentation of key poultry diseases influencing AMU in Rwanda. Without these data, farmers, veterinary professionals, policymakers, and stakeholders involved in the poultry value chain may lack a clear understanding of the most prevalent disease challenges that require antimicrobial interventions. Hence, this study aims to fill this gap by documenting the poultry diseases driving AMU in Rwanda on the basis of retrospective data from VPs' records. This study aimed to identify poultry diseases that necessitate antimicrobial use and to assess the appropriateness of antimicrobial practices in Rwanda's poultry systems.

Materials and Methods

Study Area and Period

This study took place in Rwanda, a country in Central Africa located just south of the equator. It lies between longitudes 18°63' and 30°54' east and latitudes 1°4' and 2°51' south. Rwanda shares borders with Tanzania to the East, the Democratic Republic of the Congo to the West, Burundi to the South, and Uganda to the North, covering a total area of 26,338 square kilometers. As a landlocked nation, Rwanda is situated 2,000 kilometers from the Atlantic Ocean and 1,200 kilometers from the Indian Ocean. The country is characterized by steep terrain and an average elevation of 1,700 m, forming part of the highlands of Eastern and Central Africa, which includes three distinct geographical regions (https://www.migration.gov.rw/about-rwanda) (Figure 1).

Sampling Strategy

This cross-sectional study intentionally selected 98 veterinary practitioners from across Rwanda who actively manage poultry diseases, following specific inclusion criteria. The VPs had to meet the following defined study criteria: (i) being active in managing poultry diseases, (ii) having a smartphone, and (iii) being willing to participate in the study. Utilizing retrospective data, the study descriptively analyzed variables such as disease occurrence, class of antimicrobials, and their intended purposes using frequencies and percentages.

Structured Questionnaire

The draft questionnaire was uploaded to Google Forms (https://docs.google.com/forms) to facilitate easy administration and access. A link to the form was created, allowing VPs to conveniently complete the questionnaire via their mobile phones. This approach aimed to ensure simplicity and accessibility for all respondents. All questions related to different poultry diseases and antimicrobial use can be found at the following link (https://docs.google.com/forms/d/1cV03q9p5-4TTUHagY_EW7iK-CFjHwXVbUrrUWfqDBag/edit).

Pretest of the Structured Questionnaire

A pretest was conducted with ten VPs (https://rcvd.rw/view-pub-post.php), who were purposively selected to review and complete a structured questionnaire. The questionnaire link was shared with these respondents via WhatsApp for ease of access and response. Feedback from the pretest was used to refine and finalize the questionnaire. The final version was subsequently distributed to 98 active VPs across the country via WhatsApp, leveraging the platform's accessibility to reach all respondents efficiently.

Data Collection

Data collection was conducted in a cross-sectional study design over a three-month study period from October to December 2024. Surveys were administered via Google Forms, which were linked to the platform's spreadsheet feature, enabling seamless export of responses into Microsoft Excel for analysis. This study focused on gathering information about poultry diseases contributing to antimicrobial usage and identifying the AMs most commonly used to treat these diseases in Rwanda in the past year.

Data Analysis

Data collected during the pretest phase were excluded from the analysis. The responses recorded via Google Forms were exported to Microsoft Excel. Descriptive statistics were also used for data analysis. The diseases were classified based on their etiology, transboundary significance, and international reporting requirements. The results are presented in tables, percentages, graphs, and charts. Additionally, a map (Figure 4) was designed via the Fast-Mapping Tool developed by AKADEMIYA2063 (available at https://www.fast-mapping.org/home#color).

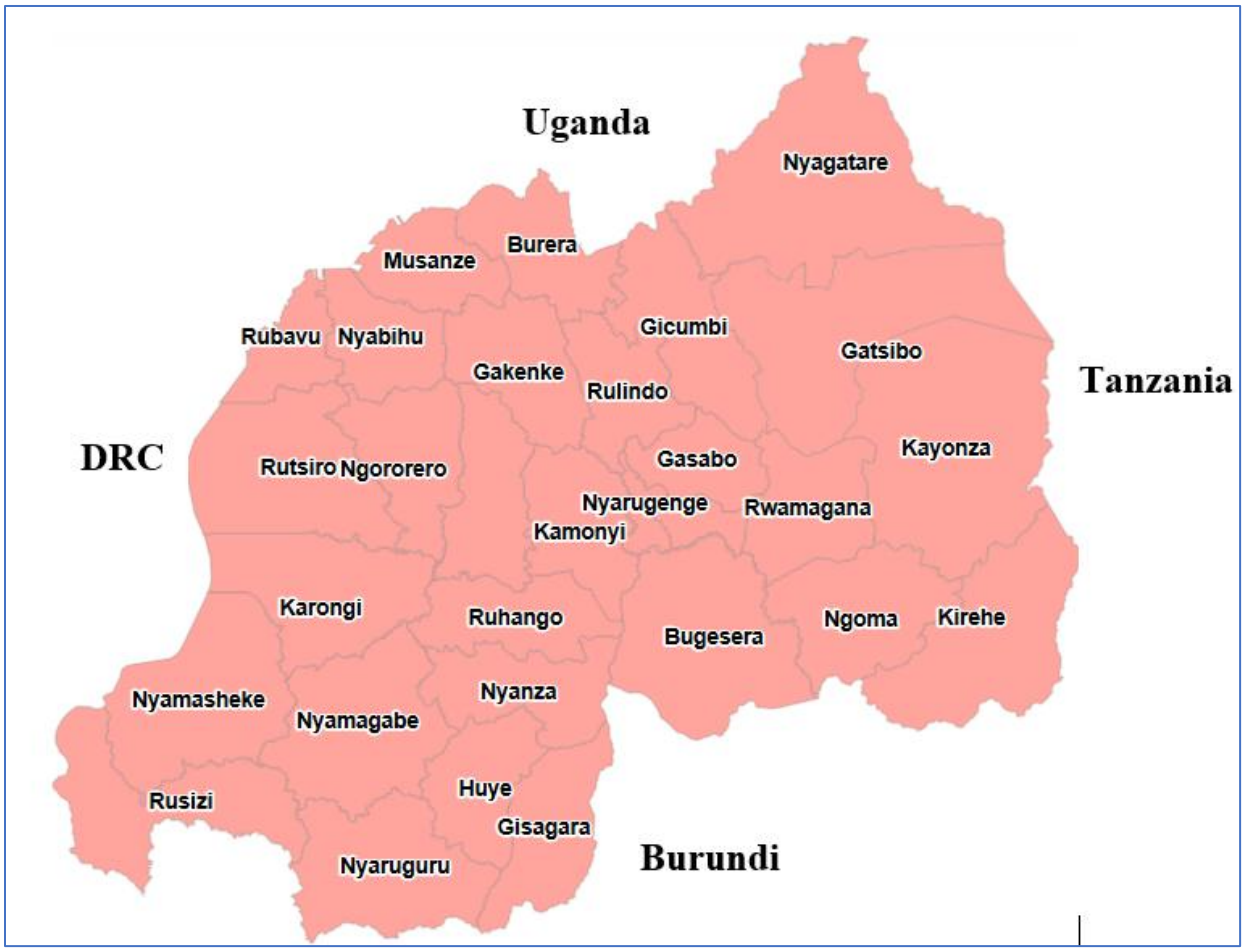

Figure 1. A map illustrating the districts of Rwanda (*Source: https://www.fast-mapping.org/home#color*).

Results

Poultry Diseases Contributing to Antimicrobial Usage in Rwanda

All 98 VPs reported challenges related to diseases on poultry farms. The most commonly reported diseases and their prevalence included infectious bronchitis (45.8%), *Escherichia coli* infections (43.3%), Marek's disease (36.0%), parasitic infections (34.8%), Newcastle disease (27.7%), egg drop syndrome (21.3%), avian salmonellosis (15.7%), and coccidiosis (15.1%) (Figure). Table 1 presents the categories of poultry diseases mostly prevalent in Rwanda. Bacterial infections are a significant concern, with *E. coli* infections being the most frequent, while pasteurellosis (6.6%) was the least. Among viral diseases, infectious bronchitis (45.8%) was the most frequent, while Gumboro disease (1.2%) was the least reported disease. Nematodes and tapeworm infestations were reported by 34.8% of VPs. Additionally, several diseases are notifiable to the WOAH, with infectious bronchitis (45.8%) and Marek's disease (36.0%) being the most prevalent, followed by Newcastle disease (27.7%).

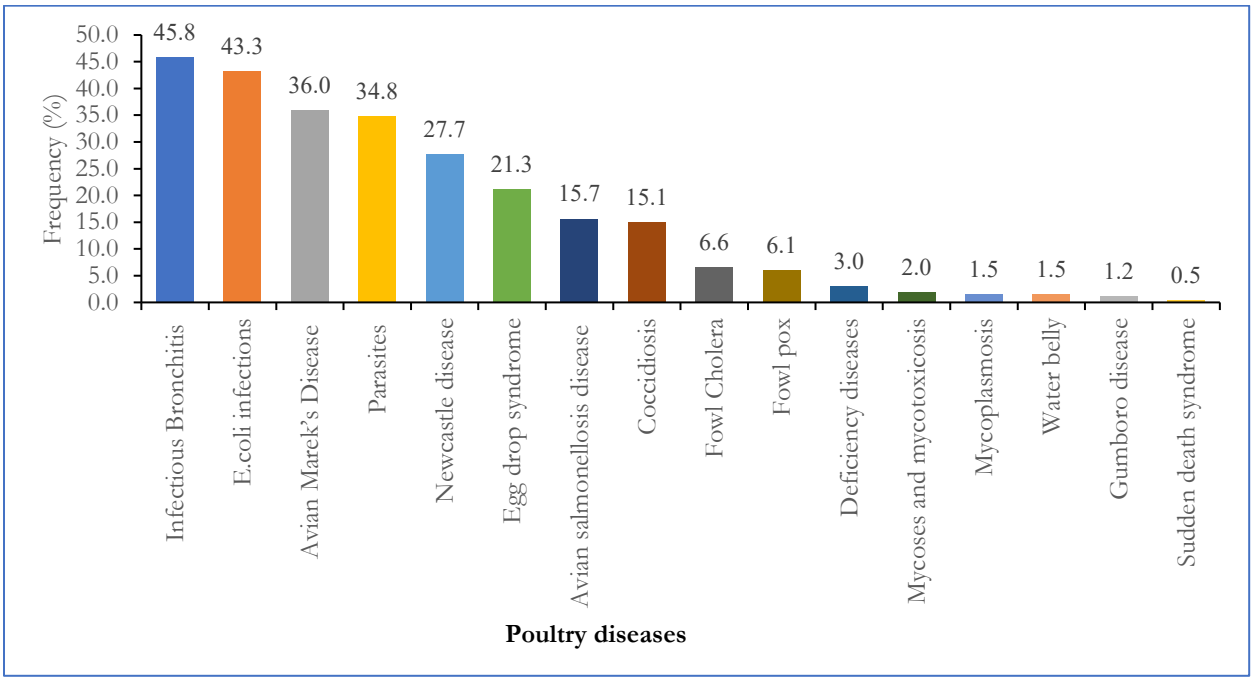

Figure 2. Prevalence of poultry disease occurrence in Rwanda.

Table 1. Classification of poultry diseases in Rwanda.

Disease category	Prevalence (%)
Bacterial diseases:	
E. coli infectious	43.3
Avian salmonellosis	15.7
Pasteurellosis	6.6
Viral diseases:	
Infectious bronchitis	45.8
Newcastle disease	27.7
Egg drop syndrome	21.3
Fowl pox	6.1
Gumboro disease	1.2
Mycoses & mycotoxicosis, and deficiency diseases:	
Deficiency diseases	3.0
Mycoses and mycotoxicosis	2.0
Parasitic diseases:	
Nematodes and tapeworms	34.8
Coccidiosis	15.1
Transboundary animal diseases:	
Newcastle disease	27.7
Gumboro disease	1.2
Diseases notifiable to the WOAH:	
Infectious bronchitis	45.8
Marek's disease	36.0
Newcastle disease	27.7
Pasteurellosis	6.6
Mycoplasmosis	1.5
Gumboro disease	1.2

WOAH = World Organization for Animal Health.

Antimicrobials Used in Poultry Farms

Different antimicrobials were used to treat primary bacterial infections, as well as secondary bacterial infections associated with viral diseases, mycoses and mycotoxicosis, deficiency diseases, and parasitic diseases (Figure 3).

Among the seven AMs found to be commonly used in the commercial poultry farms in Rwanda, the preference of VPs in Rwanda indicates that 85.7% of the AMs are

classified as veterinary critically important antimicrobials (Sulfonamides, Quinolones, Aminoglycosides, Penicillins, Cephalosporins, and Tetracyclines).

Figure 3 illustrates antimicrobial usage in poultry farms across three categories: therapeutic, preventative, and growth-promoting. For therapeutic use, sulfonamides (19.1%) were most commonly used to treat infections, while the macrolides were the least (7.9%) used therapeutic agents. Preventative applications were dominated by anthelmintic (25.8%) and antiprotozoal (21.3%), reflecting a focus on controlling parasitic and protozoal diseases. For growth promotion, usage is notably lower, with sulfonamides (6.7%) and tetracycline (5.6%) being the most common.

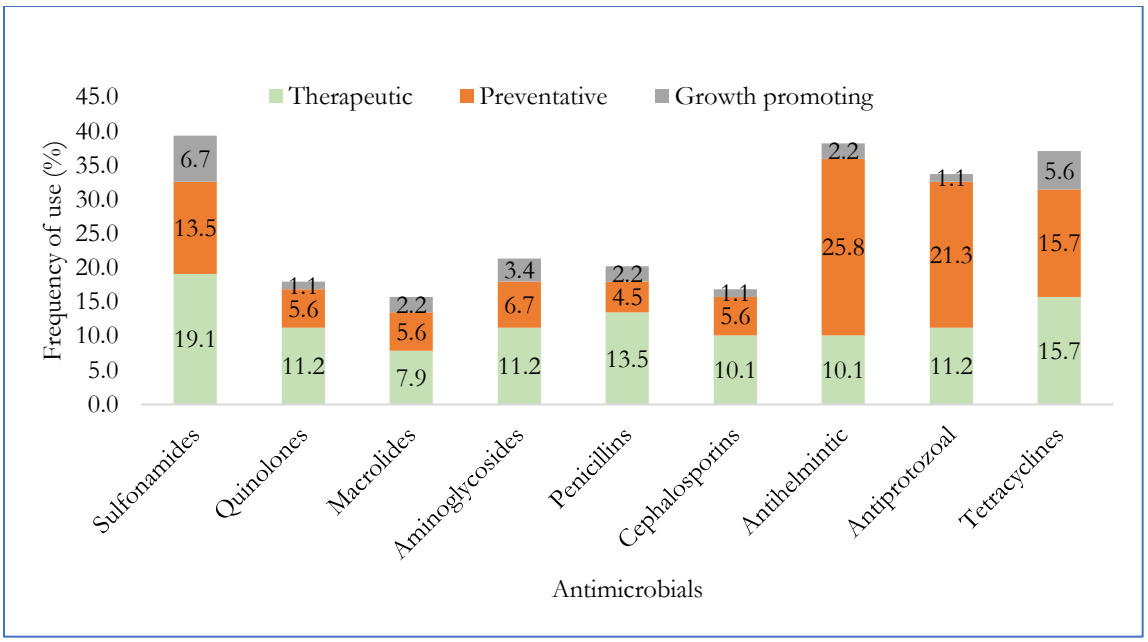

Figure 3. Proportion (%) of antimicrobials used as therapeutic, preventative, and/or growth promoting agent in poultry farms in Rwanda.

Discussion

Sixteen poultry diseases were identified, namely infectious bronchitis, *Escherichia coli* infections, Marek's disease, parasitic infections, Newcastle disease, egg drop syndrome, avian salmonellosis, coccidiosis, fowl cholera, fowl pox, deficiency diseases, mycoses and mycotoxicosis, mycoplasmosis, water belly, Gumboro disease, and sudden death syndrome. Consistent with this observation, Mazimpaka *et al.* (2020), Habimana *et al.* (2020), and Cyuzuzo *et al.* (2023) in Rwanda reported that poultry are susceptible to a range of diseases, including Newcastle disease, *E. coli* infection, Gumboro disease, coccidiosis, Marek's disease, salmonellosis, infectious bronchitis, ectoparasites, endoparasites, fowl pox, and avian influenza. These findings highlight the critical need for improved biosecurity, disease surveillance, and vaccination programs to mitigate the impact of poultry diseases on productivity, food security, and AMR in Rwanda.

In Tanzania and India, coccidiosis, salmonellosis, and Newcastle disease were also common poultry diseases that curtail poultry production if they are not detected early (Sayeed *et al.*, 2020; Machuve *et al.*, 2022; Srivastava and Pendey, 2023). The FAO recognizes that Newcastle disease, infectious bronchitis, laryngotracheitis, fowl pox, avian leucosis, lymphoid leucosis, Marek's Disease, ornithosis, salmonellosis, fowl typhoid, pasteurellosis, tuberculosis, air sac disease and chronic respiratory disease, histomoniasis, and coccidiosis are among the specific diseases of poultry (Herenda et al., 1994).

In Cambodia, Chut *et al.* (2023) also reported fowl pox, Newcastle disease, avian influenza, infectious bursal disease, fowl cholera, chronic respiratory disease, internal and external parasites, and coccidiosis as diseases that affect poultry. The presence of these diseases in poultry farming can be attributed to challenges in preventing and controlling chicken diseases, such as poor biosecurity measures, lower accessibility and/or affordability of veterinary services and vaccines, and lack of knowledge about chicken diseases among many poultry farmers. They can lead to substantial financial losses, decreased productivity, and, in some cases, mortality (Asfaw *et al.*, 2021; Muñoz-Gómez *et al.*, 2025). But poultry diseases can be prevented and controlled through the implementation of vaccination programs, biosecurity measures, good animal husbandry best practices, and targeted training programs for poultry farmers (Zhou *et al.* 2020).

The current study revealed that *E. coli* infection (43.3%) and Newcastle disease (27.7%) are among the most prevalent poultry diseases, with significant cases of parasitic infections (34.8%) and notifiable diseases such as infectious bronchitis (45.8%) and Marek's disease (36.0%). The prevalence of colibacillosis in the present study (43.3%) is comparable to the 52% reported in Ukrainian poultry farms (Halder *et al.*, 2021), indicating

that *E. coli* remains a widespread bacterial infection across different geographical contexts and is often associated with poor biosecurity practices, overcrowding, environmental stress, and immunosuppression factors in poultry production systems.

The considerable presence of infectious diseases in poultry farming suggests heavy reliance on antibiotics for both treatment and prevention, potentially contributing to the development of AMR, particularly when antibiotics are used improperly or excessively. For example, frequent treatment of colibacillosis and salmonellosis with antibiotics can lead to the emergence of resistant strains, while the high prevalence of respiratory conditions such as infectious bronchitis may result in secondary bacterial infections requiring additional antimicrobial treatments (Kurmakaeva *et al.*, 2024). This situation underscores the urgent need for alternative disease control strategies, such as improved vaccination programs and biosecurity measures, to reduce antimicrobial dependency and mitigate AMR risks in poultry production (Lambrou *et al.*, 2021).

This concern is especially relevant in Rwanda, where from 2019 to 2021, 35,291.4 kg of AMs were imported annually, with an average annual import of 11,763.8 kg (±1,486.9 kg). The adjusted AM import amounts per animal biomass were 29.1 mg/kg in 2019, 24.3 mg/kg in 2020, and 30.3 mg/kg in 2021 (Manishimwe *et al.* 2024). Notably, 99.9% of these antimicrobials, amounting to 35,253.8 kg, were intended for use in food-producing animals, including poultry. The most common imported AMs are tetracyclines (50.3%), sulfonamides (22.3%), and aminoglycosides (11.5%), with 78.9% classified as highly important antimicrobials for human medicine (Manishimwe *et al.*, 2024). This widespread use of critical antibiotics in livestock production raises significant public health concerns, as AMR rates are already high and pose a serious therapeutic challenge to managing common infections in humans (Bizimungu *et al.*, 2024; Hirwa *et al.*, 2024).

The present study revealed a high use (85.7%) of veterinary critically important antimicrobials on Rwandan poultry farms, with most of these drugs being administered without a prescription from licensed veterinary practitioners and commonly obtained through over-the-counter channels. This could pose a significant risk to public health by accelerating AMR, potentially reducing treatment options for both animals and humans (Uruén *et al.*, 2020; Ahmed *et al.*, 2024). The presence of veterinary highly important antimicrobials (14.3%) in the present study further highlights the reliance on antibiotics, which, while essential, still contributes to AMR concerns (Lhermie *et al.*, 2020). These findings underscore the urgent need for stricter AMU regulations, enhanced surveillance, and the promotion of alternative disease control strategies. This is an indication that failure to act could compromise poultry productivity, food safety, and human health, necessitating a One Health approach to mitigate risks (de Mesquita Souza Saraiva *et al.* 2024).

The present study revealed that sulfonamides (19.1%) and tetracyclines (15.7%) are the most commonly used antimicrobials for treating primary or secondary bacterial infections, while anthelmintics (25.8%) and antiprotozoals (21.3%) are primarily used for disease prevention, and sulfonamides (6.7%) and tetracyclines (5.6%) are the main antimicrobials used for growth promotion. The latter practice negatively impacts human health because of the accumulation of antibiotic residues in food products, potentially creating future AMR for consumers of these products (Rahman *et al.*, 2022). This is probably because in some cases, these antimicrobial agents may be the same as those approved for therapeutic use; however, the dose used for growth promotion is generally less than the therapeutic dose (Cardinal *et al.* 2020). Therefore, the growth promoters should be discouraged in poultry production (Rahman *et al.*, 2022; Alapu and Emodi, 2025).

The findings of the current study revealed the use of seven classes of antimicrobial agents, including sulfonamides, quinolones, aminoglycosides, penicillins, cephalosporins, tetracyclines, and macrolides. The current findings align with those of Manishimwe *et al.* (2024), who reported that tetracyclines accounted for the largest share of antimicrobial imports (50.3%), followed by sulfonamides (22.3%), aminoglycosides (11.5%), beta-lactams (7.9%), macrolides (3.7%), polypeptides (2.2%), nitrofuranes (1.0%), and fluoroquinolones (1.0%). The predominance of tetracyclines, sulfonamides, and aminoglycosides, which is consistent with national import trends, suggests a reliance on broad-spectrum agents, potentially increasing the risk of AMR. Furthermore, the current findings are consistent with those of Mulchandani *et al.* (2023), who identified these seven classes of antimicrobials among the top eleven most commonly used classes in terrestrial food-producing animals. These findings underscore the need for strengthened antimicrobial stewardship, including stricter regulation of import and usage, enhanced veterinary oversight, and farmer education on responsible use. Promoting alternative disease prevention strategies such as vaccination, improved biosecurity, and hygiene practices will be essential for reducing dependency on antimicrobials.

The antimicrobial supply chain in Rwanda comprises different actors, including manufacturers, wholesalers, distributors, retailers, and end-users. They have separate but complementary roles and are primarily from the private sector. Antimicrobial manufacturers are mostly international companies. The country depends on imports for its need for antimicrobials (Rwanda FDA, 2025). Antimicrobial importers are present in the country and run large-scale businesses that deal directly with manufacturers. They sell antimicrobials to primary, secondary, and tertiary distributors/wholesalers and retailers, as well as private and public veterinarians, nongovernment organizations, projects, and the government, to some extent.

A recent study conducted in Rwanda to assess the use of antibiotics in farm animals revealed that the use of

antibiotics was noted in 97.4% of respondent farmers (Manishimwe *et al*., 2017). Authors also reported that all respondents reported that they use antibiotics in their animals to treat diseases. However, some respondents (26.5%) agreed with the use of antibiotics as growth promoters. Another study conducted among poultry farmers reported that the use of antibiotics was more common among broiler farms and layer commercial farms than among noncommercial poultry farms (Cyuzuzo *et al.* 2023). Notably, antimicrobials can also be obtained over the counter without any veterinary prescription (Manishimwe *et al.* 2017).

In a meta-analysis of data from 901 point-prevalence studies from low- and middle-income countries from 2000 to 2018, the proportion of antibiotics with resistance higher than 50% increased from 0.15 to 0.41 in chickens, 0.13 to 0.34 in pigs, and 0.12 to 0.23 in cattle. The highest resistance rates were observed among antibiotics such as tetracyclines, sulfonamides, and penicillins (Van Boeckel *et al.* 2019). This was empirically evidenced in a recent study by Cyuzuzo *et al.* (2023) conducted in Rwanda's northern province, specifically in the Gakenke, Rulindo, and Musanze districts. The study revealed that *E. coli* isolates presented the highest resistance to tetracycline (69.8%), followed by cotrimoxazole (39.5%) and amoxicillin (34.0%). Additionally, 18.5% of the *E. coli* isolates were resistant to all three antimicrobial agents, such as cotrimoxazole, tetracycline, and amoxicillin. Therefore, the emergence of antimicrobial-resistant avian pathogenic bacteria could pose significant challenges. First, economic losses in poultry production can occur when bacterial infections become unresponsive to conventional antimicrobial treatments. Second, it presents a serious public health concern, as resistant bacterial strains can be transmitted from poultry to humans. *E. coli*, in particular, is a major zoonotic pathogen that can cause foodborne infections in humans (Abebe *et al.* 2020; Liu *et al.* 2023). These findings highlight the urgent need to improve management practices and implement stricter measures to prevent the misuse of antimicrobial drugs and reduce their use on poultry farms. According to the observations of Van Boeckel *et al.* (2017), the use of AMs in food animals could be reduced by 9 ‗ 80% by effective policies compared with a business-as-usual target of continued growth of the livestock sector with current levels of antimicrobial use. This could be achieved either by reducing the quantity of AMs used per animal or the number of animals that are raised for food. This is in accordance with the WOAH's report that 8% of the antimicrobials used in animals in 2022 belong to the category of high-priority, critically important drugs for human health. This is a reminder that while we are moving in the right direction, we must remain vigilant by preserving the efficacy of these vital medicines through using them responsibly across all sectors (WOAH, 2025).

Conclusion

This study highlights a high burden of poultry diseases in Rwanda, with infectious bronchitis, E. coli infections, Marek's disease, parasitic infestations, and Newcastle disease being the most frequently reported by value chain actors. The wide range of bacterial, viral, parasitic, and deficiency-related conditions contributes substantially to antimicrobial use (AMU), particularly reliance on veterinary critically important antimicrobials. The predominance of disease challenges and the use of high-priority antimicrobial classes underscore significant gaps in biosecurity, vaccination, diagnostic capacity, and prudent AMU practices. Strengthening preventive health measures, improving disease surveillance, and promoting antimicrobial stewardship are essential to reduce disease incidence and mitigate risks associated with antimicrobial resistance (AMR) in the poultry sector.

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Conflict of Interests

The authors declare that they have no competing interests.

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