Awareness of Human Health Risks Associated with Antimicrobial Residues in Beef and Related Antibiotic Use Practices Among Cattle Producers in Kibaha District, Tanzania

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SUMMARY

Antimicrobial agents have enhanced human and animal health by reducing infections, and they are widely applied in livestock for treatment, disease prevention, and growth promotion. However, misuse, particularly failure to observe withdrawal periods, can result in antimicrobial residues in animal products, leading to allergic reactions and contributing to antimicrobial resistance (AMR). This study assessed awareness of these health risks among 216 cattle producers in Kibaha District, Tanzania. Data were collected using a structured questionnaire in Kobo Toolbox, administered through face-to-face interviews. Descriptive statistics summarized respondents' demographics, awareness, and practices, while logistic regression examined the influence of age, education, experience, and gender. Findings revealed that although 86.6% had heard of antibiotics, only 38.2% understood withdrawal periods. Half (50.5%) believed antibiotics cure all animal diseases, and 46.7% were unaware of side effects. Awareness of AMR and antimicrobial residues was low, with more than 60% unfamiliar with these terms. Antibiotics were mostly accessed without veterinary prescriptions (81.6%), often with dosing based on past experience. Moreover, 69.8% stopped treatment once animals appeared improved. Older farmers demonstrated some safer practices but also relied heavily on informal drug use. Education had a significant positive effect, with those holding secondary education or higher showing better awareness and practices. Farming experience showed no consistent effect, while gender differences were negligible. Overall, the study highlights high antibiotic use but poor awareness of related health risks, underscoring the urgent need for farmer education, improved veterinary services, and stronger regulation to ensure safe antimicrobial use and protect public health.

Keywords: Antimicrobial residues, KAP, cattle producers, human health risks, Kibaha District.

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INTRODUCTION

Antimicrobial agents have transformed both human and veterinary medicine by significantly lowering the rates of mortality and morbidity associated with infections. In livestock production, antimicrobials are widely used not only for therapeutic purposes but also for disease prevention and growth promotion (Van Boeckel et al., 2015).However, the improper use of antimicrobials, particularly failure to observe the recommended withdrawal periods, can result in antimicrobial residues exceeding the

acceptable maximum residue limits in animal-derived food products such as meat and milk (Larkin et al., 2004). The presence of antimicrobial residues poses significant public health risks such as allergic reactions, toxic effects, disruption of intestinal microbiota, and most critically, the development of antimicrobial resistance (AMR), which is now considered a global health crisis (Arsène et al., 2022).

Globally, AMR has been described as one of the top ten threats to public health (WHO, 2020). Humans are mostly exposed to antimicrobial residues through contaminated food, contributing to the selection and spread of resistant pathogens (Endale et al., 2023). This challenge is particularly acute in low- and middle-income countries, where veterinary drug regulation, surveillance systems, and farmer awareness are often limited (Singh et al., 2025). In sub-Saharan Africa, livestock keeping is essential to food security and rural livelihoods. However, the region faces significant challenges in ensuring the safe use of veterinary antimicrobials. Several studies have highlighted poor knowledge among farmers about drug withdrawal periods and the health risks of antimicrobial residues in food products, for instance a study conducted in Ethiopia by Tadesse et al.(2025) indicated that most farmers (79.5%) lacked knowledge about antimicrobials use and antimicrobial residue, also the study conducted in Rwanda by Hirwa et al., (2024) showed that the low levels of knowledge, attitude and practice among livestock keepers on using antimicrobials, may lead to the misuse of antimicrobials hence spread of AMR.

In Tanzania, the livestock sector contributes substantially to the national economy and household incomes, particularly in rural areas. The increasing demand for animal-source foods such as meat, eggs and milk, has led to intensified livestock production in Tanzania and a parallel rise in antimicrobial use (Kimera et al., 2020; Mdegela et al., 2021).However, studies have shown that cattle producers in Tanzania often lack awareness of the human health risks associated with antimicrobial residues resulting from the improper use of veterinary drugs. Mdegela et al. (2021) reported that antimicrobial use in livestock production in Tanzania remains largely unregulated, with widespread non-adherence to withdrawal periods and continued misuse of veterinary drugs, which increases the risk of antimicrobial residues entering the food chain. . In Kibaha District where cattle farming is a common livelihood activity, a significant gap exists in research on producers' awareness of health risks associated with the improper use of antimicrobial agents.

Therefore, this study was conducted to assess the awareness of human health risks associated with antimicrobial residues among cattle producers in Kibaha District. The findings of this study seek to contribute to Tanzania's efforts in combating antimicrobial resistance and promoting sustainable livestock management since the study aligns with the National Action Plan on Antimicrobial Resistance 2023-2028 specifically strategic objective two "to improve AMR awareness, communication and education".

MATERIALS AND METHODS

Study area

The study was conducted in Kibaha District, Tanzania. The district covers an area of 1499 km^2. Kibaha District is bordered to the north by Chalinze District, to the southeast by the Kisarawe District, and to the west by Morogoro District of Morogoro Region. According to the 2022 census, the district has a total population of 123,367. The livestock sector plays an important role in the district's economy and livelihoods, with many households engaging in cattle and poultry production for income generation and food security. The study was conducted between January 2025 and April 2025.

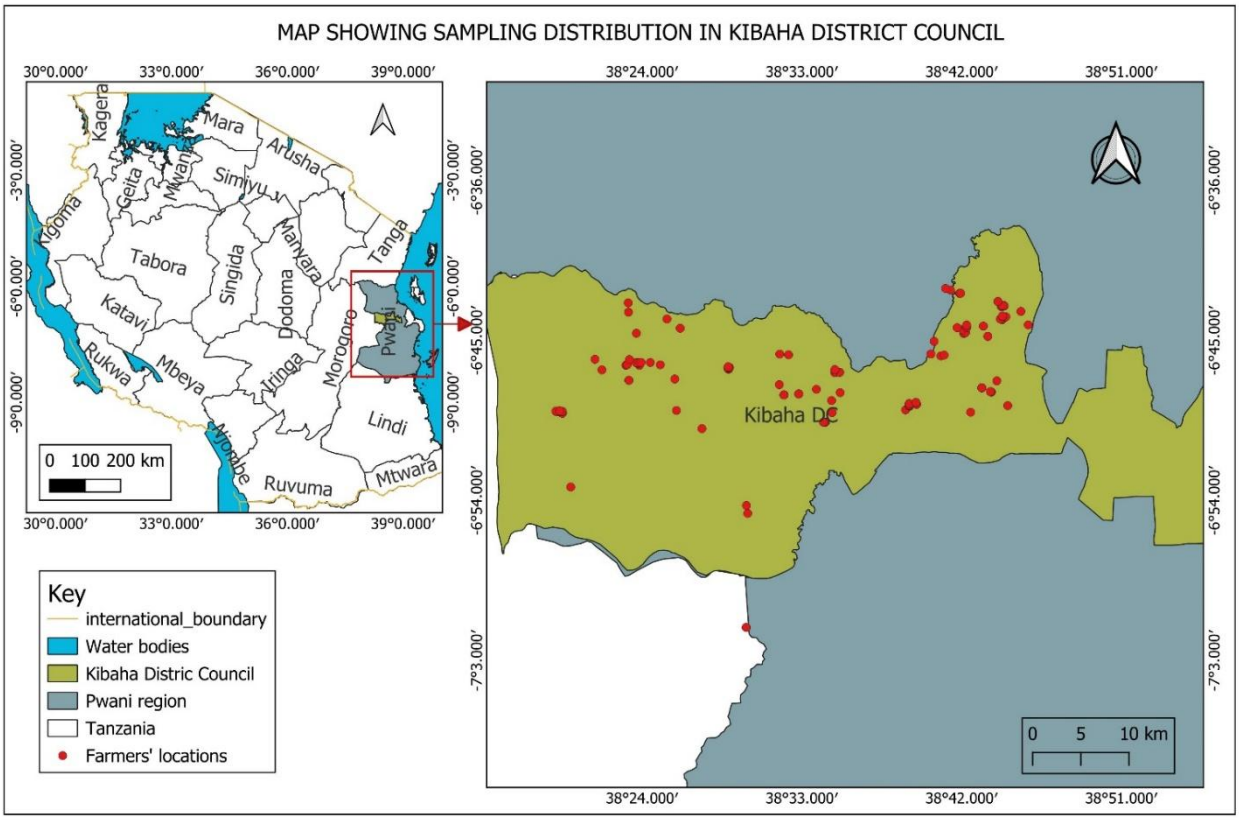

Figure 1. Sampling distribution of livestock keepers in Kibaha District, Tanzania. The map was drawn using shapefiles downloaded from the National Bureau of Statistics (NBS), Tanzania. The map was created using QGIS version 3.8.2.

Study design

A cross-sectional study design was employed to assess the level of awareness among cattle producers' human health risks associated with antimicrobial residues.

Study population

The target population included cattle farmers actively involved in livestock farming from nine selected wards in Kibaha District which were: Kwala, Magindu, Gwata, Ruvu, Dutumi, Mtongani, Kikongo, Disunyara and Kawawa.

Sampling technique and sample size

A multistage sampling technique was used to select wards and respondents. First, wards with high cattle-keeping activity were purposively selected. Second, villages were randomly sampled from selected wards. Third, cattle producers were randomly sampled from local livestock registers in the identified villages making a sample of 216 respondents eligible for the study. (Cochran, 1977) The sample per village was calculated using the formula:

$$n_i = \frac{Ni}{N} \times n$$

Where n_i = number of cattle producers sampled from village *i*

N_i = number of cattle producers in village *i*

N = total number of cattle producers in all selected villages

n = total sample size

This method avoided over- or under-representation of producers from smaller or larger villages.

Sociodemographic characteristics of respondents

A total of 216 livestock producers were interviewed. As shown in Table 1, respondents were drawn from nine wards, with the highest representation from Kwala (22.2%) and the

lowest from Kawawa (0.5%). Most respondents were male (81.9%) while 18.1% were female. The respondents' ages ranged from 30 to 55 years, with a median age of 38 years. Most livestock keepers belonged to the adult age group. Over half (51.4%) had informal education, followed by those with primary education (31.9%), secondary education (11.1%), and post-secondary education (5.6%). Regarding livestock keeping experience, the duration ranged from 1 to 66 years, with a median of 12 years.

Table 1: Sociodemographic characteristics of sampled cattle producers in Kibaha District, Tanzania (n = 216)

Parameter	Category	Frequency (n)	Percentage (%)
Ward	Disunyara	3	1.4
	Dutumi	30	13.9
	Gwata	20	9.3
	Kawawa	1	0.5
	Kikongo	39	18.1
	Kwala	48	22.2
	Magindu	25	11.6
	Mtongani	28	13.0
	Ruvu	22	10.2
Sex	Female	39	18.1
	Male	177	81.9
Education Level	Informal	111	51.4
	Primary	69	31.9
	Secondary	24	11.1
	Tertiary	12	5.6
Age (years)	Mean ± SD	42.44 ± 16.04	
	Median (IQR)	38 (30–53)	
	Range	17–80	
Farming experience (years)	Mean ± SD	18 ± 15.80	
	Median (IQR)	12 (6–26)	
	Range	1–66	

Data Collection

Data were collected using a structured questionnaire which was pre-tested in a non-sampled village (Kibwende Village) within Kibaha District to assess clarity, relevance, and consistency. Final data collection was installed in Kobo Toolbox and the questionnaire was administered through face-to-face interviews conducted by trained data collection assistants using mobile devices.

Data processing and analysis

After data collection, responses from Kobo Toolbox were exported in CSV format and initially cleaned in Microsoft Excel to check for completeness, consistency, and entry errors. The cleaned dataset was then imported into Epi Info™ version 7.2.2 (CDC, 2018) (for descriptive statistical analysis to summarize sociodemographic characteristics and key variables related to antimicrobial use and awareness. Logistic regression models were also done in Epi Info to

examine the influence of sociodemographic factors on awareness and practices related to antimicrobial use and resistance. Each outcome variable, including awareness of antibiotics, antimicrobial resistance (AMR), antibiotic side effects, withdrawal periods, and related practices, was analyzed against predictors such as age, education level, farming experience, and gender. Odds ratios (OR) with corresponding 95% confidence intervals and p-values were reported to assess the strength and significance of associations. Variables with p-values less than 0.05 were considered statistically significant.

RESULTS

Common livestock resources and diseases in the community

Cattle were the most commonly kept livestock (97.2%), followed by goats (63%), sheep (49.5%), and chickens (24.1%)."Figure 1). As shown in Figure 3, respondents reported a total of six livestock disease categories affecting their cattle. The most frequently mentioned were transboundary diseases, particularly Contagious Bovine Pleuropneumonia, followed by Anaplasmosis

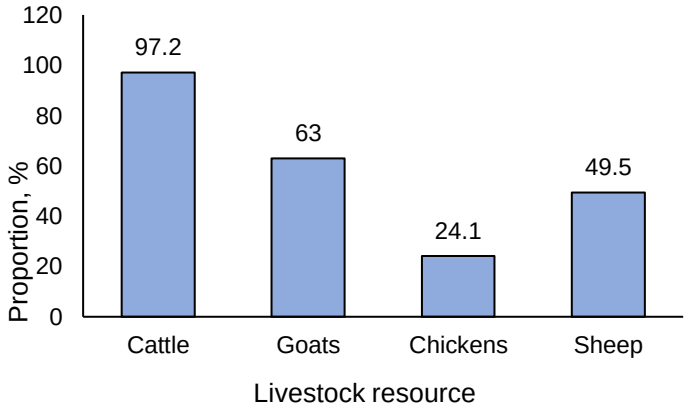

Figure 2. Distribution of livestock species kept by sampled cattle producers in Kibaha District, Tanzania

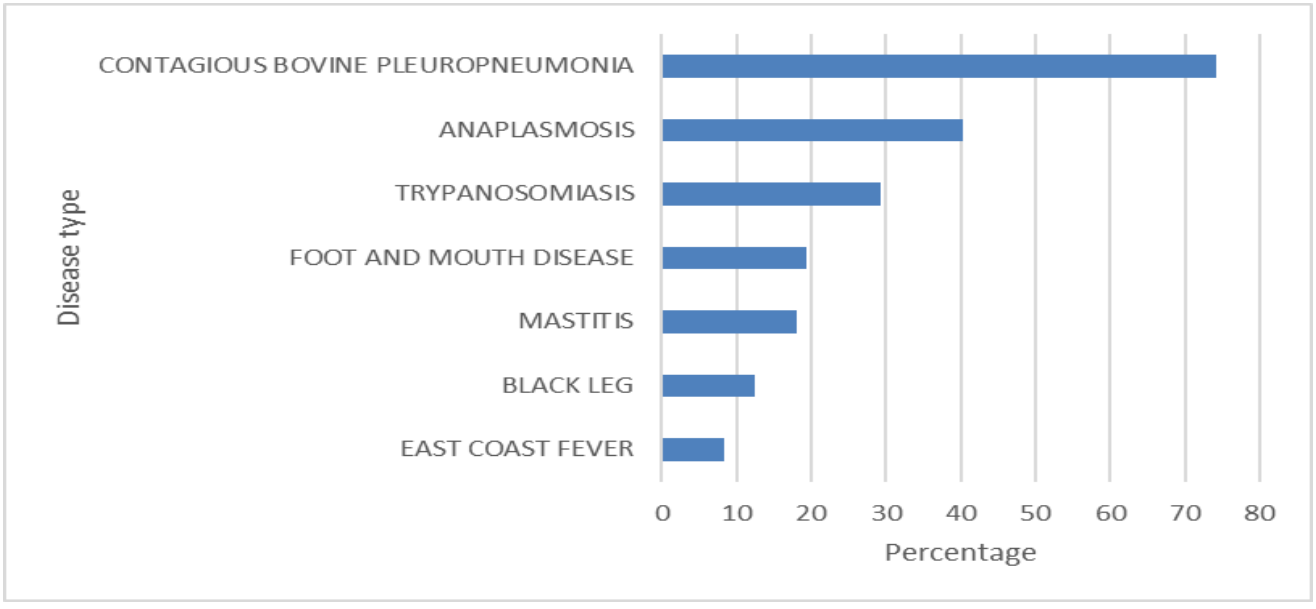

Figure 3. Frequently reported diseases affecting livestock among cattle producers in Kibaha District, Tanzania

Distribution of antibiotics commonly used by cattle producers

As shown in figure 5, Oxytetracycline was the most commonly used antimicrobial among respondents (63.89%), indicating a strong reliance on broad-spectrum antibiotics. Tylosin (23.61%) and penicillin (12.5%) were used less frequently. (Figure 4)

Sources of antimicrobials used by cattle producers

The majority of respondents obtained antimicrobials from the local market (55.6%), followed by veterinary pharmacies (40.7%). Only a small proportion sourced antimicrobials directly from a veterinarian (2.8%) or from another farmer (0.9%

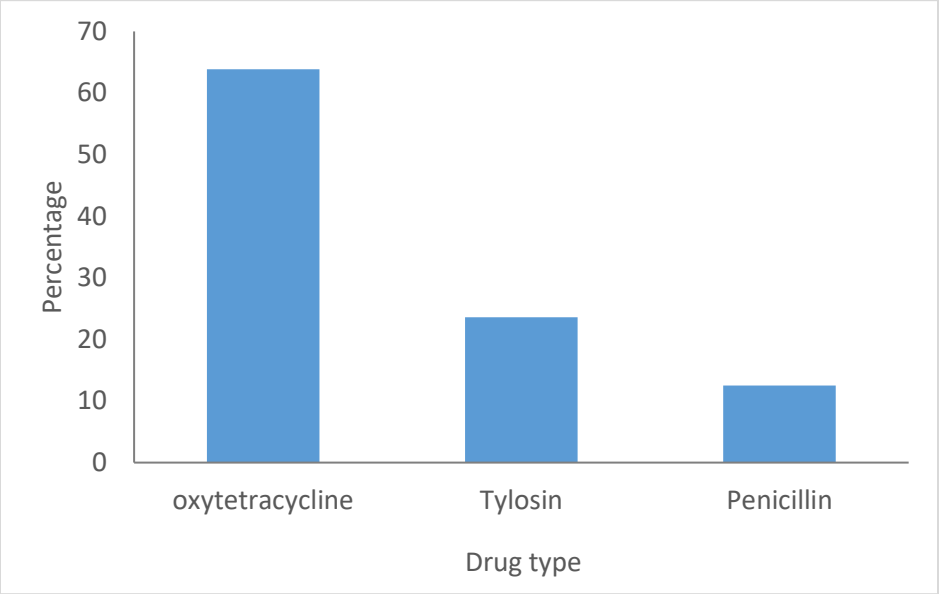

Figure 4 Antibiotics commonly used by cattle producers in Kibaha District, Tanzania

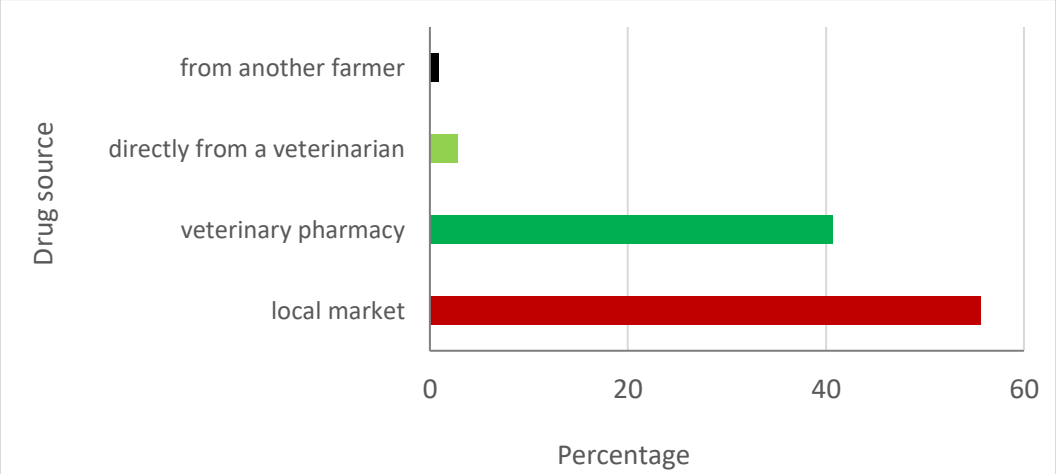

Figure 5 Reported sources of veterinary antimicrobials used by cattle producers in Kibaha District, Tanzania

Awareness of antibiotics use, residues and Antimicrobial Resistance

Approximately eighty-seven percent of respondents had heard about antibiotics (table 2). However, only 38.2% were aware of the concept of a withdrawal period. About 50.5% of the respondents believed that antibiotics can treat all diseases, and 46.7% stated that antibiotics have no side effects. Furthermore, knowledge regarding the health risks associated with consuming antibiotic residues and using expired antibiotics was limited. Twenty-three percent of farmers did not know if meat from treated animals posed any risks. About 46.2% were unaware of the effects of expired antibiotics, and only 28.3% acknowledged that expired antibiotics are dangerous. Further, 63.7% and 70.3% of farmers had never heard of antimicrobial resistance and antimicrobial residues respectively.

Table 2: Awareness of antibiotics, antimicrobial residues, and antimicrobial resistance among cattle producers in Kibaha District, Tanzania

Awareness Parameter	Frequency	Percentage (95%CI)
Heard of antibiotics	187	86.6(81.3-90.8)
Antibiotics used for all diseases	109	50.5(43.5-57.4)
Antibiotics have side effects	99	46.7(39.8-53.7)
Heard of withdrawal period	81	38.2(31.6-45.1)
Aware of risk of consuming meat from antibiotic treated animal	50	23.22(17.7-29.4)
Aware that expired antibiotics may leave harmful residues that pose health risks	60	28.3(22.3-34.9)
Heard of antimicrobial resistance (AMR)	77	36.3(29.8-43.2)
Unaware of antimicrobial residues	149	70.3 (63.6-76.4)
Aware of health risks of AMR	43	20.3(15.1-26.3)

Attitudes and practices towards antibiotic use

Half (50.5%) of the respondents believed that antibiotics are effective for all diseases, suggesting a misconception about their specificity. Only 38.2% recognized the importance of observing withdrawal periods, while others either did not know or considered it unimportant. This indicates a generally low concern about antibiotic residues in food-producing animals. Among the respondents, 34.4% supported selling or slaughtering of animal, which is in medication.

As shown in Table 3, 40.1% of respondents frequently used antibiotics, while 27.1% used them rarely. About 9.1% stated they always used antibiotics. Oxytetracycline was the most commonly used (63.9%), followed by Tylosin (23.6%) and Penicillin (12.5%). In terms of antibiotic combinations, 67.6% used single antibiotics, while 32.4% used combinations. Among combinations, oxytetracycline and penicillin were most common (82.9%).

The majority of respondents (81.6%) obtained antibiotics without a veterinary prescription. Approximately 65.6% determined dosages based on previous experience, and 69.8% stopped administering antibiotics when animals showed signs of recovery. Also, the results show that when treatment failed, 42.9% switched antibiotics, 28.3% called a veterinarian, and 34.4% admitted to selling or slaughtering animals during the withdrawal period

Table 3: Antibiotic use practices, frequency of use, and types of antibiotics used among cattle producers in Kibaha District, Tanzania

Antibiotic use frequency	**Frequency**	**%(95%CI)**
always	21	9.1(6.2-14.7)
Frequently	85	40.1(33.4-47.0)
Occasionally	48	22.1(17.2-28.9)
Rarely	58	27.1(21.5-33.9)
Antibiotic type		
Oxytetracycline	138	63.9(57.1-70.3)
Penicillin	27	12.5(8.4-17.7)
Tylosin	51	23.6(18.1-29.9)
Antibiotic combination	70	32.4 (26.2-39.1))
Amoxicillin and tylosin	1	1.4(0.04-7.7)
Other combination	10	14.3(7.1-24.7)
Oxytetracycline and Penicillin	58	82.9(71.9-90.8)
Streptomycin and sulphonamides	1	1.4(0.04-7.7)

Table 4: Antibiotic medication practices among cattle producers in Kibaha District, Tanzania

Medication Practice	**Frequency**	**95%CI**
Seeking prescription		
Yes	39	18.4(13.4-24.3)
No	173	81.6(75.7-86.6)
Determination of the dosage		
Own experience	139	65.6(58.8-71.9)
Veterinarian	50	23.6(18.0-29.9)
Drug manufacturer	23	10.9(7.0-15.8)
Dosage completeness		
Finish dosage	64	39.2(24.1-36.9)
Stop when clinical signs disappear	148	69.8(63.2-75.9)
Decision when treatment fails		
Increase dose	48	22.6(17.2-28.9)
Stop & consult a veterinarian	60	28.3(22.3-34.9)
Switch to a different antibiotic	91	42.9(36.2-49.9)
Wait for more time	13	6.1(3.3-10.2)

Predictors of antimicrobial use, knowledge and practice

Age significantly influenced awareness and practices related to antimicrobial use (Table 5). For awareness, each additional year of age increased the odds of having heard about antibiotics (OR=1.046, p=0.005), awareness of antimicrobial resistance (AMR) (OR=1.079, p=0.006), awareness of antibiotic side effects (OR=1.024, p=0.045), risks associated with eating treated animals (OR=1.066, p=0.001), understanding that incomplete antibiotic dosage leads to AMR (OR=1.065, p=0.020), awareness of withdrawal periods (OR=1.084, p<0.001), and awareness of risks from expired drugs (OR=1.056, p=0.009). In terms of practices (Table 6), age had a mixed effect: with older individuals being less likely to seek prescriptions before initiating antibiotic use (OR=0.953, p=0.010), slightly likely to treat all animals when one was sick (OR=1.025, p=0.034), and less likely to stop treatment before it is completed (OR=0.970, p=0.014). However, older age was associated with a lower likelihood of taking proper action when treatment failed (OR=0.930, p=0.008), increased use of drug combinations (OR=1.030, p=0.039), and decreased likelihood of selling treated animals (OR=0.940, p=0.002).

Education level had a significant positive influence on awareness. Respondents with education were more likely to be aware than those without any formal education, those with primary education had increased odds of awareness, for example, AMR awareness (OR=1.97, p=0.038), withdrawal period awareness (OR=2.13, p=0.028), and risks from expired drugs (OR=2.05, p=0.044). Secondary education increased odds of awareness substantially, such as AMR awareness (OR=8.62, p<0.001), withdrawal period awareness (OR=5.45, p=0.001), and awareness of risks from expired drugs (OR=9.08, p<0.001). Tertiary education had even stronger effects, increasing odds of awareness of AMR (OR=15.31, p<0.001), withdrawal period (OR=13.42, p<0.001), and risks from expired drugs (OR=15.75, p<0.001). Regarding practices, those with secondary education were less likely to seek prescriptions before use (OR=0.29, p=0.001), and tertiary-educated individuals were less likely to seek prescriptions (OR=0.20, p=0.007). However, tertiary-educated individuals were less likely to stop medication early (OR=0.26, p=0.023) and less likely to sell treated animals (OR=0.20, p=0.028). Primary education did not show statistically significant effects on practices.

Farming experience was negatively associated with awareness but had varied effects on practices. Each additional year of farming experience reduced the odds of awareness of antibiotic side effects (OR=0.958, p=0.037), risks of eating treated animals (OR=0.937, p=0.004), understanding incomplete dosage leads to AMR (OR=0.958, p=0.047), and awareness of withdrawal period (OR=0.927, p=0.002). Regarding practices, increased farming experience raised the odds of seeking prescriptions (OR=1.044, p=0.032), lowered the odds of treating all animals when one was sick (OR=0.968, p=0.035), decreased use of drug combinations (OR=0.950, p=0.004), and increased the likelihood of selling treated animals (OR=1.051, p=0.022). The influence on other practices was not statistically significant.

Gender did not significantly influence awareness or most practices. Males showed a borderline higher likelihood of seeking prescriptions before antibiotic use compared to females (OR=2.28, p=0.058), but this was not statistically significant. No other variables showed significant gender effects.

Table 5: Logistic regression analysis of factors associated with awareness of antibiotics among cattle producers in Kibaha District, Tanzania

Parameter	Odds Ratio	95%CI	S. E.	Z-Statistic	P-Value
Outcome Variable: Heard about antibiotics					
Age	1.05	1.0-1.1	0.02	2.41	0.02
Gender (Male/Female)	1.64	0.6-4.8	0.55	0.90	0.37
education (Primary/informal)	2.55	1.0-6.4	0.48	1.96	0.05
education (Secondary /informal)	1193366.33	3->1.	379.87	0.04	0.97

Parameter	Odds Ratio	95%CI	S. E.	Z-Statistic	P-Value
education (Tertiary/informal)	1063161.15	1->1.	520.52	0.03	0.98
experience farming	0.98	0.9-1.0	0.02	-1.24	0.21
CONSTANT			0.79	-0.64	0.52
Outcome Variable: Awareness of risks of eating animal undergoing treatment					
Age	1.07	1.0-1.1	0.01	4.63	0
Education (Primary/informal)	1.05	0.4-2.5	0.45	0.11	0.91
Education (Secondary /informal)	2.99	0.9-9.4	0.59	1.87	0.06
Education (Tertiary/informal)	10.41	2.3-45.	0.75	3.12	0.00
Experience farming	0.94	0.9-0.0	0.02	-3.65	0.00
Gender (Male/Female)	0.62	0.2-1.4	0.45	-1.08	0.28
CONSTANT			0.79	-3.73	0.00
Outcome Variable: Awareness on risks associated with expired drugs					
Age	1.06	1.0-1.1	0.01	4.26	0.00
Education (Primary/informal)	1.31	0.6-2.9	0.40	0.68	0.50
Education (Secondary /informal)	2.28	0.7-6.9	0.55	1.50	0.13
Education (Tertiary/informal)	12.35	2.7-55.9	0.77	3.28	0.00
Experience farming	0.95	0.9-0.0	0.01	-3.31	0.00
Gender (Male/Female)	0.80	0.3-1.9	0.43	-0.52	0.61
CONSTANT			0.73	-3.69	0.00
Outcome Variable: Awareness that antibiotics has side effects					
Age	1.02	1.0-1.04	0.01	2.21	0.03
Education (Primary/informal)	1.47	0.8-2.7	0.32	1.20	0.23
Education (Secondary /informal)	1.48	0.6-3.7	0.48	0.83	0.41
Education (Tertiary/informal)	0.66	0.2-2.4	0.67	-0.62	0.53
Experience farming	0.98	0.9-1.00	0.01	-1.65	0.10
Gender (Male/Female)	0.91	0.4-1.9	0.38	-0.25	0.80
CONSTANT			0.58	-1.56	0.12
Outcome Variable: Heard of antimicrobial resistance					
Age	1.08	1.0-1.1	0.01	5.48	0.00
Education (Primary/informal)	2.44	1.1-5.2	0.39	2.30	0.02
Education (Secondary /informal)	8.93	3.0-26.	0.55	3.95	0.00
Education (Tertiary/informal)	10.96	2.5-46.	0.74	3.24	0.00
Experience farming	0.96	0.9-1.0	0.01	-3.16	0.00
CONSTANT			0.78	-4.94	0.00
Outcome Variable: Awareness that incomplete dosage leads to AMR					
Age	1.07	1.0-1.1	0.01	4.80	0.00
Education (Primary/informal)	2.22	1.0-4.7	0.39	2.06	0.04
Education (Secondary /informal)	8.22	2.8-23.	0.55	3.86	0.00
Education (Tertiary/informal)	15.22	3.3-69.	0.78	3.51	0.00
Experience farming	0.96	0.9-1.0	0.01	-3.13	0.00
CONSTANT			0.76	-4.34	0.00
Outcome Variable: Awareness of withdrawal period					
Age	1.08	1.0-1.1	0.01	5.56	0.00
Education (Primary/informal)	2.18	1.0-4.6	0.39	2.02	0.04
Education (Secondary /informal)	4.98	1.7-14.	0.54	2.95	0.00
Education (Tertiary/informal)	10.05	2.1-46.	0.78	2.96	0.00
Experience farming	0.93	0.9-1.0	0.02	-4.86	0.00
CONSTANT			0.75	-4.23	0.00

Table 6: Logistic regression analysis of factors associated with antibiotic use attitudes and practices among cattle producers in Kibaha District, Tanzania

Parameter	Odds Ratio	95% C. I		S. E.	Z-Statistic	P-Value
Outcome Variable: Seeking Prescription						
Age	0.9532	0.93	0.98	0.01	-3.54	0.000
Education (Secondary /informal)	0.2922	0.09	0.97	0.61	-2.02	0.044
Education (Tertiary/informal)	0.1968	0.05	0.83	0.73	-2.22	0.026
Experience farming	1.0436	1.01	1.08	0.02	2.53	0.012
CONSTANT				0.80	3.42	0.001
Outcome Variable: Treat all animals when one is sick						
Age	1.03	1.00	1.05	0.01	2.18	0.029
Experience farming	0.97	0.95	0.99	0.01	-2.61	0.009
CONSTANT				0.58	-0.42	0.67
Outcome Variable: Stop medication when clinical signs disappear						
Age	0.97	0.95	0.99	0.01	-2.65	0.008
Education (Tertiary/informal)	0.20	0.05	0.74	0.67	-2.40	0.016
CONSTANT				0.66	2.70	0.01
Outcome Variable: Taking proper decision when treatment is not working						
Age	0.93	0.88	1.00	0.03	-2.11	0.035
CONSTANT				1.13	-0.03	0.98
Outcome Variable: Attitude to use Drug combination						
Age	1.03	1.01	1.06	0.01	2.80	0.005
Experience farming	0.95	0.92	0.97	0.01	-3.93	0.000
CONSTANT				0.64	-2.08	0.038

DISCUSSION

Awareness of the human health risks associated with antimicrobial residues in animal-derived food products such as meat, milk, and eggs remain a significant concern in low- and middle-income countries, where veterinary regulation and farmer education are often limited (Adegbeye et al., 2024;Ghimpețeanu et al., 2022:Khalifa et al., 2024).

Oxytetracycline was reported as the most frequently used antimicrobial (63.89%) among cattle producers in Kibaha District. This finding is consistent with reports from other Tanzania regions, where oxytetracycline use has remained high due to its availability, affordability, and broad-spectrum activity (Katakweba et al., 2012;Sangeda et al., 2021; Oladeji et al., 2025). In contrast, tylosin and penicillin were used less frequently (23.61% and 12.5%, respectively). The limited use of these antimicrobials may be influenced by insufficient knowledge of their appropriate indications. In a related study, Katakweba et al., (2012) found that 52% of livestock producers were not aware of the specific diseases treatable by antibiotics, which likely contributes to poor selection and use of antimicrobials in livestock.

While the majority of farmers in this study (86.6%) were aware of a term antibiotic, knowledge of critical aspects such as withdrawal periods was lacking. Only 38.2% understood the need for observing withdrawal periods after antibiotic treatment. In a study conducted in Dar es Salaam and Morogoro, 22% of livestock keepers lacked understanding of withdrawal periods (Katakweba et al., 2012). Also a study conducted in Malaysia by Fatokun et al., (2024) showed that majority of the participants (69.2 %) had low knowledge of antibiotics and antibiotic use in food-producing animals. These findings point to an ongoing challenge in ensuring that antimicrobial use in livestock is aligned with food safety standards. Failure to observe withdrawal periods increases the likelihood of residues persisting in meat and milk, posing risks such as allergic reactions, drug toxicity, and the development of antimicrobial

resistance (Sapkota et al., 2007; Arsène et al., 2022). Additionally, 69.8% of respondents in the current study discontinued treatment when animals showed signs of recovery, this behavior reflects a widespread lack of awareness regarding proper antibiotic use. Similarly, Kallu et al., (2024) reported that 52% of livestock farmers in Ethiopia also stopped treatment prematurely when animals appeared to improve, a practice associated with drug residues and the risk of incomplete bacterial clearance (Mesfin et al., 2024)

Informal access to antibiotics remains widespread, with 81.6% of respondents obtaining antibiotics without prescriptions and relying on past experiences for dosage. A large proportion (81.6%) of farmers obtained antibiotics without veterinary prescriptions, relying on prior experience for dosage decisions. This pattern is consistent with findings from northern Tanzania (Caudell et al., 2017), other parts of Tanzania (Mdegela et al., 2021), Burkina Faso (Sawadogo et al., 2023), and Kenya where the vast majority of farmers (95%) bought antibiotics without a prescription (Rware et al., 2024). Some farmers (0.9%) admitted to receiving antibiotics from peers, indicating informal sharing practices that bypass professional oversight (Farhan et al., 2024).

Low awareness of antimicrobial resistance (AMR) and drug residues was evident among respondents, with 63.7% and 70.3% having never heard of these terms. Similarly, only 28.3% recognized the risks of using expired antibiotics, raising concerns about treatment failure and resistance development. These findings align with previous studies: Mgonja et al., (2018) reported that 52% of respondents were unaware of drug residues in Dodoma; Katakweba et al.,(2012) found 30% had no knowledge of AMR in Dar es Salaam and Morogoro; and in Ethiopia, (Tadesse et al., 2025) noted that 79.5% lacked understanding of AMU and antibiotic residues. However, more recent data from Ethiopia by Ragassa & Berhanu ,(2023) showed moderate improvement, with 66.5% reporting awareness of AMR. Generally, perception of the human health risks associated with antibiotic use in livestock was also found to be poor. In this study, 40% of respondents did not know that antibiotics used in livestock could pose a risk to human health, similar findings was reported by Katakweba et al., (2012), where 40% of respondents in Dar es Salaam and Morogoro also failed to recognize the health risks linked to antibiotic use in livestock. This consistent pattern of unawareness suggests that many farmers do not perceive a direct connection between livestock practices and public health outcomes. Such perceptions could undermine the adoption of safe drug practices and reduce support for regulatory measures.

Sociodemographic factors were found to influence awareness and practices to varying degrees. Education was the most influential factor in antimicrobial awareness, with higher educational levels linked to better understanding of AMR, drug safety, and withdrawal periods, as also observed by Mgonja et al., (2018) in Dodoma, Omolo et al.,(2024) in Ethiopia and Hossain et al., (2022) in developing countries. Farming experience did not consistently improve awareness or practices, as decisions were often based on personal experience rather than veterinary guidance, potentially leading to harmful treatment. Gender showed no significant effect on awareness or practices, this finding underscores the need for awareness campaigns to emphasize educational outreach across all demographic groups. It is important not to assume that farming experience or gender alone leads to appropriate antimicrobial use practices.

CONCLUSION

This study revealed that while antibiotic use is common among cattle producers in Kibaha District, awareness of the associated human health risks particularly antimicrobial residues and antimicrobial resistance is low.

RECOMMENDATION

To address these challenges, comprehensive educational initiatives should be implemented to improve farmers' understanding of antimicrobial residues, the significance of withdrawal periods, and the risks associated with improper antibiotic use, it is essential to enhance veterinary services and implement stricter controls on the access and distribution of antimicrobial drugs. Moreover, it is essential to strengthen ongoing collaboration among government authorities, veterinary

professionals, farmers, and local communities so as to promote responsible antibiotic use and support sustainable livestock production.

Ethical statement

Ethical clearance approval with reference number DPRTC/R/186/48, for this study was obtained from the Sokoine University of Agriculture (SUA) Institutional Review Board (IRB), acting on behalf of the Tanzania Commission for Science and Technology (COSTECH). In addition, research permits were granted by the President's Office – Regional Administration and Local Government (PO-RALG) and the respective local authorities in the

Authors' contribution

Kaduma Charles Mwalusito designed the study, collected data, performed data analysis, and drafted the manuscript. Janeth George Laurean supervised the designing of the study, data collection and contributed to data interpretation and manuscript review. Sharadhuli Iddi Kimera provided overall supervision, contributed to study design, and critically revised the manuscript for important intellectual content. All authors read and approved the final version of the manuscript

Conflicting interest

Authors declare no conflicting interests

Data availability

All data are included in this manuscript

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