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Knowledge, Attitudes, and Practices of Poultry Farmers on Antimicrobial Use and Resistance in Kitwe, Zambia: Implications on Antimicrobial Stewardship

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Abstract

Introduction: The inappropriate antimicrobial usage (AMU) in chicken production has led to an increase in the prevalence of antimicrobial resistance (AMR). In Zambia, there is little information documented regarding the knowledge, attitude, and practices of poultry farmers on AMU and AMR. Therefore, this study assessed the knowledge, attitude and practices regarding AMU and AMR among poultry farmers in Kitwe, Zambia. **Methods:** This was a cross-sectional study conducted among 106 poultry farmers from November to December 2021 using a structured questionnaire. Data analysis was done using IBM Statistical Package for Social Sciences (SPSS) version 26. **Results:** Overall, of the 106 participants, 90.6% knew what antimicrobials were, but only 29.2% were aware of AMR. The study showed that 46.2% of the participants had low knowledge, 71.7% had negative attitudes, and 61.3% had poor practices regarding AMR. The prevalence of antibiotic use in poultry production was 83%. The most used antimicrobials were tetracycline (84%) and gentamicin (35.2%). The commonly reported reason for the use of antimicrobials was for the treatment (93.2%) and prevention (89.8%) of diseases.

Further, 76.9% of the administered antimicrobials were usually done without veterinarian consultation or prescription. **Conclusion:** The study shows that there was high AMU in poultry farms in Kitwe. However, there was low knowledge, negative attitude, and poor practices towards AMU and AMR. Therefore, there is a need for educational and sensitisation programmes regarding AMU and AMR among poultry farmers in Kitwe, Zambia. Alongside this, antimicrobial stewardship and surveillance systems should be strengthened in the livestock production sector. This will ensure food safety and public health.

Keywords

Antibiotics, Antimicrobials, Antimicrobial Resistance, Antimicrobial Stewardship, Attitudes, Knowledge, Livestock, Poultry Farmers, Practices

1. Introduction

Antimicrobials have a vital role in both humans and animals because they are used to treat infections caused by microbes [1] [2]. In poultry, most antimicrobials have been inappropriately used for growth promotion, improving production, and prevention of diseases [3] [4]. The inappropriate use of antimicrobials in poultry has contributed to the development of antimicrobial resistance (AMR) [5] [6] [7]. AMR is a phenomenon used to describe the ability of microbes to stop or resist responding to antimicrobial therapy [8] [9]. Therefore, the development and spread of antimicrobial-resistant strains have negated the ability to treat infectious diseases and save lives [10] [11]. As a result, standard treatments become ineffective, infections persist and may spread to other animals and humans [9] [12] [13]. AMR is supposed to take place as a natural phenomenon because it is due to genetic changes in the microbes but the overuse and misuse of antimicrobials enhance the process [9] [12] [14].

AMR has become a major health concern globally because it poses a threat to animal and human life, thus hindering the development of the universe at large [9] [11] [15] [16] [17] [18] [19]. Across human and animal health, the development of drug-resistant pathogens has been exacerbated by the inappropriate use of antimicrobials, low knowledge, negative attitudes, and poor practices regarding AMU and AMR [19]-[25]. Deaths from drug-resistant infections have been projected to increase from the current 700,000 to 10 million annually and are estimated to cost approximately $100 trillion worldwide by 2050 [26]. Alongside this, AMR poses many consequences and cost implications across the globe [8] [9] [27] [28].

The extensive use of antimicrobials in animals contributes to the development of resistance in human beings through the consumption of meat, milk and other animal products that contain antimicrobial residues [3] [15] [29] [30] [31]. These food-borne pathogens have become a concern to human health [30] [32]. It has been reported that there is a general misconception among poultry farmers that every sick animal needs to be given antimicrobials and that these drugs do not have side effects on animals as well as humans that consume them [33]. This highlights the possible misuse of antimicrobials among poultry farmers who have inadequate knowledge of the consequences these drugs may cause on animals and humans. Broiler chicken rearing is one of the most common businesses in Zambia while a few people keep layers and village chickens for consumption as well as selling [34].

Antimicrobial stewardship (AMS) programmes are critical in promoting the rational use of antimicrobials [35]-[43]. The AMS programmes focused on farms have been associated with a reduction in AMR in livestock [44] [45]. Alongside this, the development of Farmer Field Schools may also promote the rational use of antimicrobials and reduce AMR in poultry [46] [47]. The reduced AMR in livestock may subsequently reduce AMR in humans. Like many other countries, Zambia has also established a National Action Plan (NAP) on AMR that details a multi-sectoral approach focused on AMS for the human and animal sectors [48] [49]. This study aimed to assess the knowledge, attitude and practices (KAP) regarding antimicrobial usage (AMU) and AMR among poultry farmers in the Chimwemwe township of Kitwe district in Zambia.

2. Materials and Methods

2.1. Study Design, Site and Target Population

The study was conducted in Chimwemwe Township in Kitwe, Copperbelt province of Zambia from November to December 2021. Chimwemwe Township is a business as well as a residential area in Kitwe. The study involved all poultry farmers who reside in Chimwemwe and those selling chickens in Chimwemwe marketplaces. The target population involved poultry farmers rearing broilers, layers and village chickens.

2.2. Sample Size Estimation and Sampling Procedure

Sample size estimation was done using the Raosoft formula [50]. With an estimated 150 poultry farmers in the township, the sample size was determined with an assumption of 50% prevalence and 5% desired precision at a 95% confidence level. A sample size of 109 was estimated. Potential participants were identified through the help of veterinary assistants. A purposive sampling method was used to enroll poultry farmers in the study.

2.3. Data Collection

Data collection was done using a self-administered structured questionnaire. The questionnaires were originally written in the English language and also translated into a local language (Bemba) for some participants who were not able to respond in English. A pilot study was conducted among 15 farmers to pretest the questionnaire for face and content validity. The findings of the pilot study were not included in the analysis of the main study. The questionnaire collected data on socio-demographic characteristics (7 questions), knowledge (8 questions), attitude (4 questions), and practices (5 questions) of poultry farmers on AMU and AMR.

2.4. Data Analysis

After collecting the data, data entry was done using Microsoft Excel and exported to IBM Statistical Package for Social Sciences (SPSS) Version 26 (IBM Corporation, Armonk, New York, USA) for statistical analysis. Statistical significance was conducted at a 95% confidence level with a $p < 0.05$ considered statistically significant. To determine the knowledge, each correct answer on knowledge was given a score of one. Participants scoring 0 - 2, 3 - 4 and 5 - 8 were graded as having low, average and high knowledge respectively. To determine the attitude of the participants, each question was given a score of one for the correct answer; a zero was given allocated for the wrong answer. Responses scoring 0 - 1 were grouped as negative attitudes, whereas responses scoring 2 - 4 as positive attitudes. Practices were categorised as poor if the participants scored from 0 to 2 and good for scores from 3 to 5.

3. Results

3.1. Sociodemographic Characteristics of the Participants

A total of 106 poultry farmers participated in the study. Most of the participants were male (58.5%), and between 20 and 35 years of age (43.4%), as shown in **Table 1**. The highest level of education for most of the participants (54.7%) was secondary education, while more than half of the participants kept between 101 and 300 chickens. The majority of the participants (69.8%) kept broiler chickens with the least being keepers of layer chickens (4.7%).

3.2. Knowledge of Poultry Farmers about AMU and AMR

Overall, 90.6% of the participants knew what antimicrobials were. Additionally, 52.4% stated that antimicrobials are used to treat any kind of disease, and 54.7% knew that antimicrobials could produce unwanted effects if misused (**Table 2**).

3.3. Overall Knowledge of Farmers Concerning AMU and AMR

Most (46.2%) of the poultry farmers had low knowledge of AMU and AMR (**Figure 1**).

3.4. Sources of Farmers' Information on AMU and AMR

Most poultry farmers' sources of information regarding AMU and AMR were from school (60.7%) and the internet (53.6%) (**Figure 2**).

3.5. Association of Knowledge and the Demographic Characteristics of the Participants

Most of the participants (72.4%) who had high knowledge scores had a tertiary-

Table 1. Socio demographic information of the participants.

Variables		n (%)
Gender	Male	62 (58.5)
	Female	44 (41.5)
Age of participants (years)	<20	03 (2.8)
	20 - 35	46 (43.4)
	36 - 40	29 (27.4)
	>40	28 (26.4)
Level of education	Primary	15 (14.2)
	Secondary	58 (54.7)
	Tertiary	33 (31.1)
Main occupation	Poultry farming	36 (34.0)
	Business	47 (44.3)
	Employed	17 (16.0)
	Other (student, retired etc.)	06 (5.7)
Type of chicken kept	Broilers	74 (69.8)
	Layers	05 (4.7)
	Village chickens	11 (10.4)
	Mixed type	16 (15.1)
Number of chickens kept	1 - 50	22 (20.8)
	51 - 100	18 (17.0)
	101 - 300	54 (50.9)
	>300	12 (11.3)
Experience in poultry farming (years)	<5	33 (31.0)
	5 - 10	42 (40.0)
	>10	31 (29.0)

Table 2. Knowledge base of the participants.

Questions	Responses	n (%)
Do you know what antimicrobials are?	Yes	96 (90.6)
	No	10 (9.4)
What is the use of antimicrobials in poultry farming?	Treat any kind of disease	54 (52.4)
	Treat a specific kind of disease caused by bacteria	40 (38.8)
	To promote growth	01 (1.0)
	I don't know	08 (7.8)

Continued

Do antimicrobials have side effects if misused?	Yes	58 (54.7)
	No	01 (0.9)
	I don't know	47 (44.3)
Do you know what antimicrobial resistance is?	Yes	31 (29.2)
	No	74 (69.8)
If yes to the question above, do you know how it comes about?	Yes	24 (77.4)
	No	07 (22.6)
Can bacteria become resistant to antimicrobials?	Yes	28 (26.4)
	No	04 (3.8)
	I don't know	74 (69.8)
Is it possible for bacteria and other pathogens to be passed from chickens to humans when they consume chicken products containing them?	Yes	39 (36.8)
	No	06 (5.7)
	I don't know	61 (57.5)
Can antimicrobials be used to treat infection in humans?	Yes	70 (66)
	No	03 (2.8)
	I don't know	33 (31.2)

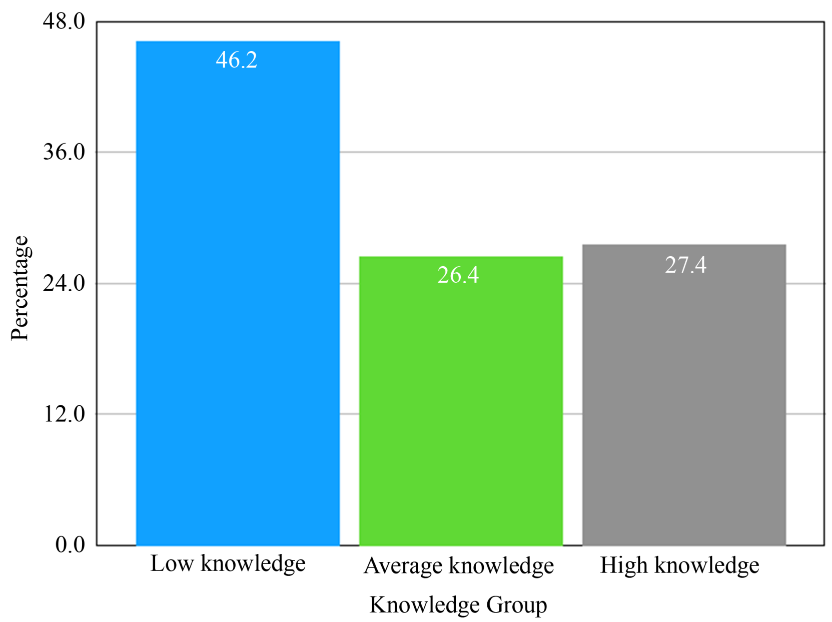

Figure 1. Knowledge of participants on AMU and AMR.

level education, while only 2% of the participants with low knowledge had achieved a tertiary-level education. The majority of entrepreneurs (60.7%) had average knowledge scores while small-scale poultry farmers had low knowledge scores (53.1%), as shown in **Table 3**. A statistically significant association was

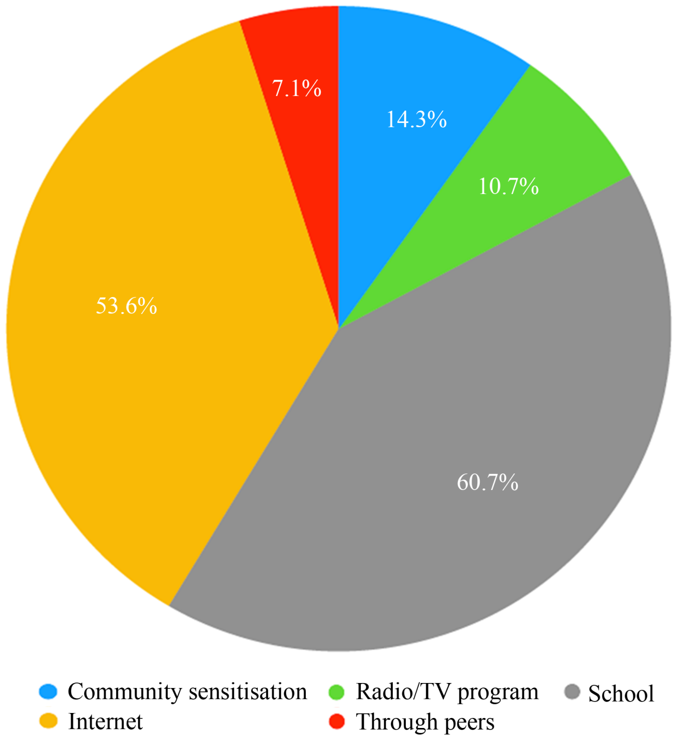

Figure 2. Sources of information for the participants.

Table 3. Association between knowledge and other variables.

CORRELATES		Low knowledge	Average knowledge	High knowledge	p-value
Level of education	Primary	12 (24.5%)	2 (7.1%)	1 (3.4%)	<0.001
	Secondary	35 (71.4%)	16 (57.1%)	7 (24.1%)	
	Tertiary	2 (4.1%)	10 (35.7%)	21 (72.4%)	
Primary occupation	Poultry farming	26 (53.1%)	4 (14.3%)	6 (20.7%)	<0.001
	Entrepreneur	20 (40.8%)	17 (60.7%)	10 (35.4%)	
	Employed	2 (4.1%)	6 (21.4%)	9 (31.0%)	
	Student	1 (2.0%)	1 (3.6%)	4 (13.8%)	
Gender	Male	26 (53.1%)	20 (71.4%)	16 (55.2%)	0.265
	Female	23 (46.9%)	8 (28.6%)	13 (44.8%)	
Poultry farming experience	<5 years	13 (26.5%)	5 (17.9%)	15 (51.7%)	0.050
	5 - 10 years	20 (40.8%)	15 (53.6%)	7 (24.1%)	
	>10 years	16 (32.7%)	8 (28.6%)	7 (24.1%)	
Type of chicken	Broilers	36 (73.5%)	20 (71.4%)	18 (62.1%)	0.887
	Layers	2 (4.1%)	2 (7.1%)	1 (3.4%)	
	Village chicken	5 (10.2%)	2 (7.1%)	4 (13.8%)	
	Mixture	6 (12.2%)	4 (14.3%)	6 (20.7%)	

found between knowledge levels and the participant's level of education ($p < 0.001$) as well as between knowledge levels and the primary occupation of the participants ($p < 0.001$), as shown in Table 3. However, other factors showed statistically insignificant associations as shown in Table 3.

3.6. Attitudes of Poultry Farmers toward AMU and AMR

Most (70.8%) poultry farmers did not know that AMR is a public health problem that should be prevented. Interestingly, almost two-thirds (64.2%) thought that it was important to consult veterinarians when chickens are sick and before administering any medicines (Table 4).

3.7. Overall Attitudes of Participants toward AMU and AMR

Most of the participants (71.7%) had negative attitudes towards AMU and AMR (Figure 3).

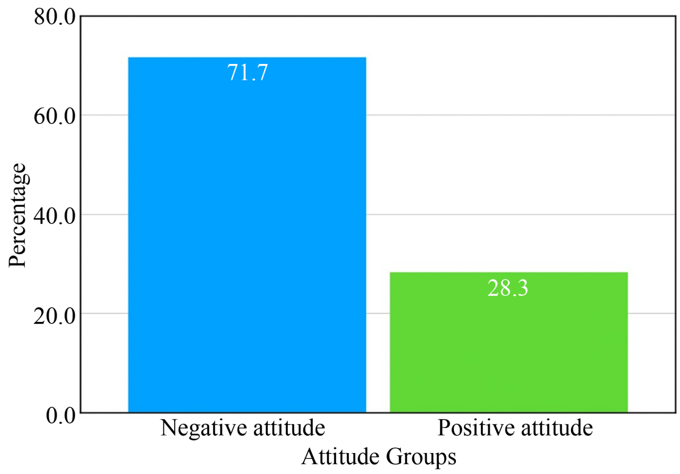

Figure 3. Attitudes of poultry farmers on AMU and AMR.

Table 4. Attitude of poultry farmers towards AMU and AMR.

Questions	Responses	n (%)
Do you think AMR is a public health problem that should be prevented?	Yes	28 (26.4)
	No	03 (2.8)
	I don't know	75 (70.8)
If yes in the question above, do you take any precautions to prevent the development of AMR?	Yes	21 (75.0)
	No	07 (25.0)
Do you think it is important to get consultations from a veterinarian whenever the chickens are sick and before administering medication?	Yes	68 (64.2)
	No	3 (2.8)
	I don't know	35 (33.0)
Do you think poultry farmers have a key role to play in the development of AMR in chickens?	Yes	30 (28.3)
	No	01 (0.9)
	I don't know	75 (70.8)

Most of the participants with low knowledge scores had negative attitudes, while those with high knowledge scores had positive attitudes ($p < 0.001$) (Table 5).

Table 5. Association between the level of knowledge and attitude scores.

Correlates	Low knowledge	Average knowledge	High knowledge	p-value
Negative attitude	47 (95.9%)	28 (100%)	1 (3.4%)	<0.001
Positive attitude	02 (4.1%)	0	28 (96.6%)	

3.8. Practices of Poultry Farmers Regarding AMU and AMR

The majority of participants (83%) admitted to using antimicrobials. The majority of the participants obtained their antimicrobials from an agrovet shop (87.8%) while a few (10%) bought them from a pharmacy. The main reason given for the use of antimicrobials by most poultry farmers was to treat (93.2%) and prevent (89.8%) diseases while a few used them for growth promotion (19.3%), as shown in Table 6. Only 70% of the participants consulted on the type of drugs and dosages before administering them to the chicken. Among these, 23.1% consulted a veterinarian while 46.3% followed the manufacturer's instructions.

3.9. Overall Practices of Participants toward AMU and AMR

The majority of the participants (61.3%) had poor practices regarding AMU and AMR (Figure 4).

3.10. Commonly Used Antimicrobials in Poultry

The commonly used antimicrobials in poultry were oxytetracycline (86.4%) followed by gentamicin/doxycycline (gentadox) (35.2%), and sulfadimidine (18.2%) as shown in Figure 5.

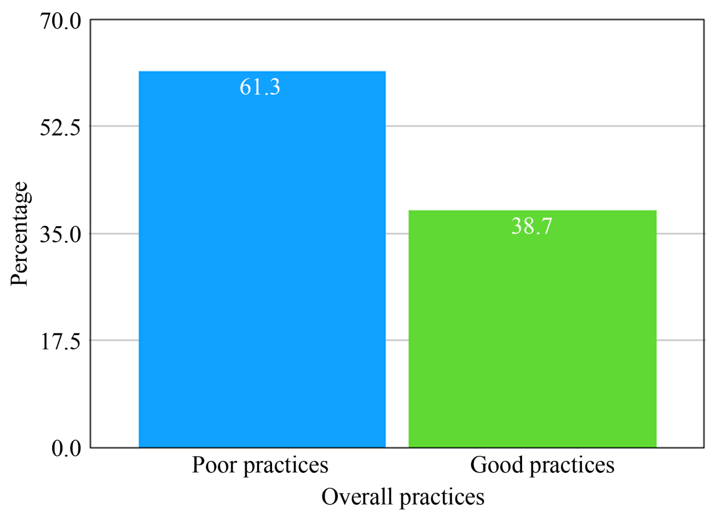

Figure 4. Overall practices of participants regarding AMU and AMR.

Table 6. Practices of participants regarding AMU and AMR.

Questions	Responses	n (%)
Do you administer antimicrobials to your chicken?	Yes	88 (83)
	No	09 (8.5)
	I don't know	09 (8.5)
If yes, why do you administer antimicrobials?	To treat disease	82 (93.2)
	To prevent disease	79 (89.8)
	Growth promotion	17 (19.3)
Do you get consultations on the type of drugs and dosages before they are administered to the chicken?	Yes	67 (70)
	No	29 (30)
If yes, what is your source of consultation?	A veterinarian	28 (23.1)
	Follow the manufacturer's instructions	56 (46.3)
	Shop attendant/seller	12 (9.9)
	Friends/Peers	25 (20.7)
Where do you usually buy the antimicrobials used for chickens?	A veterinarian	02 (2.2)
	An agrovet shop	79 (87.8)
	Pharmacy	9 (10.0)

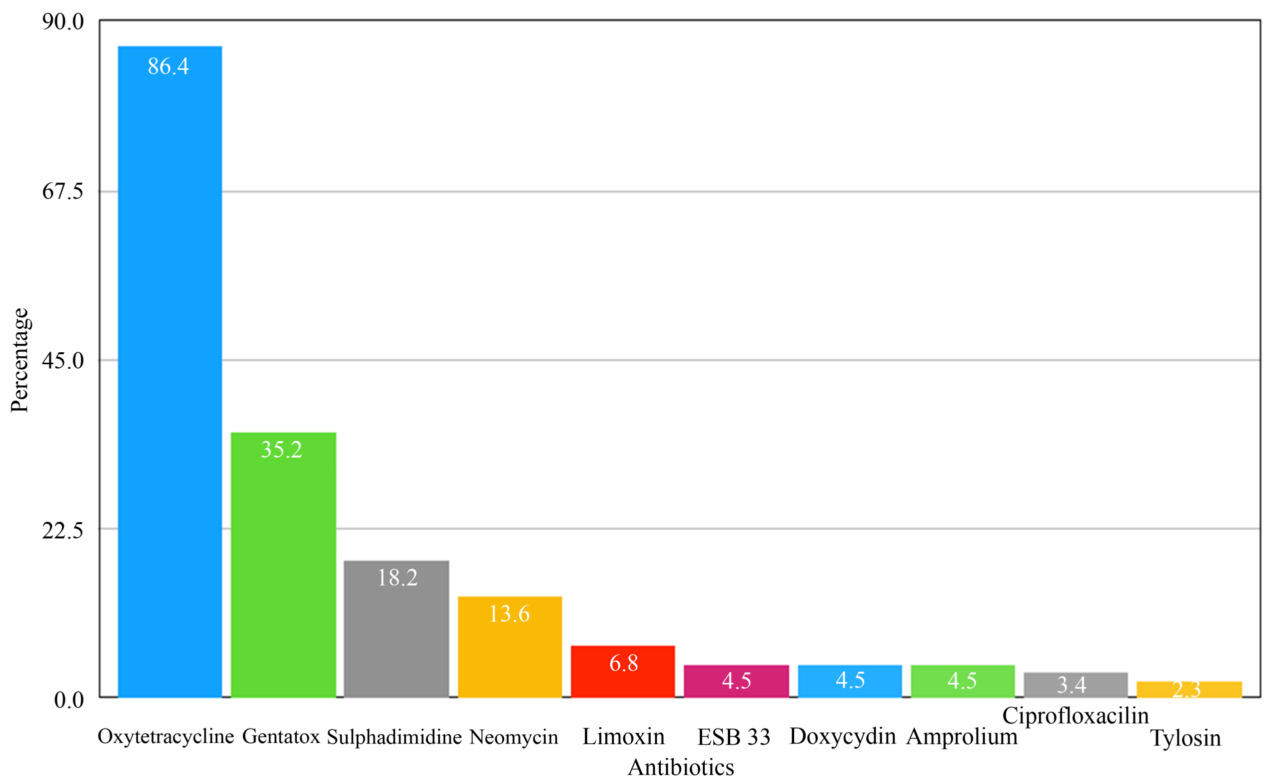

Figure 5. Antimicrobials commonly used in poultry.

4. Discussion

This study assessed the poultry farmer's knowledge, attitude and practices regarding AMU and AMR in Kitwe, Zambia. AMR resistance is a growing global public health concern. This study found a low awareness (29.2%) of AMR, low knowledge (46.2%) of AMU and AMR, negative attitude, and poor practices towards AMU and AMR. Additionally, the use of antimicrobials was found to be 83% with oxytetracycline being the most dispensed.

Overall, the current study found that most poultry farmers had low knowledge of AMU and AMR. These findings are similar to reports from Cameroon where poultry farmers had low knowledge of AMU and AMR [51]. The low knowledge scores in the current study show that there is a knowledge gap among the majority of poultry farmers. Subsequently, this may result in the irrational use of antimicrobials because poultry farmers do not know the consequences that these drugs may produce when used inappropriately. The implications of poultry farmers having low knowledge of AMU and AMR is that they may tend to use antimicrobials inappropriately and worsen AMR [33]. Hence, there is a need for these poultry farmers to be sensitised regarding correct AMU and AMR.

This study revealed that the majority of the participants (90.6%) knew what antimicrobials are but only 31% of the participants knew AMR. An earlier study by Mudenda and colleagues also revealed low awareness of AMR among layer poultry farmers in Zambia [52]. These findings correspond with a study done in Sudan where only 30% of poultry farmers interviewed knew about AMR [9]. Another study which was done in Malaysia also revealed that the majority of poultry farmers had low knowledge of AMR and how it can affect public health [33]. In Peru, similar findings were reported where the farm workers had low awareness of AMR [53]. The low awareness of AMR among poultry farmers calls for improved educational interventions and the strengthening of antimicrobial stewardship programmes.

Our study found that 52% of poultry farmers believed that antimicrobials could be used to treat any disease, and only 40% responded that they are used to treat specific infections caused by bacteria. The findings are similar to those reported by Geta and Kibret [5]. The findings are a source of concern because poultry farmers will misuse antimicrobials for any illness including viral infections. This was also evidenced by a study conducted by Mpundu and colleagues regarding AMR in poultry [54]. Another study by Moffo *et al.* 2020 found a low mean knowledge score, desirable attitude and appropriate practice towards AMU and AMR [51]. Our study found that 54% of the participants reported that antimicrobials could have side effects if misused. A study in Malaysia reported similar findings in which most poultry farmers responded that antimicrobials have side effects [33].

A significant relationship was found between the knowledge level and the level of education as well as the primary occupation of the poultry farmers. Most poultry farmers who attained tertiary education generally had high knowledge scores. This could be attributed to the fact that participants of the tertiary level and some from the secondary level may have learned about AMU and AMR or may have read about the same. A study done in Sudan had similar findings that attributed the lack of knowledge to the low level of education of the participants [55]. A similar correlation was found in Ethiopia where farmers who had low education had significantly low knowledge scores on AMR [5]. Furthermore, in this current study, other factors such as poultry farming experience and age did not have a significant relationship with the knowledge levels. This entails that from the sampled population, regardless of their experience in poultry farming, the majority had very low knowledge regarding AMR. Conversely, a study done in Ethiopia earlier reported that older farmers had more knowledge of AMR and this was attributed to more years of hands-on experience as compared to the younger age groups [5]. However, the reason for this difference could not be established with certainty due to a lack of supporting evidence.

According to this current study, most participants had negative attitudes towards AMU and AMR. Most of the participants in our study did not know that AMR is a global public health problem that should be prevented and did not know that poultry farmers play a critical role in its development. This corroborates findings from other studies where the majority of farmers had a negative attitude towards AMR [51] [56] [57] [58]. This poor attitude towards AMR could be attributed to low knowledge levels among these farmers, as shown in this study and similar studies. Our study further revealed a significant relationship between the knowledge levels and the attitude of poultry farmers towards AMU and AMR. Participants with high knowledge scores generally had positive attitudes. This is similar to a study that was done in Bangladesh, which showed that the level of farmers' knowledge influenced the attitude of the poultry farmers towards AMU and AMR [56]. This suggests that the participants' knowledge directly affects the poultry farmers' attitudes, ultimately affecting the usage of antimicrobials and related practices. It is therefore prudent that educational programs are put in place to train these farmers on AMU and AMR. With improved knowledge, most of these farmers would be cautious in their usage of antimicrobials and contribute to a reduction in AMR.

Overall, our study revealed that most participants had poor practices regarding AMU and AMR similar to findings from a study in Cambodia [58]. Further, 83% of the participants in our study reported that they administered antimicrobials to their chickens for treatment (93.2%), prevention (89.8%), and growth promotion (19.3%). The high use of antimicrobials in poultry was also reported in Nigeria [59]. In a study done in Vietnam, 84% of poultry farmers reported using antimicrobials for prophylactic rather than therapeutic purposes [60]. Similarly, high use (83.3%) of antimicrobials in poultry was reported in Grenada [61]. In Bangladesh, some poultry farmers also use antimicrobials for disease prevention and growth promotion [62]. Using antimicrobials to prevent diseases could contribute to the worsening of AMR. AMR can develop due to antibiotic selective pressure, where bacteria undergo specific genetic changes that enable the bacteria to survive in the presence of antimicrobials [63].

Our study found that most poultry farmers accessed antimicrobials from agrovets (87.8%), while few (10%) bought from a pharmacy. Only a few (23.1%) participants consulted a veterinarian while the majority depended on the manufacturer's instructions (46.3%). This is similar to a study in Bangladesh that revealed that most poultry farmers obtained antimicrobials from feed sellers and the majority did not consult veterinarians [56]. In Nigeria, poultry farmers did not consult veterinarians on the type of drug and dosages due to economic reasons [64]. In Fiji, the poultry farmers did not consult veterinarians concerning AMU in poultry because they were dissatisfied with previous services that were offered by veterinary officers from the government [39].

The most commonly used antimicrobials from this current study were tetracycline (86.4%), followed by gentamicin (35.2%). This is in line with recent studies in Zambia which showed that tetracycline and gentamicin/doxycycline were highly dispensed in community pharmacies and used in poultry farms [52] [65]. Similarly, these findings are consistent with a study that was done in Bangladesh which reported tetracycline as one of the most commonly used antimicrobials by poultry farmers [56]. A study done in Ethiopia also found that tetracycline was the most commonly used antibiotic by animal farmers on their livestock including chickens, followed by ciprofloxacin, ampicillin and gentamycin [5]. Similarly, a study that was done in Nigeria also found tetracycline and gentamicin as the commonly used antimicrobials among poultry farmers and this was attributed to the drugs being readily available and cheap [64]. The overuse of tetracyclines in the veterinary sector increases the risk of AMR according to findings from Tanzania [66] and Iran [67]. Further reports have indicated that the overuse of tetracyclines in poultry has contributed to the resistance of microbes to these antimicrobials [68] [69] [70]. Conversely, the most used antibiotic in China was amoxicillin [71] and Thailand [72]. The above findings show variability in the usage of antimicrobials in poultry. There is a need for poultry farmers to consult veterinary professionals on poultry diseases and AMU.

Strengths and Limitations of the Study

The findings of this study provide an idea of the information on AMU and AMR among poultry farmers in Kitwe. However, since it was conducted in one township, the findings cannot be generalized to the rest of the country. Besides, the nature of cross-sectional studies cannot predict the outcomes of a survey or any possible interventions.

5. Conclusion

This study revealed that there was high antibiotic use in poultry among farmers of Chimwemwe township for prophylaxis and treatment of diseases, with tetracycline being the most used drug. Consequently, there was low knowledge, negative attitude, and poor practices concerning AMU and AMR among most poultry farmers. There is a need to set up antimicrobial stewardship programmes, and antimicrobial surveillance systems and sensitise farmers to curb this fast-growing problem. This may ensure food safety and public health.

Acknowledgements

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Ethical Approval

Ethical approval was granted by the Tropical Diseases Research Centre (TDRC) with an approval number of TRC/C4/10/2021. Further approval was obtained from the National Health Research Authority with an approval number of NHRA0000007/20/2021. Participation in the study was voluntary after providing informed consent.

Conflicts of Interest

All authors declare no conflict of interest.

References

[1] Purssell, E. (2020) Antimicrobials. In: Hood, P. and Khan, E., Eds., *Understanding Pharmacology in Nursing Practice*, Springer, Cham, 147-165. https://link.springer.com/chapter/10.1007/978-3-030-32004-1_6 https://doi.org/10.1007/978-3-030-32004-1_6

[2] Paterson, I.K., Hoyle, A., Ochoa, G., Baker-Austin, C. and Taylor, N.G.H. (2016) Optimising Antibiotic Usage to Treat Bacterial Infections. *Scientific Reports*, **6**, Article No. 37853. https://www.nature.com/articles/srep37853 https://doi.org/10.1038/srep37853

[3] Agyare, C., Etsiapa Boamah, V., Ngofi Zumbi, C. and Boateng Osei, F. (2018) Antibiotic Use in Poultry Production and Its Effects on Bacterial Resistance. In: Kumar, Y., Ed., *Antimicrobial Resistance-A Global Threat*, Intech Open, London, 33-51. https://www.intechopen.com/chapters/62553 https://doi.org/10.5772/intechopen.79371

[4] Gupta, C.L., Blum, S.E., Kattusamy, K., Daniel, T., Druyan, S., Shapira, R., *et al.* (2021) Longitudinal Study on the Effects of Growth-Promoting and Therapeutic Antibiotics on the Dynamics of Chicken Cloacal and Litter Microbiomes and Resistomes. *Microbiome*, **9**, Article No. 178. https://microbiomejournal.biomedcentral.com/articles/10.1186/s40168-021-01136-4 https://doi.org/10.1186/s40168-021-01136-4

[5] Geta, K. and Kibret, M. (2021) Knowledge, Attitudes and Practices of Animal Farm Owners/Workers on Antibiotic Use and Resistance in Amhara Region, Northwestern Ethiopia. *Scientific Reports*, **11**, Article No. 21211. https://www.nature.com/articles/s41598-021-00617-8 https://doi.org/10.1038/s41598-021-00617-8

[6] Van Boeckel, T.P., Brower, C., Gilbert, M., Grenfell, B.T., Levin, S.A., Robinson, T.P., *et al.* (2015) Global Trends in Antimicrobial Use in Food Animals. *Proceedings of the National Academy of Sciences of the United States of America*, **112**, 5649-5654. https://doi.org/10.1073/pnas.1503141112

[7] Pham-Duc, P., Cook, M.A., Cong-Hong, H., Nguyen-Thuy, H., Padungtod, P., Nguyen-Thi, H., *et al.* (2019) Knowledge, Attitudes and Practices of Livestock and Aquaculture Producers Regarding Antimicrobial Use and Resistance in Vietnam. *PLOS ONE*, **14**, e0223115. https://doi.org/10.1371/journal.pone.0223115 https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0223115

[8] Dadgostar, P. (2019) Antimicrobial Resistance: Implications and Costs. *Infection and Drug Resistance*, **12**, 3903-3910. https://doi.org/10.2147/IDR.S234610

[9] Prestinaci, F., Pezzotti, P. and Pantosti, A. (2015) Antimicrobial Resistance: A Global Multifaceted Phenomenon. *Pathogens and Global Health*, **109**, 309-318. https://doi.org/10.1179/2047773215Y.0000000030

[10] Jasovský, D., Littmann, J., Zorzet, A. and Cars, O. (2016) Antimicrobial Resistance—A Threat to the World's Sustainable Development. *Upsala Journal of Medical Sciences*, **121**, 159-164. https://pubmed.ncbi.nlm.nih.gov/27416324/ https://doi.org/10.1080/03009734.2016.1195900

[11] Tembo, N., Mudenda, S., Banda, M., Chileshe, M. and Matafwali, S. (2022) Knowledge, Attitudes and Practices on Antimicrobial Resistance among Pharmacy Personnel and Nurses at a Tertiary Hospital in Ndola, Zambia: Implications for Antimicrobial Stewardship Programmes. *JAC-Antimicrobial Resist*, **4**, dlac107. https://academic.oup.com/jacamr/article/4/5/dlac107/6754768 https://doi.org/10.1093/jacamr/dlac107

[12] Llor, C. and Bjerrum, L. (2014) Antimicrobial Resistance: Risk Associated with Antibiotic Overuse and Initiatives to Reduce the Problem. *Therapeutic Advances in Drug Safety*, **5**, 229-241. https://doi.org/10.1177/2042098614554919 https://journals.sagepub.com/doi/10.1177/2042098614554919

[13] Murray, C.J., Ikuta, K.S., Sharara, F., Swetschinski, L., Robles Aguilar, G., Gray, A., *et al.* (2022) Global Burden of Bacterial Antimicrobial Resistance in 2019: A Systematic Analysis. *Lancet*, **399**, 629-655. https://doi.org/10.1016/S0140-6736(21)02724-0 http://www.thelancet.com/article/S0140673621027240/fulltext

[14] Mehdi, Y., Létourneau-Montminy, M.-P., Gaucher, M.-L., Chorfi, Y., Suresh, G., Rouissi, T., *et al.* (2018) Use of Antibiotics in Broiler Production: Global Impacts and Alternatives. *Animal Nutrition*, **4**, 170-178. https://doi.org/10.1016/j.aninu.2018.03.002

[15] Woolhouse, M., Ward, M., Van Bunnik, B. and Farrar, J. (2015) Antimicrobial Resistance in Humans, Livestock and the Wider Environment. *Philosophical Transactions of the Royal Society B: Biological Sciences*, **370**, Article ID: 20140083. https://doi.org/10.1098/rstb.2014.0083

[16] Ayukekbong, J.A., Ntemgwa, M. and Atabe, A.N. (2017) The Threat of Antimicrobial Resistance in Developing Countries: Causes and Control Strategies. *Antimicrobial Resistance and Infection Control*, **6**, Article No. 47. https://doi.org/10.1186/s13756-017-0208-x

[17] Jindal, A.K., Pandya, K. and Khan, I.D. (2015) Antimicrobial Resistance: A Public Health Challenge. *Medical Journal Armed Forces India*, **71**, 178-181. https://doi.org/10.1016/j.mjafi.2014.04.011

[18] Ventola, C.L. (2015) The Antibiotic Resistance Crisis: Part 1: Causes and Threats. *Pharmacology & Therapeutics*, **40**, 277-283.

[19] Mudenda, S., Mukela, M., Matafwali, S., Banda, M., Mutati, R.K., Muungo, L.T., *et al.* (2022) Knowledge, Attitudes, and Practices towards Antibiotic Use and Antimicrobial Resistance among Pharmacy Students at the University of Zambia: Implica-

tions for Antimicrobial Stewardship Programmes. *Scholars Academic Journal of Pharmacy*, **11**, 117-124. https://doi.org/10.36347/sajp.2022.v11i08.002

[20] Zulu, A., Matafwali, S.K., Banda, M. and Mudenda, S. (2020) Assessment of Knowledge, Attitude and Practices on Antibiotic Resistance among Undergraduate Medical Students in the School of Medicine at the University of Zambia. *International Journal of Basic & Clinical Pharmacology*, **9**, 263-270. https://doi.org/10.18203/2319-2003.ijbcp20200174

[21] Banda, O., Vlahakis, P.A., Daka, V. and Matafwali, S.K. (2021) Self-Medication among Medical Students at the Copperbelt University, Zambia: A Cross-Sectional study. *Saudi Pharmaceutical Journal*, **29**, 1233-1237. https://pubmed.ncbi.nlm.nih.gov/34819784/ https://doi.org/10.1016/j.jsps.2021.10.005

[22] Kalonga, J., Hangoma, J., Banda, M., Munkombwe, D. and Mudenda, S. (2020) Antibiotic Prescribing Patterns in Paediatric Patients at Levy Mwanawasa University Teaching Hospital in Lusaka, Zambia. *International Journal of Pharmaceutics & Pharmacology*, **4**, 1-9. https://doi.org/10.31531/2581-3080.1000138 https://1library.net/document/yn44611z-antibiotic-prescribing-patterns-paediatric-patients-mwanawasa-university-teaching.html

[23] Mudenda, S., Hankombo, M., Saleem, Z., Sadiq, M.J., Banda, M., Munkombwe, D., *et al.* (2021) Knowledge, Attitude, and Practices of Community Pharmacists on Antibiotic Resistance and Antimicrobial Stewardship in Lusaka, Zambia. *Journal of Biomedical Research & Environmental Sciences*, **2**, 1005-1014. https://doi.org/10.37871/jbres1343

[24] Al-Taani, G.M., Karasneh, R.A., Al-Azzam, S., Shaman, M.B., Jirjees, F., *et al.* (2022) Knowledge, Attitude, and Behavior about Antimicrobial Use and Resistance among Medical, Nursing and Pharmacy Students in Jordan: A Cross-Sectional Study. *Antibiotics*, **11**, Article 1559. https://www.mdpi.com/2079-6382/11/11/1559/htm https://doi.org/10.3390/antibiotics11111559

[25] Miyano, S., Htoon, T.T., Nozaki, I., Pe, E.H. and Tin, H.H. (2022) Public Knowledge, Practices, and Awareness of Antibiotics and Antibiotic Resistance in Myanmar: The First National Mobile Phone Panel Survey. *PLOS ONE*, **17**, e0273380. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0273380 https://doi.org/10.1371/journal.pone.0273380

[26] Jonas, O.B., Irwin, A., Berthe, F.C.J., Le Gall, F.G. and Marquez, P.V. (2017) Drug-Resistant Infections: A Threat to Our Economic Future (Vol. 2): Final Report (English). World Bank Group, Washington, D.C. http://documents.worldbank.org/curated/en/323311493396993758/final-report

[27] Lambraki, I.A., Cousins, M., Graells, T., Leger, A., Henriksson, P., Harbarth, S., *et al.* (2022) Factors Influencing Antimicrobial Resistance in the European Food System and Potential Leverage Points for Intervention: A Participatory, One Health Study. *PLOS ONE*, **17**, e0263914. https://doi.org/10.1371/journal.pone.0263914 https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0263914

[28] Ström, G., Boqvist, S., Albihn, A., Fernström, L.L., Andersson Djurfeldt, A., Sokerya, S., *et al.* (2018) Antimicrobials in Small-Scale Urban Pig Farming in a Lower Middle-Income Country—Arbitrary Use and high Resistance Levels. *Antimicrobial Resistance & Infection Control*, **7**, Article No. 35. https://doi.org/10.1186/s13756-018-0328-y

[29] Wee, B.A., Muloi, D.M. and Van Bunnik, B.A.D. (2020) Quantifying the Transmission of Antimicrobial Resistance at the Human and Livestock Interface with Genomics. *Clinical Microbiology and Infection*, **26**, 1612-1616.

https://doi.org/10.1016/j.cmi.2020.09.019

[30] Muloi, D., Ward, M.J., Pedersen, A.B., Fèvre, E.M., Woolhouse, M.E.J. and Van Bunnik, B.A.D. (2018) Are Food Animals Responsible for Transfer of Antimicrobial-Resistant Escherichia Coli or Their Resistance Determinants to Human Populations? A Systematic Review. *Foodborne Pathogens and Disease*, **15**, 467-474. https://doi.org/10.1089/fpd.2017.2411

[31] Azabo, R., Mshana, S., Matee, M. and Kimera, S.I. (2022) Antimicrobial Usage in Cattle and Poultry Production in Dar es Salaam, Tanzania: Pattern and Quantity. *BMC Veterinary Research*, **18**, Article No. 7. https://bmcvetres.biomedcentral.com/articles/10.1186/s12917-021-03056-9 https://doi.org/10.1186/s12917-021-03056-9

[32] Usha, P.T.A., Jose, S. and Nisha, A.R. (2010) Antimicrobial Drug Resistance—A Global Concern. *Veterinary World*, **3**, 138-139. https://www.veterinaryworld.org/

[33] Sadiq, M.B., Syed-Hussain, S.S., Ramanoon, S.Z., Saharee, A.A., Ahmad, N.I., Noraziah, M.Z., *et al.* (2018) Knowledge, Attitude and Perception Regarding Antimicrobial Resistance and Usage among Ruminant Farmers in Selangor, Malaysia. *Preventive Veterinary Medicine*, **156**, 76-83. https://doi.org/10.1016/j.prevetmed.2018.04.013

[34] Munang'andu, H.M., Kabilika, S.H., Chibomba, O., Munyeme, M. and Muuka, G.M. (2012) Bacteria Isolations from Broiler and Layer Chicks in Zambia. *Journal of Pathogens*, **2012**, Article ID: 520564. https://doi.org/10.1155/2012/520564

[35] Hsia, Y., Lee, B.R., Versporten, A., Yang, Y., Bielicki, J., Jackson, C., *et al.* (2019) Use of the WHO Access, Watch, and Reserve Classification to Define Patterns of Hospital Antibiotic Use (AWaRe): An Analysis of Paediatric Survey Data from 56 Countries. *Lancet Glob Heal*, **7**, e861-e871. https://www.global-pps.com/

[36] Kimbowa, I.M., Eriksen, J., Nakafeero, M., Obua, C., Lundborg, C.S., Kalyango, J., *et al.* (2022) Antimicrobial Stewardship: Attitudes and Practices of Healthcare Providers in Selected Health Facilities in Uganda. *PLOS ONE*, **17**, e0262993. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0262993 https://doi.org/10.1371/journal.pone.0262993

[37] Rizvi, T., Thompson, A., Williams, M. and Zaidi, S.T.R. (2018) Perceptions and Current Practices of Community Pharmacists Regarding Antimicrobial Stewardship in Tasmania. *International Journal of Clinical Pharmacy*, **40**, 1380-1387. https://doi.org/10.1007/s11096-018-0701-1

[38] Ogunnigbo, O., Nabiryo, M., Atteh, M., Muringu, E., Olaitan, O.J., Rutter, V., *et al.* (2022) Exploring the Antimicrobial Stewardship Educational Needs of Healthcare Students and the Potential of an Antimicrobial Prescribing App as an Educational Tool in Selected African Countries. *Antibiotics*, **11**, Article 691. https://www.mdpi.com/2079-6382/11/5/691/htm https://doi.org/10.3390/antibiotics11050691

[39] Khan, X., Lim, R.H.M., Rymer, C. and Ray, P. (2022) Fijian Farmers' Attitude and Knowledge towards Antimicrobial Use and Antimicrobial Resistance in Livestock Production Systems-A Qualitative Study. *Frontiers in Veterinary Science*, **9**, Article 898737. https://www.frontiersin.org/articles/10.3389/fvets.2022.898737/full https://doi.org/10.3389/fvets.2022.838457

[40] Khan, X., Rymer, C., Ray, P. and Lim, R. (2021) Quantification of Antimicrobial Use in Fijian Livestock Farms. *One Health*, **13**, Article ID: 100326. https://doi.org/10.1016/j.onehlt.2021.100326

[41] Mudenda, S., Chomba, M., Chabalenge, B., Hikaambo, C.N., Banda, M., Daka, V., *et al.* (2022) Antibiotic Prescribing Patterns in Adult Patients According to the WHO

AWaRe Classification: A Multi-Facility Cross-Sectional Study in Primary Healthcare Hospitals in Lusaka, Zambia. *Pharmacology & Pharmacy*, **13**, 379-392. http://www.scirp.org/journal/PaperInformation.aspx?PaperID=120529 https://doi.org/10.4236/pp.2022.1310029

[42] Aidara-Kane, A., Angulo, F.J., Conly, J., Minato, Y., Silbergeld, E.K., McEwen, S.A., *et al.* (2018) WHO Guidelines on Use of Medically Important Antimicrobials in Food-Producing Animals. *Antimicrobial Resistance & Infection Control*, **7**, Article 7. https://doi.org/10.1186/s13756-017-0294-9

[43] Godman, B., Egwuenu, A., Haque, M., Malande, O.O., Schellack, N., Kumar, S., *et al.* (2021) Strategies to Improve Antimicrobial Utilization with a Special Focus on Developing Countries. *Life*, **11**, Article 528. https://doi.org/10.3390/life11060528 https://pubmed.ncbi.nlm.nih.gov/34200116/

[44] Patel, S.J., Wellington, M., Shah, R.M. and Ferreira, M.J. (2020) Antibiotic Stewardship in Food-Producing Animals: Challenges, Progress, and Opportunities. *Clinical Therapeutics*, **42**, 1649-1658. https://pubmed.ncbi.nlm.nih.gov/32819723/ https://doi.org/10.1016/j.clinthera.2020.07.004

[45] Levy, S. (2014) Reduced Antibiotic Use in Livestock: How Denmark Tackled Resistance. *Environmental Health Perspectives*, 122, A160-A165. https://doi.org/10.1289/ehp.122-A160

[46] Caudell, M.A., Kiambi, S., Afakye, K., Koka, E., Kabali, E., Kimani, T., *et al.* (2022) Social-Technical Interventions to Reduce Antimicrobial Resistance in Agriculture: Evidence from Poultry Farmer Field Schools in Ghana and Kenya. *JAC-Antimicrobal Resistance*, **4**, dlab193. https://doi.org/10.1093/jacamr/dlab193 https://pubmed.ncbi.nlm.nih.gov/35156026/

[47] Waddington, H., Snilstveit, B., Hombrados, J., Vojtkova, M., Phillips, D., Davies, P., *et al.* (2014) Farmer Field Schools for Improving Farming Practices and Farmer Outcomes: A Systematic Review. *Campbell Systematic Reviews*, **10**, i-335. https://onlinelibrary.wiley.com/doi/full/10.4073/CSR.2014.6 https://doi.org/10.4073/CSR.2014.6

[48] Kapona, O. (2017) Zambia Successfully Launches the First Multi-Sectoral National Action Plan on Antimicrobial Resistance (AMR). *Health Press Zambia Bull*, **1**, 5-7. https://www.flemingfund.org/wp-content/uploads/ec74b8a828168c148bcba3700ace7989.pdf

[49] Government of the Republic of Zambia (2017) Multi-Sectoral National Action Plan on Antimicrobial Resistanc. https://www.afro.who.int/sites/default/files/2018-08/ZNPHI Document.pdf

[50] Raosoft (2012) Sample Size Calculator. http://www.raosoft.com/samplesize.html

[51] Moffo, F., Mouliom Mouiche, M.M., Kochivi, F.L., Dongmo, J.B., Djomgang, H.K., Tombe, P., *et al.* (2020) Knowledge, Attitudes, Practices and Risk Perception of Rural Poultry Farmers in Cameroon to Antimicrobial Use and Resistance. *Preventive Veterinary Medicine*, **182**, Article ID: 105087. https://pubmed.ncbi.nlm.nih.gov/32726706/ https://doi.org/10.1016/j.prevetmed.2020.105087

[52] Mudenda, S., Malama, S., Munyeme, M., Hang'ombe, B.M., Mainda, G., Kapona, O., *et al.* (2022) Awareness of Antimicrobial Resistance and Associated Factors among Layer Poultry Farmers in Zambia: Implications for Surveillance and Antimicrobial Stewardship Programs. *Antibiotics*, **11**, Article 383. https://pubmed.ncbi.nlm.nih.gov/35326846/ https://doi.org/10.3390/antibiotics11030383

[53] Dávalos-Almeyda, M., Guerrero, A., Medina, G., Dávila-Barclay, A., Salvatierra, G., Calderón, M., *et al.* (2022) Antibiotic Use and Resistance Knowledge Assessment of Personnel on Chicken Farms with High Levels of Antimicrobial Resistance: A Cross-Sectional Survey in Ica, Peru. *Antibiotics*, **11**, Article 190. https://pubmed.ncbi.nlm.nih.gov/35203794/ https://doi.org/10.3390/antibiotics11020190

[54] Mpundu, P., Muma, J.B., Mukubesa, A.N., Kainga, H., Mudenda, S., Bumbangi, F.N., *et al.* (2022) Antibiotic Resistance Patterns of Listeria Species Isolated from Broiler Abattoirs in Lusaka, Zambia. *Antibiotics*, **11**, Article 591. https://www.mdpi.com/2079-6382/11/5/591/htm https://doi.org/10.3390/antibiotics11050591

[55] Eltayb, A., Barakat, S., Marrone, G., Shaddad, S. and Lundborg, C.S. (2012) Antibiotic Use and Resistance in Animal Farming: A Quantitative and Qualitative Study on Knowledge and Practices among Farmers in Khartoum, Sudan. *Zoonoses and Public Health*, **59**, 330-338. https://pubmed.ncbi.nlm.nih.gov/22333519/ https://doi.org/10.1111/j.1863-2378.2012.01458.x

[56] Hassan, M.M., Kalam, M.A., Alim, M.A., Shano, S., Nayem, M.R.K., Badsha, M.R., *et al.* (2021) Knowledge, Attitude, and Practices on Antimicrobial Use and Antimicrobial Resistance among Commercial Poultry Farmers in Bangladesh. *Antibiotics*, **10**, Article 784. https://www.mdpi.com/2079-6382/10/7/784/htm https://doi.org/10.3390/antibiotics10070784

[57] Di Martino, G., Crovato, S., Pinto, A., Dorotea, T., Mascarello, G., Brunetta, R., *et al.* (2019) Farmers' Attitudes towards Antimicrobial Use and Awareness of Antimicrobial Resistance: A Comparative Study among Turkey and Rabbit Farmers. *Italian Journal of Animal Science*, **18**, 194-201. https://doi.org/10.1080/1828051X.2018.1504236 https://www.tandfonline.com/doi/abs/10.1080/1828051X.2018.1504236

[58] Chea, B., Kong, S., Thim, S., Ban, N., Seng, S., Fernandez-Colorado, C., *et al.* (2022) Knowledge, Attitudes, and Practices of Antimicrobial Use and Resistance among Livestock Producers in Cambodia. *Open Journal of Animal Sciences*, **12**, 454-466. http://www.scirp.org/journal/PaperInformation.aspx?PaperID=118463 https://doi.org/10.4236/ojas.2022.123034

[59] Jibril, A.H., Okeke, I.N., Dalsgaard, A. and Olsen, J.E. (2021) Association between Antimicrobial Usage and Resistance in Salmonella from Poultry Farms in Nigeria. *BMC Veterinary Research*, **17**, Article No. 234. https://doi.org/10.1186/s12917-021-02938-2 https://bmcvetres.biomedcentral.com/articles/10.1186/s12917-021-02938-2

[60] Nhung, N.T., Cuong, N.V., Campbell, J., Hoa, N.T., Bryant, J.E., Truc, V.N.T., *et al.* (2015) High Levels of Antimicrobial Resistance among Escherichia Coli Isolates from Livestock Farms and Synanthropic Rats and Shrews in the Mekong Delta of Vietnam. *Applied and Environmental Microbiology*, **81**, 812-820. https://doi.org/10.1128/AEM.03366-14

[61] Glasgow, L., Forde, M., Brow, D., Mahoney, C., Fletcher, S. and Rodrigo, S. (2019) Antibiotic Use in Poultry Production in Grenada. *Veterinary Medicine International*, **2019**, Article ID: 6785195. https://doi.org/10.1155/2019/6785195

[62] Al Masud, A., Rousham, E.K., Islam, M.A., Alam, M.U., Rahman, M., Al Mamun, A, *et al.* (2020) Drivers of Antibiotic Use in Poultry Production in Bangladesh: Dependencies and Dynamics of a Patron-Client Relationship. *Frontiers in Veterinary Science*, **7**, Article 78. https://doi.org/10.3389/fvets.2020.00078

[63] Skalet, A.H., Cevallos, V., Ayele, B., Gebre, T., Zhou, Z., Jorgensen, J.H., *et al.* (2010)

Antibiotic Selection Pressure and Macrolide Resistance in Nasopharyngeal Streptococcus Pneumoniae: A Cluster-Randomized Clinical Trial. *PLOS Medicine*, **7**, e1000377. https://pubmed.ncbi.nlm.nih.gov/21179434/ https://doi.org/10.1371/journal.pmed.1000377

[64] Al-Mustapha, A.I., Adetunji, V.O. and Heikinheimo, A. (2020) Risk Perceptions of Antibiotic Usage and Resistance: A Cross-Sectional Survey of Poultry Farmers in Kwara State, Nigeria. *Antibiotics*, **9**, Article 378. https://doi.org/10.3390/antibiotics9070378

[65] Mudenda, S., Mukosha, M., Godman, B., Fadare, J., Malama, S., Munyeme, M., *et al.* (2022) Knowledge, Attitudes and Practices of Community Pharmacy Professionals on Poultry Antimicrobial Dispensing, Use and Resistance in Zambia: Implications on Antibiotic Stewardship and WHO AWaRe Classification of Antibiotics. *Antibiotics*, **11**, Article 1210. https://www.mdpi.com/2079-6382/11/9/1210/htm https://doi.org/10.3390/antibiotics11091210

[66] Sangeda, R.Z., Baha, A., Erick, A., Mkumbwa, S., Bitegeko, A., Sillo, H.B., *et al.* (2021) Consumption Trends of Antibiotic for Veterinary Use in Tanzania: A Longitudinal Retrospective Survey From 2010-2017. *Frontiers in Tropical Diseases*, **2**, Article 694082. https://doi.org/10.3389/fitd.2021.694082

[67] Jahantigh, M., Samadi, K., Dizaji, R.E. and Salari, S. (2020) Antimicrobial Resistance and Prevalence of Tetracycline Resistance Genes in Escherichia Coli Isolated from Lesions of Colibacillosis in Broiler Chickens in Sistan, Iran. *BMC Veterinary Research*, **16**, Article No. 267. https://doi.org/10.1186/s12917-020-02488-z https://bmcvetres.biomedcentral.com/articles/10.1186/s12917-020-02488-z

[68] Granados-Chinchilla, F. and Rodríguez, C. (2017) Tetracyclines in Food and Feedingstuffs: From Regulation to Analytical Methods, Bacterial Resistance, and Environmental and Health Implications. *Journal of Analytical Methods in Chemistry. Hindawi Limited*, **2017**, Article ID: 1315497. https://doi.org/10.1155/2017/1315497

[69] Rahman, M.M., Husna, A., Elshabrawy, H.A., Alam, J., Runa, N.Y., Badruzzaman, A.T.M., *et al.* (2020) Isolation and Molecular Characterization of Multidrug-Resistant Escherichia Coli from Chicken Meat. *Scientific Reports*, **10**, Article No. 21999. https://www.nature.com/articles/s41598-020-78367-2 https://doi.org/10.1038/s41598-020-78367-2

[70] Al Azad, M.A.R., Rahman, M.M., Amin, R., Begum, M.I.A., Fries, R., Husna, A., *et al.* (2019) Susceptibility and Multidrug Resistance Patterns of Escherichia Coli Isolated from Cloacal Swabs of Live Broiler Chickens in Bangladesh. *Pathogens*, **8**, Article 118. https://www.mdpi.com/2076-0817/8/3/118/htm https://doi.org/10.3390/pathogens8030118

[71] Xu, J., Sangthong, R., McNeil, E., Tang, R. and Chongsuvivatwong, V. (2020) Antibiotic Use in Chicken Farms in Northwestern China. *Antimicrobial Resistance & Infection Control*, **9**, Article No. 10. https://doi.org/10.1186/s13756-019-0672-6 https://aricjournal.biomedcentral.com/articles/10.1186/s13756-019-0672-6

[72] Wongsuvan, G., Wuthiekanun, V., Hinjoy, S., Day, N.P. and Limmathurotsakul, D. (2018) Antibiotic Use in Poultry: A Survey of Eight Farms in Thailand. *Bulletin of the World Health Organization*, **96**, 94-100. https://doi.org/10.2471/BLT.17.195834 http://www.ncbi.nlm.nih.gov/pubmed/29403112

Data Collection Tool

Sociodemographic characteristics of participants:

1) What is your gender?

a) Male b) female

2) What is your age (years)?

a) <20 b) 21 - 35 c) 36 - 40 d) >41

3) What is your level of education?

a) Primary level b) Secondary level c) Tertiary level

4) What is your primary occupation?

a) Small scale poultry farmer b) Business man/woman c) Employed

d) Other (specify)…………………………………………………………...

5) How long have you been rearing chicken

a) <5 years b) 5 - 10 years c) >10 years

6) What type of chicken do you keep?

a) Broilers b) layers c) village chicken d) mixture

7) How many chickens do you currently have?

a) <50 b) 51 - 100 c) 101 - 300 d) >300

Knowledge questions:

8) Do you know what antimicrobials (antibiotics) are?

a) Yes b) No

9) If yes in question (11) above, what is the use of antibiotics?

a) To treat any kind of disease

b) To treat specific kinds of diseases caused by bacterial infection

c) To promote growth

d) I don't know

10) Do you think antimicrobials have unwanted effects if misused or overused?

a) Yes b) No c) I don't know

11) Do you think bacteria can become resistant to antimicrobials?

a) Yes b) No c) I don't know

12) Is it possible for bacteria and other pathogens to be passed from chicken to human beings when they consume chicken products containing them?

a) Yes b) No c) I don't know

13) Do you think antimicrobials are used to treat infection in human beings?

a) Yes b) No c) I don't know

14) Do you know what antimicrobial resistance (AMR) is?

a) Yes b) No

15) If yes in question (17) above, do you know how it comes about?

a) Yes b) No

16) If yes in question (17) above, how did you know about it?

a) Community sensitization b) Radio/Tv program c) Other (specify)……..

Attitude questions:

17) Do you think AMR is a problem that should be prevented?

a) Yes b) No c) I don't know

18) If yes in question (20) above, do you take any precautions against the development of AMR?

a) Yes b) No

19) If yes in question (21) above, what measures do you take? If any, specify……………………………………………………………………………………

20) Do you think it is important to get consultations from a veterinarian whenever the chickens are sick and before giving medication?

a) Yes, it's important

b) No, it's not important

c) I don't know

21) Do you think poultry farmers have a key role to play in the development of AMR in chickens?

a) Yes b) No c) I don't know

Antimicrobial usage/practices questions:

22) Do you administer antimicrobials to your chicken?

a) Yes b) No

23) If yes in question (25) above, why do use the antimicrobials?

□ To treat disease □ To prevent disease □ Growth promotion □ Any other (specify)…………………………….

24) Do you get consultations on the type of drug and dosages before administering it to the chicken?

a) Yes b) No

25) If yes in (27), state your source of consultation.

□ A veterinarian □ Friends □ Follow manufacturer's instructions

□ Other (specify)……………………………………………………….

26) Where do you usually buy the antimicrobials used on the chickens?

a) A veterinarian b) An agrovet shop c) Pharmacy

d) Other (specify)…………………….

27) Mention the common antibiotics used: ……………………………………

Thank you for your participation