

**FACTORS CONTRIBUTING TO AMR OCCURRENCE IN INFECTIOUS
AGENTS OF BROILER CHICKENS IN SELECTED DISTRICTS IN ZAMBIA**

BY

ROBERT MIRISHO

**A dissertation submitted to the University of Zambia in partial fulfilment of the
requirements for the award of the degree of Master of Science in Tropical Infectious
Diseases and Zoonosis (TZD)**

**The University of Zambia
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COMPLETION

I, **Robert Mirisho**, do hereby certify that this dissertation is the product of my own work and in submitting it for my Master of Science in Tropical infectious Diseases and Zoonosis, further attest that it has not been submitted to another university in part or whole for the award of any programme.

I, having supervised and read this dissertation is satisfied that this is the original work of the author whose name it is being presented. I confirm that the work has been completed satisfactorily and is ready for presentation to the examiners.

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APPROVAL

The University of Zambia, School of Veterinary Medicine approves this Dissertation of Robert Mirisho as partial fulfillment of the requirements for the award of the degree of Master of Science in Tropical infectious Diseases and Zoonosis.

Examiner I

Signature..... Date.....

Examiner II

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Examiner III

Signature Date.....

Chairperson

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DEDICATION

I dedicate this work to Jesus Christ, My Savior, Provider, and God; my family (wife and children) and relatives and friends who love me and wish me well.

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LIST OF ABBREVIATIONS

AMR:	Antimicrobials resistance
AMU:	Antimicrobial usage
CSE:	Centre for Science and Environment
GAPs	Good Agricultural Practices
GHPs	Good Hygiene Practices
GVPs	Good Veterinary Practices
LMICs:	Low Medium Income Countries (LMICs)
MDR:	Multi drug resistance
NAP:	National Action Plan
WHO:	World Health Organization
XDR	Extreme Drug Resistance
ZIARSF:	Zambia’s Integrated Antimicrobial Resistance Surveillance Framework
ZNPHI	Zambia National Public Health Institute

DEFINITION OF TERMS

Antimicrobial: A substance, such as an antibiotic, that kills or stops the growth of microbes, including bacteria, fungi, or viruses. Antimicrobials are grouped according to the microbes they act against (antibiotics, antifungals, and antivirals).

Antimicrobial resistance: the ability of microbes to grow in the presence of a chemical (drug) that would normally kill them or limit their growth.

Bacteria: Any group of microscopic single celled organisms that live in enormous numbers in almost every environment on earth.

Food borne disease: is any illness resulting from the food spoilage of contaminated food, pathogenic bacteria, viruses, or parasites that contaminate food or water that is meant for human consumption.

Isolates: Bacteria isolated from a specimen (e.g., stool, blood, food).

Microbial contamination: Inclusion or growth of harmful microorganisms such as *Clostridium botulinum* in an item used for food making it unfit for consumption.

Microbiological contamination: The non-intended or accidental introduction of infectious material like bacteria, yeast, mold, fungi, virus, prions, protozoa or their toxins and by products.

Multi drug resistance: is antimicrobial resistance shown by a species of microorganism to multiple antimicrobial drugs.

Resistance pattern: A description of the antibiotic resistance testing results for an isolate.

ABSTRACT

Antimicrobial resistance (AMR) has remained one of the growing public health problems globally. The misuse and abuse of antimicrobials in agriculture, veterinary, and human medicine have been described as major contributing factors for the emergence of AMR.

Globally, it is estimated that antimicrobial resistance (AMR) will be responsible for 10 million deaths per year by 2050 if steps are not taken immediately to combat and prevent the spread of AMR.

The aim of this study was to determine factors associated with AMR occurrence in broiler chickens in selected districts in Zambia, specifically to determine prevalence of AMR in broiler poultry from secondary data and also to analyse the factors contributing to AMR occurrence of broiler chickens in selected districts in Zambia.

The study design was cross-sectional conducted in Ndola, Kitwe, Choma, Chilanga and Kafue districts. The study population included small, medium and commercial scale broiler farmers. Both probability and non-probability sampling techniques were employed and structured questionnaires were administered for collecting the information about the risk factors of AMR of poultry farmers.

A total of 109 broilers chicken's farms were included in this study and overall AMR prevalence was 84.4% (92). In univariate analysis the variables age category, gender, marital status, sources of drinking water, electricity, poultry housing type, floor housing type, presence of drainage a system, destination of the drainage, bird population, poultry house fenced, use of protective gears, buying drugs from veterinary personnel, drug prescription when buying, drugs administered by veterinary personnel, drugs administered by an untrained farmer and administered by owner which had $P < 0.25$ were taken for further screening in the logistic model, The multivariate logistic regression model showed that gender, marital status, administration of drugs by veterinary personnel or the farmer, and the drainage destination were predictors of a broiler chicken farm having an antimicrobials resistance problem.

The Pearson Chi-square goodness-of-fit test ($p = 0.486$) showed that the model fitted the data, thus increasing its reliability in predicting AMR farm status. The Receiver-Operating characteristic Curve (ROC) analysis demonstrated that the model was good in prediction farm-AMR status (ROC=0.8). The model had relatively high sensitivity and specificity in classifying the farm as having an AMR problem or not

The high prevalence of AMR in broiler chicken suggests a greater antimicrobials use in poultry production in Zambia. Several potential risk factors for AMR identified in this study such as gender, marital status, administration of drugs by veterinary personnel or trained farmer, and the drainage destination.

Key words: Antimicrobial Resistance (AMR), Prevalence, Broiler, Poultry

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Antimicrobial resistance (AMR) has remained one of the growing public health problems globally. AMR is defined as the resistance of microorganisms to an antimicrobial against which they were originally sensitive. Though a natural evolutionary phenomenon, it is accelerated by the misuse and abuse of antimicrobials (Jindal, 2014) in agriculture, veterinary, and human medicine (Sindato et al., 2020). Modern food animal production systems often include antimicrobial agents to prevent, control, and treat bacterial infections, and these agents are commonly used as growth promoters in poultry production systems (Gardner et al., 2012). The burden of AMR is rapidly growing across antibiotic classes and has remained a significant challenge in poultry production (Phiri et al., 2020).

Widespread use of antimicrobials benefits livestock producers but contributes to the increasing concern about drug-resistant bacteria (Gardner et al., 2012). Factors that can influence bacterial resistance on farms are numerous and depend on flock health status, farm management practices such as the use of broad-spectrum drugs instead of narrow-spectrum drugs, and the environment (Guo et al., 2021). Administration of low doses of antimicrobials for growth promotion (Length, 2009), and use of non-approved drugs are believed to contribute to the development of antimicrobial resistance (Gardner et al., 2012).

There is a well-documented connection between the rise in antibiotic-resistant infections and the ninety billion tons of chicken meat that are produced worldwide annually (Angulo et al., 2004). The worldwide increase in the use of antibiotics as an integral part of the poultry and livestock production industry to treat and prevent infectious bacterial diseases, as well as administration of growth promoters, at sub-therapeutic levels in feed, has led to the problem of the development of bacterial antibiotic resistance during the past years (Kapena, 2020).

In addition, antimicrobial drugs are also readily available over the counter without prescription because access to veterinary drugs is presently not being regulated in the country, thereby encouraging

the use of these drugs by poultry farmers indiscriminately in production. Poultry farmers continue to use antibiotics in poultry feed or water for prophylaxis, treatment of diseases, and growth promoters in developing countries, including Zambia (Kamweli et al., 2019).

Antibiotic resistance is a growing global health concern, with the enormous societal risk of reverting to a pre-antibiotic era if not addressed. In recent years, public health concern has been the development of AMR bacteria that markedly reduce the number of antimicrobials available for effective treatment of infectious diseases in humans and animals (Chiyangi et al., 2017). In Zambia, recent findings showed that *Salmonella* sp. And *E. coli* (18% and 25.5%, respectively) were among the most detected organisms causing bacterial diarrhoeal disease in children between the ages of 0-59 months at the University Teaching Hospital (Chiyangi et al., 2017; Muonga, 2020).

Poultry meat production is one of the most critical activities in the livestock sector in many countries, including Zambia. Production of chicken meat requires great care to ensure food safety. However, the disease burden has remained a significant challenge in poultry meat production.

Chicken is one of the highly consumed meat products globally, both in developed and developing nations. Global Livestock Counts report that there are almost 19 billion chickens globally (Private Report. 2011. Accessed 2022), making it the most common species of birds.

Europe consumes an average of 2.5 kg of chicken per capita per year, whereas Africa's annual average consumption per capita stands at 6 kilograms (Hafez & Attia, 2020). In Zambia, poultry is currently the main meat consumed by the population, totalling an estimated proportion of 50 per cent of the total meat consumption in the country. For this reason, the poultry industry is one of the most critical sectors in the growth of the country's economy (Phiri et al., 2020). Further, the Zambian poultry industry has been one of the fastest-growing subsectors of the livestock sector; it produces a variety of protein-containing foods such as chickens, eggs, and many others (Phiri et al., 2020). They contribute significantly to a daily healthy diet of an average human being, given their affordability and importance as a readily available source of protein (Kapena, 2020). In terms of nutritive value, egg protein is a complete protein food as it has nine essential amino acids (and nine non-essential amino acids), (Hafez & Attia, 2020).

1.2 Statement of the Problem

AMR has recently gained worldwide recognition as the emergence of multidrug-resistant organisms has led to increased mortality and economic burden. Zambia is no exception to the challenges faced due to AMR (Kamweli et al., 2019). Regardless of their indication, the routine use of antibiotics on farms selects for and maintains a reservoir of resistant bacteria capable of causing human disease or passing mobile resistance determinants to human pathogens (Davis et al., 2018).

Widespread use of antimicrobials has benefits for producers. Still it contributes to the increasing challenge of drug-resistant bacteria due to misuse and abuse of antibiotics caused by improving poultry production (Gardner et al., 2012). A study by Jain et al., 2020 reported that poultry production is commonly associated with the large scale use of antibiotics and is therefore considered one of the significant sources of new combinations of antibiotic resistance.

Globally, it is estimated that AMR will be responsible for 10 million deaths per year by 2050 if steps are not taken immediately to combat and prevent the spread of AMR. In addition, the cumulative economic cost of AMR, estimated to be 100 trillion USD, is more than one and a half times the annual world gross domestic product as of 2015 (Kabali et al., 2021).

Farmers use antibiotics in disease prevention to mitigate against the highly prevalent infections, unhygienic conditions and absence of biosecurity to poultry compared to other livestock animals. Consequently, antibiotics are found in meat as residues, and bacteria are continuously being exposed to them with a risk of developing resistance (Phiri et al., 2020). Therefore, humans may obtain antimicrobial-resistant *E. coli* or resistance genes of animal origin directly via contact with animals, food of animal origin, and the environment (Mtonga et al., 2021).

First, it is necessary to identify the factors that influence the presence of this resistance to stop the emerging and ultimately reduce antimicrobial resistance levels. Therefore this study aimed to identify factors influencing the AMR of broiler chicken.

1.3 Justification

Scholars have reported the use of antibiotics to be an important factor in the emergence, selection and spread of antibiotic-resistant pathogens in veterinary medicine.

Some poultry farmers use antibiotics as growth promoters, which are perceived as an inexpensive management practice. In contrast, other farmers use antibiotics in disease prevention as a mitigation measure against the highly prevalent unhygienic conditions and absence of biosecurity. Therefore, this study was carried out to analyse factors associated with AMR bacteria of broiler poultry and provide baseline data that can be used as part of an integrated AMR surveillance system and facilitate the evaluation of interventions used to prevent and control drug resistance.

1.4 General Objective

To determine factors associated with AMR occurrence in broiler chickens in selected districts in Zambia.

1.4.1 Specific objectives

1. To determine the prevalence of AMR in broiler poultry from secondary data
2. To analyse the factors contributing to AMR occurrence of broiler chickens in selected districts in Zambia.

1.5 Research question

1. What is the prevalence of AMR in broiler chicken from the secondary data?
2. What factors contribute to AMR occurrence in broiler chickens in selected districts in Zambia?

CHAPTER TWO

2.0 LITERATURE REVIEW

AMR occurs when bacteria, viruses, fungi and parasites change over time and no longer respond to antimicrobial medicines (including antibiotics, antivirals, antifungals and antiparasitics). AMR makes infections harder to treat and increases the risk of disease spread, severe illness and death (Kabali et al., 2021). A study done by (Phiri et al., 2020), AMR was defined as non-susceptibility to three or more antimicrobial classes of antibiotics tested. A study by (Kabali et al., 2021) defined extreme drug resistance (XDR) as non-susceptibility in all but 2 or fewer antibiotic categories in the antibiotic classes tested per international expert proposal for interim standard definitions for resistance.

According to WHO, AMR is occurring globally, compromising the ability to treat infectious diseases and undermining many other advances in health and medicine (Kabali et al., 2021).

A study by Mtonga et al., 2021 reported increasing resistance to commonly used antibiotics, namely ampicillin, co-trimoxazole, gentamicin, erythromycin, tetracycline and a third-generation cephalosporin.

The incidence of AMR is thus undoubtedly worse in developing countries, including Zambia, where humans interact intimately with animals and the environment (Kapena, 2020). Also infectious disease rates are higher, regulations on antibiotic use, the development, implementation and monitoring of AMR prevention and containment measures are inadequate and frequently non-existent (Kapena, 2020).

AMR evolves as a natural consequence of antimicrobial usage (AMU) in multiple sectors such as human health, animal health and animal production, aquaculture, and agriculture (Amin, 2020). It is considered a crucial multifactorial and complex global problem because of the rapid emergence and spread of resistant bacteria among humans, animals, and the environment (Amin, 2020).

In the poultry industry, antimicrobial has been used at sub-therapeutic or therapeutic doses to enhance growth, feed conversion efficiency, and prevent and control diseases (Jain et al., 2020). AMR bacteria in food animal production represents a health risk to humans because AMR bacteria of animal origin can be transmitted from animals to humans through the food supply, water, or direct contact with

animals. Resistance genes may even be transferred from animals through human pathogens that are usually human-specific (Gardner et al., 2012). The study by Kabali et al., 2021 found antibiotic-resistant *Salmonella* sp. and *E. coli* in broiler chickens at farm level and open markets in selected districts of Zambia. These bacteria are of public health importance because they may be transferred to humans. Also, the study by Phiri et al., 2020 revealed that out of the 280 isolates subjected to antimicrobial susceptibility testing, 94.6% (265/280) were resistant to three or more antibiotics.

Resistance to commonly used antibiotics has significant socioeconomic and public health implications. The socioeconomic implications of AMR include increased morbidity, mortality, disease burden, healthcare expenditure, and reduced livelihoods (Amin, 2020). In contrast, the public health implications include decreased ability to treat common infections (Ventola, 2015), resulting in increased human suffering and death (Kamweli et al., 2019). In Zambia, recent findings showed that *Salmonella* sp. and *E. coli* (18% and 25.5%, respectively) were among the most detected organisms causing bacterial diarrhoeal disease in children between the ages of 0-59 months at the University Teaching Hospital, Lusaka District (Chiyangi et al., 2017; Muonga, 2020).

Poultry meat forms an integral part of the diet, especially in developing countries. It is popular because it is a cheaper protein source, easier to produce than other meat products, and the absence of cultural and religious restrictions for its consumption (Carrique-mas, 2017; Muonga, 2020). However, the high demand for poultry meat puts a strain on producers, who have to meet the ever-growing demand and realise profits in a competitive market environment (Muonga, 2020).

Developing countries are more vulnerable to AMR due to inappropriate and overuse of antibiotics, poor quality drugs, livestock use of antibiotics, inadequate drug monitoring and surveillance system, lack of awareness of AMR, and poverty (Ahmed et al., 2019). However, most Low Medium Income Countries (LMICs) are still far behind high resource settings in curbing the spread of AMR generally and via the food chain specifically (Ahmed et al., 2019).

The actual burden of AMR in food animals is only partially documented, and its threat via the food chain is underestimated in low resource settings (Founou et al., 2016). Given the expansion of the

human population, globalisation of trade in animals and food products, international travels and animals movements, AMR can quickly spread globally via the food chain (Founou et al., 2016).

Food-animal farming systems in Zambia, including poultry, are diversified from small household farms to medium and large-scale commercial farms. Due to the absence of adequate government animal healthcare system, farm owners mainly depend on informal and unqualified healthcare providers to treat their animals (Chishimba et al., 2016; Fisheries & Office, 2017). Therefore, irrationally prescribed and easy access to antibiotics leads to misuse, abuse, suboptimal, or overuse of these drugs in farms (Roess et al., 2015).

The lack of country specific data on the burden of AMR and factors driving its spread means that interventions are likely to be limited and even misdirected (ZIARSF report 2020). Therefore, in 2017, Zambia through the Zambia National Public Health Institute (ZNPPI) and the Centre for Science and Environment (CSE), as part of an existing collaboration to support implementation of Zambia's NAP-AMR, developed a multi-sectoral National Action Plan (NAP) on AMR, which sets out priority actions and strategies to address the factors influencing development and spread of AMR in the Zambian context.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study design

A cross-sectional study design was used to determine factors for occurrence of AMR in broiler chicken.

3.2 Study area

The study was conducted out in Ndola, Kitwe, Choma, Chilanga and Kafue districts of Zambia.

The districts were conveniently selected because of increased number of broiler farmers, there is a high demand for broilers, increase in population.

3.3 Study Population

This study included small, medium and commercial scale broiler farmers from the selected districts who participated voluntarily.

Inclusion criteria were any poultry farms with 50 and above broilers intended for sale.

3.4 Variables

Under this cross-sectional study, the dependent variable was chicken-farm AMR status, defined as the resistance of isolates to at least three or more classes of antibiotics observed on the farm. The independent variables were from the social demographic factors, farm characteristics and farm management and practices (refer to questionnaire appendix 01).

3.5 Sample size determination

Sample size was determined using the formula for unknown population, as currently the number of broiler farmers in the selected districts for the study was unknown. The formula used for sample size determination was as follows:

$$N = (Z)^2 * S * (1-S) / (E)^2$$

$$N = ((1.96)^2 \times .5(.5)) / (.05)^2 = (3.8416 \times .25) / .0025$$

$$N = 0.9604 / .0025$$

$$N = 384.16$$

$$N = 384$$

The minimum sample size was 384 respondents, adjusted at 6% and non-response bias at 6% for attrition to get 407 as the sample size of respondents.

Where:

N = required minimum sample size

Z = Standard value corresponding to a confidence level

S = sample standard deviation

E = Accepted magnitude of error

The population of broiler farmers was unknown, due to the limitation of locating them the maximum sample of 109 respondents was located for this study based on where the farm was located.

3.6 Data collection techniques and tools

3.6.1 Sampling method

Three stage sampling technique was used to select respondents (broiler farmers) from the target population (broiler farmers within selected districts). Both probability and non-probability sampling techniques were employed, including purposive, stratified, and snowball sampling. Firstly, purposive sampling was employed, including only livestock keepers rearing broilers.

The second level of sampling involved stratified sampling of broiler farmers. Thus, the broiler farmers were categorised into three groups: Commercial, medium and small-scale based on their bird rearing capacity. Commercial (>1000 birds per poultry house), Medium (500 to 1000 birds per poultry house) and small scale (<500 birds per poultry house). The final sampling level was snowball sampling, where each identified broiler farmer assisted in locating the next farmer rearing broilers to arrive at the required sample size.

3.6.2 Data collection techniques

Structured questionnaires (appendix 1) were administered to poultry farmers, verbal and written consent was obtained from poultry farmers before the interview. After being interviewed, a questionnaire was given a code ready for data entry.

Secondary data from already analysed laboratory data from study by Phiri et al., 2020. was used to determine the prevalence of the AMR in selected districts. For the data from the laboratory where an isolate was resistance for three classes of antibiotics was considered a AMR positive were coded 1 and those isolate was not resistance to three class of antibiotics was considered AMR negative were coded 0 at excel sheet and imported to Stata 12 software for analysis.

3.6.3 Data collection instruments

A structured questionnaire was used to collect information on risk factors from the poultry farms (Appendix 01).

3.6.3 Pre-test study

A pre-test of the data collection tool was conducted by administering questionnaires before going to the field. This enhanced editing of the questionnaire to avoid ambiguity to some specific questions. The pre-testing was done in 10 poultry farms in Chisamba district before the commencement of the study.

3.7 Quality control

Questionnaires collected were checked for accuracy and completeness. The completed questionnaire was coded and entered into Excel and then data was transferred to Stata 12 programme. Data was

securely kept by keeping them in custody in a room as hard copy and restricted to the research personnel only.

3.8 Statistical method

Data were analysed using STATA 12 statistical software. The Chi-square test evaluated associations between two categorical variables in univariate analysis. In contrast, the multiple effects of predictor variables on the outcome were analysed using the logistic regression model (Odds Ratio (OR) and 95% confidence interval (CI) to determine the association between risk factors. P-values less than 0.05 were considered to be statistically significant. The dependent variable was chicken-farm AMR status, defined as resistance of isolates (It can be one or more isolates from one farm) to at least three or more antibiotics classes. The independent variables were from social demographic factors, farm characteristics, and farm management and practices.

3.9 Ethical consideration/issues

Ethical approval was sought from the University of Zambia Biomedical Research and Ethics (UNZABREC). Further, the permission was sought from district authorities (Kitwe, Ndola, Choma, Chilanga and Kafue).

CHAPTER FOUR

4.0. RESULTS

4.1. Prevalence of AMR

Litters & cloacal swabs samples were collected by Phiri et al., 2020 and isolation of *Salmonella sp.* and *E. coli*, identification, confirmation of the isolates and antibiotic susceptibility testing (AST) were performed in the laboratory. From the laboratory results, samples that were resistance to at least three class of antibiotic was coded 0 and those that were susceptible to at least three class of antibiotics were coded 1 and entered to excel and imported to Stata 12 software for analysis. Total of 109 broiler chicken farms were included in this study. Table 1 below shows the prevalence of AMR samples by the district where by Ndola, Choma and Kafue had higher prevalence of 87.1%, 88.9% and 86.4% respectively while Chilanga and Kitwe had relatively low prevalence 78.6% and 73.3% respectively.

Table 1: Prevalence of AMR on broiler chicken farms (n=109)

Province	District	Negative n (%)	Positive n (%)
Lusaka	Kafue	3 (13.64)	19 (86.36)
	Chilanga	3 (21.43)	11 (78.57)
Southern	Choma	3 (11.11)	24 (88.89)
Copperbelt	Kitwe	4 (26.67)	11 (73.33)
	Ndola	4 (12.90)	27 (87.10)
Overall prevalence		17 (18.48)	92 (84.40)

4.2 Univariate analysis of demographic characteristics for AMR of broiler chicken farms

Table 2, shows cross-tabulation results of the outcome variable (Farm AMR status) and hypothesised demographic characteristics in Chi-square analysis. Only those variables, which had $P < 0.25$ were taken for further screening in the logistic model, and these included: age category, gender, and marital status

Table 2: Univariate analysis of the demographic factors for AMR in broiler

Variable	Level	N (%)	Positive n (%)	Negative n (%)	p-value
District	Kafue	22 (20.2)	19 (86.4)	3 (13.4)	0.662
	Chilanga	14 (12.8)	11 (78.6)	3 (21.4)	
	Choma	27 (24.8)	24 (88.9)	3 (11.1)	
	Kitwe	15 (13.8)	11 (73.3)	4 (26.7)	
	Ndola	31 (28.4)	27 (87.1)	4 (12.9)	
Farm category	Small scale	104 (95.4)	88 (84.6)	16 (15.4)	0.58
	medium scale	2 (1.8)	2 (100)	0 (0)	
	Commercial	3 (2.8)	2 (66.7)	1 (33.3)	
Gender	Male	48 (44.1)	37 (77.1)	11 (22.9)	0.173
	Female	61 (55.9)	53 (89.7)	7 (10.3)	
Age category	15 – 20	9 (8.3)	7 (77.8)	2 (22.2)	0.234
	21 – 30	35 (32.1)	25 (73.5)	10 (26.5)	
	31 – 40	26 (23.9)	24 (92.3)	2 (7.7)	
	41 – 50	17 (15.6)	14 (82.4)	3 (17.7)	
	51 >	22 (20.2)	21 (95.5)	1 (4.5)	
Marital status	Married	64 (58.7)	58 (90.6)	6 (9.4)	0.14
	Single	35 (32.1)	25 (71.4)	10 (28.6)	
	Others	10 (9.2)	9 (9.8)	1 (5.9)	
Education level	Not attend school	8 (7.5)	7 (87.5)	1 (12.5)	0.863
	Primary	14 (13.1)	13 (92.9)	1 (7.1)	
	Junior Sec	23 (21.5)	19 (82.6)	4 (17.4)	
	Senior Sec	32 (29.9)	27 (84.4)	5 (15.6)	
	Tertiary	30 (28.0)	24 (80.0)	6 (20.0)	
Farm location	Urban	34 (32.1)	28 (82.4)	6 (17.7)	0.481

Peri urban	47 (44.4)	42 (89.4)	5 (10.6)
Rural	25 (23.6)	19 (76.0)	6 (24.0)

4.3 Univariate analysis of farm characteristics for AMR of broiler chicken farms

Table 3 shows cross-tabulation results of the outcome variable (Farm AMR status) and hypothesised farm characteristics factors in Chi square analysis. Only those variables which had $P < 0.25$ were taken for further screening in the logistic model, and these included: sources of drinking water, electricity, poultry housing type, floor housing type, presence of drainage system and destination of the drainage.

Table 3: Univariate analysis of the farm characteristics factors for AMR in broiler

Variable	Level	N (%)	Positive n (%)	Negative n (%)	p-value
Sources of drinking water	Pipe (Water authority)	54 (50.9)	49 (90.7)	5 (9.3)	0.035
	Bore hole/well	42 (39.6)	31 (73.8)	11 (26.2)	
	Others	10 (9.4)	9 (90.0)	1 (10.0)	
Electricity	Yes	95 (89.6)	79 (83.2)	16 (16.8)	0.141
	No	11 (10.4)	11 (100.0)	0 (0.0)	
Poultry house in backyard	Yes	89 (83.9)	76 (85.4)	13 (14.6)	0.358
	No	17 (16.1)	13 (76.5)	4 (23.5)	
Poultry farm type	All in all, out	68 (64.7)	58 (85.3)	10 (14.7)	0.704
	Continues	37 (35.2)	30 (81.1)	7 (18.9)	
Poultry housing type	Open sided type	53 (53)	44 (83.0)	9 (17.0)	0.058
	Close sided type	47 (47)	41 (87.2)	6 (12.8)	
Floor house type	Concrete	89 (84)	85 (95.5)	4 (4.5)	0.188
	Soil	17 (16)	14 (8.2)	3 (1.8)	
Drainage system present	Yes	36 (33.9)	30 (76.9)	6 (23.1)	0.108
	No	70 (66.1)	62 (88.6)	8 (11.4)	
Drainage destinations	Land	65 (61.3)	58 (89.4)	7 (10.6)	0.005

	Fields	32 (30.2)	23 (71.9)	9 (28.1)	
	Others(body of water/concrete yard)	9 (8.5)	8 (88.9)	1 (11.1)	
Different ages kept together	Yes	18 (17)	15 (83.3)	3 (16.7)	0.896
	No	88 (83)	75 (85.2)	13 (14.8)	
Facility to isolate sick birds	Yes	41 (38.7)	36 (88.1)	5 (11.9)	0.633
	No	65 (61.3)	54 (83.3)	11 (16.7)	
Sources of feed	Self-formulated	2 (1.9)	1 (50.0)	1 (50.0)	0.349
	Commercially prepared	99 (93.4)	85 (86.0)	14 (14.0)	
	Both	5 (4.7)	4 (80.0)	1 (20.0)	
Poultry house fenced	Yes	7 (6.6)	7 (100.0)	0 (0.0)	0.22
	No	99 (93.4)	84 (84.8)	15 (15.2)	

4. 4 Univariate analysis of farm management and practices factors for AMR of broiler chicken farms

Table 2, 3 and 4 shows cross-tabulation results of the outcome variable for farm AMR status and hypothesised risk factors in Chi square analysis. Only those variables which had $P < 0.25$ were taken for further screening in the logistic model, and these included: bird population, use of protective gears, buying drugs from veterinary personnel, drug prescription when buying, drugs administered by veterinary personnel, drugs administered by an untrained farmer and administered by owner.

Table 4: Univariate analysis of the farm management & practices factors for AMR in broiler

Variable	Level	N (%)	Positive n (%)	Negative n (%)	p-value
Recycle Beddings	Yes	8 (7.5)	7 (87.5)	1 (12.5)	0.831
	No	98 (92.5)	83 (84.7)	15 (15.3)	
Litter type	Manure product of bedding	105 (98.1)	88 (83.8)	17 (16.2)	0.535
	Others	2 (1.9)	2 (100.0)	0 (0.0)	
Bird population	< 500	51 (71.8)	43 (84.3)	8 (15.7)	0.212

	500 – 1000	12 (16.9)	11 (91.7)	1 (8.3)	
	Above 1000	8 (11.3)	5 (62.5)	3 (37.5)	
Mixed bird species	Yes	5 (4.7)	4 (80.0)	1 (20.0)	0.871
	No	101 (95.3)	86 (85.1)	15 (14.9)	
Birds reared purpose	Meat for sale	9 (8.3)	7 (77.8)	2 (22.2)	0.567
	Sale and home consumption	100 (91.7)	85 (85.0)	15 (15.0)	
Poultry Origin	Same company	17 (15.7)	14 (82.4)	3 (17.6)	0.373
	Different company	51 (47.2)	46 (90.2)	5 (9.8)	
	Not known	40 (37.0)	32 (80.0)	8 (20.0)	
Personnel restricted house	Yes	90 (87.4)	75 (83.3)	15 (16.7)	0.633
	No	13 (12.6)	12 (92.3)	1 (7.7)	
Other Domestic animal	Yes	65 (61.9)	55 (84.6)	10 (15.4)	0.958
	No	40 (38.1)	34 (85.0)	6 (15.0)	
Use of protective gear	Yes	76 (70.2)	62 (81.6)	14 (18.4)	0.104
	No	32 (29.6)	30 (93.7)	2 (6.3)	
Rats on the farms	Yes	58 (55.2)	49 (84.5)	9 (15.5)	0.888
	No	47 (44.8)	39 (82.9)	8 (17.1)	
Common diseases of birds	Cough & flu	12 (11.5)	11 (91.7)	1 (8.3)	0.602
	Diarrhea	83 (79.8)	69 (83.1)	14 (16.9)	
	Other	9 (8.7)	8 (88.9)	1 (12.1)	
Use of antibiotics to treat birds	Yes	94 (94.9)	80 (85.1)	14 (14.9)	0.756
	No	5 (5.1)	4 (80.0)	1 (20.0)	
Buy Antibiotics in retail shop	Yes	87 (85.3)	19 (21.8)	68 (78.2)	0.332
	No	15 (14.7)	5 (33.3)	10 (66.6)	
Buying antibiotics from Vet clinic	Yes	87 (85.3)	70 (80.5)	17 (19.5)	0.528
	No	15 (14.7)	11 (73.3)	4 (26.7)	
Buying from Vet personel	Yes	87 (85.3)	1 (1.2)	86 (98.8)	0.155

Drug prescription when buy	No	15 (14.7)	1 (6.7)	14 (93.3)	0.135
	Yes	23 (22.8)	18 (78.3)	5 (21.7)	
Administered by vet personel	No	61 (60.4)	54 (88.5)	7 (11.5)	0.021
	Unknown	17 (16.8)	12 (70.1)	5 (29.4)	
Admin by trained farmer	No	88 (83.8)	85 (85.9)	3 (50.0)	0.379
	Yes	88 (83.8)	79 (84.9)	9 (75.0)	
Admin by untrained farmer	No	17 (16.2)	14 (15.1)	3 (25.0)	0.2
	Yes	88 (83.8)	56 (87.5)	32 (78.1)	
Admin by owner	No	17 (16.2)	8 (12.5)	9 (21.9)	0.177
	Yes	65 (61.9)	52 (80.0)	13 (20.0)	
Use of growth promoter	No	40 (38.1)	36 (90.0)	4 (10.0)	0.588
	Yes	38 (37.2)	33 (86.8)	5 (13.2)	
	No	64 (62.3)	53 (82.8)	11 (17.2)	

4.5 Logistic regression model and Validation

The multivariate logistic regression model showed that gender, marital status, administration of drugs by veterinary personnel or the farmer, and the drainage destination were predictors of a broiler chicken farm having an antimicrobials resistance problem (Table 05).

The odds of a female-managed farm having an AMR problem was 2.5 (95% C.I: 0.74-8.74) higher than that managed by a male farmer, which was the reference group.

The odds of a farm managed by a married person having an AMR problem were 4.0 (95% C.I: 1.15-14.17), and others were 1.51 (95% C.I; 0.13 – 17.48) higher than those managed by a single person which was as a reference group. The odds of a farm having an AMR problem where the drugs were administered by other personnel to broiler chickens were 11.91 (95% C.I; 1.28 – 110.86) times higher risk than the one where drugs were administered by the veterinary personnel (reference group). The

odds of a farm having an AMR problem where untrained farmers administered the drugs were 2.02 (95% C.I: 0.58 – 7.00) higher than the farm where a trained farmer administered the drugs (reference group). The odds of drainage flowing out to the land being contributed to AMR on the farm was 3.1 (95% C.I: 0.88 – 11.02), compared to and drainage flow out to other destinations 3.2 (95% C.I: 0.30 – 34.41); and higher than the farms where the drainage was flowing out to the fields/garden as the reference group.

Table 5: Multivariate analysis of factors for AMR in broiler

Variable	Odds ratio	95% C.I	P-value
Gender			
Male	Ref	Ref	
Female	2.54	0.74 - 8.74	0.14
Marital status			
Single	Ref	Ref	
Married	4.04	1.15–14.17	0.03
Others (Divorced/widowed)	1.514	0.131- 17.48	0.74
Administered by vet personnel			
No	Ref	Ref	
Yes	11.91	1.28 - 110.86	0.03
Admin by untrained farmer			
No	Ref	Ref	
Yes	2.02	0.58 - 7.01	0.26
Drainage destination			
Fields/Garden	Ref	Ref	
Land	3.12	0.88 – 11.02	0.08
Others	3.21	0.30 – 34.41	0.33

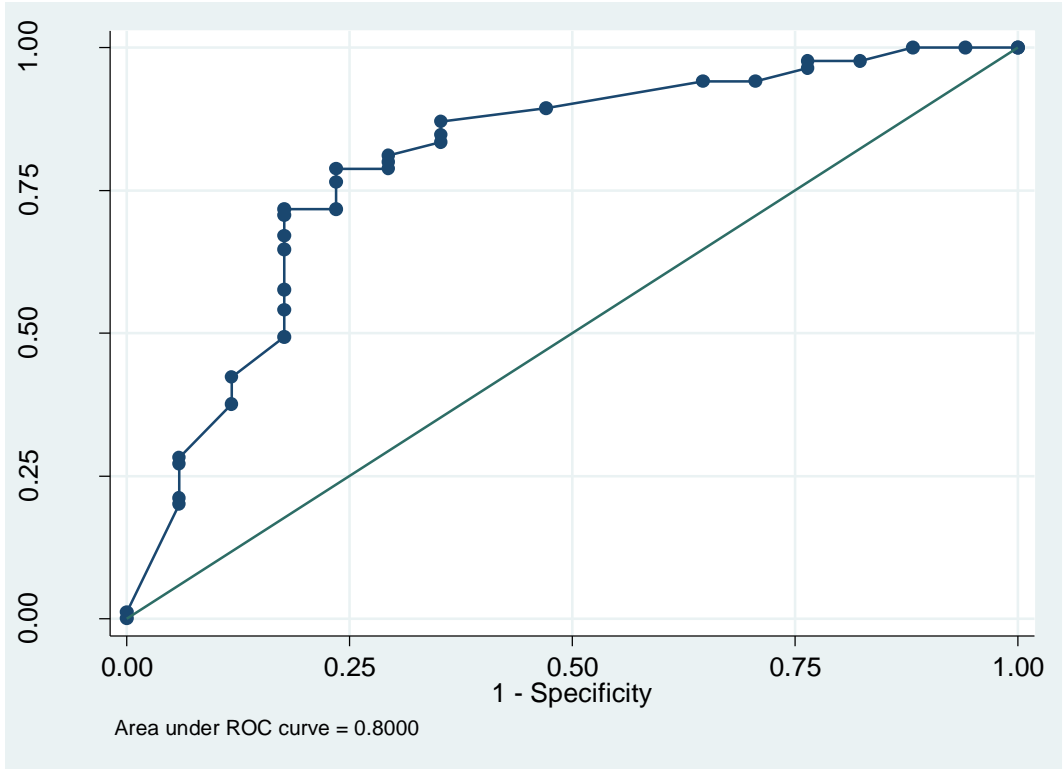


Figure 1: ROC curve demonstrating predictability of the model

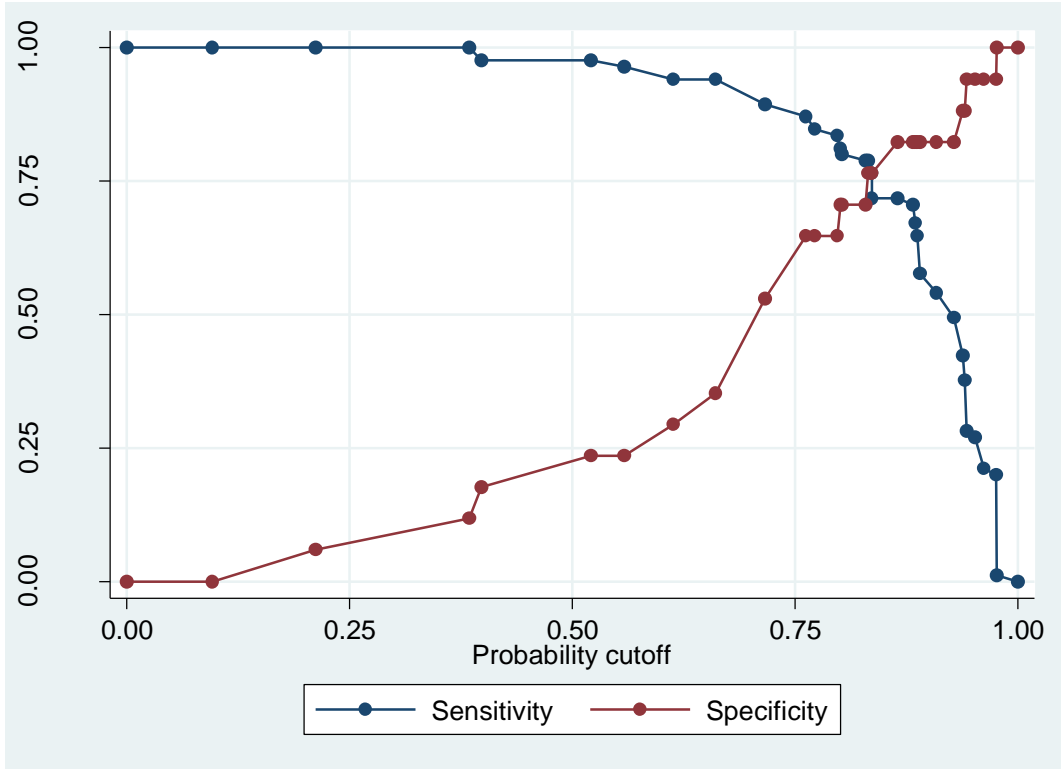


Figure 2: Graphs demonstrating probability cut off vs sensitivity and specificity

CHAPTER FIVE

5.0 DISCUSSION

This study aimed to determine the risk factors associated with AMR in the selected districts of Zambia. The study use the secondary data from the laboratory after analysed it gives the overall prevalence of AMR 84.4% on poultry farms which is relatively low to the one reported in previous studies undertaken between August 2017 and May 2018 in selected districts in Zambia that found 94% to at least three or more antimicrobial agents (Muligisa-muonga et al., 2020). However, the cited study included the open market and abattoir. The difference could be attributed to the contamination during the chicken dressing at abattoir and markets because open market is the unrestricted area, not housed in building where food products are often sold exposed. This finding is greater than the previous reports (Abunna et al., 2016; Karim et al., 2017; Kindu & Addis, 2013; Makaya et al., 2012; Ngai et al., 2021) who reported 15.12%, 32% 41.9%, 10% and 12% in Modjo (Ethiopia), Dhaka (Bangladesh), Jimma (Ethiopia), Zimbabwe and Kenya respectively. The reason for higher prevalence in the present study could be attributed to the low levels of poultry farm biosecurity associated with lack of biosecurity knowledge; sources of breeding stock, availability and easy accessibility of antibiotics; disease burden, particularly for small scale to prevent high morbidity and mortality rates (Muligisa-muonga et al., 2020); and easy access of information on antibiotics for prevention hence widespread usage of a wide range of these antibiotics for prophylaxis and treatment (Phiri et al., 2020). The poultry production system may also play role in the distribution of pathogens, by shedding of the pathogen to the environment. Besides, direct transmission of the bacteria from humans as well as the difference in contamination levels of poultry feeds may be the factor for the prevalence of AMR.

Comparable prevalence results among the study districts showed that Ndola, Choma and Kafue had the highest farm level AMR prevalence of 87.1%, 88.9% and 86.4%, respectively. The other districts, Chilanga (78.6%) and Kitwe (73.3%) showed a slightly lower prevalence. The reasons for these differences are not easily discernible and could be the subject of another study. The highest prevalence of resistance in poultry for the mentioned districts can be attributed to the availability and easy accessibility of antibiotics for preventive purposes by poultry farmers particularly small scale to prevent high morbidity and mortality rates due to colibacillosis in the broilers (Muligisa-muonga et al.,

2020). Also the high prevalence in mentioned districts can be attributed due to easy access of information on antibiotics for prevention hence widespread antibiotics usage for prophylaxis and treatment (Phiri et al., 2020).

The current findings are higher than the 40% reported among the poultry farms in Colombia (Gardner et al., 2012) and the 41% among the retail store and supermarkets in Colombia (Castellanos et al., 2015), 34.4% among the poultry farms in Algeria (Djeffal et al., 2018) and 48-65% among chickens in China (Cui et al., 2016; Yu et al., 2018). Although the reason behind such differences in the prevalence of isolate is unclear, several factors can contribute to such variations such as differences in the definition of what is termed 'positive AMR farm', differences in sample collection techniques, season, and bacterial identification methods, as well as country policy on the use of antibiotics for growth promotion, observed bio-security in poultry, and AMR surveillance as well as regulation enforcement.

The majority of the broiler farmers were small-scale and married. More females (56%) took part in broiler production than males. Because of the low capital for start-up and a high return on investment for broiler production, women are able to venture into this business to contribute to income generation for school fees, household food and nutrition security. This is consistent with a study carried out in Tanzania and Zambia that showed that women are more engaged and are the key beneficiaries of chicken production (Queenan et al., 2018).

This study also showed that most broiler farmers (89.6%) had houses with electricity. Moreover, most farmers (84%) also kept chickens in the backyard poultry houses, and 95% of the houses were not fenced. A review by Conan et al., 2012 reported that poultry represents an essential sector in animal production, with backyard flocks representing a huge majority, especially in developing countries. Backyard production methods imply low biosecurity measures and a high risk of infectious diseases.

The majority of the farmers in this study were at the age category of 21- 30 years in the selected districts of Zambia, indicating that majority of farmers < 30 years were involved in poultry farming. The study by Miriam & Agnes, (2014) however found majority of farmers aged 47 years in Kenya. The reasons may be due to awareness of agriculture programme and level of education as significant factors for the youth to be interested in poultry farming. Also people aged 30 years participate more in

poultry farming because they have more access to credit and view poultry farming as a profitable venture.

Fifty-four farmers (49.5%) in this study reported using water from tap (safe water from water authority from manispal council) and among these 44.9% were positive with AMR. Source of water was not a significant risk factor for AMR, development in the water sector that improve the availability of safe and clean water in diferent districts in Zambia does not seem to contribute to AMR in poultry sector. A study in Bangladesh (Mandal et al., 2022) showed source of water for poultry was significant for AMR. People and livestock would swim in the same water used for other household purposes resulting in pollution.

Seventy farmers (64%) had no drainage system in their poultry house which was significantly associated with the AMR. In addition, drainage system destination was related to AMR as sixty-six farms (61%) were directing the drainage in backyard land hence increase the risk of AMR to the environment which result into AMR to human through consumption of vegetable and acquatic environment. After the discharge to backyards sewage, the next carrier of the bacterial contaminants are rivers, which are affected by selective pressure due to the release of antibiotic-resistant bacteria and residual antibiotics. Many antibiotics can even persist in the environment and are detected frequently in drinking water. Antimicrobial resistance can spread in the environment through horizontal and vertical gene transfers via mutation and recombination, and most resistance gene transferred to pathogenic bacteria through horizontal gene transfer originate from bacteria living in the environment (Praveenkumarreddy et al., 2020). Antimicrobials administered in poultry farming remain the leading driver of AMR environmental pollution in Egypt (Hedman et al., 2020). Environments with sustained excretion of resistant determinants substantially alter the soil microbiome (Hedman et al., 2020). Besides the risk of favouring microbial antibiotic resistance, plants can absorb antibiotic residues, interfering with physiological processes and causing potential ecotoxicological effects (Larsson, 2014).

Thirty per cent (30%) of the farmers did not use any protective gear. Use of separate shoes and clothes for the poultry house, and wearing head covering and masks prevent transmission of infectious

organisms from humans to poultry and vice versa. Shared materials between humans and animals may contribute to the transmission of antibiotic-resistant bacteria (Mandal et al., 2022).

As expected, farms with high bird stocking densities were more likely to have AMR problems. This was mainly a problem among small-scale backyard farmers. This could be attributed to the fact that high bird population density compromises hygiene standard and promote disease transmission between infected and susceptible birds, a situation that may lead to the use of antimicrobials. Moreover, the study by Mandal et al., 2022 reported that the stocking density of birds was a risk factor for the occurrence of antibiotic-resistant *E. coli* in broilers.

Drugs prescription, drug administration by trained personnel or veterinary personnel was statistically significant to AMR. Further, the odds of having farm bacterial AMR were 12 times higher in farms where drugs were administered by other personnel or untrained farmers than when administered by veterinary personnel. This could be due to a lack of veterinary drug knowledge that could lead to misuse, such administration of sub-therapeutic dosages in food animals (Abdi et al., 2017). In addition, a study by Talukder et al. 2021 from Bangladesh stated that poultry farms with farmers that had less knowledge of drug administration were at high risk of developing AMR. One of the major concerns is the over the counter sale of antibiotics without prescription that promotes irrational use, overuse, and misuse of antibiotics in the animal health as well as human health sectors in most of the developing countries including Zambia (Kalam et al., 2021; Masich et al., 2020; Matin et al., 2020; Orubu et al., 2021). Subsequently, indiscriminate use of antibiotics without prescription contributes to the development and spread of AMR (Ayukekbong et al., 2017).

The study showed that the common group of diseases encountered on broiler poultry farms were diarrhoea diseases (79.8%) and respiratory diseases (11.5%). Most poultry farmers (95.0%) used antibiotics and bought the antibiotics without a prescription. In addition, more than one-third of the farmers used antibiotics as growth promoters for the birds. A review by Mund et al., 2017 reported that the use of antibiotics in poultry is everyday disease management practice in developing countries and that the most commonly used antibiotics were: tetracycline, gentamicin, neomycin, tylosin, erythromycin, virginiamycin, ceftiofur, and bacitracin.

Multivariable logistic regression model identified factors such as, gender, marital status, administration of drugs by veterinary personnel or the farmer, and the drainage destination as predictors of a broiler chicken farm having an AMR problem. The married are significantly associated with AMR problem as the odds for AMR problem were 4 times higher in married persons than for single and others. This could be attributed by the reason that the married women most of them they are involved in home activities such as taking care of children, cooking and cleaning in general which make them to be exposed to contamination from environment and with rarely using of biosecurity measures they can transmit the infectious agents to the poultry farms.

The Pearson Chi-square goodness-of-fit test ($p = 0.486$) showed that the model fitted the data, thus increasing its reliability in predicting AMR farm status. The Receiver-Operating characteristic Curve analysis (ROC) demonstrated that the model was good in predicting farm-AMR status (ROC=0.8). The model had relatively high sensitivity and specificity in classifying the farm as having an AMR problem or not.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusion

The present study identified several potential risk factors for AMR in broiler poultry farms in selected districts of Zambia. The potential risk factors include; demographic characteristics such as gender, marital status; farm characteristics and farm management and practices also factors such as low bio-security levels on the farms and the occasional use of personal protective gear when dealing with poultry, as well as a great degree of overlap between the farming and household environment, compound the problem of AMR.

This study highlight a serious need of continuous monitoring, surveillance and quality inspection programs for the AMR, in the food chain supply because of the public health implications of a potential spread of resistant microorganisms.

Antimicrobial use in broiler poultry generally occurs within the household environment (backyard) in Zambia; these settings often result in intimate human animal exposures. In addition sanitation, and hygiene conditions, contribute to spread of AMR organisms.

6.2. Recommendations

- The government of Zambia should strengthen education and awareness on AMR.
- Low levels of bio-security on poultry farms and inadequate/ no use of personal protective equipment when handling poultry, as well as a great degree of overlap between the farming and household environment contribute to contamination of birds with AMR organisms. The above mentioned issues need to be addressed by local government and other relevant stakeholders. Emphasis should be on educating the farmers, relevant officers (veterinary officers, agricultural officer and agro dealers) as well as the community in Good Hygiene

Practices (GHPs) and Good Agricultural Practices (GAPs) and Good Veterinary Practices (GVPs) in poultry production to provide safe food to the consumers.

- The Medicines Regulatory Authority should put strict regulations for selling antibiotics through prescription only.
- Policymakers through the Ministry of Livestock and Fisheries should formulate and enforce policy, regulations and laws on AMR and hygiene practice for broiler poultry farmers to reduce antibiotic resistance.

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8.0 APPENDICES

8.1. Appendix 1: Questionnaire



THE UNIVERSITY OF ZAMBIA
SCHOOL OF VETERINARY MEDICINE
DEPARTMENT OF DISEASE CONTROL

Questionnaire

Research Study on
FACTORS CONTRIBUTING TO AMR OCCURRENCE IN INFECTIOUS AGENTS OF BROILER
CHICKEN

Questionnaire serial number:

Appendix 1

**Questionnaire- risk factors associated with antibiotic resistance in Salmonella
Campylobacter and E. coli on broiler poultry farms in Zambia**

The purpose of this research study is to gather information on the risk factors associated with antibiotic resistance in Salmonella, Campylobacter and E. coli on broiler poultry farms in Zambia. You have been asked to participate in this research study and please note that by completing this questionnaire you are voluntarily agreeing to participate in this study. You will remain anonymous and all information given will be treated as confidential

Please mark the appropriate block with an X or write your answer on the space provided.

**Section A: Farm
Identification**

1.0 Name of interviewer _____

2.0 Date of interview dd/mm/yy

<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
----------------------	----------------------	----------------------	----------------------	----------------------	----------------------	----------------------

Start
time: _____

Farm ID _____

Respondent
3.0 District

<input type="text"/> 1	Chipata	<input type="text"/> 6	Lusaka
<input type="text"/> 2	Chinsali	<input type="text"/> 7	Mansa
<input type="text"/> 3	Choma	<input type="text"/> 8	Mongu
<input type="text"/> 4	Kabwe	<input type="text"/> 9	Ndola
<input type="text"/> 5	Kasama	<input type="text"/> 10	Solwezi

**For
Use** **Official**

4.0 Specific area of District 2

5.0 Farm category

<input type="text"/> 1	Small scale (1-1000 birds)
<input type="text"/> 2	Medium scale (1001-5000)
<input type="text"/> 3	Commercial scale (Above 5000)

6.0 GPS Reading (Coordinates)

S _____

E _____

7.0 Altitude _____

6

8.0 Interviewee

1	Farm owner
2	Farm manager
3	Others specify.....

Section B: Demographic Characteristics

9.0 Gender

Male Female

10.0 Age

1	15-20	2	21-30	3	31-40
4	41-50	5	51-60	6	Above 60

11.0 Marital status

1	Married	2	Single	3	Divorced/ separated
4	Cohabiting	5	Widowed		

12.0 Number of people living in the household: specify

13.0 Highest level of education

1	None (did not attend school)
2	Primary (grade 1-7)
3	Junior Secondary (grade 8-9)
4	Senior Secondary (grade 10-12)/ Vocational training
5	Tertiary

14.0 Location of household

Urban Peri-urban Rural

15.0 If urban, is it

1	High density	2	Medium density
3	Low		

density

16.0 What is the household's main source of drinking water?

Pipe borne

Borehole

River/ Pond/
Dam

Sachet/ Bottled/
filtered

Others specify

17

18-

17.0 Does the house have electricity?

Yes

No

20

18.0 What are the household's cooling facilities?

Refrigerator

Freezer

Both Refrigerator and Freezer

None

Others specify

Section C: General poultry farm characteristics

19.0 Where is the farm located?

Urban

Peri Urban

Rural

20.0 Is the poultry house in the backyard?

Yes

No

25

21.0 What is the poultry farm type?

All in All
out

Continous

26

22.0 What is the source of poultry water for drinking and cleaning bird house?

1

Borehole

2

Well

3

Municipality/
piped

4

Others.....

23.0 Whats is the type of the poultry housing?

Open sided

2
3
4

structure
 Closed with small windows
 Closed with air conditioning
 Others
 Specify.....

		29
		30-3

24.0 What is the floor type?

1
2
3

Concrete
 Soil
 Others specify.....

25.0 Is there a drainage system to the housing facility to prevent accumulation and stagnation of water?

1

Yes

2

No

--

26.0 Where does the drainage system lead the water?

1
3
4

Land

2

Fields

--

Body of water

Others specify.....

--	--

27.0 What is the type of bedding used?

Multiple responses

1
2
3
4
5

Wood chops/ Sawdust

Chopped grass

Cages

Old

newspapers

Others specify.....

28.0 Do you recycle beddings?

1

Yes

2

No

--

29.0 What is the used bedding used for?

1
2
3

Manure

Feed

Others specify.....

30.0 What is the number of birds per production

--

47

cycle?

31.0 How many bird houses are there on the farm?

48

32.0 What is the house size in square metres?

49

33.0 What is the bird population density

50

34.0 What other breeds of birds are produced at the farm? Tick any which apply

1
3
5

Layers

Local breeds/
chickens

Village

2

Ducks

4

Quails

Others specify.....

35.0 Do you mix different species of birds in one house?

Yes

No

36.0 What are the birds reared for?

1

Meat
for sale

2

Meat for sale and Home
consumption

3

Others
specify.....

58

59

37.0 What is the origin of the birds?

Same
company

Different companies

60

38.0 Are different age groups of birds kept together in the same poultry house?

Yes

No

39.0 Is there a facility for isolating sick birds?

1
2
3

Yes

No

Cannot identify sick
birds

40.0 What is the source of the feed given to the birds?

1
2
3

Self formulated
 From feed producers
 specify.....
 Both from feed producers and self formulated

63

Section D: Biosecurity practices

41.0 Is the housing fenced off from other surroundings (including natural fencing)?

1

Yes

2

No

--

42.0 Is the housing restricted only to personnel?

1

Yes

2

No

--

43.0 If No to question 42, who else has access to the housing?

.....

--	--	--	--

69-7

44.0 Are there other domestic animals including cats and dogs near the housing facility?

1

Yes

2

No

--

45.0 If Yes to question 44, indicate the types of domestic animals

.....

--	--	--	--	--	--

46.0 What activities do you do to prepare the house before introducing the birds?

.....

--	--	--

80-5

47.0 Do personnel wear protective clothing when working in the bird house?

1

Yes

2

No

48.0 If Yes to Question 47, indicate types of protective clothing

.....

--	--	--

83-85

49.0 What hygienic practices are applied before entering the bird house?

.....
.....
50.0 Are there rats on the farm?

Yes

No

--	--	--

51.0 How are the pest (rats) managed at the farm?

.....
.....

--	--	--

89-9

52.0 What are the common diseases encountered if birds got sick?

.....
.....
.....

53.0 If bird get sick, in which growth period? Multiple responses

1
3
5

Week
one (1)
Week
three
(3)
Week
five (5)

2
4
6

Week two (2)

Week four (4)

Week six (6)

92-9

94-9

96-9

54.0 What did you do when birds were sick?

.....
.....

--	--

98-99

55.0 Any natural/ indigenous methods of treating the birds, indicate

.....
.....

--	--

100-
102

56.0 Do you use antibiotics to treat the birds when sick?

Yes

No

57.0 If Yes to question 56, give the types commonly used and for what conditions?

.....
.....

--	--	--

10
10

58.0 Do you know how the antibiotics work to stop the sickness?

Yes

No

59.0 If yes to question 58, explain in simple term

.....
.....

60.0 Where do you buy the veterinary antibiotics? Multiple responses

Retailor's shop/ drug stores
Individual Veterinarians
(Vet)
unknown
Others specify.....

Veterinary clinic
Sales communities

within

61.0 Do drug sellers usually ask for a prescription when selling vet antibiotics?

Yes

No

Sometimes

Unknown

62.0 Where do you usually store your antibiotics?

Fridge
Open shelf indoors
In the poultry house
Others specify.....

Cupboard
Shelf in direct sunlight

63.0 Who administers the antibiotics to the birds?

Veterinary officers
Untrained farm personnel
Others

Trained farm personel

Farm owner

specify

115

116

64.0 Are antibiotics (such as in feed) given to the birds to promote their growth?

Yes

No

65.0 If Yes to question 62, indicate the types used

.....
.....

118-
121

66.0 How are dead birds disposed off? Multiple responses

1	Throwing	2	Burying
3	Burning	4	Sold for food
5	Others specify.....		

67.0 How do you sell the birds when ready for market?

1	Live
2	Dressed
3	Both Live and Dressed

--

68.0 If you answered 2 or 3 to question 65, where are the birds dressed?

1	Home
2	Abattoir
3	Others specify.....

69.0 Where do you sell the birds?

.....

.....

--	--	--	--

129
132

70.0 What mode of transport is used to take the birds to the processing plant and/or market?

1	Light truck	2	Van
3	Bicycle	4	Taxi
5	Others specify		

71.0 How is the vehicle prepared before transporting the birds to the market?

.....

.....

--	--	--

135-
137

Section E: Knowledge on the implication of antibiotic resistance to consumers

72.0 Are you aware of antibiotic resistance in poultry production?

1	Yes	2	No
---	-----	---	----

--

73.0 If yes to question 72, what is antibiotic resistance?

.....

.....

--	--	--

74.0 If yes to question 72, what is the effect of antibiotic resistance on consumer health?

.....
.....
.....

--	--	--	--

75.0 Where do you get information on antibiotic resistance?

1
2
3

Social
media
Television
(TV)
Peers/Friends

4
5

Hospital
Others,
specify.....

End
time: _____

Thank you for your time and contributions!!!!

The purpose of this research study is to gather information on the risk factors associated with anti Campylobacter and E. coli on broiler poultry farms in Zambia. You have been asked to participate in this research. By completing this questionnaire you are voluntarily agreeing to participate in this study. You will remain anonymous and your information will be treated as confidential.

Please mark the appropriate block with an X or write your answer on the space provided.

8.2. Appendix 2: Consent Form



THE UNIVERSITY OF ZAMBIA

SCHOOL OF VETERINARY MEDICINE

DEPARTMENT OF DISEASE CONTROL

INFORMED CONSENT FOR BIRDS KEEPER

Research Study on

**FACTORS CONTRIBUTING TO AMR OCCURRENCE OF INFECTIOUS AGENTS OF
BROILER CHICKEN**

PI: Mirisho Robert

Supervisors: Prof John.B. Muma, Chisoni Mumba and Dr. Mainda Geoffrey

Study title: Analysis of Factors Contributing to AMR Occurrence in infectious agents of Broiler Chickens of Selected Districts in Zambia

Purpose for the research:

This study aims to analyse factors associated with AMR bacteria in poultry and provides baseline data that can be used as part of an integrated AMR surveillance system and can facilitate the evaluation of interventions used to prevent and control drug resistance.

Study procedure:

Participants in this study will be asked some questions, which I will record in the questionnaire

- The information required for this research in the questionnaire are all on factors contributing to AMR in broiler chicken.

Risks and discomforts

You may get tired when answering the questionnaire or may not want to give answers to specific questions, some questions which will be asked may appear to be sensitive but you are free to skip questions which you are not comfortable with. It is also possible that other neighbouring farmers may share what you talk about with them, but will ask everyone to respect each other's privacy.

Benefits

If you participate in this study, you will help us to determine factors associated with AMR Occurrence in broiler chickens so that it will facilitate the evaluation of interventions used to prevent and control drug resistance.

Compensation

They are no rewards or incentives offered for participation in this study. Participation is purely voluntary.

Confidentiality:

Any information that will be collected during this study will be kept confidential and be kept in locked cabinets and computer only accessed by Mirisho Robert and other team members. During data collection for the questionnaire no names shall be included and information collected will not be shared to the third part. The information gathered will be used for research purposes only.

Your alternatives to joining the study

You are entirely free not to participate in this study you agree to join as a participant and later change your mind, you are also free to leave the study and no longer be a participant of the study without any penalty. However, if you decide to participate, we will use the information collected from the point you left it. I therefore encourage you to participate for the betterment of your health and improve your livestock (birds) welfare.

Who do you call if you have questions or problems?

If you have any questions about this research, please contact Mirisho Robert C/O School of Veterinary Medicine, the University of Zambia, and Great east road campus. P.O Box 32379, Lusaka, Zambia. Email: robertmirisho@yahoo.com cell 0976946305/0954687121.

If you have questions about your rights as a study participant or if you feel you have not been treated fairly or if you have any concerns, you may contact the University of Zambia Biomedical Research and Ethics (UNZABREC), Ridgeway Campus P.O. Box 50110 Lusaka, Zambia. E-mail: unzarec@unza.zm and telephone 260-1-256067.

Participant statement

The above information regarding my participation in the study is clear to me. I have been given a chance to ask questions and have been provided with answers to my satisfaction. I will provide information on factors associated with AMR Occurrence in broiler chickens. I have been assured of confidentiality on any information shared. My participation in this study is voluntary.

Signature of participant.....

Date.....

Name & Signature of person obtaining consent

.....

.....

Date.....

Principal Investigator

Name: Robert Murisho

Phone number: 0976946305

Address: The University of Zambia School of Veterinary Medicine

Email address: robertmirisho@yahoo.com

Colinga cake ca kudziwa

Maphunziro awa ndikufuna kuona monwe kadoyo ka pena kalombo ka ARM mu nyumba ya nkuku ndiponso machitidwe oyeresa kasiwezedwe pambali ya ARM zipangangizo zaka mwaku phuzitse kuthesa makhwala. Ndodomeko yake

Uthengako mbari mu mahwairo afisdwa mayankho, omwe asalembedwa momfusidwa.

Uthenga wake ufunikira pa mphaiziro awa mwakufunsa comwe cilengesa kuti matenda la AMR ku nkuku za loni.

Kuipa kwake ndi mpindu ndipo mungathe kufokera po yonkha mafunso pena simufuna kaperaka mayako mu choonadi, mafunso ena azafutsindwa mozama koma ndimwe mungathe kulumpa kupita kwa ena mafunso yomwe muli choonadi nao, cili capafupi ku madziko omwe tilinayo pafupi monga alimi mungathe kungawana nao koma mufunsidwa kumapereka ulemu wina ndi mzaka mwa ndaga.

Ubwino

Ngati inu mutengako mbari pa kuphizira uku muzakhala othandiza ife momwe ARM ingathere ku nkuku za loni kuti tinga nkhole opuzitsa mu mafunso kasewezetsidwe mothesa makhwala.

Kulipiridwa

Kulimbe malipiro omwe mupasidwe pothegako mbari pa kudziwa.

Mwacitsisi

Uthenga uli yonse uzathengedwe nthawi yophuzira pomwe muzaika mwacitsisi ndiku khoma mu nyumba ya pa mwamba ya ma koputala osegula chambe ndi a mirisho Robert ndi ena omwe asewezela pa gulu limodzi. Pomwe mutenga uthenga osiyana ku mafunso, dzina iyenera kulembendwa ndipo uthenga othengedwa uzapatsidwa ka citatu. Uthenga uzathengedwe pa maphuziro ndi mphindu lake.

Pa kusankha kwanu po lora maphuziro

Munalowa momasuka musatengako mbari pa ma mphuziro a wa, ndipo ndimwe ololendwe kuleka maphuziro popanda kulipiridwa ndipo ngati mukufuna kutengako mbari, tizasesesa maphuziro omwe munatenga pomwe munalekira. Tikulimbikitsani inu omwe othengako mbari pa nkhani za umoyo pakuthesa kapena kathetheza mbalame.

Mungaitane ndani ngati muli ndifunso kapena mabvuto

Ngati muli ndi mafunso monga mwakudziwa za maphuzira muyenera kutuma kwa a Mirisho Robert c/o sukulu la Nyama za umoyo kapena mankwala, sukulu lalikulu la

Zambia, ipezeka njira la kumumawa P.o Box 32379, Mzinda wa Lusaka Zambia Email: robertmirisho@yahoo.com cell 0976946305/0954687121.

Ngati muli ndi funso pa kuphuzira bwino, ndinu omasuka kunena ngati simuna landiridwi bwino kapena colinga cina. Mungatume ku sukulu lalikulu la Zambia yomwe imayanginira za makhwala, maphuziro ndi zina (UNZABREC)

Utengaka mbari Zayo

Utenga omwe wapasadwa kwa inu kuthengako mbari pa maphuziro zoonadi kwa inu ndapasadwa ndanga kufunsa momwe matenda ya AMR agathele ku Nkhuku za Ioni. Ndipo na simikisa kuti uthenga usapitaponse-ponse kwa ine, pa kuthenga mbari pa maphuziro.

Signature of participant _____ Tsika

Dzina ndi signecha la munthu

omwe _____

Tsiku: _____

8.3. Appendix 3: Ethical clearance