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Antibiotic Use in Poultry Production in Selected Districts of East Showa Zone, Central Ethiopia: From Antibiotic Stewardship Perspective

[1]Mezene Woyessa, [2]Getahun E. Agga, [3]Balako Gumi, [4]Dinka Ayana and [5]Gezahegn Mamo

[1]School of Veterinary Medicine, Wollega University, P.O. Box: 395, Nekemte, Ethiopia
[2]USDA, Agricultural Research Service, Food Animal Environmental Systems Research Unit, 2413 Nashville Road, B-5 Bowling Green, KY 42101, USA
[3]Aklilu Lemma Institute of Pathobiology, Addis Ababa University, P.O. Box: 1176, Addis Ababa, Ethiopia
[4]College of Veterinary Medicine and Agriculture, Addis Ababa University, P.O. Box: 34, Bishoftu, Ethiopia

Abstract: Misuse and overuse of antibiotics is a primary contributor for the development of antibiotic resistance. The World Health Organization estimates that in the past decade the number of deaths attributed to antibiotic resistant bacteria exceeded the combined number of deaths due to influenza, human immunodeficiency virus and traffic accidents. Antibiotic stewardship plays a major role for the control of antibiotic resistance. For the assessments of antibiotic usage on the poultry farms, structured questionnaire surveys and in-depth interviews with poultry producers, poultry managers and key-informants (veterinarians, animal production experts working on the farm) were performed. All farms used one or more antibiotics and administered them mainly through feed/water. Tetracycline (100% of farms) and sulfadiazine + trimethoprim (94.1%), fluoroquinolones (41.5%) and cloxacillin + ampicillin (29.1%) were the most frequently used drugs. Antibiotics were used for disease treatment (100% of farms), for disease prevention (56%) or for growth promotion (32.2%). Diseases for which antibiotics were frequently used include Newcastle disease (100% of farms), Gumboro disease (54.4%), coccidiosis (53.4%), Marek's disease (49.7%), foul typhoid (45.9%) and foul pox (39.2%). Majority (61.9%) of the farms obtained antibiotics by prescription from veterinarian, over the counter as self-prescription (32.2%) or as recommended by friends with prior experience (11.9%). Veterinary pharmacies (100% of farms), veterinary clinic (51.0%), human pharmacies (26.8%) and open market (16.2%) were the sources of antibiotics. Although on 37.9% of farms antibiotics were administered by veterinary professionals, majority of the farms administered antibiotics by themselves based on the drug labels or as directed by a prescriber or pharmacist. This study clearly demonstrated lack of awareness about antibiotic use that in turn can lead to the propagation of antibiotic resistant bacteria and foster accumulation of antibiotic residues in poultry products in the study area. There is also lack of polices and regulatory system on antibiotic use, in the country as a whole. Antibiotic stewardship programs such as removing the use of antibiotics for growth promotion, open market access as well as increasing veterinary and diagnostic services will help to mitigate antibiotic resistance.

Key words: Antibiotic Use · Poultry · Antibiotic Stewardship · Antibiotic Resistance

INTRODUCTION

The problem of bacterial resistance to antibiotics is a burning question throughout the world. According to an estimate by the World Health Organization (WHO), during the past decade the number of deaths caused by some resistant strains exceeded the combined number of deaths caused by influenza, human immunodeficiency virus and traffic accidents [1]. Over the past few decades, new antibiotics have not been produced and almost all known

Corresponding Author: Mezene Woyessa Bussa, School of Veterinary Medicine, Wollega University, P.O. Box: 395, Nekemte, Ethiopia.

antibiotics are increasingly losing their activity against pathogenic microorganisms [2]. The levels of multi-drug resistant bacteria have also increased [3-5]. It is known that worldwide, more than 60% of all antibiotics are used in animal production both for therapeutic and non-therapeutic purposes [6].

According to the World Organization for Animal Health (OIE) annual report on antimicrobial agents intended for use in animals [7], in many countries antibiotics were widely available virtually with no restriction or control. Of 143 OIE member countries and three non-OIE member countries assisted through the OIE performance of veterinary service pathway, as of November 2017, seven countries did not yet have completed relevant legislation to ensure appropriate condition for import, distribution, manufacturing and use of veterinary medicinal products including antimicrobial agents. As a result, these products circulate freely, like ordinary goods and are often falsified or substandard. Inappropriate use of antimicrobials creates condition for high risk for the development and spread of antibiotic resistance [8-10]. The rapid surge in the development and spread of antibiotic resistance is the main cause for concern [11]. In recent years, enough evidence highlighting a link between excessive use of antimicrobial agents and antibiotic resistance from animals as a contributing factor to the overall burden of antibiotic resistance has emerged [12-14]. The extent of usage is expected to increase markedly over coming years due to intensification of farming practices in most of the developing countries[15]. The main reasons for the use of antibiotics in food-producing animals include prevention of infections, treatment of infections, promotion of growth and improvement in production in the farm animals [16, 17].

Poultry is one of the most wide spread food animal industries worldwide. Chicken is the largest farmed animal species, with over 90 billion tons of chicken meat produced per year [18]. Large amounts of antimicrobials are used to raise poultry in most countries. Large number of such antimicrobials are considered essential in human medicine. Indiscriminate use of essential antimicrobials in animal production is likely to accelerate the development of antibiotic resistance in pathogenic and commensal bacteria. Antimicrobial resistance(AMR) would result in treatment failures, economic losses and could act as source of gene pool for transmission to humans [19]. In addition, there are also human health concerns about the presence of antimicrobial residues in meat, eggs and other animal products [20].

It has been planned to increase the total broiler production by 235% and the total egg production by 828% from 2015 to 2020 through improved family poultry as semi-scavenging crossbreeds and working towards commercial specialized layer and broiler operations in Ethiopia [21]. Even though the goal of the plan is to reduce poverty and improve household nutrition as well as to increase national income, such transformative production systems may lead to unrecognized risks to human health in terms of antibiotic resistance and drug residues as a result of intensified production systems.

While antibiotic resistance is recognized as a ‘one health’ issue and international organizations such as WHO, OIE, Food and Agriculture Organization of the United Nations (FAO) have been adopting global action plan to combat antibiotic resistance [22], data on antibiotic use in poultry production system in Ethiopia is limited. Despite limited antibiotic resistance studies in poultry, studies assessing the knowledge, attitude and practices related to antibiotic use in poultry farms are lacking in Ethiopia. Our objective was to collect baseline data on the use of antibiotics in poultry production and to provide a greater understanding of the potential impact of veterinary practices on public health. We used structured and semi structured questionnaire survey in major poultry producing districts in East Shewa Zone of Oromia, Ethiopia.

MATERIALS AND METHODS

Relevance and Description of Study Area: Almost all large-scale commercial poultry farms in Ethiopia are found in East Shewa Zone of Oromia regional state. In addition, there are also emerging intensive small-scale poultry farms in the urban and peri-urban areas in which small number of exotic breeds of chicken (50-1, 000) are produced along commercial lines using relatively modern management methods [23]. Booming poultry production in this area provides a major source of income in and around the major cities including Bishoftu, Dukam, Adama and Modjo. Most of the supply of eggs and dressed poultry meat to Addis Ababa supermarkets come from small and large commercial farms located in these cities. The study was conducted in Ada’a, Akaki, Adama and Lume districts because of large concentrations of poultry farms in the area.

East Shewa Zone is situated from 38° 03' to 40° 05' E longitude and from 7° 04' to 9° 10' N latitude covering a total land area of about 13766.5 km^2. The altitude of the study area ranges from 538 to 3, 101 m above sea level.

East Shewa Zone is characterized by semi-arid and sub-humid climate based on the moisture index climate classification. Considering the long-term average seasonal (June - September) rainfall, the area receives 458-518 mm rain. Based on meanannual rainfall and temperature of the area, the major climatic classes of the zone are dry climate and tropical rainy climate [24].

Questioner Survey: For the assessments of antibiotic usage on the poultry farms, structured questionnaire surveys and in-depth interviews with poultry producers, poultry managers and key-informants (veterinarians, animal production experts working on the farm) were performed from January, 2019 to November, 2020. Questionnaire survey focusing on the demography of the respondents, farm characteristics, common antibiotics used, common poultry diseases encountered, antibiotics used (types, doses, administration routes, formulation, reason for use, time and duration, etc.) and a researcher's own observation were used to identify indicators for the use of antibiotics on the farms. It was planned to include 100-120 respondents from each district based on the availability of poultry farms from every poultry production system. All large and medium scale commercial type poultry farms were included due to their limited number and one respondent from each farm based on their responsibility for farm management were selected. The respondents owning backyard poultry were included if they had more than 10 chicken based on the information gained from the local development agencies.

Data Analysis: Data collected through the questionnaire survey were entered into Microsoft Excel, cleaned, organized and sorted. Data were then coded and imported into IBMSPSS statistics 22 for data analysis. Descriptive analysis was done to generate frequencies and percentages for an outcome variable from the independent variables (demographic characteristics of the respondent, farm characteristics, common antibiotics used, major poultry disease and antibiotic use practice and administration).

RESULTS

Demographic Characteristics of the Respondents: As shown in Table 1, majority (81.4%) of the poultry farmers interviewed were male, were 31-50 years of age (48.4%), completed primary school (35.8%), secondary school (31.2%), or post-secondary education (26.0%). Bishoftu and Adama are the potential cities where poultry production has been growing. Almost all poultry farming activities were carried out by the farm owners (88.9% of farms). About 41.2% of the respondent's had over 10 years of experience in poultry production.

Over half of the respondents (56.4%) were rearing different improved breeds of chicken for commercial purpose while the rest of the respondents (43.6%) had different local breeds with less than 100 chicken being reared under backyard production system for subsistence life. The commercial producers kept either layers (27.8%) or broilers (24.5%) by using semi-intensive (44.6%) and intensive (8.8%) production system. Very few farms (1.3%) were using cage system of housing while more than half of the producers (56.2%) were using deep litter system of housing (Table 2). The backyard scavenging production systems were using different housing system (traditional type) different from the two commercial production systems.

All the poultry farms (n=388) used one or more antibiotics on their farms and administered mainly by mixing them with feed or water (Personal observation and information from the leaflet). The antibiotics used are in different commercial products with a wide variety of trade names (not reported in this study for ethical reasons). Tetracycline group (oxytetracycline + doxytetracycline) (100 % farms) and sulfadiazine + trimethoprim (94.1%) and fluroquinolones (enrofloxacin + norfloxacin) were the most frequently used antibiotics (Table 3).

Antibiotics were used on all farms for different purposes. All farms frequently used antibiotics for the treatment of diseased chicken; 50% for disease prevention; 32.2% for growth promotion while 98.7% reported using antibiotics for all three purposes i.e. for treatment, prevention and growth promotion (Figure 1).

The commonly encountered poultry diseases which necessitated frequent use of antibiotics were Newcastle disease (100%), Gumboro disease (54.4%), coccidiosis (53.4%), Marek's disease (49.7%), Fowl typhoid (45.9%) and Fowl pox (39.2%) in decreasing order (Table 4). Almost three-fourths (71%) of the diseases encountered in the farms were attributed to viral diseases (Figure 2).

Even though all (100%) farms reported getting antibiotics from veterinary drug shops, in addition they also obtained from public veterinary clinic (51.0%), human pharmacies (26.8%) and open markets (16.2%) (Table 5). While the majority (61.9%) of the farms reported obtaining antibiotics by prescription or recommendation by veterinarians or veterinary assistants at the drug stores or hired by the farms, 32.2% reported self-prescription and 11.9% of farms reported using antibiotics based on advice from friends or other farm owners with previous experience.

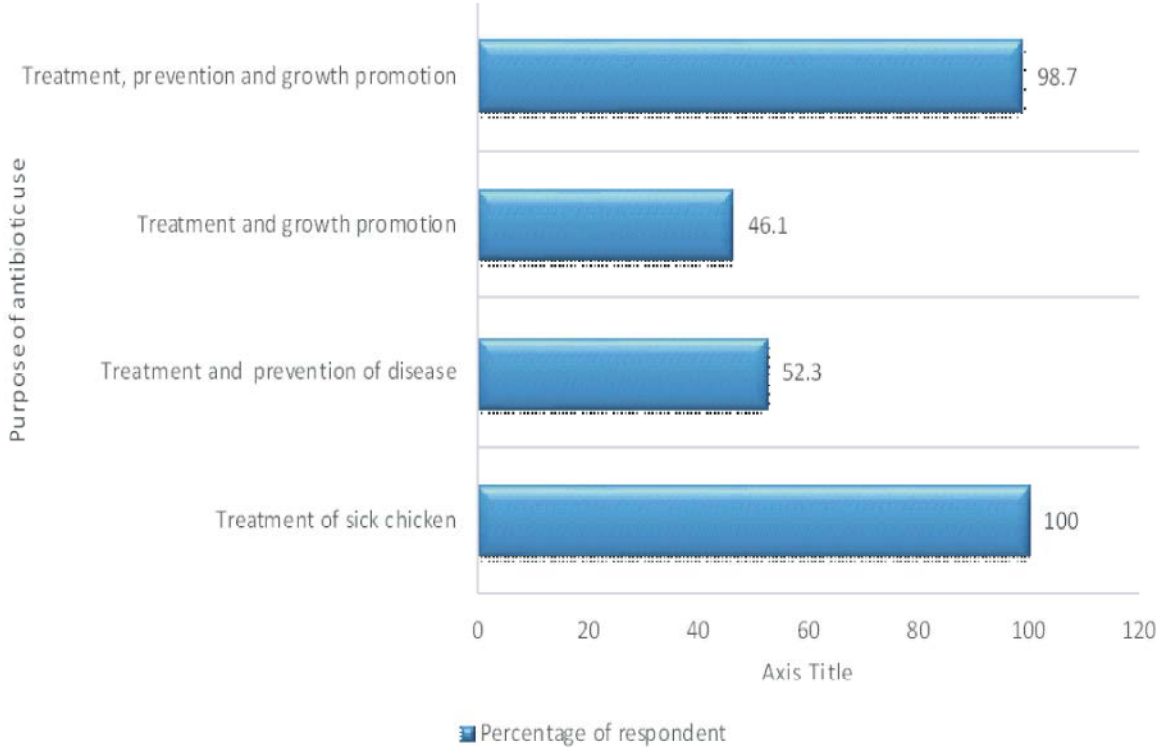

Fig. 1: Proportion (n=388) of farmers by the purpose of antibiotic use

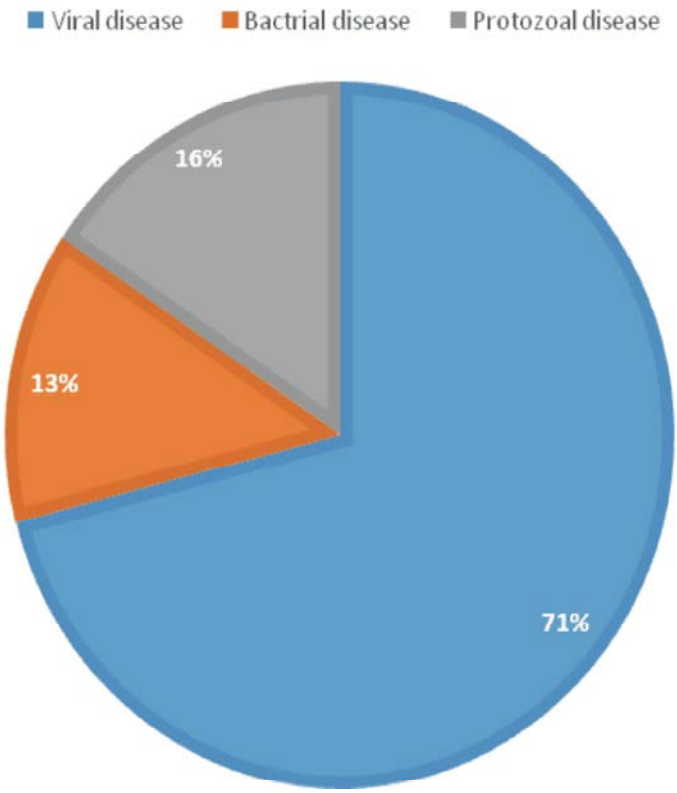

Fig. 2: Percentages of the frequency of disease occurrence by causative agent

Table 1: Demographic characteristics of poultry farm respondents

Characteristics of the respondent		No of respondents	Percentage (n=388)
1.Location:			
District	Town/kebele		
Ada'a	Bishoftu	83	21.4
	Udde	37	9.5
Akaki	Dukam	36	9.3
	Ensilale	63	16.2
Lume	Modjo	28	8.5
	Tsededilima	33	7.2
Adama	Adama	71	18.3
	Adulala hate haroret	37	9.5
2.Age category:			
	Less than 30 years	107	27.6
	31-50 years	188	48.4
	Greater than 50 years	93	24.0
3.Sex:	Male	316	81.4
	Female	72	18.6
4.Education level:			
	Cannot write and read	27	7.0
	Primary school (1-8)	139	35.8
	Secondary school (9-12)	121	31.2
	TVET	92	23.7
	University graduate	9	2.3
5.Work experience:			
	Less than 5 years	126	32.5
	5-10 years	102	26.3
	Greater than 10 years	160	41.2
6.Responsibility of the respondent in poultry farms:			
	Farm owner	345	88.9
	Hired manager	43	11.1

Table 2: Characteristics and/or management of the poultry farms

Characteristics and/or management	No of respondents	Percentage (n=388)
1.Chicken breed		
Local	169	43.6
Exotic	219	56.4
2.Number of chicken		
Less than 100	181	46.6
101-1000	173	44.6
More than 1000	34	8.8
3.Production type		
Layers	108	27.8
Broilers	95	24.5
Dual purpose	185	47.7
4.Production system		
Backyard scavenging	181	46.6
Semi-intensive	173	44.6
Intensive	34	8.8
5.Housing type		
Deep litter system	218	56.2
Cage system	5	1.3
Traditional housing	165	42.5

Table 3: Types and frequency of antibiotic use in poultry farms

Antibiotics	No of Respondent	Percentage (n=388)
Oxytetracycline + doxytetracycline	388	100.0
Lactaclox(Cloxacillin+ ampicillin)	113	29.1
Amoxycillin	85	21.9
Colistinsulphate	65	16.6
Enrofloxacin + norfloxacin	161	41.5
Sulfadiazine+ trimethoprim	365	94.1
Tylosin	55	14.2

Table 4: Common infectious diseases encountered at the poultry farms within the past one year

Disease	Disease category	Number of farms	Percentage (n=388)
Newcastle	Viral	388	100.0
Gumboro disease	Viral	211	54.4
Marek's disease	Viral	193	49.7
Fowl typhoid	Bacterial	178	45.9
Fowl pox	Viral	152	39.2
Coccidiosis	Protozoal	207	53.4

Table 5: Source, prescription and administration of antibiotics on the poultry farms

Questions	Frequency of respondent	Proportion (n=388)
1. From where you get drugs used on your poultry farm?		
Veterinary drug shop	388	100.0
Public Veterinary clinic	198	51.0
Human pharmacy	104	26.8
Open market/hawkers	63	16.2
2.Who prescribe (recommend to the use) antibiotics in your farm for intended use?		
Animal health personnel	240	61.9
Friends with experience	46	11.9
Self-prescription	125	32.2
3.Who administer antibiotics to your chicken?		
Self-administer	297	76.5
Animal health personnel	147	37.9
4. How is an antimicrobial dosage determined before usage in birds in your farms?		
After reading a leaflet	188	48.5
From the prescription paper	109	28.1
With assumption	113	29.1
5.What is/are the common route of antibiotic administration?		
Injection	19	4.9
In feed or water	388	100.0
Drop into the mouth	72	18.6

Only 147(37.9%) of the farms reported that antibiotics were administered by animal health workers. However, on over whelming majority (297/388, 76.5%) of farms antibiotics were administered by farm owners themselves based on instruction given by veterinary drug stores or by prescriber (28.1%), after reading a leaflet insert (48.5%),

or by assumption based on prior experience (29.1%). All (100%) farms reported that they incorporate antibiotics in to either feed or water, but only few intensive farms had sensitive balance or measuring cylinder for accurate dosages (Table 5).

DISCUSSION

Antibiotic usage in farm animals has raised many concerns among which the potential transfer of antibiotic resistant pathogens from animals to humans. This transfer can have severe health implications including treatment failures, which may lead to death and increased cost of human therapies [25]. Furthermore, overuse of antibiotics leads to the occurrence of harmful residues in edible poultry tissues (meat and eggs) and other animal products, which consequently are detrimental to health when such products are consumed by the public [26]. In low and middle income countries, the use of antimicrobials in food producing animals is not well regulated which can contribute to the development and spread of antibiotic resistant bacteria [27]. This study is the first knowledge and practice-based study in central Ethiopia and the results provide vital information on the potential risk factors that can increase the occurrence and spread of antibiotic resistance. The findings also have implications for public health in other parts of the country and the world since there is unlimited movement of people, goods and animals which provide a ready environment for the propagation and spread of antibiotic resistant bacteria [28].

The most frequently used antibiotics observed in the present study were tetracyclines, sulfadiazine and trimethoprim combination, fluroquinolones, amoxycillin, colistinsulphate and tylosin (Table 3). Our finding is consistent with that of GumpholWongsuvan *et al*. [29] from Thailand in poultry farms and Adebowale *et al*. [30] from Nigeria in commercial poultry laying hens, who reported the use of enrofloxacin, amoxicillin, colistin, doxycycline and oxytetracycline. Multidrug resistance to the listed antibiotics has been reported in bacteria of food animal origin in Ethiopia and other countries [31, 32] and the studies have attributed this to the uncontrolled use of antibiotics by farmers because of a lack of antibiotic control policies specially in developing countries [33].

Tetracycline, amoxicillin, fluroquinolones and colistin are highly important antimicrobials in human medicine [34]. The use of quinolones in poultry is worrisome as this drug is classified by the WHO as a priority for risk management and as critically important drug for the treatments of enteric diseases in humans and has been associated with increased resistant bacteria in humans exposed to it from farm animals. Several countries have therefore banned fluoroquinolone use in poultry. Since 2003 fluoroquinolones were withdrawn for use in animals in Denmark and it has also been banned for poultry production in the United States since 2005, BEUC [35]. The increased use of this drug has been attributed to several factors that include its broad-spectrum activity, its easy application in water and feed and its lack of restrictions. Colistin, another critically important drug, is currently considered to be the last defense against multidrug resistant bacteria especially those resistant to carbapenem antibiotics. The increased use of colistin in livestock production in China resulted in high selection pressure leading to the acquisition of the mobilizable colistin resistance *mcr-1* gene by *Escherichia coli*. China recently banned the use of colistin as a growth promoter and released a mandate controlling the use of colistin only for the treatment of diseases in animals [36].

The antibiotic usage pattern observed in this surveys showed that poultry farmers in the study area heavily relied on antimicrobial medications. Most farms used combinations of antibiotics and all farms used one or more antibiotics for therapeutic (100%), prophylactic (56%) and to a lesser extent for growth promotion (Fig. 1). Our result is higher than similar study from Nigeria [37] in which antibiotics were commonly administered for therapy (36.2%), prophylaxis (29.3%) and growth promotion (7%). Another study from Nigeria [38] reported that 86% of the poultry farms used antibiotics for growth promotion. The dependence of poultry farmers on antibiotics for therapeutic and/or prophylactic purposes may also be due to poor environmental sanitation, unhygienic practices, lack of biosecurity and other management inadequacies leading to increased exposure to bacterial pathogens [39]. Ensuring these measures is important for judicious use of antibiotics.

Disease was listed as the most important problem by the poultry producers, reducing both the number and productivity of the birds [40]. Some farmers had given up rearing poultry because of an increase in disease problems. Even though it was difficult to identify poultry diseases based only on clinical signs and symptoms, the most common diseases complained by the farmers were Newcastle, Gumboro disease, Marek's disease, Fowl typhoid, Fowl pox and coccidiosis (Table 4). The overall proportion of the disease caused by viral agent comprised about 71% as indicated in Fig. 2. All respondents

including veterinarians recommended administration of antibiotics following any disease outbreak whether it was bacterial, viral or protozoan origin purposefully to combat secondary bacterial complications by animal health professionals or unknowingly by poultry producers in response to disease outbreaks. This is not in line with the OIE guideline on responsible and prudent use of antimicrobial agents in veterinary medicine [41]. According to OIE guideline on judicious use of antimicrobials, viral, fungal and other non-bacterial infections are not treated with antimicrobials. Veterinarians must pay special attention to disease outbreaks to determine if and when antimicrobial therapy is warranted. Every effort should be made to address disease outbreaks with other disease management strategies prior to the initiation of antimicrobial therapy. Mortality and morbidity on farms must be closely monitored; diagnostic evaluations are performed to confirm bacterial involvement prior to antimicrobial therapy.

The veterinary drug supply chain starts from importers in Addis Ababa (the capital city of the country) and finally to veterinary drug shops and animal health posts found in each district [42]. In the current study, poultry farmers obtain antibiotics from veterinary drug stores (100%) and additionally from public veterinary clinic (51.0%), human pharmacy (26.8%) and open market (16.2%) (Table 5). This is in agreement with Takele *et al.* [43], who reported the presence of drug venders in Bishoftu town who distribute medicines in a packet in direct sunlight, violating the drug handling and storage recommendations by the WHO [44] and possibly causing substantial changes to the drug active ingredients. This study also advances our understanding of the factors that contribute to antimicrobial misuse and the results show there is a need for collaboration between animal agriculture and the public health sectors to assess risk factors, develop and distribute protocols to monitor the use of antibiotics and improve antimicrobial resistance surveillance in animals and humans.

In this study although 61.9% of the respondents, reported that antibiotics were prescribed or recommended for use by veterinarians and veterinary assistants, the rest of the respondents (38.1%) used antibiotics without prescription based on their own and their friends past experiences (Table 5). This is relatively better than the report of Dishon Muloi *et al*. [45], in which all veterinary drug stores sold antibiotics without a prescription in Nairobi, Kenya. The knowledge gap is relatively higher among Ethiopian poultry producers as compared to the report of Adebowale *et al*. [30] in commercial poultry laying hens in Nigeria in which 78.6% agreed that antibiotics used in poultry should be regulated and used when prescribed by veterinarians only. To minimize the risk of resistance selection during veterinary therapeutic use and to safe guard the future utility of antibiotics in veterinary medicine, a document titled 'Principles for the Responsible Use of antibiotics in Veterinary Medicine', was published by concerned global organizations like WHO, OIE and FAO [46]. According to these principles, administration on prescription-only and under veterinary supervision were recommended.

It is probable that, the method or regimen of drug administration has a significant influence on the likelihood of resistance strains emerging in an individual host [47]. The vast majority (76.5%) of the respondents administered antibiotics by themselves based on the instructions given from the veterinary drug shops or prescriber, long years' of experience and using an information on the leaflet insert about the dosage, duration and route of administration (Table 5). Treating only sick individual animals reduces the population of bacteria exposed to antibiotics. However, this is not always practical, especially during disease outbreaks because of labor requirements, expense, rapidity of disease spread in intensively reared animals and for animal welfare reasons or stress of catching and restrain [48]. To overcome this challenge, almost all antibiotics ready for poultry use are formulated for use as in-feed and in-water. But making a balanced ratio between the drug and feed/water is an area of irrationality in antibiotic use. Only few intensive poultry farms had sensitive balance or measuring cylinder to make a correct ratio between the drugs and feed/water. Thus, lower concentration (lower doses) and longer duration of exposure (course) appear to provide the highest selection pressure for resistance [49]. Resistance is more likely to be selected where the concentration and diversity of bacterial population is high, namely in some areas of normal flora such as bowel, mouth and throat. At normal flora site with mixed bacterial population there is the additional risk of selecting for resistance in potential pathogens by the transfer of resistance genes from bacteria sharing that niche [50].

The other risk factor for the development of resistance may be adjusting the amount of antibiotics to the total number of chickens that need therapy or prophylaxis. The respondents also mentioned that observation of a single sick chicken can lead to a blanket prescription of antimicrobials to the entire flock at the farms because of the fear that, it may be followed by an

outbreak. This is not consistent with a theoretical complication of administrating antibiotics in the feed in the variable dose that each animal may receive. Poor feeders, especially those that are ill, may naturally limit their food intake and thus receive lower doses than intended [51]. According to the respondents, duration of antibiotic administration is dependent on the duration of clinical sign of the disease. This means, as soon as the clinical sign disappears, antibiotic administration is stopped. The low level of knowledge among the respondents is not surprising in this geographical context. Since low and middle income countries are often more challenged in allocating adequate resources and instituting policies to address the gaps in knowledge and practices in food production industries. Antibiotic use in food animals remains unregulated, leading to inappropriate use of the drugs and widespread increase in antibiotic resistance [52]. Similar findings of low knowledge of antibiotic stewardship have been reported in countries such as in Vietnam [53].

CONCLUSION

Antibiotics are limited resources. The more antibiotics are used today, the lesser it is likely they will still be effective in the future. Antibiotic resistant infections are increasing in humans, animals and the environment. Antimicrobial resistance is considered one of the major threats to the world's health. This study clearly demonstrated lack of awareness about antibiotic use that in turn can lead to the propagation of antibiotic resistant bacteria and foster accumulation of antibiotic residues in poultry products in the study area. The misuse and overuse of antibiotics in poultry production is a major source of the problem observed. Antibiotics identified by WHO, as critically important for human treatment are commonly using in poultry for treatment, prevention and growth promotion. About half of the respondents confirmed as antibiotics used without prescription based on their own and their friends past experiences. The vast majority of the respondents administered antibiotics by themselves based on the instructions given from the veterinary drug shops. Almost all antibiotics ready for poultry use are formulated for use as in-feed and in-water. Only few large scale commercial poultry farms do have sensitive balance to make a correct ratio of antibiotic to feed/water. The respondents also mentioned that observation of a single sick chicken can lead to a blanket prescription of antimicrobials to the entire flock at the farms because of the fear that, it may be followed by an outbreak. There is also lack of polices and regulatory system on antibiotic use, resistance and residues in the country as a whole. Surveillance and research on antibiotic use and antibiotic resistance are very infant. Maintaining the status quo and continuing to misuse antibiotics as we have been doing will jeopardize our ability to effectively treat infectious diseases in the future. National authorities, veterinarians, physicians and farmers all have a role in "preserving the power of antibiotics". Perhaps the single most important action needed to greatly slow down the development and spread of antibiotic-resistant infections is to change the way antibiotics are used. Therefore, there is an urgent need for action on the issue of antibiotic resistance particularly in developing countries. National regulation and improved surveillance are needed to ensure that antibiotics are used prudently and are not routinely fed to animals for nontherapeutic purposes.

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