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Knowledge and Practices of Poultry Farmers Contributing to Antimicrobial Resistance in Nsukka

Nijerya, Enugu Eyaleti, Nsukka'daki Tavuk Yetiştiricilerinin Antimikrobiyal Dirence İlişkin Bilgi ve Uygulamaları

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ABSTRACT

Antimicrobial use in animal husbandry has been ascribed to antimicrobial resistance (AMR) gene selection and build-up in treated animals' microbiota. This ends up in the food chain and contributes immensely to drug resistance in the society. Studies on risk factors for antimicrobial resistance in poultry can be useful in providing data and designing appropriate control measures. This study therefore assessed the knowledge and practices affecting AMR in poultry farms in Nsukka, Enugu State, Nigeria. A semi-structured and pre-tested questionnaire was administered to 44 poultry farmers in the study area. Among the farmers, 90.91% were aware that excessive antimicrobial use contributes to the emergence of antimicrobial resistance. More than 70% of the farms lacked basic hygiene and biosecurity facilities/measures. Sixty percent of the farmers buried their dead birds, all (100%) packaged their dung for subsequent land disposal, and 50% dumped expired, unused/used drug packets in the nearest bush. About 65, 100, and 90% of antimicrobial usage were for growth promotion, prophylactic purposes, and therapeutic purposes, respectively. Finally, only 18.18% observed withdrawal periods before disposal of their products. The study found that the farmers used non-therapeutic antimicrobials as a "simple fix" or to compensate for poor management practices. There is need to further educate the farmers on the contributions of their activities to drug resistance in the society.

Keywords: Antibiotic use, antimicrobial resistance, knowledge, poultry farm, practices

ÖZ

Hayvancılıkta antimikrobiyal kullanımı, antimikrobiyal direnç (AMR) gen seçimine ve tedavi edilen hayvanların mikrobiyotasında birikime neden olmaktadır. Bu durum gıda zincirinde son bulmakta ve toplumdaki ilaç direncine büyük ölçüde katkıda bulunmaktadır. Kanatlı hayvanlarda antimikrobiyal direnç için risk faktörleri üzerine yapılan çalışmalar, veri sağlama ve uygun kontrol önlemlerinin tasarlanması açısından faydalı olabilir. Bu çalışmada Nijerya'nın Enugu Eyaleti, Nsukka'daki tavuk çiftliklerinde AMR'yi etkileyen bilgi ve uygulamalar değerlendirilmiştir. Çalışma alanındaki 44 tavuk yetiştiricisine yarı yapılandırılmış ve önceden test edilmiş bir anket uygulanmıştır. Yetiştiricilerin %90,91'i aşırı antimikrobiyal kullanımının antimikrobiyal direncin oluşumuna katkıda bulunduğunun farkındaydı. Çiftliklerin %70'inden fazlası temel hijyen ve biyogüvenlik tesislerinden/önlemlerinden yoksundu. Yetiştiricilerin %60'ı ölü tavukları gömmüş, tamamı (%100) gübrelerini daha sonra araziye atmak üzere paketlemiş ve %50'si son kullanma tarihi geçmiş, kullanılmamış/kullanılmış ilaç paketlerini en yakın çalılık araziye atmıştır. Antimikrobiyal kullanımının yaklaşık %65, %100 ve %90'ı sırasıyla büyümeyi teşvik etme, profilaktik amaçlar ve tedavi amaçlıydı. Son olarak, yetiştiricilerin sadece %18,18'i ürünlerini imha etmeden önce atılım sürelerine dikkat etmiştir. Çalışma, yetiştiricilerin "basit bir çözüm" olarak veya kötü yönetim uygulamalarını telafi etmek için non-terapotik antimikrobiyaller kullandığını ortaya koymuştur. Toplumdaki ilaç direncine katkılarının farkında olmaları için yetiştiricilerin daha fazla eğitilmesi gerekmektedir.

Anahtar Kelimeler: Antibiyotik kullanımı, antimikrobiyal direnç, bilgi, tavuk çiftliği, uygulamalar

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INTRODUCTION

Poultry meat and eggs provide a substantial portion of the dietary needs of the world's rapidly growing population and remain the world's foremost sources of animal protein.[1] Over the last 35 years, global poultry meat and egg production, as well as sales of poultry products, have witnessed significant increase.[2,3] In Nigeria, there are about 180 million poultry birds generating 650,000 metric tons of eggs and 300,000 metric tons of meat every year, with approximately 13 million families engaging in poultry production.[4] As a result, the poultry sector in Nigeria is an important source of animal protein, accounting for about 10% of agricultural gross domestic product (GDP) and 3.1% of national GDP.[4] In addition, poultry manure has become an inseparable part of agriculture in improving soil fertility and optimum crop yield.[5] Increased demand for poultry products therefore, has resulted in many poultry farmers resorting to unwholesome use of antimicrobials.[6] Presently, antimicrobials are used for both curative and prophylactic purposes.[7] This use of antimicrobials for optimal productivity has resulted to drug residues in the tissues and organs of the treated animals, even crops[8] which eventually reach the human population via the food chain.[9] Exposure to drug residues through poultry products has been connected to allergic reactions, changes in intestinal microbiota, and, eventually, the emergence of antimicrobial resistance (AMR) among the consumers.[10]

Antimicrobial resistance naturally occurs when microorganisms are exposed to antimicrobials which exerts selection pressure on them thereby resulting to a loss of sensitivity to such drugs.[11, 12] It is a key threat to both animal and human health and has major ramifications for public health due to the evolution of multi-drug-resistant pathogens that have become a major source of concern to veterinarians, physicians, and food microbiologists.[13] The increased use of antimicrobial agents as prophylactic and therapeutic agents has been linked to an increase in the prevalence of antimicrobial-resistant Enterococcus species,[14] as well as other resistant bacteria organisms. Humans usually are exposed to these resistant pathogens by handling and consuming contaminated products. Once acquired, such resistant bacteria populations invade intestinal tract and propagate the genes responsible for antibiotic resistance to different bacteria in the endogenous microflora, making effective bacterial infection treatment more difficult.[14]

In Nigeria, the administration of antibiotic formulations with multivitamins and minerals is common in the poultry business.[4] The country's challenges in effectively reducing excessive antimicrobial usage have been attributed to several factors, including the unrestricted sale of antibiotics without prescription, inappropriate or sub-therapeutic use in food animals, proliferation of unregulated pharmacies, and dearth of information regarding antimicrobial resistance and poor knowledge of proper antimicrobial usage.[15]

Several studies have documented the perceptions of antimicrobial resistance risk among poultry farmers in some parts of the world.[16,17] and likewise in Nigeria.[4,15] However, there is a dearth of information on the above subject matter among poultry farmers in Nsukka, Enugu State, Nigeria. This study was therefore designed to determine the knowledge and practices concerning antimicrobial resistance among poultry farmers in Nsukka, Enugu State, Nigeria.

MATERIALS AND METHODS

Study Area

The study was conducted in Nsukka, Enugu State, Nigeria. The town is geographically located at coordinates 6°27’9.60’’N 7°30’37.20’’E.[18] In Nsukka town, there is a sizeable number of poultry farmers who rear commercial birds most of whom belong to the local poultry association (The Nsukka Poultry Farmers Association). The town, as well, harbors a big poultry market, patronized by numerous neighboring towns and the University of Nigeria, Nsukka community.

Study Design, Sample Size Determination, and Sampling of Farms

This cross-sectional study undertook a survey among poultry farmers in Nsukka, Enugu State, Nigeria, between August and December 2019. A comprehensive list of poultry farms was obtained from the chairman of the Nsukka Poultry Farmers Association. With the list of the farms obtained from the chairman as sampling frame, simple random sampling by balloting was conducted targeting 10% of the farms. The managers/representatives of each chosen farm were contacted via mobile phones. The study was thoroughly explained to the respondents and with their anonymity and confidentiality assured, oral informed consent was obtained. Subsequently, an interviewer administered questionnaire was used to elicit information from the respondents on a visit to each farm. Only farmers that belonged to the association and gave consent were recruited for the study. Poultry farmers that were not members of the famers association and those that did not give consent were excluded. In all, forty-four (44) poultry farms and farmer’s/farm managers were surveyed in this study.

The Questionnaire Survey

A semi-structured and pretested questionnaire was used to obtain data on demographical characteristics, knowledge of appropriate and the consequences of inappropriate use of antibiotic in food-producing animals; the types and conditions of antimicrobial usage, as well as husbandry and biosecurity practices in each poultry farm. The questionnaire was translated to the local dialect for the benefit of those not fluent in English language and administered to each respondent.

Scoring of Responses

There were four questions in the knowledge survey, and three (75%) correct responses were considered as good, while less scores were considered poor knowledge.

In the practices section, out of the fifteen questions on biosecurity measures subsection, scores of ≥10 or less were regarded as "good" or "poor", respectively. For the class of antimicrobial agent used, giving ≥4 or <4 correct answers out of eight questions were regarded as good or poor scores, respectively. Furthermore, ≥ 3 or < 3 correct responses out of five questions regarding conditions for antimicrobial usage were scored good or poor, respectively. Correct responses ≥2 or < 2 out of three questions was regarded as good or poor methods of disposal of used or expired drug packets respectively. Correct responses of ≥ 4 or < 4 out of five questions were adjudged as good or bad practices with regards to the disposal of dead birds, respectively.

Approval for this study was obtained from the ethical committee of the Department of Veterinary Public Health and Preventive Medicine, Faculty of Veterinary Medicine, University of Nigeria, Nsukka (date: April 17, 2019, reference no: VPHPM/UNN/23/202).

Data Presentation and Statistical Analysis

Data from the survey were analyzed descriptively and presented in tables. Chi-square statistic was used to test for significant association between the sociodemographic characteristics of the respondents, and knowledge as well as practices concerning antimicrobial resistance (KAMR) in the farms visited. Furthermore, the factor score analysis was used as a part of the adjusted multivariate logistic regression analysis to determine the association with key themes regarding the respondents' demographics. Results were expressed as odds ratios (ORs) at 95% confidence intervals (95% CIs), and $P < .005$ used as the threshold for statistical significance. All statistical analysis was done using SPSS version 25 (IBM SPSS Corp., Armonk, NY, USA).

RESULTS

This study was undertaken to gain insight into the challenges, possible control measures given that at the moment there are no programs in place to combat drug resistance in domestic animals in Nigeria. The study was therefore conducted in 44 poultry farms which represent 10% of the farms in the study area.

Demographic Characteristics of the Respondents (poultry farmers) in Nsukka Area

The demographic characteristics of the respondents as shown in figure 1, showed that most of the farmers (72.73%) were males, and attained tertiary education level (81.82%). Approximately 41% of the farmers had 10 years' experience in poultry production, with 59.09% and 31.82% rearing layers and broilers, respectively. As it pertains to the sizes of the farms, 4.55% and 36.36% of the farms had more than 10,000 and fewer than 500 birds, respectively. All the farms (100%) engaged in intensive system of production, where 86.36% and 13.64% were of the deep litter and battery cage management systems, respectively.

Knowledge of Antimicrobial Resistance and Conditions of Antimicrobial Use Among Farms Sampled in Nsukka Area

Figure 2, depicts the farmers' knowledge of antimicrobial resistance. About 90.91% of them were aware that imprudent use of antimicrobial agents and non-observance of withdrawal period could result to antimicrobial resistance. Figure 3, summarizes the antimicrobial usage conditions observed in the poultry farms visited. While most of the farms (72.7%) sourced drugs from the veterinary pharmacies, in most cases (100 and 95.45%), the drugs were used for prophylaxis and therapeutic purposes, respectively. Moreover, 72.73 and 63.64% of the farmers consulted veterinarians for diagnosis and subsequent prescription of drugs, respectively. However, only 18.18% of the farmers reported observing the withdrawal period.

Biosecurity Measures and Waste Disposal Methods Used in the Farms Sampled in the Study Area

The biosecurity measures adopted by the various farms are presented in figure 4. All the farms (100%) visited were fenced and had net. Of the farms sampled, 18.20, 9.10, 27.30, 18.20, 54.50, and 95.90% observed the all-in-all-out principle, quarantine measures, wearing protective clothing, hand washing facilities, use of foot dips, and regular vaccination, respectively. Figure 5, depicts the waste disposal systems available in the farms.

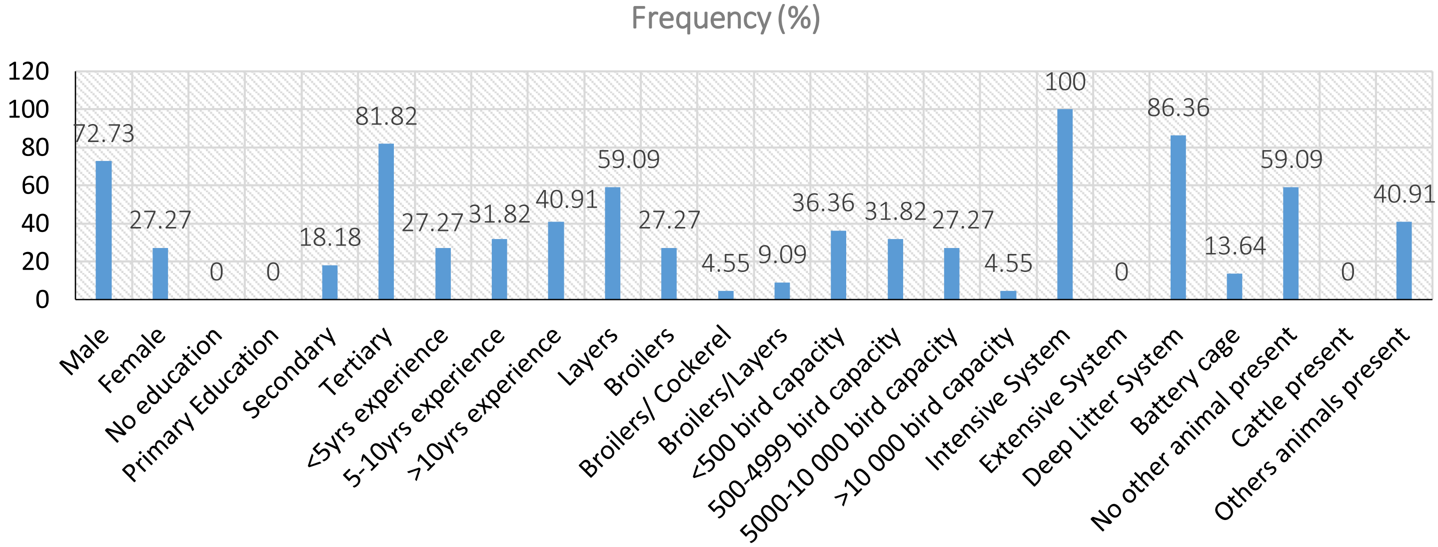

Figure 1: Demographic characteristics of poultry farmers within Nsukka

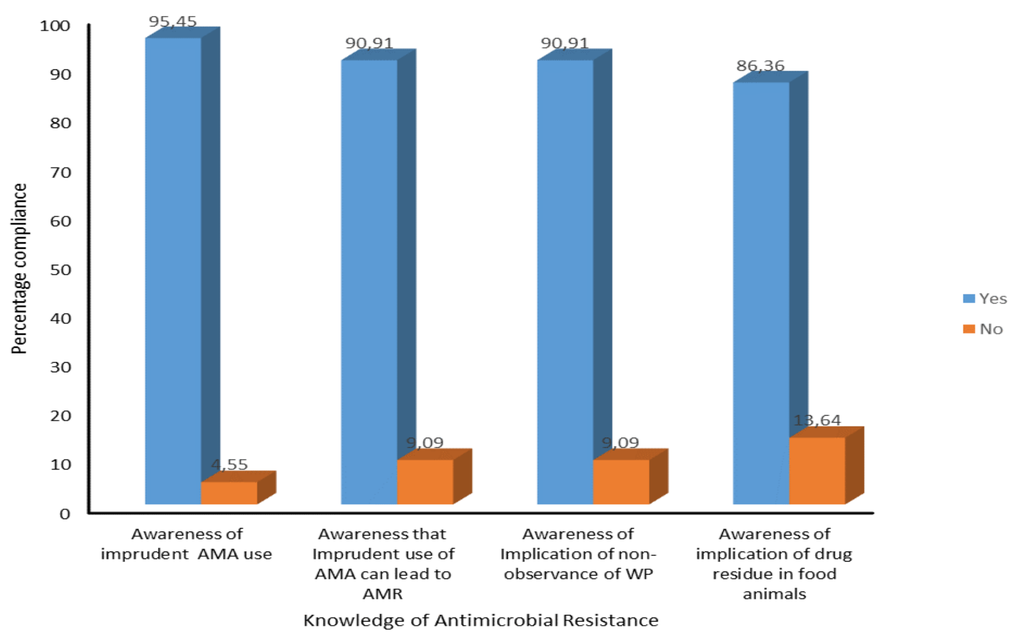

Figure 2: Knowledge of antimicrobial resistance among poultry farmers in the study area.
AMA: Antimicrobial Agents; WP: Withdrawal Period; AMR: Antimicrobial Resistance.

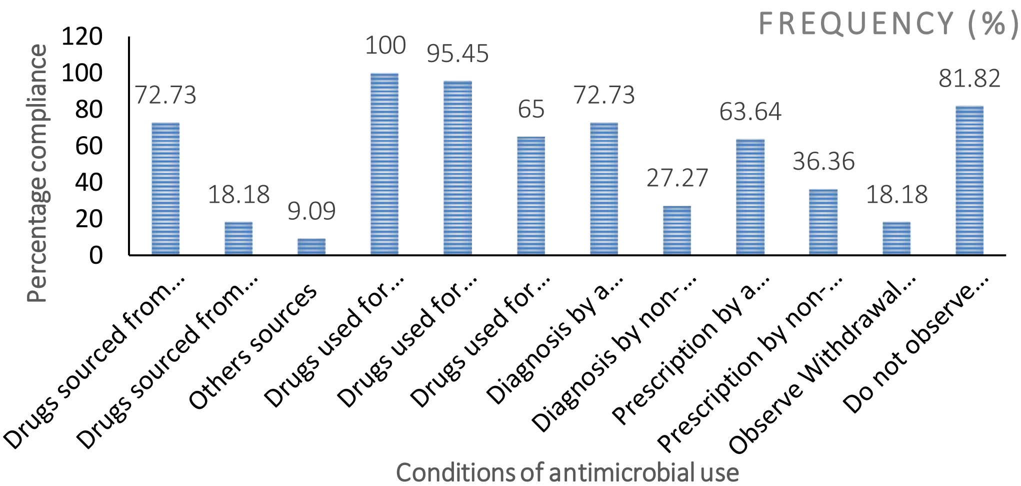

Figure 3: Conditions of antimicrobial use in farms sampled in Nsukka town.

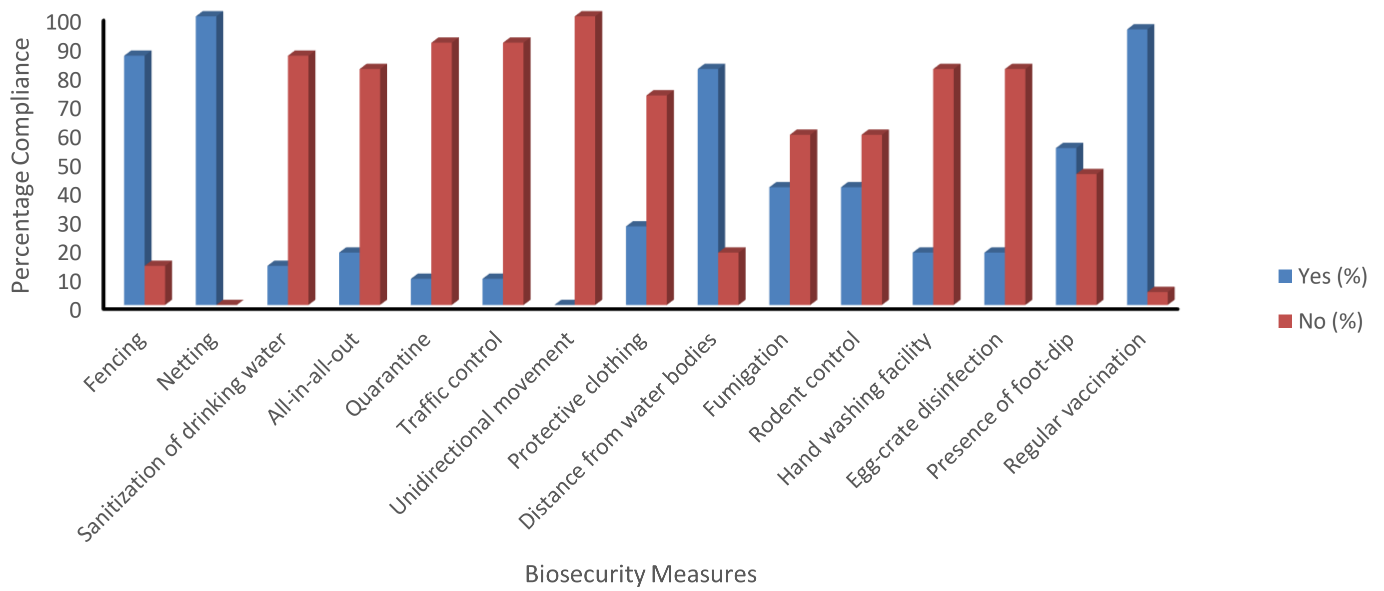

Figure 4: Biosecurity measures in the farms sampled in Nsukka town.

The respondents (100%) reported not selling or eating dead birds which were disposed of in the bush, fed to the dog, buried, or burned by 27, 13, 64, 68, and 54.55% of the farms, respectively. All (100%) the farmers adopted composting as a means of manure disposal, while 50% of them dumped expired drugs and used drug packets into the bush.

Types and Frequency of Antimicrobials Used in Poultry Farm in the Study Area

The types and frequency of antimicrobial usage in the study area is presented in figure 6. Different antimicrobial agents belonging to eight classes of antimicrobial drugs were used by the farmers. The most frequently used classes of antimicrobials were tetracyclines (100%), macrolides (100%), aminoglycosides (94%), and penicillin (63%), while polymyxin (13%) and chloramphenicol (0%) were rarely used.

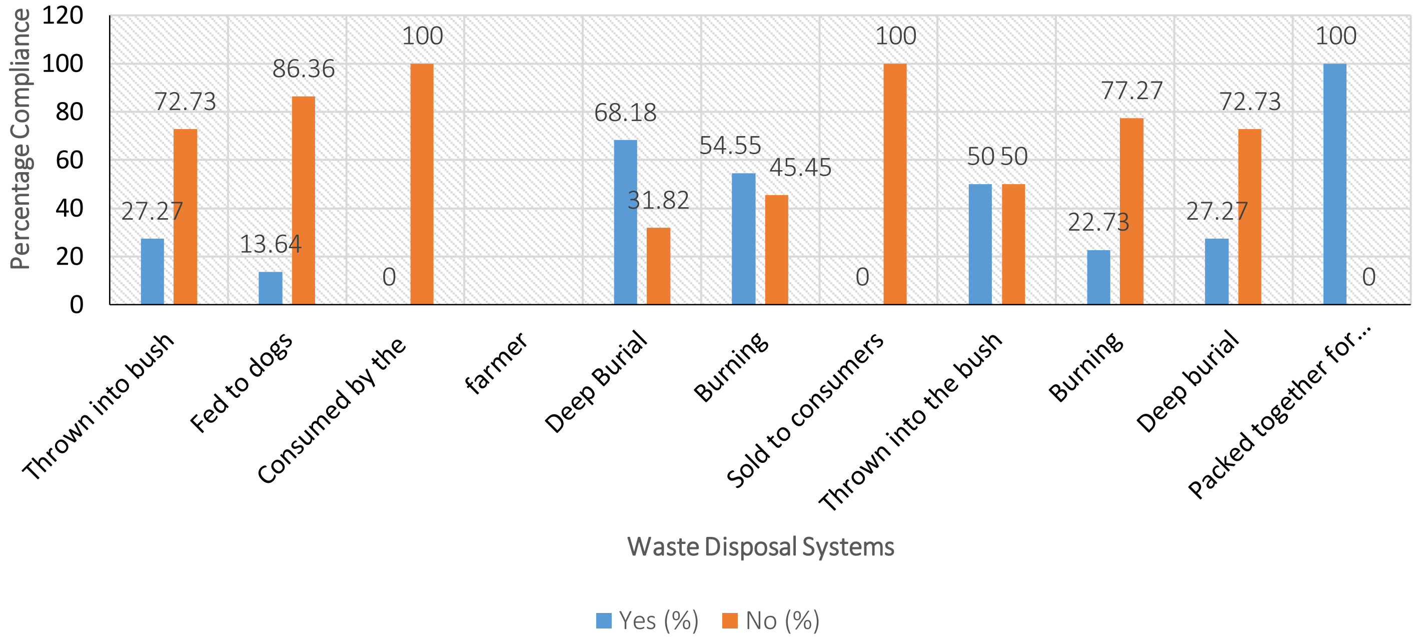

Figure 5: Waste disposal systems among farms sampled in Nsukka Area

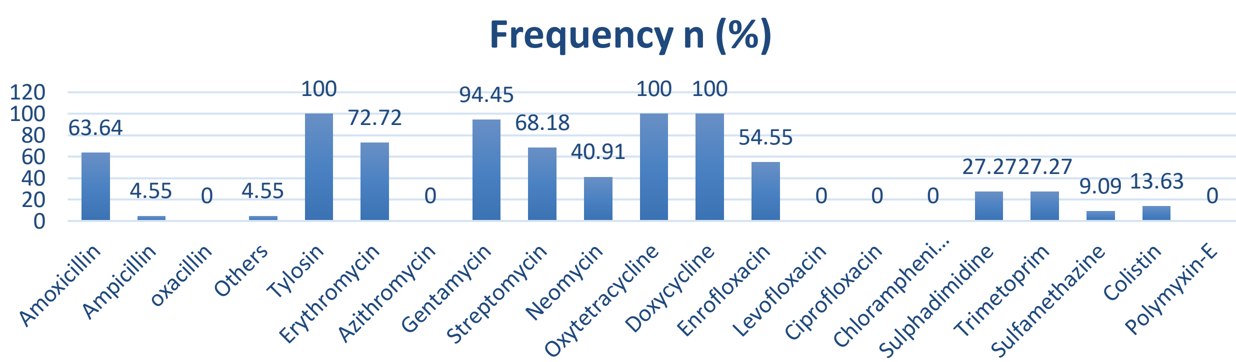

Figure 6: Types and frequency of antimicrobial usage in the farms sampled in Nsukka area.

Factors Associated with the Knowledge of Antimicrobial Resistance Among Poultry Farmers in Nsukka Area

Tables 1 to 5, depict the levels of association between the demographic characteristics of the farmers and their knowledge as well as practices as it concerns antimicrobial resistance. Knowledge of antimicrobial resistance among farmers showed statistical significant association with their level of education (p =0.001), gender (p=0.004), farm size (p =0.048), and the type of bird reared (p =0.001). Statistical significant associations was also observed between practices and: farming experience (p =0.022), farm size (p = 0.031), knowledge of antimicrobial resistance (p = 0.004), and the type of bird reared (p = 0.051), respectively.

Table 6 presents the findings of the adjusted logistic regression analysis of the respondents' demographic characteristics and their level of knowledge, and practices. Most importantly, the findings revealed that farmers' educational level was strongly associated with their knowledge of antimicrobial resistance (KAMR) (OR = 70.210, CI = 4.646-161.005, p = 0.002).

Table 1. Bivariate analyses of factors associated with the knowledge of antimicrobial resistance (KAMR) among the farmers in Nsukka area

Parameter	Variable	Good Knowledge	Poor Knowledge	*P*
Educational Level	Secondary Education	4 (50%)	4 (50%)	.001*
	Tertiary Education	36 (100%)		
Gender	Male	32 (100 %)		.004*
	Female	8 (66.7%)	4 (33.3%)	
Farming Experience	<5years	12 (100%)		.011*
	5–10 years	10 (71.4%)	4 (28.6%)	
	>10 years	18 (100%)		
Farm Size	1(<500 birds)	12 (75%)	4 (25%)	.048*
	2(500-4999)	14 (100%)		
	3(5000-10 000)	12 (100%)		
	4(>10 000)	2 (100%)		
Type of bird Sampled	1(Layers)	26 (100%)		.001*
	2(Broilers)	10 (83.3%)	2 (16.7%)	
	3(Broiler & Cockrel)		2 (100%)	
	4(Broiler & Layer)	4 (100%)		
Type of Intensive System Practiced	1(Deep litter)	34 (89.5%)	4 (10.5%)	.627
	2(Battery cage)	6 (100%)		
Presence of other Animals	1(None)	24 (92.3%)	2 (7.7%)	1.000
	3(Goat, sheep, Pig & dog)	16 (88.9%)	2 (11.1%)	

KAMR: knowledge of antimicrobial resistance; p: probability level; %: percentage, *=statistical significance.

Table 2. Effect of socioeconomic characteristics of farmers cum knowledge of antimicrobial resistance on the frequency of antimicrobial use (FAU) among the respondents:

Parameter	Variable	Minimal Use	Extensive Use	*P*
Educational Level	Secondary Education		8 (100%)	.339
	Tertiary Education	6 (16.7%)	30 (83.3%)	
Gender	Male	4 (12.5%)	28 (87.5%)	1.000
	Female	2 (16.7%)	10 (83.3%)	
Farming Experience	<5years	4 (33.3%)	8 (66.7%)	.022*
	5 – 10 years	2 (14.3%)	12 (85.7%)	
	>10 years		18 (100%)	
Farm Size	<500 Birds	2 (12.5%)	14 (87.5%)	.184
	500 -4999 Birds	4 (28.6%)	10 (71.4%)	
	5000-10,000 Birds		12 (100%)	
	>10,000 Birds		2 (100%)	
Type of Bird Sampled	Layers	4 (15.4%)	22 (84.6%)	.903
	Broilers	2 (16.7%)	10 (83.3%)	
	Broiler and Cockrel		2 (100%)	
	Broiler and Layer		4 (100%)	
Type of Intensive System Practiced	Deep Litter System	4 (10.5%)	34 (89.5%)	.182
	Battery Cage System	2 (33.3%)	4 (66.7%)	
Presence of other Animals	None	6 (23.1%)	20 (76.9%)	.067
	Goat, Sheep, Pig and dog		18 (100%)	
Knowledge of Antimicrobial Resistance (KAMR)	Poor Knowledge		4 (100%)	.627
	Good Knowledge	6 (15%)	34 (85%)	

FAU: frequency of antimicrobial use; p: probability level; %: percentage, *= statistical significance.

Table 3. Effect of socioeconomic characteristics of farmers cum knowledge of antimicrobial resistance on the purpose of antimicrobial use (PAU) among the respondents

Variable	Characteristics	Treatment	Treatment&growth promotion	*P*
Educational Level	Secondary Education		8 (100%)	1.000
	Tertiary Education	2 (5.6%)	34 (94.4%)	
Gender	Male	2 (6.25%)	30 (93.75%)	.594
	Female		12 (100%)	
Farming Experience	<5years		12 (100%)	.328
	5 – 10 years		14 (100%)	
	>10 years	1 (11.1%)	16 (88.9%)	
Farm Size	<500 Birds		16 (100%)	.160
	500 -4999 Birds		14 (100%)	
	5000-10,000 Birds	2 (16.7%)	10 (83.3%)	
	>10,000 Birds		2 (100%)	
Type of Bird Sampled	Layers	2 (7.7%)	24 (92.3%)	.670
	Broilers		12 (100%)	
	Broiler and Cockrel		2 (100%)	
	Broiler and Layer		4 (100%)	
Type of Intensive System Practiced	Deep Litter System	2 (5.3%)	36 (94.7%)	1.000
	2 Battery Cage System		6 (100%)	
Presence of other Animals	1 None		26 (100%)	.162
	3 Goat, Sheep, Pig and dog	2 (11.1%)	16 (88.9%)	
Knowledge of Antimicrobial Resistance (KAMR)	Poor Knowledge		4 (100%)	1.000
	Good Knowledge	2 (5%)	38 (95%)	

PAU: purpose of antimicrobial use; p: probability level; %: percentage, *=statistical significance.

Table 4. Effect of socioeconomic characteristics of farmers cum knowledge of antimicrobial resistance on the disposal of dead animals (DDA) among the respondents:

Parameter	Variable	Poor Practice	Good Practice	*P*
Educational Level	Secondary Education	4 (50%)	4 (50%)	1.000
	Tertiary Education	16 (44.4%)	20 (55.6%)	
Gender	Male	14 (43.75%)	16 (56.25%)	.746
	Female	6 (50%)	6 (50%)	
Farming Experience	<5years	6 (50%)	6 (50%)	1.000
	5 – 10 years	6 (42.9%)	8 (57.1%)	
	>10 years	8 (44.4%)	10 (55.6%)	
Farm Size	<500 Birds	10 (62.5%)	6 (37.5%)	.031*
	500 -4999 Birds	6 (42.9%)	8 (57.1%)	
	5000-10,000 Birds	2 (16.7%)	10 (83.3%)	
	>10,000 Birds	2 (100%)		
Type of Bird Sampled	Layers	10 (38.5%)	16 (61.5%)	.245
	Broilers	8 (66.7%)	4 (33.3%)	
	Broiler and Cockrel		2 (100%)	
	Broiler and Layer	2 (50%)	2 (50%)	
Type of Intensive System Practiced	Deep Litter System	16 (42.1%)	22 (57.9%)	.387
	Battery Cage System	4 (66.7%)	2 (33.3%)	
Presence of other Animals	None	14(53.85%)	12 (46.15%)	.227
	Goat, Sheep, Pig and dog	6 (33.3%)	12 (66.7%)	
Knowledge of Antimicrobial Resistance (KAMR)	Poor Knowledge	2 (50%)	2 (50%)	1.000
	Good Knowledge	18 (45%)	22 (55%)	

DDA: disposal of dead animals; p: probability level; %: percentage, * = statistical significance.

Table 5. Effect of sociodemographic characteristics of farmers cum knowledge of antimicrobial resistance on the disposal of drug packs (DDP) among respondents:

Parameter	Variable	Poor Practice	Good Practice	*P*
Educational Level	Secondary Education	4 (50%)	4 (50%)	.185
	Tertiary Education	28 (77.8%)	8 (22.2%)	
Gender	Male	24 (75%)	8 (25%)	.707
	Female	8 (66.7%)	4 (33.3%)	
Farming Experience	<5years	10 (83.3%)	2 (16.7%)	.631
	5 – 10 years	10 (71.4%)	4 (28.6%)	
	>10 years	12 (66.7%)	6 (33.3%)	
Farm Size	<500 Birds	12 (75%)	4 (25%)	.085
	500 -4999 Birds	12 (85.7%)	2 (14.3%)	
	5000-10,000 Birds	8 (66.7%)	4 (33.3%)	
	>10,000 Birds		2 (100%)	
Type of Bird Sampled	Layers	18 (69.2%)	8 (30.8%)	.051*
	Broilers	10 (83.3%)	2 (16.7%)	
	Broiler and Cockrel		2 (100%)	
	Broiler and Layer	4 (100%)		
Type of Intensive System Practiced	Deep Litter System	28 (73.7%)	10 (26.3%)	1.000
	Battery Cage System	4 (66.7%)	2 (33.3%)	
Presence of other Animals	None	18 (69.2%)	8 (30.8%)	.733
	Goat, Sheep, Pig and dog	14 (77.8%)	4 (22.2%)	
Knowledge of Antimicrobial Resistance (KAMR)	Poor Knowledge		4 (100%)	.004*
	Good Knowledge	32 (80%)	8 (20%)	

DDP: disposal of drug packs; p: probability level; %: percentage; * = statistical significance.

Table 6. Adjusted logistic regression analysis of the factors associated with the farmers knowledge of antimicrobial resistance (KAMR), and practices on antimicrobial use (DDP, PAU & DDA).

Variables	Knowledge	Practices		
	KAMR	PAU	DDP	DDA
	OR, 95% CI, p	OR, 95% CI, p	OR, 95% CI, p	OR, 95% CI, p
Gender	9.113, 0.923-89.945, 0.059	0.022,0.011-2.313, 0.375	0.581, 0.032-10.707, 0.715	0.251, 0.251-26.793, 0.424
Level of Education	70.210, 4.646-161.005, 0.002*	0.922, 0.754-4.211, 0.495	1.108, 0.062-19.857, 0.945	0.920, 0.071-11.974, 0.949
Farming Exp	0.235, 0.030-1.822, 0.166	0.784, 0.032-2.910, 0.125	2.791, 0.669-11.639, 0.159	0.550, 0.147-2.052, 0.373
Layers	7.250, 0.257-204.146, 0.245	0.000, 0.000-0.000, 0.998	0.429, 0.008-23.129, 0.677	0.628, 0.026-14.900, 0.774
Broilers	0.634, 0.055-7.271, 0.715	0.431, 0.305-3.041, 0.375	0.245, 0.004-15.889, 0.508	0.240, 0.007-8.010, 0.425
Farm Size	2.220, 0.456-10.824, 0.324	0.000, 0.000-0.000, 0.998	2.640, 0.670-10.404, 0.165	1.603, 0.590-4.353, 0.355
Type of Intensive System	0.000, 0.000-0.000, 0.999	0.379, 0.217-2.447, 0.565	3.199, 0.146-69.838, 0.460	2.115, 0.161-27.799, 0.569
Other Animals Reared	2.703, 0.222-32.964, 0.436	0.000, 0.000-0.000, 0.997	0.082, 0.004-1.821, 0.114	3.207, 0.264-38.955, 0.360
KAMR		0.833, 0.023-2.110, 0.125	0.057, 0.002-1.380, 0.078	0.948, 0.055-16.476, 0.971

KAMR: knowledge of antimicrobial resistance; DDP: disposal of drug packs; PAU: purpose of antimicrobial use; DDA: disposal of dead animals; OR: odds ratio; CI: confidence interval; p: probability level; %: percentage.

DISCUSSION

The present study reveals that poultry farmers who had tertiary education demonstrated a commendable level of understanding regarding resistance to antimicrobials. This finding aligns with some previous research outcomes.[16,19] Attaining high level of education has been reported to expose farmers to veterinary facilities, good farm management, adopting biosecurity measures and better understanding of the use of antimicrobials.[20] On the contrary, farmers with low level of education are more likely to depend on self-help rather than consult professionals, thereby increasing the chances of antibiotic misuse and the resultant AMR development. [16] Although a good number of the respondents in this study had good knowledge of AMR, it did not translate to good farm practices. Hence, though most of the farmers were aware that non-observance of the withdrawal period could result in antimicrobial resistance, yet only 18.18% practiced it. This could be ascribed to the fact that most farmers are more concerned with profit rather than the health of the consumers. Such mindset can only be corrected by enforcement of legislations on antimicrobial use as well as advocacy.

This study also found knowledge of antimicrobial resistance to be positively associated with farm size with respondents with increased farm size having better knowledge. Given that much capital is invested in setting up large farms, such farms usually employ or consult professionals (veterinarians) to ensure prudent antimicrobial use in order to protect the investment. This is unlike small-scale poultry farms where little capital is invested, and given that antimicrobial use is poorly controlled in Nigeria, most of these rely on unauthorized drug sellers for prescription and purchase of antibiotics, which is usually not devoid of abuse.[16]

The study also found good knowledge of antimicrobial resistance to be associated with gender with more of the males having good knowledge than the females. This may be attributed to the fact that majority of the males (59%) had tertiary education, and therefore were more likely to be exposed to information on antimicrobial resistance. In line with this, another study[15] also a reported male poultry farmers showing better understanding of antimicrobial resistance. Furthermore, keeping only layers was also found to be a factor in having good understanding of antimicrobial resistance. This observation may be credited to the fact that layer farmers are more likely than broiler farmers to consult with veterinarians when selecting antimicrobials.[16] In addition, layers are known to take longer time to reach the production level and as well last longer. As a result, rearing of layers necessitates greater investment, experience, and knowledge. Farmers who raise layers are therefore more likely to observe antimicrobial resistance given that the longer the birds last in the farms the more the likelihood of exposure to infections and the accompanied antimicrobial treatment and possible experiencing of antimicrobial resistance. This aligns with the fact that this study also found farming experience to be associated with the knowledge of AMR. The study found the more experienced farmers to have better knowledge of AMR than those with fewer years of experience. This finding is consistent with the report of other researchers.[16,21] Increased years of experience among poultry farmers, according to Hassan et al.[16], may result to proficiency in poultry farming, insight for exploring veterinary services, and involvement in continuous training, and awareness programs gearing towards AMU and AMR.

Ironically, having an appreciable year of experience in the poultry industry did not translate into responsible use of antimicrobials, among the respondents. All categories of farmers, including those who had spent more than ten years in the business were involved in extensive use of antimicrobial agents. This finding lends credence to the notion that some poultry farmers turn to antibiotic doping as a quick fix for poor management practices.[4] Regrettably, improper disposal of expired or used drug packs was observed even among some poultry farmers with good knowledge of antimicrobial resistance. This finding contradicts previous belief which stated that improved education and knowledge are positive predictors of behavioral changes among farmers battling AMR.[16]

The work also observed better disposal of dead birds among farmers with higher capacity farms. It is not surprising to observe proper disposal of dead animals among farmers with higher flock sizes. This could be attributed to the fact that with more to loss in the case of disease outbreak and the fact that such farms are more likely to employ the services of experts in poultry production, they seem to be more careful with the handling and disposal of dead birds.

This study found that most of the farms surveyed lacked basic hygienic and biosecurity procedures, despite most of the farmers having tertiary education and had been in production for more than a decade. Biosecurity measures in animal husbandry refer to a variety of actions taken to prevent the introduction and spread of infectious agents on the farm [22]. Basic biosecurity measures include limiting the presence of other farm animals, rodents, and insects; curtailing unlimited access to the poultry pen; enforcing strict hygienic rules such as handwashing; changing boots and overalls before entering the pen; as well as using footbaths containing disinfectants among others. Such poor farm biosecurity and hygiene practices have been linked to AMR due to increased antimicrobial use arising from the incessant exposure of the farm animals to infections.[23] Therefore, controlling antimicrobial use in livestock farms via adequate biosecurity measures remains an effective means of curtailing the emergence of antimicrobial resistant pathogens.[24] Studies on the presence of *Escherichia coli* and *Campylobacter* in poultry have revealed a link between poor biosecurity and the occurrence or persistence of antibiotic resistance in farms[22] and in piggeries improved biosecurity measures resulted in minimal antimicrobial use.[22] In all this, there is the danger of dissemination of antimicrobial-resistant bacteria and resistance genes via varied means, such as contaminated feed, resistance genes in animal wastes as well as transmission between farms, migrating animals, and via contaminated environment.[25] These therefore underscores the need for strict hygienic and biosecurity measures.

All the farmers interviewed in this study packed and disposed the farm dung on land. The common practice of dumping animal manure into the environment has been linked to the emergence of antimicrobial-resistant bacteria.[26] Faecal enterococci from broiler chickens, for instance, are known potential carriers of conjugal transposons that confer resistance.[14] The ongoing spread of such mobile genetic elements in the microbial environment is thus a cause for concern. Faecal contamination of ready-to-eat food products such as vegetables and fruits, which are typically consumed without prior heat treatment, as well as the risk of farm and abattoir workers being exposed to these antimicrobial-resistant pathogens, is of serious public health concern, especially in developing countries. This is particularly true, given the poor level of sanitary measures adopted in farms, slaughterhouses and food processing facilities in Nigeria.[27] Given that many farms and slaughter houses are channeled into water bodies in Nigeria, these serve as sources of contamination of seafood and products, which serve as suitable substrates for microbial growth when such faeces are washed into the water bodies, and pose public health threats.[28]

Quite a good number of the farmers used antimicrobials for growth promotion, prophylactic, and therapeutic purposes. For decades, the use of antimicrobials to enhance growth has been contentious.[29] High doses and/or indiscriminate use of antimicrobials for therapeutic, preventive, and non-therapeutic purposes, culminate in the build-up of drug residues in the edible components of treated animals, and has been linked to allergic reactions, carcinogenicity, and the development of AMR.[10] Farmers, as observed in this study, were involved in non-therapeutic antimicrobial usage as an "easy fix" or compensation for poor management practices and to increase profits. As earlier stated, antibiotic doping for prophylaxis or growth acceleration is detrimental to public health and cannot replace effective farm management practices that encourage rigorous biosecurity, routine immunization, and proper nutrition.[4] To curb incessant antimicrobial use, measures such as drug licensing, drug use surveillance,[21] and compulsory testing of food of animal origin for drug residues and punishment of offenders should be implemented. Finally, poor disposal of used or expired drug packs was also practiced by the farmers who reared either layers or broilers, or both. Improper disposal of unused antimicrobials result to the accumulation of antimicrobial resistant bacteria and resistance genes in the environment recognized as an emerging pollutant.[30] Proper disposal of antimicrobials therefore remains an important aspect of the drug management cycle. There should be continuous education in the forms of town hall meetings, radio jingles and the use of social media targeting the farmers in the study area to put into their consciousness that antimicrobial resistance originates from the misuse and poor handling of drugs.

In conclusion despite good knowledge of antimicrobial resistance, a significant proportion of farmers encountered in this study engaged in poor biosecurity measures, indiscriminate use of antimicrobials for prophylaxis and growth enhancement, as well as poor adherence to withdrawal periods. Therefore, proper sanitary measures and adequate biosecurity measures in farms, especially poultry farms, are of utmost importance. Strict adherence to policies on the use of antimicrobials in livestock production should be adopted in the study area.

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