

# Activities and influence of veterinary drug marketers on antimicrobial usage in livestock production in Oyo and Kaduna States, Nigeria

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## Abstract

Antimicrobial usage in animals contributes to the emergence of antimicrobial resistant bacterial strains. Investigations were carried out on how the characteristics, knowledge, attitude and practices of antimicrobial marketers influenced antimicrobials usage in animal production in Oyo and Kaduna States, Nigeria. Focus group discussions, in-depth interviews and structured questionnaires were used to gather information about the characteristics and activities of antimicrobial marketers. Overall, 70 (56.9%) of 123 marketers had post-secondary education while 76 (61.8%) were trained on the use of antimicrobials. Eighteen (14.6%) of the marketers were licensed veterinarians. Only 51 (41.5%) marketers displayed adequate knowledge about antimicrobials and antimicrobial usage. Sixty-seven (54.6%) marketers requested a prescription before selling antimicrobials while 113 (91.9%) marketer recommended antimicrobials for use in animals. Two-third of the marketers (66.7%) prescribed antimicrobials without physically examining sick animals but based their prescriptions on verbal reports of clinical signs by farmers and on their personal experience. Marketers with higher educational qualification displayed more adequate knowledge of antimicrobials and antimicrobial usage than those with basic education background only. More years of experience in antimicrobial marketing did not translate to better knowledge on antimicrobial usage. Only 45 (36.6%) respondents were aware of the existence of regulatory agencies monitoring the use of antimicrobials in animals. Farmers ignored the services of veterinarians in the diagnosis and control of animal diseases but resorted to drug marketers for help. Effective communication of existing legislations on antimicrobial usage, improved access to veterinary services and strict enforcement of regulatory policies are recommended for checking non-judicious use of antimicrobial agents in animal production. Sales of antimicrobial agents for animal use without veterinarian's prescription must be prohibited.

**Keywords:** antimicrobial resistance, attitude, injudicious antimicrobial usage, knowledge, socio-cultural practices

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## 1 Introduction

The challenge posed by infectious disease is a major limiting factor to the development of livestock industry in Africa (Rweyemamu *et al.*, 2006). Recurrent

morbidity and high mortality that characterise bacterial infections make animal production a high-risk business (Pritchett *et al.*, 2005). To mitigate against economic losses associated with disease outbreaks, farmers rely heavily on antimicrobial agents for the prevention and treatment of infections (Ojo *et al.*, 2016). Antimicrobials are also used as growth promoters to enhance performance and boost feed conversion efficiency (Dhama

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et al., 2014). Sometimes, farmers use antimicrobial agents to cover for lapses such as poor management, inadequate resources and substandard facilities that could predispose animals to infections (Ojo et al., 2016).

With the increasing demands for antimicrobials in Nigeria, marketing of these drugs has become an attractive and lucrative business (Adesokan et al., 2015). There is high turnover rate, good profit and low risk. Poor regulation, high demand and relatively easy start-up have led to great increase in the activities of drug marketers with influx of different brands of antimicrobial agents into the market for animal consumption. With more participation and increasing competition, marketers have devised strategies to outwit competitors and maximise profits. Some of these marketing strategies are unwholesome as they are geared towards profit making with little or no consideration for the preservation of antimicrobial efficacy. Thus, antimicrobials are readily accessible to the general public without restrictions leading to injudicious use of antimicrobial with grave consequences on the efficacy of antimicrobials for the treatment of human and animal diseases.

Okeke et al. (1999) observed that in Africa, many interwoven socioeconomic and behavioural factors contribute to the emergence and spread of antimicrobial resistance. The use of antimicrobial agents especially in animals has been implicated as a major contributory factor to the increasing emergence and dissemination of antimicrobial resistance among bacteria (Chantziaras et al., 2014). Marketing may have direct and indirect influence on buyers and the pattern of antimicrobial usage in animals. There is a need for better regulation of the sales and distribution of antimicrobial agents in any attempt to promote judicious use of antimicrobials.

We hypothesised that proliferation of veterinary drug marketing and ready availability of antimicrobial agents promote the excessive use of antimicrobials in livestock production in Nigeria. Furthermore, the activities of antimicrobial marketers may have profound impact on antimicrobial usage pattern including the level of antimicrobial usage, choice of antimicrobial agents, mode of administration and consequently the outcome of antimicrobial therapy. Hence, knowledge, attitude and practices of antimicrobial marketers are relevant to antimicrobial usage in animal production and should be considered among the factors that contribute to the emergence of antimicrobial resistance.

In view of this, the present study investigated some factors associated with the activities of antimicrobial marketers in the use of antimicrobial agents in animal

production. Emphasis was placed on the characteristics, knowledge, attitudes and practices of marketers in relation to antimicrobial usage in food animal production in Oyo and Kaduna States of Nigeria.

## 2 Materials and methods

The present study examined the knowledge, practices and attitude of antimicrobial marketers in Kaduna and Oyo States of Nigeria and assessed the influence of the activities of antimicrobial marketers on antimicrobial usage in animal production. With huge human populations and booming commercial activities, Oyo and Kaduna States are the socioeconomic hubs of western and northern Nigeria, respectively. The favourable climatic conditions of the States support profitable agriculture and encourage high levels of agricultural activities including animal husbandry. There are many large-, medium- and small-scale livestock farms in these states thus creating a huge demand for veterinary drugs and readily available markets for veterinary drugs merchants.

Data were collected through focus group discussions (FGD), in-depth interviews and structured questionnaires. The structured questionnaire comprised of 38 questions divided into two sections. In the first section, data were obtained on the demographic attributes of respondents while the second section was used to assess the knowledge, attitude and practices of the respondents.

Information was obtained from 123 marketers of antimicrobial drugs (AMD) in 12 communities within 12 Local Government Areas (LGAs) in both States (Table 1). Sixty-two marketers were sampled from seven communities within seven LGAs in Kaduna State while 61 marketers were sampled from five communities within five LGAs in Oyo State (Table 1). The survey targeted marketers of antimicrobial agents including drug importers, major distributors of antimicrobial agents, wholesalers and drug retailers (including local drug vendors and veterinary drug outlets) (Table 2).

## 3 Data analysis

Data were analysed using statistical package software (Statistical Package for the Social Sciences, SPSS version 16). The level of knowledge among participants was examined by ten questions. The questions were graded with allotment of scores. One point each was allotted for correct answer to the ten questions. Respondents with total score of seven points and above

**Table 1:** Locations of sampled antimicrobial drug marketers in Oyo and Kaduna States.

State	Local Government Area	Communities Selected	Number of marketers selected
Oyo	Egbeda	Ibadan	21
	Atiba	Oyo township	12
	Saki West	Saki	12
	Atisbo	Ago-Are	6
	Iseyin	Iseyin	10
Subtotal	5	5	61
Kaduna	Zango Kataf	Zonkwa	9
	Jema	Kafanchan	10
	Soba	Maigana	6
	Zaria	Zaria	13
	Birnin Gwari	Birnin Gwari	8
	Kaduna North	Kaduna	8
	Lere	Saminaka	8
Subtotal	7	7	62
Overall Total	12	12	123

**Table 2:** Business status of antimicrobial marketers.

Ownership status of marketers	Oyo State (n = 61; %)	Kaduna State (n = 62; %)	Total (n = 123; %)
Manufacturer	3.3	0	1.6
Importer	0	1.6	0.8
Major distributor	14.8	1.6	8.1
Wholesaler	24.6	16.1	20.3
Retailer	57.4	80.6	69.1

were considered to have good knowledge while those with total score of six points and below were categorised to have poor knowledge. Other attributes in terms of attitude and practices were expressed with descriptive statistics and frequency distributions, which were used to generate summarized results. Pearson Chi Square and Fisher's exact test were used to test for association between responses from Kaduna and Oyo States and levels of knowledge. Inferences were interpreted as being statistically significant at  $p \leq 0.05$ . Relationship between personal attributes of respondents (in terms of level of education and years of experience in marketing of antimicrobial drugs) and level of knowledge about antimicrobial drug usage was assessed using Spearman Correlation Coefficient.

## 4 Results

### 4.1 Characteristics of marketers of antimicrobial drugs

Small to medium scale retailers dominated antimicrobial marketing in the study areas. Overall, 69 % of all marketers were retailers (Table 2). Out of the 123 marketers in both states, 106 (86 %) were male (Table 3).

More than 90 % of all marketers had at least primary/basic education (Table 3). The primary occupations of the marketers were much related to agriculture and relevant to marketing of antibiotic drugs. A significantly higher ( $p < 0.001$ ) percentage of marketers in Oyo State (77 %) than those in Kaduna State (37 %) attained post-secondary education. Sixty-six (54 %) marketers had less than 10 years of experience in the business. This indicated an expansion of the veterinary drug marketing over the last 10 years (Table 3). Sixty-seven (54 %) drug marketers were involved in trade associations.

**Table 3:** Personal and business characteristics of marketers of antibiotics drugs.

	Oyo State (n = 61; %)	Kaduna State (n = 62; %)	Total (n = 123; %)
<i>Sex</i>			
Male	80.3	91.9	86.2
Female	19.7	8.1	13.8
<i>Age categories (years)</i>			
Less than 30	21.3	19.4	20.3
30–60	73.7	74.2	74.0
Above 60	4.9	6.5	5.7
<i>Educational status</i>			
No formal education	3.3	9.7	6.5
Primary education	3.3	17.7	10.6
Secondary education	16.4	35.5	26.0
Post-secondary education	77.0*	37.1*	56.9
<i>Years of experience</i>			
Less than 10	47.5	59.7	53.7
Above 10	52.5	40.3	46.3
Mean values	12.7	13.1	12.9
<i>Primary occupation</i>			
Veterinary doctors	26.2*	3.2*	14.6
Livestock producers	37.7*	6.5*	21.9
Agrochemical input dealers	3.3*	41.9*	22.8
Civil servant	9.9*	22.6*	16.2
Crop Farming	22.9	25.8	24.4
<i>Membership of association</i>			
None	45.9	66.1	54.0
Yes	54.1	33.9	43.9

\* : values are significantly different ( $p < 0.001$ )

#### 4.2 Activities of marketers of antimicrobial drugs

The number of antimicrobial brands sold by individual marketer per day ranged from 1 to 25. On a daily basis, marketers in Oyo State sold an average of 11 commercial antimicrobial brands while in Kaduna State, the average number of antimicrobial brands sold by marketers was 10. An average of 18 people in Oyo State and 23 people in Kaduna State requested for antimicrobials from each marketer daily. Marketers in both states sold imported and local brands of antimicrobial agents. Most of the antimicrobial agents marketed for use in animals were imported to the country. Local brands of antimicrobial agents were manufactured overseas for local companies that packaged, branded and marketed the drugs in Nigeria. The antimicrobial stocks came predominantly from Asia (China, India) and the Middle East (Jordan). Other sources were Europe (The Netherlands and the United Kingdom) and North America (Canada).

Overall, 55 % of marketers asked for a prescription before selling. This number was significantly higher ( $p < 0.005$ ) in Oyo State ( $n = 41$ ; 67 %) than in Kaduna State ( $n = 26$ ; 42 %). Many marketers (81 %) asked questions relating to the purpose of antimicrobial purchase before selling to farmers. Marketers also recommended antimicrobial agents to farmers for use in animals. However, findings showed that majority of the marketers had no formal training on antimicrobial usage and were not licensed to prescribe antimicrobials for animal use. In most cases, antimicrobials agents were prescribed without physical examination of sick animals and collection of clinical samples for laboratory investigations such as bacterial isolation and antimicrobial susceptibility testing (Table 4). A significantly higher proportion ( $p < 0.001$ ) of marketers in Oyo State (57 %) than in Kaduna State (29 %) followed up with farmers after sales of antimicrobial agents. Most (94.5 %) of the marketers that followed up cases with farmers in Oyo State were veterinarians.

**Table 4:** Activities of marketers in handling of antimicrobials.

S/No	Activities	Oyo State (n = 61; %)	Kaduna State (n = 62; %)	Total (n = 123; %)
1.	Ask for prescription before selling antibiotics	67.2*	41.9*	54.5
2.	Ask for reasons for purchasing antibiotics from buyers	75.4	85.5	80.5
3.	Volunteer information on the use of antibiotics	93.4	90.3	91.9
4.	Buyers asking for guidance on the use of antibiotics	90.2	88.7	89.4
5.	Buyers ask for drug prescription for their animals	93.4	95.2	94.3
6.	Prescribe drugs for buyers	90.2	93.2	91.9
7.	See/examine animals before drug prescription	39.3	27.4	33.3
8.	Submit samples for bacteria isolation and antimicrobial sensitivity before prescribing drugs	9.8	8.1	8.9
9.	Based prescription on past experience	86.9	91.9	89.4
10.	Receive complaints from farmers about drug failures	54.1	69.4	61.8
11.	Had training on the use of antibiotics	65.6	58.1	61.8

\*: values are significantly different ( $p < 0.05$ )

#### 4.3 Perceptions and knowledge of marketers on antimicrobial usage

Only 37 % of the total marketers in both States knew about the existence of agencies regulating drug marketing activities and sales of antimicrobial agents (Table 5). Regulatory agencies known to marketers included National Agency for Food Drug Administration and Control (NAFDAC), Veterinary Council of Nigeria (VCN), Departments of Veterinary Services in State Ministries of Agriculture as well as Local Government Veterinary Departments.

Most of the drug marketers interviewed agreed that the use of antimicrobial agents required special training. Types of training included formal training through school system leading to award of diplomas and degrees, training through seminars and workshops, on-the-job training/apprenticeship, informal training through membership of associations, trade groups and other sources. The proportion of marketers that got the correct description of an antimicrobial agent is significantly higher ( $p < 0.001$ ) in Oyo State (36 %) than in Kaduna State (13 %). About 93 % of the marketers from both States believed that the sales of antimicrobial agents should be by prescription.

This study showed a positive correlation between level of education and adequate knowledge of antimicrobial usage and not year of experience, sex and age. This indicated that knowledge was a function of training and level of education but not years of experience, sex, and age. More marketers in Oyo (48 %) than in Kaduna (36 %) had adequate knowledge of antimicro-

bial usage. However, the difference in the level of knowledge between the two states was not statistically significant.

#### 4.4 Experience of drug failure among marketers of antimicrobial drugs

In Kaduna State, 69 % of antimicrobial marketers and 54 % in Oyo State reported that farmers do complain about failure of antimicrobial chemotherapy (Table 6). When farmers complained about drugs, many of the antimicrobial marketers (57 % in Kaduna State and 53 % in Oyo State) would simply recommend another drug. Most veterinary drug marketers (91 %) knew that the use of antimicrobial agents contribute to the incidence of antimicrobial resistance in bacterial pathogens (Table 6).

## 5 Discussion

Overdependence on antimicrobial usage in food animals and non-compliance with withdrawal period before processing edible animal products for human consumption are responsible for the high level of antimicrobial resistance and presence of antimicrobial residues in animal-source foods (Olatoye & Ehinmowo, 2010; Mensah *et al.*, 2014). Every form of antimicrobial usage has the tendency to precipitate antimicrobial resistance in exposed bacteria (Davies & Davies, 2010). However, the increasing pace of development and widespread dissemination of antimicrobial resistance is aggravated by excessive and indiscriminate use of antimicrobial agents in food animal production (Founou *et*

**Table 5:** Perception of marketers on the use of antimicrobials.

Perception	Oyo State (n = 61; %)	Kaduna State (n = 62; %)	Total (n = 123; %)
Aware of regulatory bodies controlling antimicrobial drug administration	44.3	29.0	36.6
Use of antibiotics requires special training	88.5	95.2	91.9
Sales of antibiotics require prescriptions	86.9	98.4	92.7
Stricter measures are necessary to restrict of antibiotics use on animals	80.3	91.9	86.2
Use of antibiotics in animals could impact human health	90.2	93.5	91.9
Correct description of antibiotics	36.1*	9.7*	22.8

\* : values are significantly different ( $p < 0.001$ )

**Table 6:** Experience on drug failure among marketers.

Perception	Oyo State (n = 61; %)	Kaduna State (n = 62; %)	Total (n = 123; %)
<i>Do farmers complain about drug failures</i>			
Yes	54.1	69.4	61.8
No	45.9	30.6	38.2
<i>Frequency of complaints</i>			
Occasionally	63.9	64.5	64.2
Often	1.6	1.6	1.6
Very often	0	3.2	1.6
<i>Action taken in case of drug failure</i>			
Referred to veterinarian	29.5	41.9	35.8
Referred to laboratory	16.4	9.7	13.0
Changed the drug	52.5	56.5	54.5
Visited the farm	23.0	19.4	21.1
Took no action	1.6	3.2	2.4
<i>Antibiotic use contributes to incidence of antibiotic resistance</i>	88.5	93.5	91.1
<i>Follow up after sales</i>	57.4	29.0	43.1

al., 2016; Ojo et al., 2016). High level of exposure to infectious agents, poor accessibility to veterinary services from qualified professionals and inadequate implementation of regulatory policies on antimicrobial usage contribute to overdependence on antimicrobials for the prevention and treatment of diseases in food animal production (Grace, 2015). There are not enough reliable and up-to-date information on antimicrobial usage in many developing countries (Grace, 2015). Many developed countries have put in place organised antimicrobial resistance monitoring and surveillance programmes as parts of concerted effort to identify the sources of threat, understand the extent of the problems and develop preventive strategies against antimicrobial resistance (Founou et al., 2016). Regrettably, in developing countries, there are no monitoring and surveillance pro-

grammes (Grace, 2015). Insufficient data from developing countries on antimicrobial usage and antimicrobial resistance is a major limitation in the assessment of the actual situation regarding antimicrobial resistance. Thus, there is no strong basis for the development of realistic and sustainable preventive measures (ibid).

Sales of antimicrobial agents for use in animal is on the increase in Nigeria (Adesokan et al., 2015). Results from the present study showed there is the possibility of greater accessibility and more usage of antimicrobials in Oyo State relative to Kaduna State due to presence of several major distributors. The increasing use of antimicrobials in animals is due largely to a system that allows unrestricted access to antimicrobial agents (Grace, 2015; Ojo et al., 2016). More men than women were involved in marketing of antimicrobial agents probably

because men may have more capital to invest in business than women. Sociocultural practices in the study areas favour men being in business than women (Danjuma *et al.*, 2013). More young people (below 50 years old) than old people (above 50 years old) participated in marketing of antimicrobial drugs. This implies that most of the marketers are within the active age category. The youthfulness of the marketers should influence positively their innovativeness and opportunities for improving their capacity of acquiring information towards effective adoption and compliance with new regulations (Sebba *et al.*, 2009; Adegbidi *et al.*, 2012).

More educated people were involved in handling of livestock drugs in Oyo State than in Kaduna State. Improved educational status promotes good practices in handling of drugs and in provision of useful information to end-users. Low level of education may promote quackery and substandard service delivery among antimicrobial retailers thus jeopardizing the health of the nation's livestock and consequently public health. Marketers join trade associations to establish networks among themselves. This is important as a form of internal self-regulatory mechanisms for coordinating the activities of the marketers (FAO, 2005). These associations also serve as channels of disseminating information and for capacity building. Government interventions in monitoring and regulating antimicrobial sales and usage in animals can be routed through these associations. The higher involvement of marketers in trade associations in Kaduna State than in Oyo State could be a sign of greater interdependency and mutual cooperation among the traders in Kaduna State. Marketers in Kaduna State probably rely more on one another for support and information because of their lower level of education. Lower level of involvement in trader association by marketers in Oyo State suggests that marketers are more independent-minded probably because of higher level of educational attainment.

The years of experience in drug marketing did not translate to increased knowledge; many of the experienced marketers displayed inadequate knowledge about antimicrobials and antimicrobial usage. As a business with implications for public health, the experience and knowledge of the marketers (in drugs handling and provision of correct information and advice to users) are critical factors in the correct handling of antimicrobials. The availability of different brands of antimicrobial agents reflects the many sources of antimicrobial agents arriving at the markets for use in animal production (Ojo *et al.* 2016). This study showed that most of the antimicrobial agents marketed for use in animals were imported to the country.

The number of people requesting for antimicrobial drugs from marketers was relatively high. This signifies the high demand for antimicrobial agents and high consumption rate (Alo & Ojo, 2007; Ojo *et al.*, 2016). Antimicrobial agents are widely used by farmers without prescription and supervision by veterinarians (Grace 2015). In most livestock operations, bacterial infections are common due to unsanitary conditions of animal husbandry, inadequate biosecurity measures and poor vaccination programmes (European Food Safety Authority, 2007; Leung *et al.*, 2011). Many marketers showed interest in the welfare of the animals and made efforts in providing good service to the purchasers of antimicrobial drugs by asking questions that could provide useful clues to the clinical conditions of the animals on farms. However, these marketers were mostly non-professional with poor knowledge of diagnosis and treatment of animal diseases. Although, marketers provided guidance to farmers based on experience, they were not officially authorised to prescribe and dispense antimicrobial agents. The practice of prescribing antimicrobial agents by unauthorised persons should be discouraged (Leung *et al.*, 2011; Office International des Épizooties, 2016). Asking questions about the clinical conditions of animals cannot substitute for physical examination of the animals and laboratory analysis of clinical samples for more accurate diagnosis. Laboratory investigations are very important aids for accurate disease diagnosis and crucial to making informed decision on the choice of appropriate antimicrobial agent in the treatment of bacterial infections (Leekha *et al.*, 2011; Leung *et al.*, 2011; De Briyne, *et al.* 2013, Office International des Épizooties, 2016). Use of antimicrobial agents without microbiological analysis of clinical samples and antimicrobial sensitivity testing could lead to misuse thereby promoting the emergence of antimicrobial resistant strains of bacteria (Berild *et al.*, 2006).

Previous studies have shown that antimicrobial agents that have been prohibited for use in both humans and animals were widely marketed for use in Nigerian food animal production system (Adebowale *et al.*, 2016; Ojo *et al.*, 2016). Moreover, many antimicrobial brands marketed for use in animal production have similar active agents as those used in humans (Lander *et al.*, 2012; Ojo *et al.*, 2016). The abuse of these drugs in animals can accelerate the emergence and widespread dissemination of antimicrobial resistance (Woolhouse *et al.*, 2015). It can lead to the presence of antibiotic residues in animal products which when consumed by humans can cause toxicity, allergy and malignancies. The transfer of antimicrobial resistance from animals to humans is of global public health importance with potentially

devastating socioeconomic consequences (Cosgrove & Carmeli, 2003).

Drug marketers suggested antimicrobial agents to farmers, advised on the usage of these drugs and inquired about the outcome of antimicrobial therapy in treated animals. Veterinarians normally should carry out these activities. Marketers provided these important services to farmers without additional costs to the price of antimicrobial agents. Thus, by patronising antimicrobial marketers, farmers did not need to pay for veterinary services that could increase the total cost of production and impinge on profitability. In cases where farmers do not have ready access to veterinary services from qualified professional, the marketers are available as (reliable) alternatives to bring reprieve to farmers and their animals. However, the services provided by the marketers could be uninformed, insufficient and sometimes could complicate the case at hand leading to more losses. Marketers reported that farmers do complain about failure of antimicrobial therapy. Non-response to antimicrobial therapy could be due to many factors including wrong diagnosis and involvement of antimicrobial resistant bacterial strains in disease conditions (Finch & Chalmers, 2014). Therefore, farmers should be encouraged to seek help from qualified professionals. Moreover, Government intervention is required to make veterinary services more readily accessible and affordable to farmers.

Most of the marketers agreed that handling and use of antimicrobials required special training. Furthermore, majority concurred that antimicrobial agents should be sold based on presentation of a prescription from qualified and authorised professionals. The unrestricted sales and uncontrolled access to antimicrobials is possible because of poor regulation and inadequate monitoring by regulatory agencies. Most marketers were not aware of the presence of regulatory agencies and were unfamiliar with regulatory processes. Although there are good policies to regulate sales and usage of antimicrobials in humans and animals, these policies are poorly implemented (Grace, 2015). Lack of communication on legislations, low level of awareness on health hazards and socioeconomic implications of antimicrobial resistance as well as poor access to veterinary services have been identified as major constraints to policy implementation (Adebowale *et al.*, 2016; Grace, 2015). In the present study, marketers showed their dislike for introduction of stricter measures in marketing and use of antimicrobial agents. However, they believe stricter measures are necessary to safeguard the continued efficacy of antimicrobial agents for the protection of animal welfare and public health. Aversions to regulatory measure could be

due to perceived loss of patronage and possible loss of business with stricter control of antimicrobial usage in animals.

## 6 Conclusion and recommendations

The study showed that antimicrobial agents are widely distributed and poorly regulated in the study areas. The activities of antimicrobial marketers influenced antimicrobial usage in animal production. The existing regulatory policies on distribution and use of antimicrobial agents are ineffective therefore implying inadequacies of regulatory agencies in the administration and control of antimicrobial drugs.

There should be restricted access to antimicrobial drug through effective communication and enforcement of existing policies and regulations (Office International des Épizooties, 2016). Antibiotics should only be sold on the basis of a veterinary prescription. All antimicrobial marketers should be made to register with appropriate government regulatory agency and obtain an operating licence. The licence should be renewed periodically after demonstration of satisfactory compliance with regulatory standards. All marketers should operate within the limits of their roles in dispensing antimicrobial agents without infringing on the duties of veterinarians. Only veterinarians should prescribe and supervise antimicrobial usage in animals. Marketers should keep detailed records of every transaction involving antimicrobial sales. These records must be made available to regulatory agencies for monitoring purposes. Implementation of antimicrobial legislations through adequate monitoring and penalisation of offenders will help to promote compliance. Government can employ 'stick and carrot' approach whereby there are rewards and compensations for good practices and punishments for unacceptable practices. Moreover, local government authorities should employ more veterinarians to make veterinary services readily accessible to farmers at subsidised cost (Leung *et al.*, 2011). The ensuing increase in the involvement of qualified veterinarians in disease diagnosis, treatment and consultancy services will curb excessive and non-judicious use of antimicrobials in food animals. Adequate supervision of antimicrobial usage by veterinarians at farm level would ensure adherence to dosage regimen. Furthermore, regulatory agencies can utilise the operations of the trade associations to disseminate information, create awareness and publicize regulatory policies by providing training workshops aimed at reorienting the marketers towards responsible antimicrobial stewardship and best practices in antimicrobial dispensing. Better control of drug manufactur-



ing, importation and distribution in Nigeria will limit the influx of antimicrobial agents into the market. This will help to check the increasing trend of antimicrobial usage in animals.

#### Authors' contributions:

OOE, FE and DMA. were responsible for project conceptualisation, design and implementation. OOE and FE were involved in sample collection and data collation. OOE, AOJ and FE were responsible for data analysis and interpretation of results. OOE prepared the manuscript. AOJ, FE and DMA were involved in manuscript review. DMA was the project leader.

#### Competing interests:

The authors declare that they have no conflict of interest.

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