**Knowledge and practices regarding antibiotic use among small-scale poultry**

**farmers in Enugu State, Nigeria**

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**Running title:** Antibiotic use practices in small-scale poultry production

**Novelty statement**

* Drug sellers (98.9%) and other poultry farmers (81.8%) were the major sources of information on antibiotics to the small-scale farmers.
* Only 2.3% of the farmers relied on results of culture and sensitivity testing for selecting antibiotics used in the treatment of infections in their farms.
* Critically important antimicrobial agents were often (48.9 %) or always (27.2 %) used in the farms.
* Farmers with good knowledge of antibiotic use were four times more likely to misuse antibiotics than those with poor knowledge.
* Farmers with good knowledge of antibiotic resistance were five times more likely to misuse antibiotics than those with poor knowledge.

**Abstract**

This study examined the knowledge and practices regarding antibiotic use among small-scale poultry farmers in Enugu State, Nigeria. A multistage sampling technique was employed to select a total of 88 poultry farmers in two agricultural zones of the state. Interview schedule was used as a principal primary data collection method. The respondents’ knowledge indices of antibiotic use (KABU) and antibiotic resistance (KABR) and index of antibiotic use practices (PABU) were determined. A binary logistic regression was performed to ascertain the effect of some socio-demographics of respondents, knowledge of antibiotic use and knowledge of antibiotic resistance on the likelihood that farmers use antibiotic inappropriately. All the poultry farmers studied used antibiotics for growth promotion, disease prevention, and treatment. The mean index of KABU was 0.54 with 48 % of the respondents having good KABU while the mean index of KABR was 0.65 and 70.5 % of the farmers had good KABR. The farmers’ mean index of PABU was 0.47 and 83 % of them used antibiotics inappropriately. Farmers with good KABU (OR=4.2; 95% CI=1.030-17.222) and KABR (OR=4.5; 95% CI=1.258-15.791) were more likely to misuse antibiotics than those with poor knowledge. Antibiotics are routinely used in small-scale poultry farms in Enugu State, Nigeria. Antibiotics are valuable agents whose efficacy can only be preserved if they are handled with care. Education of small-scale formers through training in the form of seminars, workshops or conferences will provide them the opportunity to improve their knowledge and practices regarding antibiotics use.

**Keywords:** Knowledge, antibiotics, resistance, best practices, small-scale poultry.

**Introduction**

Socioeconomic development and population growth as witnessed in many low- and medium-income countries (LMICs) have resulted in increased demands for animal protein (Founou et al., 2016; Walther *et al*., 2016). The poultry sector contributes about 9-10% of the agricultural domestic products of the Nigerian economy (Heise *et al*., 2015). In order to meet the rising demand for animal protein, intensive livestock farming associated with regular, heavy and unregulated use of clinically-relevant antimicrobials in suboptimal doses as growth promoters, prophylactics, and metaphylactics, has become indispensable (Van Boeckel *et al*., 2015; Richter *et al*., 2015; Founou *et al*., 2016; Walther *et al*., 2016; Nguyen *et al*., 2016). Inappropriate antibiotic use practice potentially increases selection pressure on bacteria leading to the development of antimicrobial resistance (Mensah and Ansah, 2016; Depoorter *et al*., 2012). Misuse of antibiotics in animal production also contributes to accumulation of antibiotic in the animal tissues with its attendant food safety or public health concerns (Muaz *et al*., 2018).

Majority of poultry production activities in LMICs are undertaken at small scale level (Gilbert *et al*., 2015) and provides investment opportunities and additional income for families. Since a greater proportion of poultry production activities in LMICs are small scale in nature, identification of knowledge and practices regarding antibiotic use among this category of farmers will enable veterinary extension agents to design and disseminate appropriate educational messages with the view of assisting them engage in best antibiotics use practices thereby slowing the development of antibiotic resistant bacteria as well as provision of safe poultry products to the public. Thus, this study was conducted to ascertain the knowledge and practices regarding antibiotic use among small-scale poultry farmers in Enugu State, Nigeria.

**Materials and methods**

***Study area and sampling***

A cross-sectional study of small-scale poultry farms in Enugu State, Nigeria, was conducted over a period of three months (April - June) in 2019. The state was purposefully chosen because small-scale poultry farming is one of the most important livelihood strategies of the inhabitants in the state. All poultry farms with 50 to 200 chickens constituted the population for the study. A multistage sampling procedure and random sampling technique were employed in selecting respondents. In the first stage, two agricultural zones were randomly selected from the six agricultural zones in the state. In the second stage, two blocks were also randomly chosen from each of the selected agricultural zone, giving a total of four blocks. In the third stage, two circles were selected from each block resulting in a total of eight circles. In the fourth stage, eleven small-scale poultry farms (50-200 chickens) were selected through snow-balling sampling technique in which an identified small-scale farmer leads the researcher to another similar farmer in each circle. Thus, a total of 88 poultry farms were selected for the study. In each selected farm, the owner or designated worker was requested to participate in the study. Oral informed consent to participate in the study was obtained from each respondent.

***Data collection***

The instrument developed for data collection was validated by two agricultural extension academic staff specializing in rural sociology, and a veterinarian specializing in Veterinary Microbiology with interest in antibiotic use and resistance. The validated instrument was pretested in a non-study circle for clarity. Data was collected using structured interview schedule which contained relevant questions on socio-demographic characteristics of respondents, antibiotic use characteristics of the respondents, knowledge of antibiotic use (KABU) and antibiotic resistance (KABR) and practices of antibiotic use (PABU).

To determine the KABU, the respondents were requested to provide answers to a set of 15 statements bordering on appropriate and inappropriate use of antibiotics. The KABR was assessed by requesting the respondents to provide answers to another set of 15 statements on antibiotic resistance while responses to another set of 15 statements on practices relating to antibiotic use were used to determine the PABU. In all cases, a correct response was scored one point while an incorrect one scored zero.

***Data management and analysis***

The data were entered into Microsoft Excel worksheet. Socio-demographic and antibiotic use characteristics and the KABU, KABR and PABU of the respondents were determined using descriptive statistics. The KABU index for each respondent was determined by summing the scores of the 15 statements and dividing by 15. The KABR and PABU indices were similarly calculated. A respondent with a KABU or KABR index of 0.6 and above was regarded as having good knowledge of antibiotic use or antibiotic resistance. A respondent with a PABU index of 0.6 and above was considered to be using antibiotics appropriately. A binary logistic regression was performed to ascertain the effects of age, sex, farming experience, years spent in school, knowledge of antibiotic use and knowledge of antibiotic resistance (as independent variables) on the likelihood that farmers use antibiotic inappropriately (dependent variable). Good knowledge of antibiotic use or antibiotic resistance and appropriate practices of antibiotic use were coded “1” while poor knowledge and inappropriate use practices were coded “0”. All analyses were done using SPSS version 23 and at 5% level of probability.

**Results**

***Socioeconomic characteristics of small-scale poultry farmers in Enugu State***

The personal characteristics of the respondents are presented in the supplementary data. Females constituted 67% of the respondents. The age of the respondents ranged from 22-70 years with a mean of 36.8 year and the majority (65.9%) were below 40 years. The majority (75%) of the farmers were married; farming was reported as the primary occupation for 47.7% of the respondents. The number of years spent in school as indicated by the respondents ranged from 0-20 years with a mean of 6.8 years, with 35% having spent 7-12 years.

***Antibiotics use characteristics of small-scale poultry farmers in Enugu State***

All respondents reported use of antibiotics in their farms in the preceding one year prior to the study (Supplementary data). The number of years antibiotics have been in use in their farms ranged from 1-20 with a mean of 6.5 years. Forty-two (47.3%) of the farmers had 1 to 5 years’ experience on antibiotics use on their farms, while 43.2% of them had 6 to 10 years’ experience. The respondents indicated the antibiotics used in their farms were “prescribed” or recommended by themselves (62.5%), veterinarian (30.7%) or fellow farmers (5.7%).

Nearly 99% of the farmers use antibiotics in their poultry farms for growth promotion, disease prevention and treatment. Over 77% of the respondents indicated that their choice of antibiotic was guided by personal experience in using a particular antibiotic, cost of antibiotic and ease of administering the antibiotic. However, selection of antibiotic by 63.6% of the farmers was based on the recommendation from veterinary experts. It is worthy of note that only 2.3% of the respondents relied on results of culture and sensitivity testing for selecting their antibiotics.

The respondents reported they obtained information on appropriate use of antibiotics from a variety of sources. Drug sellers and other poultry farmers were stated by 98.9% and 81.8% of the respondents, respectively, to be their sources of information on antibiotics. Internet or extension provided information on antibiotic use to 18.2% of the respondents while less than 10% obtained such information through mobile phones, training, handbills and electronic/print media.

The majority (93.2%) of respondents were interested in deepening their knowledge on antibiotics use; with about 47% of them willing to receive training through seminars/workshops or physical classes.

***Classes of antibiotics used in small-scale poultry farms in Enugu State***

The respondents reported they use antibiotics belonging to seven classes/subclasses of antibiotics (Table 1). Tetracyclines were reported to be used either often (53.4%) or always (46.6%) while penicillins (59.1%), aminoglycosides (53.4%) and macrolides (51.1%) were often used in the farms. Respondents indicated that ionophores (61.4%), cephalosporins (54.5%) and polypetides (52.3%) were never used in their farms; however, 3.4%, 4.5% and 5.7%, respectively, reported that these agents were always used. Although 40.9% of respondents never used fluoroquinolones in their farms, 39.8% and 9.1%, respectively, reported that they often and always use them.

***Knowledge on use of antibiotics by farmers in Enugu State***

The respondents’ knowledge indices in respect of the fifteen statements on use of antibiotics ranged from 0.27-0.80 with a mean of 0.54 (Supplementary data). About 48% of the respondents had good knowledge (KABU index ≥0.6) of antibiotic use. Percentage responses to the knowledge statements are presented in Table 2. Responses depicting incorrect knowledge on the use of antibiotics were reported by majority of the respondents in 8 (53.3%) of the 15 statements. All (100%) the farmers correctly agreed that antibiotics can cure bacterial infections and that treated birds can recover quickly if treatment is initiated as soon as bacterial infection is diagnosed while nearly 91% correctly agreed that it is proper to follow instructions when administering antibiotics. However, about 80, 81, 82 and 86% incorrectly agreed, respectively, that it is proper to: obtain prescription about use of antibiotic from another farmer, good to administer antibiotic prior to emergence of signs of disease, administer antibiotics without a veterinary prescription and appropriate to discontinue use of antibiotic as soon as the health conditions of the birds improve. About 59% of the respondents incorrectly disagreed that it is proper to perform culture and sensitivity testing prior to antibiotic administration.

***Knowledge of antibiotic resistance***

The respondents’ indices on the fifteen statements about knowledge on antibiotic resistance ranged from 0.33-0.87 with a mean of 0.65 (Supplementary data). Good knowledge of antibiotic resistance (KABR index ≥ 0.6) was found in 70.5% of the respondents. Percentage responses to the KABR statements are presented in Table 3. Responses indicating correct knowledge of antibiotic resistance were reported by the majority of respondents in 12 (80%) of the 15 statements. A vast majority (95.5%) of the respondents incorrectly agreed that antibiotic resistance occurs when the bird becomes resistant to antibiotics. The respondents correctly agreed that indiscriminate use of antibiotics can lead to emergence of resistance (96.6%) and antibiotic resistance could result in poor clinical response to antibiotic treatment (88.6%). The respondents also correctly reported that resistance could lead to increased mortality and health care cost (84.1%) and that antibiotic resistance is an important and serious health issue (83%). However, 94.3% of the farmers incorrectly disagreed with the need to perform culture and sensitivity testing when infection is not responding to treatment while 51.1% also incorrectly disagreed that antibiotic resistance is a problem worldwide.

***Antibiotics use practices***

Indices of the antibiotic use practices ranged from 0.13-0.73 with a mean of 0.47 (Supplementary data). Only 17% of the respondents were found to use antibiotic appropriately (PABU index ≥ 0.6) in their farms. Percentage responses to the PABU statements are presented in Table 4. Responses indicating incorrect practices regarding antibiotic use were reported by majority of the respondents in 7 (46.7%) of the 15 statements. Nearly 91% of the respondents reported that they use antibiotics to improve the quantity and quality of the poultry products while 86.4% discontinue antibiotic administration as soon as the signs of disease stop. Other incorrect antibiotic use practices reported by the farmers include: administration of antibiotics in all disease cases (84.1%), storage of leftover antibiotics to be used in the event of other illnesses (80.7 %) and excessive administration of antibiotics (75%). However, majority of the farmers disagreed to incorrect practices such as not observing the expiration date of antibiotics (88.6%), buying antibiotics without prescription (75%) and using antibiotics without consulting a veterinarian (67%). About 85% of the farmers agreed to the correct practice of administering antibiotics in accordance with the prescription on the label while 75% agreed that they purchase these drugs from a veterinary drug store or pharmacy based on prescription.

The logistic regression model on the effects of age, sex, farming experience, years spent in school, knowledge of antibiotic use and knowledge of antibiotic resistance on the likelihood that farmers misuse antibiotics was statistically significant (χ2(df=6) = 15.185, p = 0.019). The model explained 25.9% (Nagelkerke R2) of the variance in antibiotic use practices and correctly classified 81.8% of the practices. Farmers with good knowledge of antibiotic use were significantly (OR = 4.211; p = 0.045) more likely to misuse antibiotics than those with poor knowledge (Supplementary data). Similarly, those with good knowledge of antibiotic resistance were significantly (OR = 4.527; p = 0.018) more likely to misuse antibiotics than those with poor knowledge.

**Discussion**

In this study the knowledge of antibiotic use and antibiotic resistance as well practices regarding antibiotic use among small-scale poultry farmers in Enugu State, Nigeria were examined. The findings show that all the 88 poultry farmers in the study have used antibiotics in their farms at various times within the preceding one year prior to the study and majority of the farmers used these agents based on self-prescription. Thus, use of antibiotics in poultry farming is a common practice in the study area. Antibiotics belonging to the tetracyclines (particularly oxytetracycline and chlortetracycline), macrolides (tylosin and erythromycin), aminoglycosides (gentamicin and neomycin) and penicillins (ampicillin) classes were the agents often or always used in over 70% of the farms. This observation is similar to that of Galadima *et al.* (2018) in Maiduguri, Northeast Nigeria, in which tetracycline and aminoglycoside were the most popular classes of antibiotics used by poultry farmers. The high rate of usage of these antibiotic agents in poultry production may be attributed to their affordable prices as well as to the fact that a greater proportion of poultry drug formulations in the Nigerian market contain these antibiotic agents. Drug formulations containing fluoroquinolones (especially ciprofloxacin or flumequine) and cephalosporins (particularly cefotaxime) were often or always used in 48.9 % and 27.2 % of the farms, respectively. These are critically important antimicrobial agents and their use in food animals can select resistant bacteria which may be transmitted to humans through the food chain. Apart from treatment purposes, nearly all the farmers used antibiotics for disease prevention and growth promotion. This finding is similar to those of several previous authors (Carrique-Mas *et al*., 2015; Wongsuvan *et al*., 2018; Pham-Duc *et al.,* 2019; Xu *et al*., 2020). Although use of antibiotics at subtherapeutic doses in animal production is reported to improved growth performance (Alarcon, *et al.,* 2014), such application has also been found to contribute to the emergence of antibiotic resistant bacteria. However, WHO (2017) recommended complete restriction on use of all classes of medically important antimicrobials in food-producing animals for growth promotion and disease prevention. Many developed countries have banned the use of antimicrobial agents as growth promoters (Maron *et al*., 2013; Teillant *et al*., 2015). Citing growing AMR in Nigeria, the National Agency for Food and Drug Administration and Control (NAFDAC) in 2018 issued a ban on use of antibiotic additives in animal feed. However, drug formulations containing a cocktail of antimicrobial agents (including medically important antimicrobials) abound in Nigerian markets whereby poultry farmers purchase and routinely administer them to their birds via drinking water for therapeutic and non-therapeutic purposes. Thus, the high rates of resistance to penicillins, tetracyclines, fluoroquinolones and cephalosporins among members of the Enterobacteriaceae reported from chicken in several studies in Nigeria (Oluduro, 2012; Ojo *et al*., 2012; Agada *et al.*, 2014; Oloso *et al*., 2018; Nwiyi *et al*., 2018; Chah *et al.*, 2018) could be attributed to excessive use of these agents in poultry production.

Majority of the farmers were engaged in self-prescription while choice of antibiotics used by over 75 % of the farmers was based on their personal experience, cost and ease of administration of the drugs and about 64 % based on recommendation from a veterinarian; a finding similar to that of Nsofor *et al*. (2013). Most of the farmers interviewed believe that there is no need to request the assistance of the veterinarian since they can follow the instructions on the drug label and would only seek for prescription from a veterinarian if the birds are not responding to treatment. In Nigeria, as in many low- and medium-income countries (LMIC), sales of antibiotics are largely unregulated (Byarugaba, 2004; Okeke *et al*., 2005). Both self-prescription and purchase of antibiotics without veterinary prescription promotes irrational use of antibiotics and its attendant consequences (Usui *et al.,* 2014). In order to avoid treatment failures and development of AMR, it is best practice to perform laboratory diagnosis and antimicrobial sensitivity testing (AST) prior to administration of antibiotic agent. Unfortunately, in the present study only 2.3% of the farmers indicated that choice of antibiotics used depended on the results of the AST. This observation is not surprising given the fact that only one veterinary microbiology diagnostic facility exists in the study area. Additionally, the respondents were small-scale farmers who raised chickens to augment family income and therefore will not be willing to increase production cost. Drug sellers, other farmers and friends were the major sources of information for the farmers on antibiotics; an observation that suggest a weak linkage between veterinarians/veterinary extension services and the small-scale poultry farmers in the study area. Some previous authors have also reported on drug sellers, other farmers and friends as major channels of information dissemination to farmers (Nsofor *et al*., 2013; Kigozi and Higenyi, 2017; Pham-Duc *et al.,* 2019). For profit interest, information from drug sellers, can be biased in favour of more antibiotics purchases and consequent excessive use in poultry production. In line with the findings of Di Martino *et al*. (2019) and Adebowale *et al.* (2016), poultry farmers in the present study indicated interest in deepening their knowledge on antibiotics with seminars/workshop and classroom as the preferred training platforms. Veterinarians and extension agents can therefore use these platforms to interface with the poultry farmers in the provision of accurate and reliable information on antibiotics and their prudent use.

Although 48 and 70.5% of the respondents had good knowledge on antibiotic use and resistance, respectively, 83% of them were still engaged in inappropriate antibiotic use practices. Farmers with good knowledge of antibiotic use and antibiotic resistance were, respectively, 4 and 5 times more likely to misuse antibiotics than those with poor knowledge. This observation is quite surprising as one expects good knowledge to translate into appropriate or best practices. This finding indicates that knowledge did not change the farmers’ attitudes towards antibiotic use. Although the farmers were aware that antibiotic misuse was associated with antibiotic resistance, they did not consider it as an important problem that could affect human health; a finding similar to that of Carter *et al*. (2016). The farmers also stated that they were not ready to take any risk of losing their birds, especially during the first week of life, by not administering antibiotics such as tetracycline. Thus, the main concern about the wellbeing of their chickens most likely contributed to the inappropriate use of antibiotics by the farmers studied.

**Conclusion**

Antibiotics are valuable agents whose efficacy can only be preserved if they are handled with care. Unfortunately, it is clear from the results of this study that antibiotics are routinely used, and in many occasions injudiciously, in small-scale poultry production in Enugu State, Nigeria. Gaps in small-scale poultry farmers’ knowledge of and practices regarding use of antibiotics in their production activities have been identified. Education through training in the form of seminars, workshops or conferences will provide the small-scale farmers the opportunity to improve their knowledge and practices regarding antibiotics use. Strengthening the linkage between veterinarians, veterinary extension agents and poultry farmers’ association will create ample opportunities for sharing accurate information on appropriate use of antibiotics in poultry production in the study area.

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**Table 1: Classes and frequency of antibiotics used in small-scale poultry farms in Enugu State**

|  |  |
| --- | --- |
| **Antibiotics used**  | **Frequency (%) of use** |
| ***Never*** | ***Rarely***  | ***Often*** | ***Always*** |
| Tetracyclines e.g. chlortetracycline and oxytetracycline | 0 (0.0) | 0 (0.0) | 47 (53.4) | 41 (46.6) |
| Macrolides e.g. erythromycin, tylosin | 14 (15.9) | 0(0.0) | 45 (51.1) | 29 (33.0) |
| Aminoglycosides e.g. gentamicin, neomycin, streptomycin | 14 (15.9) | 3 (3.4) | 47 (53.4) | 24 (27.3) |
| Penicillin e.g. amoxycillin | 15 (17.0) | 8 (9.1) | 52 (59.1) | 13 (14.8) |
| Fluroquinolones e.g. enrofloxacin, flumequine  | 36 (40.9) | 9 (10.2) | 35 (39.8) | 8 (9.1) |
| Cephalosporins e.g. cefotaxime | 48 (54.5) | 16 (18.2) | 20 (22.7) | 4 (4.5) |
| Polypeptides e.g. bacitracin | 46 (52.3) | 18 (20.5) | 19 (21.6) | 5 (5.7) |
| Ionophores e.g. monensin | 54 (61.4) | 28 (31.8) | 3 (3.4) | 3 (3.4) |

**Table 2: Knowledge of small-scale poultry farmers about use of antibiotics**

|  |  |
| --- | --- |
| **Statements about use of antibiotics** | **Response, n (%)** |
| **Agree** | **Disagree** | **Correct** |
| Antibiotics cure bacterial infection(s) | 88 (100.0) | 0 (0.0) | 88 (100.0) |
| Infected birds can recover quickly if treatment is initiated on time | 88 (100.0) | 0 (0.0) | 88 (100.0) |
| It advisable to use antibiotics for growth promotion | 57 (64.8) | 31 (35.2) | 31 (35.2) |
| Excessive use of antibiotics makes them ineffective | 70 (79.5) | 18 (20.5) | 70 (79.5) |
| Excessive use of antibiotics can result in side effects | 69 (78.4) | 19 (21.6) | 69 (78.4) |
| It is proper to administer antibiotics without a veterinary prescription  | 72 (81.8) | 16 (18.2) | 16 (18.2) |
| It is proper to obtain prescription about use of antibiotics from another farmer | 70 (79.5) | 18 (20.5) | 18 (20.5) |
| It is proper to follow instructions given to administer antibiotics | 80 (90.9) | 8 (9.1) | 80 (90.9) |
| It is appropriate to complete the full course of antibiotics prescribed even when birds have recovered | 66 (75.0) | 34 (25.0) | 66 (75.0) |
| It is proper to perform culture and sensitivity testing before giving antibiotics | 36 (40.9) | 52 (59.1) | 36 (40.9) |
| Improper use of antibiotics can cause secondary infection by killing good bacteria in animals | 49 (55.7) | 39 (44.3) | 49 (55.7) |
| Appropriate administration of antibiotics to birds may shorten the duration of bacterial diseases | 34 (38.6) | 54 (61.4) | 34 (38.6) |
| It is good to administer antibiotics before signs of disease emerge | 71 (80.7) | 17 (19.3) | 17 (19.3) |
| Stop administering antibiotics as soon as the birds get better | 77 (87.5) | 11 (12.5) | 11 (12.5) |
| It is better to use broad spectrum antibiotics than narrow spectrum ones | 66 (75.0) | 22 (25.0) | 22 (25.0) |

**Source: Field survey, 2019**

**Table 3: Knowledge of small-scale poultry farmers on antibiotics resistance**

|  |  |
| --- | --- |
| **Knowledge of antibiotics resistance** | **Response, n (%)** |
| **Agree** | **Disagree** | **Correct** |
| Antibiotic resistance occurs when the bird becomes resistance to antibiotics | 84 (95.5) | 4 (4.5) | 4 (4.5) |
| Indiscriminate and imprudent use of antibacterial can lead to emergence of resistance | 85 (96.6) | 3 (3.4) | 85 (96.6) |
| Antibiotic resistance results in poor clinical response to antibiotic treatment | 78 (88.6) | 10 (11.4) | 78 (88.6) |
| Infections caused by resistant bacteria can be very difficult to treat  | 72 (81.8) | 16 (18.2) | 72 (81.8) |
| It is necessary to performculture and susceptibility testing when infection is not responding to antibiotic treatment | 5 (5.7) | 83 (94.3) | 5 (5.7) |
| Antibacterial resistance is a problem worldwide | 43 (48.9) | 45 (51.1) | 43 (48.9) |
| Inappropriate use of antibiotics prevents antibacterial resistance | 18 (20.5) | 70 (79.5) | 70 (79.5) |
| Efficient use of antibiotics could lead to antibacterial resistance | 18 (20.5) | 70 (79.5) | 70 (79.5) |
| Antibacterial resistance can lead to increased mortality and health care cost | 74 (84.1) | 14 (15.9) | 74 (84.1) |
| If taken too often or unnecessarily the antibiotics are less likely to work in the future | 65 (73.9) | 28 (26.1) | 65 (73.9) |
| Use of antibiotics in poultry does not cause antibiotic resistance that could affect humans | 38 (43.2) | 50 (56.8) | 50 (56.8) |
| Antibiotic resistance is an issue that could affect me and my family | 55 (62.5) | 33 (37.5) | 55 (62.5) |
| Overuse and misuse of antibiotics in animals does not cause antibiotic resistance in human bacteria because the antibiotics that are used to treat animals are different from those used to treat humans | 33 (37.5) | 55 (62.5) | 55 (62.5) |
| Antibiotic resistance does not constitute a problem to effective treatment of diseased poultry birds  | 25 (28.4) | 63 (71.6) | 63 (71.6) |
| Antibiotic resistance is an important and serious health issue | 73 (83.0) | 15 (17) | 73 (83.0) |

***Source: Field survey, 2019***

**Table 4: Antibiotics use practices of small-scale poultry farmers in Enugu State**

|  |  |
| --- | --- |
| **Statements on antibiotic use practices** | **Response, n (%)** |
| **Agree** | **Disagree** | **Correct** |
| I stop using antibiotics whenever signsof disease stop | 76 (86.4) | 12 (13.6) | 12 (13.6) |
| I give a lot of antibiotics to my birds | 66 (75.0) | 22 (25.0) | 22 (25.0) |
| I usually keep antibiotics and use them later for other illnesses | 71 (80.7) | 17 (19.3) | 17 (19.3) |
| I use antibiotics for low feed intake | 55 (62.5) | 33 (37.5) | 33 (37.5) |
| I use antibiotics without consulting a veterinarian | 29 (33.0) | 59 (67.0) | 59 (67.0) |
| I stop administering antibiotics to the birds before completing the course of treatment | 43 (48.9) | 45 (51.1) | 45 (51.1) |
| I prefer to get antibiotics from other farmers without having to see a veterinarian  | 34 (38.6) | 54 (61.4 | 54 (61.4 |
| I buy and encourage buying of antibiotics without prescription | 22 (25.0) | 66 (75.0) | 66 (75.0) |
| I do not look at the expiry date of the antibiotics before using it | 10 (11.4) | 78 (88.6) | 78 (88.6) |
| I administer antibiotics according to the prescription on the label | 75 (85.2) | 13 (14.5) | 75 (85.2) |
| I buy antibiotics from the veterinarydrugshop/pharmacy based on prescription | 66 (75.0) | 22 (25.0) | 66 (75.0) |
| I use leftover antibiotics in an event of repeated illness | 63 (71.6) | 25 (28.4) | 25 (28.4) |
| I give antibiotics to birds for all types of illnesses | 74 (84.1) | 14 (15.9) | 14 (15.9) |
| I use antibiotics to improve the quantity and quality of poultry products | 80 (90.9) | 8 (9.1) | 8 (9.1) |
| I do not treat the entire flock by mass application of the antibiotics to the entire flock in drinking water | 44 (50.0) | 44 (50.0) | 44 (50.0) |

***Source: Field survey, 2019***

**Supplementary Materials**

**S1: Socioeconomic characteristics of small-scale poultry farmers in Enugu State, Nigeria**

|  |  |
| --- | --- |
| **Variables**  | **Frequency (%)** |
| **Personal characteristics** |  |
| ***Sex*** |  |
| Male | 29 (33.0) |
| Female | 59 (67.0) |
| ***Age (years)*** |  |
| below 30 | 22 (25.0) |
| 30-39 | 36 (40.9) |
| 40-49 | 19 (21.6) |
| 50-59 | 7 (8.0) |
| 60-69 | 3 (3.4) |
| above 69 | 1 (1.1) |
| ***Marital status*** |  |
| Single | 21 (23.9) |
| Married | 66 (75.0) |
| Widowed | 1 (1.1) |
| ***Years spent in school*** |  |
| 0-6  | 22 (25.0) |
| 7-12 | 31 (35.2) |
| Above 12 | 17 (19.3) |
| ***Primary occupation*** |  |
| Crop farming | 42 (47.7) |
| Trading | 36 (40.9) |
| Civil service | 6 (6.8) |
| Artisanship | 4 (4.5) |
| ***Farming experience (years)*** |  |
| 1-5 | 42 (47.7) |
| 6-10 | 38 (43.2) |
| 11-15 | 5 (5.7) |
| 16-20 | 3 (3.4) |

**\***multiple response

**S2: Antibiotic use characteristics of small-scale poultry farmers in Enugu State, Nigeria**

|  |  |
| --- | --- |
| **Variable** | **Frequency (%)** |
| ***Antibiotics farm use*** | 88 (100.0) |
| Yes |  |
| ***Source of prescription(n=88)\**** |  |
| Self | 55 (62.5) |
| Veterinarian | 27 (30.7) |
| Poultry farmers | 5 (5.7) |
| ***Reasons for antibiotic use (n=88)\**** |  |
| Growth promotion | 87 (98.9) |
| Disease prevention | 87 (98.9) |
| Treatment | 87 (98.9) |
| Antiseptics | 8 (9.1) |
| ***Criteria for choice of antibiotics (n=88)\**** |  |
| Personal experience using particular antibiotics | 84 (95.5) |
| Cost of antibiotics | 78 (88.6) |
| Ease of administration | 68 (77.3) |
| Perceived ability to correctly administer certain antibiotics | 59 (67.0) |
| Preference of specific antibiotics | 58 (65.9) |
| Recommendations from veterinary experts | 56 (63.6) |
| Withdrawal period consideration | 49 (55.7) |
| Result of culturing and sensitivity testing | 2 (2.3) |
| ***Farmers’ sources of information on antibiotics (n=88)\**** |  |
| Drug sellers | 87 (98.9) |
| Other farmers | 72 (81.8) |
| Friends and relatives | 60 (68.2) |
| Trader association | 21 (23.9) |
| Age group association | 18 (20.5) |
| Extension agents | 16 (18.2) |
| Internet  | 16 (18.2) |
| Mobile phones | 7 (8.0) |
| Training  | 6 (6.8) |
| Fliers/hand bills | 5 (5.7) |
| Television  | 4 (4.5) |
| Radio | 2 (2.3) |
| Newspaper | 1 (1.1) |
| ***Interest to deepen knowledge on antibiotics*** |  |
| Yes | 82 (93.2) |
| No | 6 (6.8) |
| ***Training preference(n=82)\**** |  |
| Seminar/workshop | 41 (46.6) |
| Classroom training | 41 (46.6) |
| Farm visits | 5 (5.7) |
| Group meeting | 3 (3.4) |
| Online training | 2 (2.3) |

**\***multiple response

**S3: Indices of knowledge of antibiotic use (KABU), Knowledge of antibiotic resistance (KABR) and practices of antibiotic use (PABU) of poultry farmers in Enugu State, Nigeria**

|  |  |  |
| --- | --- | --- |
| **KABU** | **KABR** | **PABU** |
| 0.73 | 0.73 | 0.47 |
| 0.27 | 0.53 | 0.47 |
| 0.40 | 0.60 | 0.60 |
| 0.67 | 0.73 | 0.40 |
| 0.53 | 0.60 | 0.67 |
| 0.73 | 0.40 | 0.53 |
| 0.53 | 0.53 | 0.47 |
| 0.47 | 0.67 | 0.53 |
| 0.60 | 0.67 | 0.40 |
| 0.53 | 0.67 | 0.47 |
| 0.60 | 0.47 | 0.53 |
| 0.73 | 0.53 | 0.40 |
| 0.47 | 0.53 | 0.60 |
| 0.47 | 0.47 | 0.47 |
| 0.80 | 0.67 | 0.33 |
| 0.67 | 0.73 | 0.73 |
| 0.60 | 0.80 | 0.47 |
| 0.67 | 0.80 | 0.40 |
| 0.53 | 0.87 | 0.40 |
| 0.40 | 0.47 | 0.60 |
| 0.67 | 0.87 | 0.33 |
| 0.53 | 0.60 | 0.33 |
| 0.67 | 0.60 | 0.40 |
| 0.53 | 0.73 | 0.33 |
| 0.47 | 0.67 | 0.33 |
| 0.27 | 0.53 | 0.47 |
| 0.47 | 0.73 | 0.47 |
| 0.33 | 0.53 | 0.60 |
| 0.73 | 0.80 | 0.47 |
| 0.47 | 0.53 | 0.13 |
| 0.40 | 0.53 | 0.40 |
| 0.67 | 0.53 | 0.60 |
| 0.40 | 0.73 | 0.40 |
| 0.40 | 0.60 | 0.60 |
| 0.47 | 0.53 | 0.40 |
| 0.53 | 0.67 | 0.40 |
| 0.67 | 0.87 | 0.47 |
| 0.53 | 0.80 | 0.40 |
| 0.40 | 0.80 | 0.40 |
| 0.47 | 0.53 | 0.40 |
| 0.33 | 0.73 | 0.40 |
| 0.60 | 0.87 | 0.40 |
| 0.67 | 0.67 | 0.47 |
| 0.53 | 0.60 | 0.53 |
| 0.60 | 0.73 | 0.40 |
| 0.67 | 0.60 | 0.40 |
| 0.60 | 0.73 | 0.40 |
| 0.67 | 0.80 | 0.47 |
| 0.60 | 0.80 | 0.53 |
| 0.73 | 0.53 | 0.27 |
| 0.60 | 0.53 | 0.47 |
| 0.60 | 0.53 | 0.53 |
| 0.67 | 0.67 | 0.13 |
| 0.47 | 0.53 | 0.73 |
| 0.40 | 0.73 | 0.53 |
| 0.67 | 0.80 | 0.53 |
| 0.53 | 0.67 | 0.47 |
| 0.33 | 0.33 | 0.73 |
| 0.60 | 0.53 | 0.60 |
| 0.47 | 0.53 | 0.40 |
| 0.53 | 0.67 | 0.47 |
| 0.47 | 0.73 | 0.47 |
| 0.27 | 0.53 | 0.53 |
| 0.33 | 0.60 | 0.67 |
| 0.27 | 0.53 | 0.73 |
| 0.60 | 0.60 | 0.47 |
| 0.33 | 0.67 | 0.73 |
| 0.67 | 0.73 | 0.47 |
| 0.53 | 0.67 | 0.53 |
| 0.53 | 0.60 | 0.53 |
| 0.73 | 0.60 | 0.47 |
| 0.47 | 0.73 | 0.40 |
| 0.33 | 0.73 | 0.53 |
| 0.60 | 0.80 | 0.27 |
| 0.60 | 0.73 | 0.33 |
| 0.73 | 0.40 | 0.40 |
| 0.73 | 0.67 | 0.53 |
| 0.53 | 0.87 | 0.47 |
| 0.67 | 0.60 | 0.40 |
| 0.47 | 0.53 | 0.73 |
| 0.67 | 0.80 | 0.33 |
| 0.60 | 0.87 | 0.47 |
| 0.73 | 0.73 | 0.53 |
| 0.60 | 0.67 | 0.47 |
| 0.33 | 0.67 | 0.40 |
| 0.60 | 0.60 | 0.47 |
| 0.47 | 0.67 | 0.47 |
| 0.67 | 0.60 | 0.27 |

**S4: Factors influencing misuse of antibiotics among small-scale poultry farmers in Enugu State**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **B** | **S.E.** | **Wald** | **df** | **Sig.** | **Exp(B)** | **95% C.I.for EXP(B)** |
| ***Lower*** | ***Upper*** |
| Age | -0.052 | 0.037 | 1.940 | 1 | 0.164 | 0.949 | 0.882 | 1.021 |
| YrsSch | -0.022 | 0.057 | 0.145 | 1 | 0.703 | 0.979 | 0.875 | 1.094 |
| FarmExp | 0.097 | 0.062 | 2.439 | 1 | 0.118 | 1.102 | 0.976 | 1.244 |
| Gender(1) | 0.070 | 0.648 | 0.012 | 1 | 0.915 | 1.072 | 0.301 | 3.819 |
| GKABU(1) | 1.438 | 0.719 | 4.003 | 1 | 0.045 | 4.211 | 1.030 | 17.222 |
| GKABR(1) | 1.510 | 0.637 | 5.612 | 1 | 0.018 | 4.527 | 1.298 | 15.791 |
| Constant | -1.858 | 1.591 | 1.363 | 1 | 0.243 | 0.156 |  |  |

NagelkerkeR2= 25.9%

B = Regression coefficient; S.E. standard error; Exp(B) = exponentiated coefficient = Odds ratio (OR); C.I. = Confidence interval; GKABU = Good knowledge of antibiotic use; GKABR = Good knowledge of antibiotic resistance; YrsSch = Years spent in school; FarmExp = Farming experience