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Antibiotic use and knowledge of antibiotic resistance among pig farmers in Ejisu and Juaben municipalities of Ashanti region, Ghana

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Abstract

Introduction: *the indiscriminate use of antibiotics has led to the development of antibiotic-resistant pathogens which have now become a threat to public health. Antibiotic use is high in poultry and pig production, compared to other food-producing animals, yet in Ghana, there is limited data and surveillance studies on their use. The study investigates the knowledge of farmers on antibiotics and antimicrobial resistance.* ***Methods:*** *a cross-sectional study, utilizing a structured questionnaire, was therefore conducted to investigate antibiotic usage and to assess the knowledge of antibiotic resistance among pig farmers in the Ejisu and Juaben municipalities in the Ashanti region of Ghana.* ***Results:*** *results obtained indicate that 98% of respondents use antibiotics. Penicillin-streptomycin is the most frequently used antibiotic by the farmers (98%, n = 49), followed by sulfadimidine (72%, n = 36), tetracyclines (70%, n = 35) and trimethoprim (2%, n = 1). Knowledge of pig farmers on antibiotic resistance was generally poor with only 26% having adequate knowledge of antibiotics and antimicrobial resistance. Only 22.4% of the farmers sought veterinary advice before administering antibiotics.* ***Conclusion:*** *this study established that farmers' knowledge of antibiotics and antimicrobial resistance is influenced by their education, experience in pig farming, information source, and veterinary services advice. There is inadequate knowledge of pig farmers on antibiotics and antimicrobial resistance and poor practices regarding antibiotic use. Hence the need to intensify farmer-education programs on the appropriate use of antimicrobials to minimize the development of resistant strains of pathogens.*

Introduction

The discovery of antibiotics has greatly improved the treatment and prevention of infectious diseases of bacterial origin that were lethal to humans and animals. This improvement has positively impacted both human and animal health delivery worldwide and played a critical role in the betterment of animal welfare as well as in ensuring food safety and food security [1]. Antibiotics are used in food-producing animals (mainly cattle, poultry, and pigs) for therapeutic, metaphylaxis, prophylaxis and as growth promoters [2]. Amongst the most frequently used antibiotics for human treatments are penicillin, macrolides, and fluoroquinolones, while tetracyclines, penicillin, and sulfonamides are the most commonly used in animal health [3]. It is therefore imperative to safeguard the efficacy of these life-saving and indispensable medications, as well as guarantee their continuous availability for both human and veterinary use, so that the future can be preserved [1].

The surge in the use of antibiotics in animal production is driven by the increase in livestock production to meet the growing demand of citizens for animal protein, particularly in low- and middle-income countries, where the use of antibiotics is poorly regulated and used irrationally to compensate for poor biosecurity measures and other inappropriate animal husbandry practices [4]. The overuse and misuse of antibiotics has led to the development and spread of antimicrobial resistance (AMR) which has now become a threat to public health globally [5]. The emergence of AMR strains is dependent on several factors relating to the antimicrobial itself, including dosage, frequency and duration of use [6]. Antibiotics usage is particularly high in poultry and pig production, compared to other food-producing animals. The intensive conditions under which pigs and chickens are often housed may be associated with greater vulnerability to infectious disease potential and therefore a greater reliance on antibiotics to control sub-clinical infections [6]. In animal husbandry alone, the average yearly consumption of antibiotics has been estimated as 172 mg/kg in pigs, 148 mg/kg in chicken, and 45 mg/kg in cattle worldwide [6].

In Ghana, domestic commercial production of pigs has grown significantly over the past decade, mainly as a result of increasing domestic pork

consumption [7]. Commercial pig farming in the Ashanti region, Ghana, is the second most recognized form of commercial food animal production after poultry with Ejisu municipality being the leading producer of pigs in the Ashanti region [8]. About 41% of livestock and poultry farmers in Ghana use antibiotics for infection prevention at least once a month [9] leading to the development of resistant strains of pathogens [10].

Antimicrobial resistance both in human and veterinary medicine has reached alarming levels in most parts of the world and has now been recognized as a significant emerging threat to global public health and food security [11]. The potential threat to human health resulting from inappropriate antibiotic use in food animals is significant, as pathogenic-resistant organisms propagated in the livestock are poised to enter the food supply chain and could be widely disseminated in food products [12]. To tackle the menace posed by antibiotic resistance, proper antibiotic administration practices such as accurate dosing, route of administration, observance of withdrawal periods, and strict adherence to manufacturers´ instructions have been suggested as important solutions [2]. There is, however, a paucity of data and surveillance studies on antibiotic use and farmers´ knowledge of antibiotic resistance in Ghana, especially in pig husbandry.

The World Health Organization´s Global Action Plan on AMR 2016 also addresses the need to strengthen knowledge and evidence-based practices through surveillance and research. This cross-sectional study seeks to provide information crucial for the development of an appropriate intervention to reduce the spread of antibiotic resistance in Ghana using Ejisu and Juaben municipalities as a model to provide evidence on inappropriate antibiotic use and inadequate knowledge of antibiotics by pig farmers. Hence, this study was set out to investigate antibiotic usage among pig farmers as well as to assess pig farmers´ knowledge on antibiotics, and antibiotic resistance in Ejisu and Juaben municipalities in the Ashanti region of Ghana.

Methods

Study area: this study was carried out in the Ejisu and Juaben municipalities of the Ashanti region, Ghana. Data available at the Ejisu-Juaben Municipal Agricultural office indicates that chicken (70.3%) is the most-reared animal by households in the municipality. Other types of animals reared by households are sheep (10.2%) and goats (8.3%). There are about 104 pig farmers in the municipality representing (2.4%) of the livestock keepers.

Study design: a cross-sectional study using a close-ended questionnaire was designed and applied to collect data on antibiotic usage and pig farmers´ knowledge of antibiotic resistance. The study was conducted from May 2022 to September 2022.

Questionnaire development: questionnaires from previous studies were adopted and modified [13,14]. The questionnaire was piloted with 5 pig farmers and reviewed for clarity before implementation. The final version had three sections: demographics of pig herd and farmer; knowledge of antibiotics and antibiotics resistance; and pattern of antibiotic use. The word 'pattern´ explains the use of antibiotics in terms of the active ingredients; the route of administration such as injection or via feed and water; and the purpose of the use, including treatment, prophylaxis, and growth promotion. The questionnaire contained mostly closed-ended questions with few open-ended questions. Pictures of different types of antibiotics were obtained from veterinary pharmacies and were added to the questionnaire to help farmers with easy identification of the antibiotics they used on their farms.

Study population: pig farmers who were involved in the day-to-day activities on their farms and in active production were the target group for this study.

Sample technique: the snowball technique was adopted for this study since there were no established documents containing the phone number and locations of the farmers. In addition, contacts provided by agriculture extension officers, district veterinary officers as well as local Pig Farmers´ Association were used in identifying some of the farmers.

Sample size: fifty (50) pig farmers were sampled for this study. The sample size was determined using standardized sample size estimates for the prevalence of antimicrobial resistance in a large population developed by the World Organization for Animal Health (WOAH) (OIE Standards, Guidelines and Resolution on antimicrobial resistance and the use of antimicrobial agents, 2015). The parameters were: level of confidence = 90%, desired precision =10%, and expected prevalence of farmers´ antibiotic usage =20%.

Validity and reliability of the instrument: the content validity of the questionnaire was ensured by facts identified from the literature review. The responses to the structured questionnaire were subjected to the Cronbach Alpha test to verify the reliability of the questions asked in the questionnaires; thus, the reliability coefficient (Cronbach alpha) was compiled. A Cronbach alpha which had a reliability coefficient of 0.72 was deemed acceptable.

Data collection: permission was obtained from the respondents before questionnaires were administered and they were informed that their identification was not required. The questionnaire was developed and administered in English language but translated into Twi (the local Ghanaian language), when needed, in a face-to-face interview. Telephone calls were made with farmers who were not available for a face-to-face interview. The first section collected demographic information such as farmer´s age, gender, education level, number of pigs owned, type of pig husbandry methods, and their main source of income. The second section assessed farmer´s knowledge of antibiotics and antibiotic resistance. Two questions in this section were asked as open-ended questions but immediately categorized by the interviewer (how do you think an antibiotic works and what is the impact of antibiotic resistance?). Immediately after the questions that assessed if farmers had an accurate understanding of antibiotics and antibiotic resistance or not, the definition of antibiotics was clearly explained before proceeding to the third section of the questionnaire which assessed antibiotic use in pigs. Eight questions were selected to assess the knowledge of farmers on antibiotics and antibiotic resistance. A correctly answered question scored one (1) whereas a wrongly answered question scored zero (0). Farmers were grouped into having adequate or inadequate knowledge based on their assessment score of ≥ 4/8 and < 4/8 respectively and similarly into appropriate or inappropriate practices on antibiotic use assessment score of ≥ 5/9 and < 5/9 respectively.

Each interview took an average of 13 minutes (telephone) and 25 minutes (face-to-face) to complete. All responses were recorded on paper and subsequently entered and managed in Google Forms and Microsoft Excel Spreadsheets respectively. The research maintained absolute confidentiality throughout the study.

Data analysis: data was entered into Microsoft Excel version 2019 for cleaning and for the generation of graphs. The responses were then coded into figures and exported to the Statistical Package for Social Sciences (SPSS) for further analysis. Descriptive statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 20.0. Pearson´s Chi-square test was used to determine the association between demographic characteristics and farmers´ knowledge of antibiotics and antibiotic resistance. The same approach was used for farmer practices on antibiotic usage. Statistical significance was tested at a 5% significant level or a 95% confidence interval. Significance values that were less than or equal to 0.05 were considered statistically significant.

Results

Socio-demographic characteristics of the respondent: a total of 50 pig farmers were sampled for this cross-sectional survey. Out of the 50 farmers interviewed (Table 1), most of the respondents were male (88%, n = 44) and most of them belonged to the 41-50-year age group (48%, n = 24) with only (4%, n = 2) belonging to the 18-30-year group. There was no significant difference in a number of farmers who had primary and secondary education (36%, n = 18 and 34%, n = 17 respectively). The majority of the farmers (60%, n = 30) had less than 10 years of experience in pig rearing. In terms of source of income, nearly half (48%, n = 24) had pig rearing as their main source of income.

Commonly used antibiotics in the study area: several antibiotic types were used by farmers in the study area. Nearly all (96%, n = 48) the farmers used at least two antibiotic types. Only one farmer did not use any antibiotics on pigs. Of the antibiotics used, penicillin-streptomycin was the most commonly used antibiotic type (98%, n = 49), sulfadimidine (72%, n = 36), tetracyclines (70%, n = 35) with trimethoprim (2%, n = 1) being the least commonly used antibiotic (Figure 1).

Knowledge of farmers on antibiotics and antibiotic resistance and their practices: to assess farmers´ knowledge on antibiotics and antibiotic resistance, farmers were asked 8 questions as indicated in Table 2. Most (88%, n = 44) of the respondents said they knew what antibiotics are and of this percentage, 66% (n = 29) heard about antibiotics from colleague farmers. When specifically asked how antibiotics work, a larger proportion of the respondents (79.5%) did not know how antibiotics work.

Only 30% of the respondents have heard about antibiotic resistance and of this percentage, 42.8% (n = 6) heard about antibiotic resistance from seminars. A majority of the respondents who heard about antibiotic resistance (73.3%, n = 11) are likely to say antibiotic resistance make antibiotics less effective. A sizeable proportion (72%) of the respondents disagreed with the fact that overdose/low dose may lead to antibiotic resistance. Surprisingly, 82% (n = 41) further gave a negative response when asked whether the misuse and overuse of antibiotics could result in antibiotic resistance and affect the health of both humans and animals. Only 26% answered yes when they were asked whether they are aware of drug residue, preceding whether drugs taken by pigs can pass to meat which received 42% yes responses. Knowledge of farmers on antibiotics and antibiotic resistance was categorized as adequate (26%) and inadequate (74%) as shown in Table 2.

Practices on antibiotic use among pig farmers are detailed in Table 3and Figure 2. Almost all the farmers had ever given antibiotics to their pigs (98%, n = 49). When asked the frequency of antibiotic use, 79.6% said they give antibiotics to their pigs anytime they look sick and about half of them (51%) gave antibiotics to their pigs just after weaning. Other farmers gave antibiotics to their pigs routinely; every three months (40%), monthly (16.3%), and weekly (8.2%). Of farmers who give antibiotics to their pigs (98%, n = 49), 40.8% used them as growth promoters while 82% used them to prevent diseases. Diarrhea was the most common clinical sign that prompted antibiotic use with a (100%, n = 49) response among farmers who used antibiotics. Inappetence was a factor that prompted 75.5% of the farmers to use antibiotics in pig production. With regards route of administration, 36% added antibiotics to feed mostly just after weaning, 14% by water medication, and 50% used injectable antibiotics (Table 3).

A larger proportion of the farmers (66%) consulted veterinary services only when their animals did not respond to treatment; 22.4% consulted veterinary technicians before the administration of antibiotics. On following manufacturer´s instructions, 74% of the farmers followed label instructions which they relied on for treatment as

an alternative to veterinary services to save time and to reduce cost of production. When asked about observing withdrawal periods, 53% said they observed withdrawal periods after antibiotic administration (Table 3). About 91% of the farmers purchased antibiotics from the markets in Ejisu and Juaben. A total of 69.4% of farmers stored antibiotics on their farms (mostly in polytene bags and containers in which the drugs were bought) which they kept in feed stores. Only one farmer had a designated box for the storage of drugs. Most of the farmers (83.7%) did not keep records of antibiotics used on their farms (Table 3).

Influence of demographic characteristics on farmers´ knowledge of antibiotics and antibiotic resistance and their practices: an association test was performed to show the significant factors between the demographic variables and knowledge. The results demonstrated in Table 4, show that farmer´s level of education (p = 0.001) and experience in pig rearing (p = 0.006) were the significant factors influencing the knowledge of farmers on antibiotics and antibiotic resistance.

Factors such as famer´s level of education (p = 0.017) and farm type (p = 0.020) were significant demographic factors influencing the practices involved in antibiotic use. A greater proportion of farmers who had tertiary education (69.2%, n = 9) and more than half of the large-scale farmers (58.8%, n = 10) practices were appropriate. Detailed results are indicated in Table 4.

Influence of veterinary services involvement on knowledge of farmers on antibiotics and antibiotic resistance and their practices: an association test was performed to assess how the involvement of veterinary services in pig rearing influenced the farmer´s knowledge on antibiotics and antibiotic resistance (Table 5). Farmers that accessed veterinary services only when they are unable to treat (84.8%) had inadequate knowledge which was significant (p = 0.037). Source of information by the farmers was a significant factor that influenced their knowledge (p = 0.001). This study revealed that 86.2% of the farmers who heard about antibiotics and resistance from colleagues had inadequate knowledge while 60% of farmers who heard about antibiotics and resistance from veterinarians had adequate knowledge. All those farmers who heard about antibiotics from seminars had adequate knowledge on antibiotics and antibiotic resistance.

The test analysis revealed veterinary consultation (p = 0.003) before antibiotic use was a significant factor influencing practices (Table 5). Veterinary consultation before antibiotic use resulted in appropriate practices. The practices of majority of the farmers who accessed veterinary services only when they were unable to treat (75.8%) were inappropriate.

Discussion

Extensive use of antibiotics in food-producing animals contributes significantly to the development and emergence of antimicrobial resistance which has become a threat to public health globally. Recognizing this threat, the World Health Organization´s Global Action Plan on AMR 2016, addresses the need to strengthen knowledge and evidence-based practices on antibiotic use through surveillance and research.

This cross-sectional study examined antibiotic use and pig farmers´ knowledge of antibiotic resistance in Ghana's Ejisu and Juaben municipalities. Results obtained indicate that 98% of pig farmers surveyed use antibiotics in pig production. The common classes of antibiotics used include penicillin, sulfonamides, tetracyclines, aminoglycosides, macrolides, and fluoroquinolones which is consistent with results of previous studies by Hossain *et al.* [14], Osei-Sekyere [8], Phares *et al.* [15] and Wangmo *et al.* [16].

In our study, penicillin-streptomycin was the most commonly (98%, n = 50) used antibiotic type amongst the pig farmers. This finding is contrary to previous work done in the study area by Osei-Sekyere [8] and in Ethiopia [17] which found

tetracyclines as the most commonly used antibiotic type. The study revealed that 69.4% of the respondents do not consult veterinarians before administering antibiotics to their pigs. They give antibiotics to their pigs without any specific indication warranting their use; thus, giving antibiotics to pigs anytime they appeared sick or not feeding well. Most of the respondents who called on veterinarians did that only when their animals did not respond to treatment. Our finding is consistent with those of previous studies done in Bangladesh [14], Shandong province, China [18] Ashanti region, Ghana [8], and Southern Ghana [15].

Most farmers (91%) purchased antibiotics from market-based pharmacies, often without a veterinarian's prescription. The farmers mostly relied on prior experience and advice from fellow farmers for the choice of antibiotics used. Easy access to antibiotics is possible because the use of antibiotics in animals is poorly regulated in many countries [6], which supports our finding.

Participants in this survey had a 26% total knowledge score on antibiotics, their proper application, and antibiotic resistance. This result emphasizes the need for user education to prevent antibiotic misuse and overuse, which can harm humans and animals. These levels of knowledge are comparable to those observed in earlier studies, including Nigeria [19], Timor-Leste [13], Sudan [20], China [18], and Bangladesh [14].

According to studies by Osei-Sekyere [8], Phares *et al.* [15] and Addah *et al.* [21], the observance of withdrawal period among farmers is nearly absent in Ghana. In our study, however, 53% of the respondents stated that they observed a withdrawal period according to manufacturer´s instruction. This finding even though low, is better than what was previously reported and can be improved upon through seminars and training for these farmers on the proper utilization of antibiotics.

A study done in Sudan found a significant association between farmers´ low education level and poor knowledge on antibiotic use and AMR awareness [20]. Our study found that farmers' understanding of antibiotics and antibiotic resistance is influenced by education level, animal husbandry knowledge, information source, and veterinary services advice as opined by Phares *et al.* [15]. Long-time pig farmers knew much more than those with less than five years experience. This may come from extensive practice. University-educated animal farmers employed antibiotics more successfully than those with only a primary education. This agrees with Geta and Kibret [17] and Osei-Sekyere [8].

This study again revealed that farmers who heard about antibiotics and AMR in seminars and those who consulted veterinarians prior to antibiotic use had higher knowledge levels and used antibiotics more appropriately. Due to a low number of veterinarians in Ghana, few farmers access veterinary services for farm inspections and antibiotic prescription [22].

Prior to the time of the study, there was an outbreak of African swine fever in the study area which led to the loss of a large number of pigs, completely wiping out the flock of some farmers. This unfortunate occurrence drove some farmers out of production, hence affecting the sample size of this study. This limitation did not, however, have any significant impact on the quality of the data collected. Accordingly, the results of the study are a true reflection of the situation in the study area.

Conclusion

This study has identified penicillin-streptomycin as the most frequently used antibiotic in the study area, exposed the inadequate knowledge of farmers on antibiotics and antibiotic resistance, and also the poor practices regarding antibiotic use amongst farmers in the Ejisu and Juaben municipalities of Ashanti region, Ghana. This

suggests a critical need for effective policy development and implementation to increase awareness of antibiotics and antibiotic resistance and the need to ensure the enforcement of already existing policies to mitigate the indiscriminate use of antibiotics because it can negatively impact humans, animals, the environment, and food security.

What is known about this topic

- *Much literature has shown that antimicrobial resistance is a global issue with serious implications and needs to be tackled;*
- *Farmers have been indicated to be at the end usage of high levels of antibiotics in raising animals;*
- *The increased and excessive usage of antibiotics has made the cost of treating animal diseases very expensive hence a need to address the issue.*

What this study adds

- *This study adds to the existing literature on the knowledge of antibiotic usage in Ghana among livestock farmers with a focus on the pig industry;*
- *It provides critical information on the perceptions of how antibiotics work when used by pig farmers as well as their current practices;*
- *The study also indicates strongly the need for awareness creation on proper antibiotic usage and stewardship among pig farmers.*

Competing interests

The authors declare no competing interests.

Authors' contributions

Conceptualization of the study: Raphael Folitse and Rejoice Esenam Nyarku; data gathering: Richard Dogbatse; statistical analysis: Vitus Burimuah, and Esther Amemor; manuscript drafting and editing: Richard Dogbatse, Raphael Folitse, and Benjamin Obukowho Emikpe. All the authors read and approved the final version of this manuscript.

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Tables and figures

Table 1: demographic and socio-economic characteristics of the respondent

Table 2: knowledge of pig farmers regarding antibiotics and antibiotic resistance

Table 3: pig farmers´ practices with regards to antibiotics usage

Table 4: effect of demographic characteristics on farmer knowledge on antibiotics and farmer antibiotic usage (practices)

Table 5: effect of veterinary involvement on knowledge of farmers and their practices regarding antibiotic usage

Figure 1: antibiotics commonly used by pig farmers

Figure 2: frequency of antibiotic usage among pig farmers

References

1. World Health Organisation (WHO). Global Action Plan on Antimicrobial Resistance. 2015. **Google Scholar**

2. World Health Organisation (WHO). Global Antimicrobial Resistance Surveillance System (GLASS) Report: Early Implementation 2016-2017. World Health Organization, Geneva, Switzerland. 2017. **Google Scholar**
3. Ma F, Xu S, Tang Z, Li Z, Zhang L. Use of antimicrobials in food animals and impact of transmission of antimicrobial resistance on humans. Biosaf Health. 2021;3(1): 32-8. **Google Scholar**
4. Dadgostar P. Antimicrobial resistance: implications and costs. Infect Drug Resist. 2019 Dec 20;12: 3903-3910. **PubMed**| **Google Scholar**
5. Acar JF, Moulin G. Antimicrobial resistance: a complex issue. Rev Sci Tech. 2012;31(1): 23-31. **PubMed**| **Google Scholar**
6. Van Boeckel TP, Brower C, Gilbert M, Grenfell BT, Levin SA, Robinson TP *et al*. Global trends in antimicrobial use in food animals. Proc Natl Acad Sci U S A. 2015 May 5;112(18): 5649-54. **PubMed**| **Google Scholar**
7. Banson KE, Nketsia-Tabiri J, Anno K, Dagbui EK. Economic and market analysis of swine rearing and pork production in Ghana. J Life Sci. 2014;8(8). **Google Scholar**
8. Osei Sekyere J. Antibiotic Types and Handling Practices in Disease Management among Pig Farms in Ashanti Region, Ghana. J Vet Med. 2014;2014: 531952. **PubMed**| **Google Scholar**
9. Paintsil EK, Ofori LA, Akenten CW, Fosu D, Ofori S, Lamshöft M *et al*. Antimicrobial Usage in Commercial and Domestic Poultry Farming in Two Communities in the Ashanti Region of Ghana. Antibiotics (Basel). 2021;10(7): 800. **PubMed**| **Google Scholar**
10. Ohene Larbi R, Ofori LA, Sylverken AA, Ayim-Akonor M, Obiri-Danso K. Antimicrobial Resistance of *Escherichia coli*from Broilers, Pigs, and Cattle in the Greater Kumasi Metropolis, Ghana. Int J Microbiol. 2021 Jun 5;2021: 5158185. **PubMed**| **Google Scholar**
11. Wall BA, Mateus AL, Marshall L, Pfeiffer DU, Lubroth J, Ormel HJ *et al*. Drivers, dynamics and epidemiology of antimicrobial resistance in animal production. Food and Agriculture Organization of the United Nations. 2016. **Google Scholar**
12. Landers TF, Cohen B, Wittum TE, Larson EL. A review of antibiotic use in food animals: perspective, policy, and potential. Publ Health Rpt. 2012;127(1): 4-22. **PubMed**| **Google Scholar**
13. Ting S, Pereira A, Davis S, Vong da Silva PG, Alves A, Dos Santos C *et al*. Knowledge and Practices on Antibiotic Use and Antibiotic Resistance Among Smallholder Pig Farmers in Timor-Leste. Front Vet Sci. 2022 Jan 6;8: 819643. **PubMed**| **Google Scholar**
14. Hossain MT, Rafiq K, Islam MZ, Chowdhury S, Islam P, Haque Z *et al*. A Survey on Knowledge, Attitude, and Practices of Large-Animal Farmers towards Antimicrobial Use, Resistance, and Residues in Mymensingh Division of Bangladesh. Antibiotics (Basel). 2022 Mar 24;11(4): 442. **PubMed**| **Google Scholar**
15. Phares CA, Danquah A, Atiah K, Agyei FK, Michael OT. Antibiotics utilization and farmers´ knowledge of its effects on soil ecosystem in the coastal drylands of Ghana. PLoS One. 2020;15(2): e0228777. **PubMed**| **Google Scholar**
16. Wangmo K, Dorji T, Pokhrel N, Dorji T, Dorji J, Tenzin T. Knowledge, attitude, and practice on antibiotic use and antibiotic resistance among the veterinarians and para-veterinarians in Bhutan. PLoS One. 2021;16(5): e0251327. **PubMed**| **Google Scholar**
17. Geta K, Kibret M. Knowledge, attitudes and practices of animal farm owners/workers on antibiotic use and resistance in Amhara region, north western Ethiopia. Sci Rep. 2021;11(1): 21211. **PubMed**| Google Scholar

18. Dyar OJ, Zhang T, Peng Y, Sun M, Sun C, Yin J *et al*. Knowledge, attitudes and practices relating to antibiotic use and antibiotic resistance among backyard pig farmers in rural Shandong province, China. Prev Vet Med. 2020;175: 104858. **PubMed**| **Google Scholar**
19. Oyebanji B. Use of Antibiotics and Knowledge of Antibiotics Resistance by Selected Farmers in Oyo Town, Nigeria. Uganda J Agri Sci. 2018 Mar 15;18(1): 43-56. **Google Scholar**
20. Eltayb A, Barakat S, Marrone G, Shaddad S, Stålsby Lundborg C. Antibiotic use and resistance in animal farming: a quantitative and qualitative study on knowledge and practices among farmers in Khartoum, Sudan. Zoonoses Public Health. 2012;59(5): 330-8. **PubMed**| **Google Scholar**
21. Addah W, Baah J, Tia S, Okine E. Knowledge and practices of smallholder farmers and herdsmen in the use of acaricides and gastrointestinal anthelminthes in Ghana. Livestock Research for Rural Development. 2009;21(11): 1-0. **Google Scholar**
22. Faizal A, Kwasi OY. Determinants of small ruminant farmers decision to participate in veterinary services in Northern Ghana. J Vet Med Ani Health. 2015;7(5): 193-204.

Table 1: demographic and socio-economic characteristics of the respondent

Variable	**Category**	**Frequency**	**Percentage (%)**
Age	18-30	2	4.0
	31-40	15	30.0
	41-50	24	48.0
	>50	9	18.0
Sex	Male	44	88.0
	Female	6	12.0
Education	Primary	18	36.0
	Secondary	17	34.0
	Tertiary	13	26.0
	No school	2	4.0
Experience	<10	30	60.0
	10-20	13	26.0
	20-30	7	14.0
Main source of income	Pig rearing	24	48.0
	Others	9	18.0
	Both	17	34.0
Farming system	Intensive	50	100.0
Farm type	Small scale <50	18	36.0
	Medium scale 50-100	15	30.0
	Large scale >100	17	34.0

Table 2: knowledge of pig farmers regarding antibiotics and antibiotic resistance			
Variable	**Category**	**Frequency**	**Percentage (%)**
Do you know what antibiotic medicines for pigs are?	Yes	44	88.0
	No	6	12.0
Where did you hear about antibiotics? N (44)	From colleagues	29	66.0
	Veterinary officer	5	11.4
	Seminar	4	9.0
	Personal research	6	13.6
How do you think antibiotic medicine works? N (44)	Kills or inhibits bacteria	9	20.5
	Others (wrong)*	35	79.5
Have you heard about antibiotic resistance?	Yes	15	30.0
	No	35	70.0
Where did you hear about antibiotic resistance? N (14)	From experience	4	28.6
	Personal research	2	14.3
	Veterinary officer	2	14.3
	Seminar	6	42.8
What is the impact of antibiotic resistance? N (15)	Antibiotics less effective	11	73.3
	Antibiotics more effective	3	20.0
	I don□t know	1	6.7
Do you know an overdose/low-dose course may lead to antibiotic resistance?	Yes	14	28.0
	No	36	72.0
Are you aware that misuse and overuse of antimicrobials expose humans and animals to antimicrobial-resistant bacteria with dire consequences on human/animal health?	Yes	9	18.0
	No	41	82.0
Are you aware of drug residue?	Yes	13	26.0
	No	37	74.0
Do you know if drugs taken by pigs pass to meat?	Yes	21	42.0
	No	29	58.0
Level of knowledge on antibiotics and antibiotic resistance	Adequate	13	26
	Inadequate	37	74

Table 3: pig farmers´ practices with regards to antibiotics usage			
Variables	**Category**	**Frequency**	**Percentage (%)**
Do you or anyone else give your pigs antibiotics?	Yes	49	98.0
	No	1	2.0
How often do you use antibiotics? N (49)	When pigs look sick	39	79.6
	Just after weaning	25	51.0
	Every three months	20	40.8
	Monthly	8	16.3
	Weekly	4	8.2
Why do you use antibiotics? N (49)	Treatment of diseases	49	100.0
	Prevention of diseases	40	82.0
	To promote growth	20	40.8
How often do you access veterinary services?	Weekly	1	2.0
	Monthly	7	14.0
	When treatment gets out of hand	33	66.0
	Never	9	18.0
Route of administration of antibiotics	Water	7	14%
	Feed	18	36%
	Injectables	25	50%
Do you speak with a veterinary or livestock technician before using antibiotics in pigs?	Yes	11	22.4
	No	34	69.4
	Sometimes	4	8.2
Do you follow the label instructions when using antibiotics?	Yes	36	74
	No	11	22
	I don□t know	2	4
Do you observe withdrawal periods?	Yes	26	53.0
	No	23	47.0
Source of antibiotics	Market (Ejisu/Juaben)	45	91.8
	Veterinary office	3	6.0
	Veterinary pharmacy	20	41.0
	Veterinary technician	4	8.2
Have you ever stored antibiotics on your farm?	Yes	34	69.4
	No	15	30.6
Where do you store antibiotics N (34)	Feed store	33	97.0
	First aid box	1	3.0
Do you record antibiotics used on your farm? N (49)	Yes	8	16.3
	No	41	83.7
What signs prompt antibiotic use on your farm? N (49)	Diarrhea	49	100
	Fever	43	87.8
	Respiratory signs	42	85.7
	Skin infections	44	89.8
	Anorexia	37	75.5

Table 4: effect of demographic characteristics on farmer knowledge on antibiotics and farmer antibiotic usage (practices)

Variable	Category	Knowledge		P-value
		Inadequate	Adequate	
Age	18-30	2 (100%)		0.109
	31-40	13(86.7%)	2(13.3%)	
	41-50	18(75.0%)	6(25.0%)	
	>50	4(44.4%)	5(55.6%)	
Sex	Male	33(75.0%)	11(25.0%)	0.662
	Female	4(66.7%)	2(33.3%)	
Level of education	Primary	16(88.9%)	2(11.1%)	0.001*
	Secondary	15(88.2%)	2(11.8%)	
	Tertiary	4(30.8%)	9(69.2%)	
	No school	2(100.0%)		
Experience	<10	26(86.7%)	4(13.3%)	0.006*
	10-20	9(69.2%)	4(30.8%)	
	20-30	2(28.6%)	5(71.4%)	
Farm type	Small scale <50	15(83.3%)	3(16.7%)	0.453
	Medium scale 50-100	11(73.3%)	4(26.7%)	
	Large scale >100	11(64.7%)	6(35.3%	
Variable	**Category**	**Practice**		**P- value**
		Inappropriate	**Appropriate**	
Age	18-30	2(100%)		0.085
	31-40	12(80.0%)	3(20.0%)	
	41-50	16(66.7%)	8(33.3%)	
	>50	3(33.3%)	6(66.7%)	
Sex	Male	28(63.6%)	16(36.4%)	0.339
	Female	5(83.3%)	1(16.7%)	
Level of education	Primary	14(77.8%)	4(22.2%)	0.017*
	Secondary	13(76.5%)	4(23.5%)	
	Tertiary	4(30.8%)	9(69.2%)	
	No school	2(100%)		
Experience	<10	21(70.0%)	9(30.0%)	0.378
	10-20	9(69.2%)	4(30.8%)	
	20-30	3(42.9%)	4(57.1%)	
Farm type	Small scale<50	13(72.2%)	5(27.8%)	0.020
	Medium scale 50-100	13(86.7%)	2(13.3%)	
	Large scale >100	7(41.2%)	10(58.8%)	

Table 5: effect of veterinary involvement on knowledge of farmers and their practices regarding antibiotic usage

Variable	Category	Knowledge		p-value
		Inadequate	Adequate	
How often do you access veterinary services?	When I am an able to treat	28(84.8%)	5(15.2%)	0.037
	Weekly	1(100%)		
	Monthly	4(57.1%)	3(42.9%)	
	Never	4(44.4%)	5(55.6%)	
Do you consult a veterinarian before using antibiotics?	Yes	7(63.6%)	4(36.4%)	0.402
	No	29(76.3%)	9(23.7%)	
Source of information	From colleagues	25(86.2%)	4(13.8%)	0.001
	Veterinary officer	2(40.0%)	3(60.0%)	
	Personal research	4(66.7%)	2(33.3%)	
	Seminar	4(100%)		
Variable	**Category**	**Practice**		**p-value**
		Inappropriate	**Appropriate**	
How often do you access veterinary services?	When I am an able to treat	25(75.8%)	8(24.2%)	0.142
	Weekly	1(100%)		
	Monthly	4(57.1%)	3(42.9%)	
	Never	4(44.4%)	5(55.6%)	
Do you consult a veterinarian before using antibiotics?	Yes	3(27.3%)	8(72.7%)	0.003
	No	29(76.3%)	9(23.7%)	

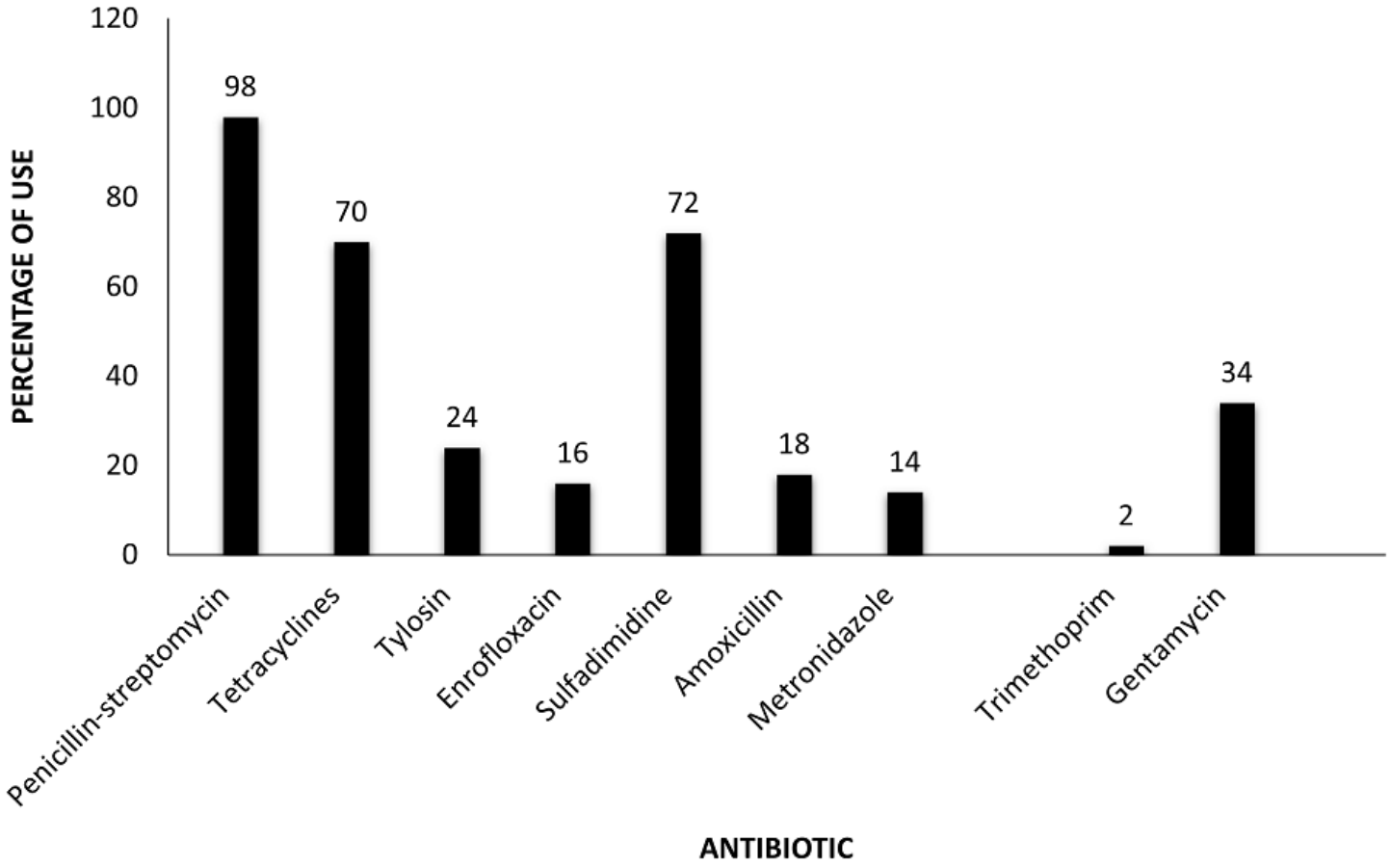

Figure 1: antibiotics commonly used by pig farmers

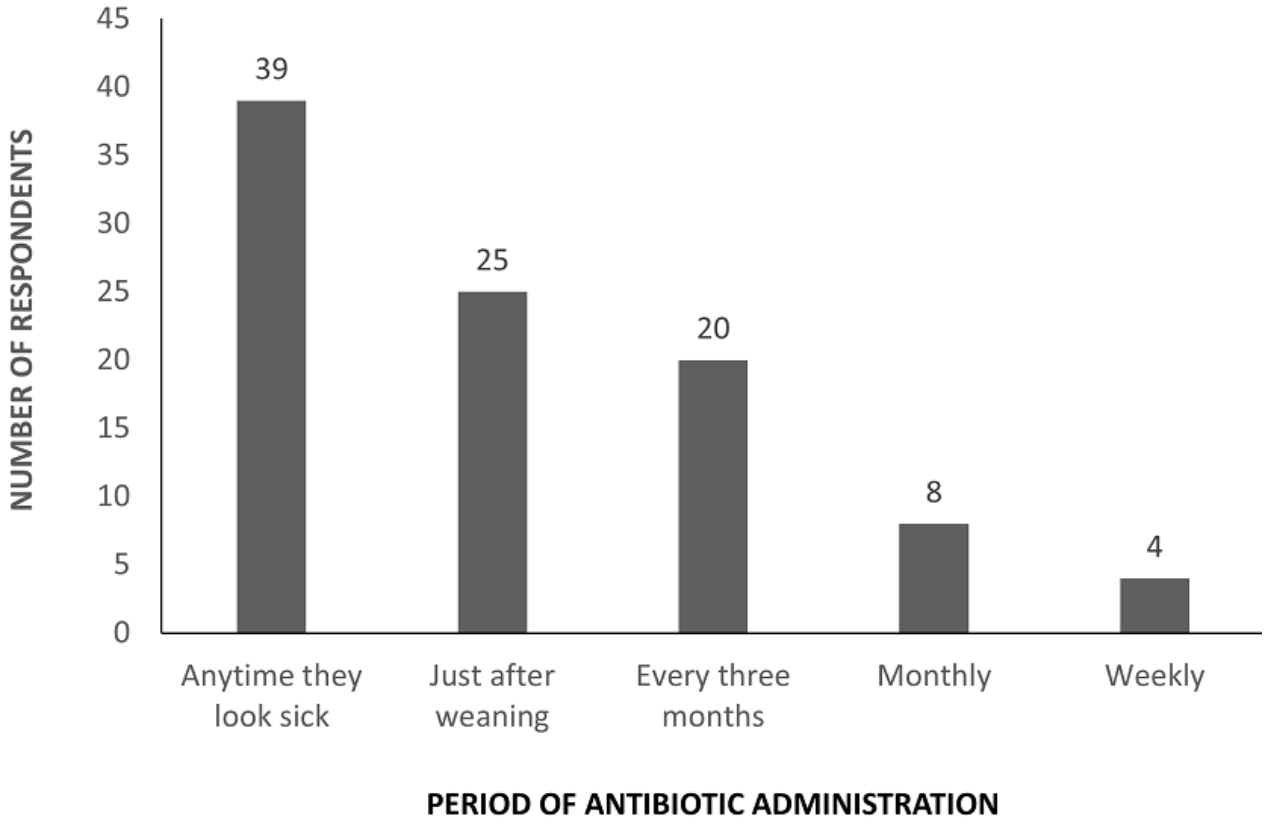

Figure 2: frequency of antibiotic usage among pig farmers