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Article

A cross-sectional study: farmer's perceptions, practices, and knowledge (PPK) on antimicrobial drug (AMD) and antimicrobial drug resistance (AMDR) at rural households in selected areas of Cumilla district, Bangladesh

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Abstract: In response to unwise and inappropriate antimicrobial drug (AMD) use, antimicrobial drug resistance (AMDR) is rising globally. The present research was performed to find out and evaluate the perceptions, practices, and knowledge (PPK) of the farmers regarding AMD use and AMDR propagation in rural households. The study was conducted using a pre-tested questionnaire upon 200 respondents with a duration of 5 months in selected areas of Cumilla district, Bangladesh. The correlation analysis showed a significant (p<.01) relationship between farmers' knowledge and practicing proper administration of drugs in the animal. The sex of the respondents was also found to be correlated with the understanding of Antibiotic Resistance (AR) (p<.01), AR transmission (p<.05), and propagation from livestock to humans (p<.01). Additionally, through the qualitative analysis, we found the powerful impacts of media availability and accessibility, participation in the training program, and good quality education on the improvement of farmers' PPK. Therefore, the government must need to emphasize this topic and educate the farmers about AR to control the spread of AR in order to secure both animal and public health.

Keywords: antimicrobial drug (AMD); antibiotic resistance (AR); perceptions; practices; knowledge; farmers

1. Introduction

Antibiotics are the drugs that fight against bacteria and treat bacterial infections. When bacteria make adjustments to the use of antibiotics, Antibiotic resistance (AR) develops (Kurt Yilmaz and Schiffer, 2021). In the present world, AR has become undoubtedly a significant global crisis and one of the greatest challenges faced by both humans and animals (Kandelaki *et al.*, 2015). It is straightforward that the findings of AR are prevalent all over the world, especially in developing countries. The ecologic expansion of AMD and the propagation of resistant genes are linked to the growth of more resistant pathogenic organisms (He *et al.*, 2020). The predisposing factors for gaining AR include insufficient care of the animals, surveillance, and farmer's lack of knowledge regarding AMD and AR leading to the inappropriate use of antibiotics which results in the introduction of different AR bacteria and AR genes in both human and animal (Al Amin *et al.*, 2020). For example, *Salmonella* spp. an MDR (Multi Drug Resistant) zoonotic microorganism that can spread from

animals to humans, was identified as resistant to several antibiotics due to certain resistant genes, named as '*tetA' and 'SHV'*, including erythromycin (87.5%), tetracycline (86.76%), oxytetracycline (75.73%), and so forth (Eashmen *et al*., 2021; Sobur *et al.*, 2019; Kabir *et al*., 2018; Hasan *et al*., 2018; Hossain *et al*., 2017). The farmers who work closely with livestock have high chances of acquiring the AR microbes, which can put both animal and public health at risk. Today, a large number of the population of Bangladesh is entangled in raising livestock for nourishing themselves by food consumption or the sale of animals and animal products. Along with the ecological spread of AMD, farmers' misuse of AMD in their livestock is substantially helping in the rise of AR (Al-Asif *et al.*, 2021). So, the study was run with the objectives to find out the present scenario of the farmer's knowledge, perceptions, and practices of use, and misuse of AMD and AMDR in the rural households in Cumilla district, Bangladesh.

2. Materials and Methods

2.1. Study design and period

The cross-sectional study was conducted using a pre-tested questionnaire among 200 respondents from four different villages (Kushiara, Singula, Autbag, Velanogor) of Cumilla district, Bangladesh (Figure 1) from January to July 2022. The farmers responded to each question during the face-to-face interview session. The questionnaire was formed with five sections; socio-demographic profile of the farmers; perceptions about AMD and AR; practices of AMD application and AR propagation; knowledge of the farmers regarding AMD, AMD application, and AR; access to knowledge and information about AMD use and AR.

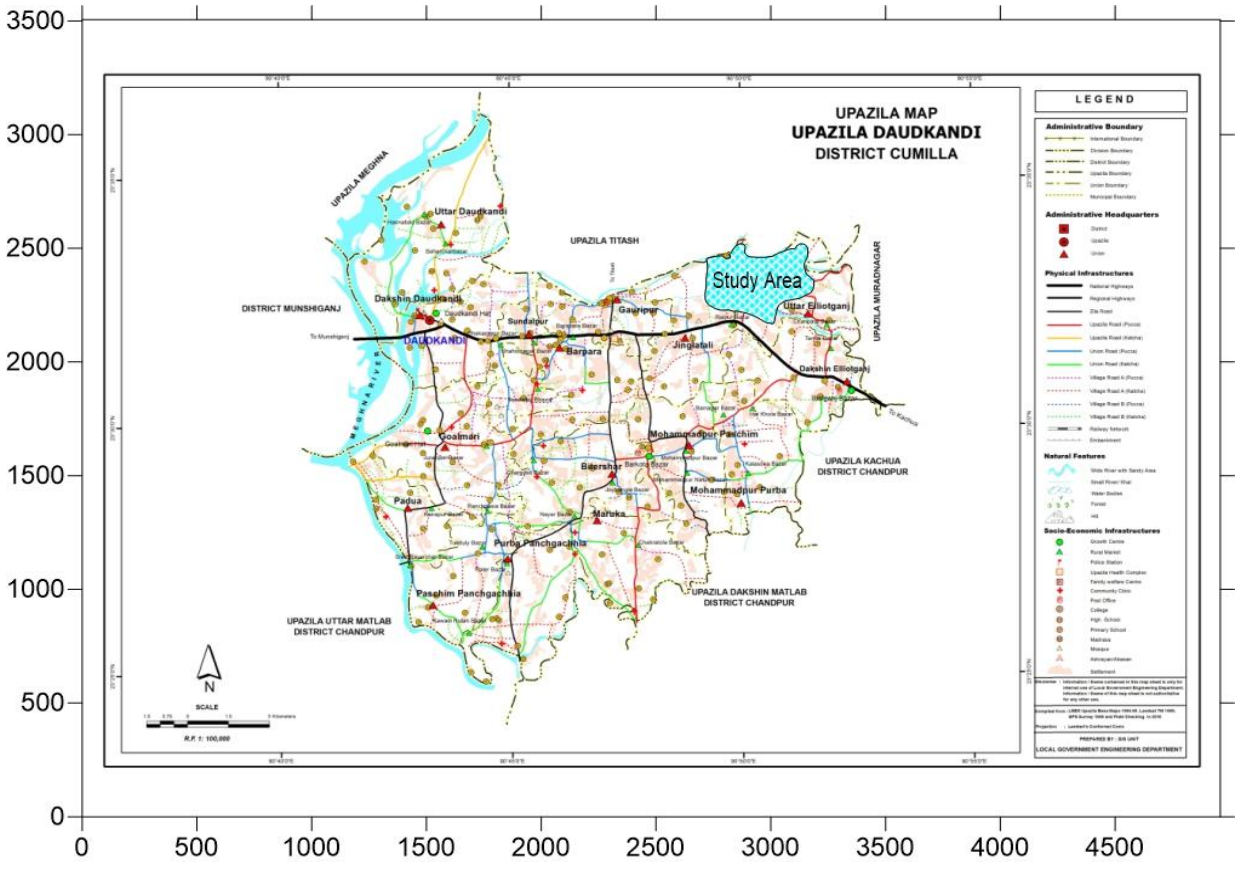

Figure 1. Map of the survey area (Village: Kushiara, Singula, Autbag, Velanogor, Upazila: Daudkandi).

2.2. Data input and analysis

The data were processed in Microsoft Excel 2010. Later on, SPSS (Statistical Package for Social Sciences, Version 25) software was used to code and analyze. The frequency of the following items was expressed in percent and correlation analysis, and Chi-square analysis with symmetric measures was used to evaluate and observe the interrelationship of the variables.

3. Results and Discussion

3.1. Quantitative analysis

3.1.1. Socio-demographic profile

A total of two hundred (200) participants responded to the questionnaire of which 86.5% (173/200) were male and 13.5% (27/200) were female and their ages were from 21 to 72 years (Mean age ± SD = 42.99 years±11.635) (Table 1). Similarly, female participants were comparatively lower than the males in a study among the farmers of Turkey (Di Martino *et al*., 2019). In terms of educational qualification, the majorities of participants (38%) were illiterate and completed higher secondary education. Most of the subjects were found to be engaged in agriculture as their primary and secondary occupation either full-time or part-time.

Table 1. Demographic profile of the respondents.

Variables		**Value (ranges)**	
Total number of respondents (n)		**200**	
Age range (in years)		**21-72**	
Mean age±SD (in years)		**42.99 ±11.635**	
	Category	**Frequency (n)**	**Percentage (%)**
Sex	Male	173	86.5
	Female	27	13.5
	Total	200	100.0
Educational qualification	Illiterate	76	38.0
	Secondary	9	4.5
	Higher secondary	76	38.0
	Graduation	39	19.5
	Total	200	100.0
	Total	200	100.0
Primary occupation	Service holder	53	26.5
	Agriculture	66	33.0
	Agriculture	32	16.0
	Labor	25	12.5
	Business	24	12.0
Secondary occupation	Total	200	100.0
	No secondary occupation	60	30.0
	Agriculture	67	33.5
	Labor	6	3.0
	Business	27	13.5
	Total	200	100.0

3.1.2. Perceptions section

A sizable portion of respondents 57% (114/200) and 79% (158/200) agreed that it is crucial to control AR and appropriately use AMD in animals in order to protect both humans and animal health (Table 2). In a study performed in northwestern Ethiopia, the researchers found that only 19.8% (18, N=91) participants acknowledged the significance of controlling AR in animals for the safeguarding of both human and animal health which was considerably minimal than the present findings (Geta and Kibret, 2021).

We found through the analysis that about the fourth-fifth of the respondents, 80.5 % (161/200) had the cognizance that the AR can be passed from animals to humans. On the other hand, 7 % (14/200) were neutral towards the statement, whereas 12.5% (25/200) disagreed. According to a survey in central Nigeria, 39.6% (152/384) of total participants had complete knowledge that lactating cows can transmit AR to humans. Comparing the percentage of the responses to current findings, the knowledge and perceptions of the farmers who were interviewed were quite more satisfactory than the percentage in central Nigeria (Alhaji *et al.*, 2019).

The analysis revealed that a vast majority (176/200)/(88%), (128/200)/(64%), consented that AMD must be used correctly and appropriately by abiding by the guidelines and prescriptions for both animal and human use. However, the slightest percentage disagreed with the following concept.

Table 2. Perceptions of the farmers about Antimicrobial Drug (AMD) and Antibiotic Resistance (AR).

Variables		Value (ranges)	
	Category	**Frequency (n)**	**Percentage (%)**
AR control in animals is significant for securing public and animal health	Strongly agree	47	23.5
	Agree	67	33.5
	Neutral	38	19.0
	Disagree	42	21.0
	Strongly disagree	6	3.0
	Total	200	100.0
Using inappropriate AMD in animals is associated with the emergence of resistance in both humans and animals	Strongly agree	82	41.0
	Agree	76	38.0
	Neutral	28	14.0
	Disagree	13	6.5
	Strongly disagree	1	.5
	Total	200	100.0
The AR bacteria can be transmitted to humans from animals	Strongly agree	88	44.0
	Agree	73	36.5
	Neutral	14	7.0
	Disagree	25	12.5
	Total	200	100.0
AMD should be properly used by following the prescriptions in both animals and humans	Strongly agree	72	36.0
	Agree	104	52.0
	Neutral	17	8.5
	Disagree	7	3.5
	Total	200	100.0
The AR can stop the effectiveness of AMD	Strongly agree	25	12.5
	Agree	69	34.5
	Neutral	76	38.0
	Disagree	29	14.5
	Strongly disagree	1	.5
	Total	200	100.0
Proper antibiotic use according to prescriptions can reduce the AR in animals and humans	Strongly agree	19	9.5
	Agree	109	54.5
	Neutral	53	26.5
	Disagree	19	9.5
	Total	200	100.0
Prolonged AMD use can pose to AR	Strongly agree	20	10.0
	Agree	79	39.5
	Neutral	53	26.5
	Disagree	40	20.0
	Strongly disagree	8	4.0
	Total	200	100.0

3.1.3. Practice section

Out of 200 households, we found that 120 (60%) families keep animals for satisfying their family needs by consuming animal products (Figure 2). The remaining 40% (80/200) raise livestock for getting an economic return by selling animals, animal products, and byproducts in the market. In addition, the vast majority of responses (131 farm owners) confirmed that AMD had been applied to their livestock multiple times which indicates their experiences of applying AMD. Several studies reported that high doses of AMD application can result in the presence of antibiotic residue in animal food products such as milk, meat, and egg which can lead to the gene transmission to humans which is responsible for resistance to antibiotics (Hu *et al.*, 2013; Dutta *et al.*, 2019; Van *et al.*, 2020). Besides that, due to prolonged antibiotic use and administration of a high dose, the feces of the administered animal contain the residue of the drug which moves to the pasture land and give rise to AR transmission due to grazing (Darwish *et al.*, 2013). Ignorance of these farmers who reared livestock either for family needs mitigation or selling animal products can lead to AR proliferation.

Through the study, we found that roughly half of the respondents (52%) sought treatment from a licensed veterinarian, compared to 38.5 % and 9.5 % who, respectively, sought treatment from a local quack and a local

drugstore owner. A study of Ethiopia showed the least percentage who took veterinarian help for treatment of the animals (Geta and Kibret, 2021). Both the study demonstrates the unlicensed sources of treatment which can lead to AR propagation.

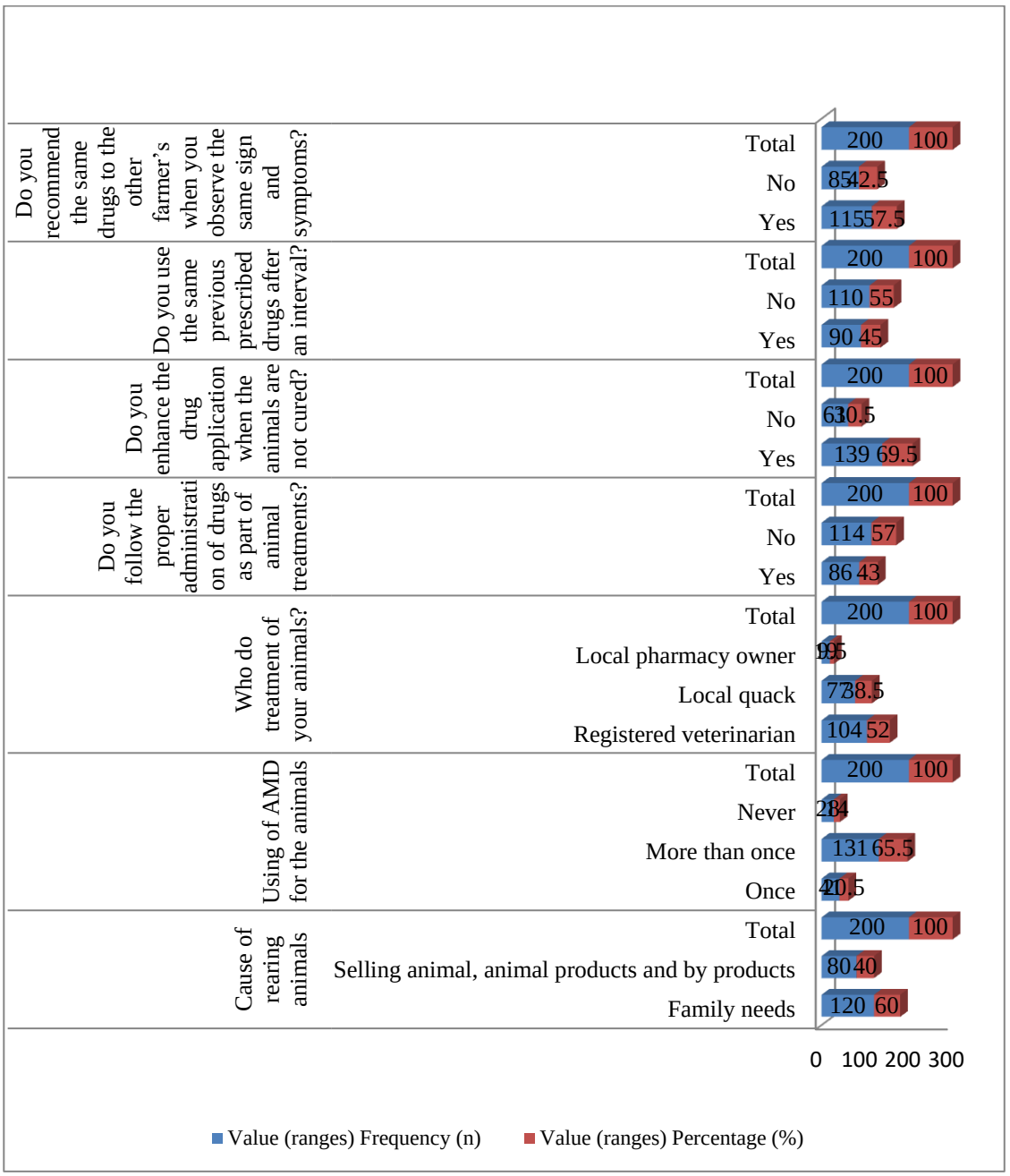

Figure 2. A bar diagram of practices of AMD application and propagation of AR by the farmers.

In this study, 43% of respondents asserted that they follow proper administration of drugs according to the prescriptions. On the other hand, 57% replied negatively. In addition to that, almost 70% of subjects consented that when the animals are not cured after the application of the drugs, they enhance the doses. When another similar question (Do you use the same previous prescribed drugs after an interval?) was asked to the respondents, 45% responded affirmatively that they use the same prescribed drugs to the animals when they observe repeated signs and symptoms. Among these 200 participants, almost 58% recommended the same drugs to the other farmers when they observed the same sign and symptoms which is a self-practiced treatment. Following the responses, it can be concluded that a very small percentage of the respondents were aware of the proper administration of the drugs and their side effects in both animals and humans. Repeated and inappropriate AMD uses lead to AR development (Dutta *et al.*, 2019).

3.1.4. Knowledge section

When asked, "Do you know what an antibiotic is?," 46.5 % (93/200) of the participants responded in the affirmative, while 53.5% (107/200) of the respondents answered negatively to the question (Table 3). From a study of 271 farmers, only 35% (97/271) were reported to know about antibiotics (Dyar *et al.*, 2020). In response to the second question, "Do you know what is AR?," about three-fourths of the respondents claimed that they had no cognizance of AR. Around 17% of the farmers were found who understand AR, according to a study of Turkey conducted in 2019 by Yasin Ozturk and his colleagues.

An almost similar result was found when investigating the farmers' knowledge about AR transmission. The current study revealed that more than 75% of the respondents were not cognizant that AR can spread from animal to human. Another study found that 86% of respondents were ignorant of the transmission of antibiotic resistance and used to apply high doses of antibiotics to dairy cows (Friedman *et al.*, 2007).

When the final question was asked to the farmers about AMDs recognition, almost 90% replied, 'No'. However, a small percentage replied affirmatively. The overall responses suggest that a large number of farmers connected with livestock farming in both developed and developing countries are still unaware of AMD, AMD application, AR, and AR transmission.

Table 3. Knowledge of the farmers regarding AMD, AMD application, and AR.

Variables		Value (ranges)	
	Category	**Frequency (n)**	**Percentage (%)**
Do you know what is antibiotics?	Yes	93	46.5
	No	107	53.5
	Total	200	100.0
Do you know what is AR?	Yes	47	23.5
	No	153	76.5
	Total	200	100.0
Do you know how AR occurs?	Yes	45	22.5
	No	155	77.5
	Total	200	100.0
Do you know how AR spreads from livestock to humans?	Yes	42	21.0
	No	158	79.0
	Total	200	100.0
Can you recognize the AMDs?	Yes	24	12.0
	No	176	88.0
	Total	200	100.0

3.1.5. Knowledge, information, and advice source

Data in Figure 3 shows the access to knowledge, information, and consultation about AMD use and AR. This section showed that a large number of respondents were out of online and offline media accessibility, seminar participation, and better quality of education. Different programs on the following aspects are promoted substantially by online and offline media which can assist a farmer to obtain adequate information regarding AR. A research in Vietnam ran out by Pham-duc and his colleagues found that the farmers with more knowledge about AR had television access as their major source of information. (Pham-duc *et al.*, 2019).

Additionally, taking part in workshops and obtaining a quality education can allow farmers to develop their PPK, which can strengthen practical farming and help to limit the spread of AR.

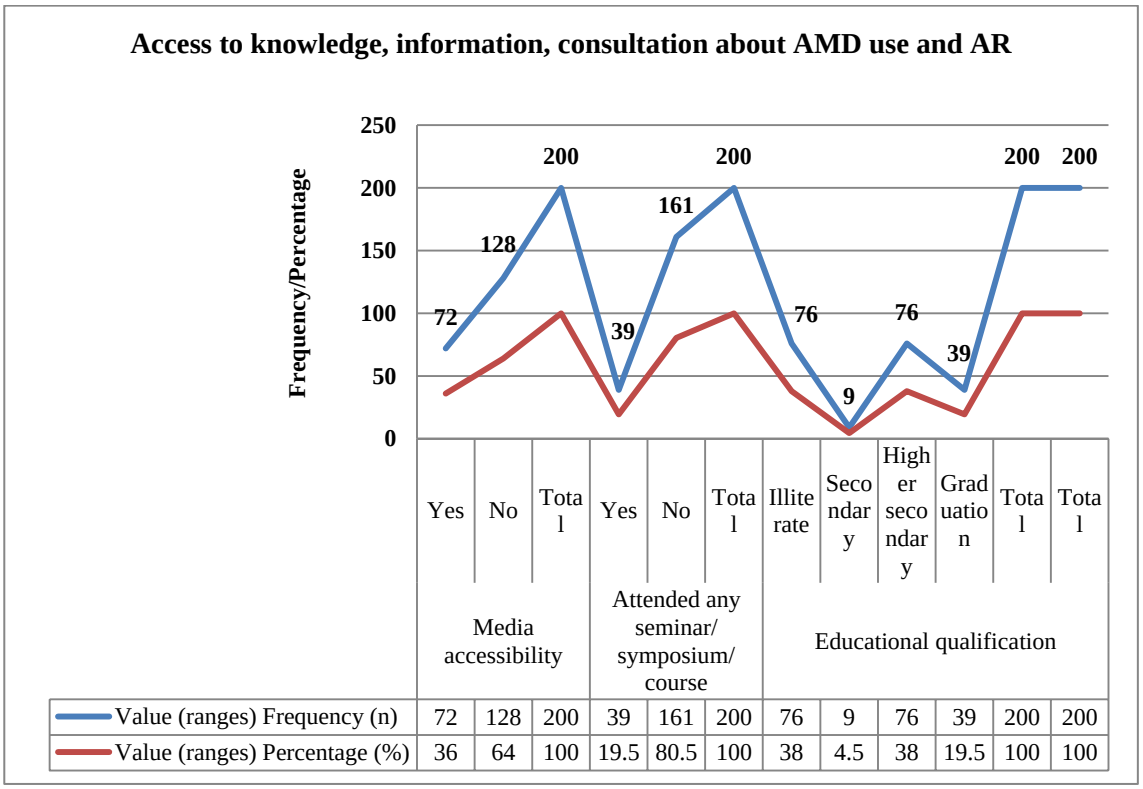

Figure 3. Access to knowledge, information, and consultation about AMD use and AR.

3.2. Qualitative analysis

3.2.1. Pearson's correlation analysis

To evaluate and observe the statistical correlation between the farmer's knowledge, sex, and level of practices regarding AMD, AMD application, and AR propagation, a Pearson's correlation analysis with cross-tabulation was performed. The summary of the findings were presented in Tables 4 and 5.

Table 4. Statistical relationship between the farmer's knowledge and practices regarding AMD, AMD application, and AR propagation.

Variables	Pearson correlation coefficients (value)	Do you know what is antibiotics?	Do you know what is AR?	Do you know how AR occurs?	Do you know how AR spreads from livestock to humans?	Can you recognize the AMDs?
Do you follow the proper administration of drugs as part of animal treatments?	**R**	**.284****	**.424****	**.451****	**.470****	**.332****
	P	**.000**	**.000**	**.000**	**.000**	**.000**
Do you increase the drug application when the animals are not cured?	R	-.014	.085	.071	.075	.078
	P	.846	.229	.319	.292	.275
Do you use the same previous prescribed drugs after an interval?	R	-.219**	-.335**	-.343**	-.318**	-.272**
	P	.002	.000	.000	.000	.000
Do you use any drugs for animal growth?	R	-.083	-.193**	-.206**	-.160*	-.181*
	P	.243	.006	.003	.024	.010
Do you recommend the drugs to the other farmers when you observe the same signs and symptoms?	R	-.192**	-.311**	-.312**	-.327**	-.305**
	P	.006	.000	.000	.000	.000

****Correlation is significant at 1% (2-tailed)**
***Correlation is significant at 5% (2-tailed)**

Table 5. Understanding and knowledge of farmers according to their sex.

Variables	Sex				
	Category	Male	Female	Total	Correlation
Do you know what is antibiotic?	Yes	83	10	93	R .075
	No	90	17	107	p .292
	Total	173	27	200	
Do you know what is AR?	**Yes**	**46**	**1**	**47**	**R .184****
	No	**127**	**26**	**153**	**p .009**
	Total	**173**	**27**	**200**	
Do you know how AR occurs?	**Yes**	**44**	**1**	**45**	**R .178***
	No	**129**	**26**	**155**	**p .012**
	Total	**173**	**27**	**200**	
Do you know how AR spreads from livestock to human?	**Yes**	**42**	**0**	**42**	**R .204****
	No	**131**	**27**	**158**	**p .004**
	Total	**173**	**27**	**200**	
Can you recognize the AMDs?	Yes	23	1	24	R .101
	No	150	26	176	p .155
	Total	173	27	200	

****Correlation is significant at 1% (2-tailed)**
***Correlation is significant at 5% (2-tailed)**

The data in Table 4 illustrates the relationship between the farmer's practices and knowledge of AMD, AMD application, and AR propagation. Positive statistical relationships were found through the analysis, indicating the impact of knowledge on the proper administration of drugs (p<.01).
Table 5 represents the understanding and knowledge of farmers according to their sex. We found a strong correlation between sex and farm owners' understanding of AR (p<.01), its progression (p<.05), and its spread from livestock to human being (p<.01).

3.2.2. Chi-square analysis

A chi-square analysis with cross-tab and Phi/Cramer's V coefficient was performed to assess and examine the effects of media availability and accessibility, participating seminar/symposium/course, and educational qualification on farmers' PPK.
Table 6 illustrates the association between both the farmers' PPK and their access to media. The analysis demonstrated a strong correlation between farmers' PPK and their access to media, indicating that the media has a significant impact on farmers' PPK. Farm owners who had media accessibility responded better than the other farmers.

Table 6. Association between media accessibility and PPK of the farmers.

Variables	Media accessibility						
	Category	Yes	No	Total	Pearson chi-square/ Likelihood ratio/ Fisher's exact test	Phi/Cramer's V coefficients	
AR in animals is significant for securing public health and animal health***	**Strongly agree**	**28**	**19**	**7**	**χ^2 -Value 34.600**	**Phi (value) .416**	
	Agree	**32**	**35**	**67**	**df 4**	**Cramer's V (value) .416**	
	Neutral	**3**	**35**	**38**			
	Disagree	**8**	**34**	**42**			
	Strongly disagree	**1**	**5**	**6**	**P- value .000**		
	Total	**72**	**128**	**200**			
Using AMD in animals is associated with the emergence of resistance in both humans and animals ***	**Strongly agree**	**42**	**40**	**82**	**χ^2 -Value 16.538**	**Phi (value) .282**	
	Agree	**20**	**56**	**6**	**df 4**	**Cramer's V (value)) .282**	
	Neutral	**5**	**23**	**22**	**P- value .002**		
	Disagree	**5**	**8**	**13**			
	Strongly disagree	**0**	**1**	**1**			
	Total	**72**	**128**	**200**			

Table 6. Contd.

Variables	Media accessibility						
	Category	Yes	No	Total	Pearson chi-square/ Likelihood ratio/ Fisher's exact test	Phi/Cramer's V coefficients	
The AR bacteria can be transmitted to humans from animals* **	**Strongly agree**	**47**	**41**	**88**	**χ^2 -Value**	**21.282**	**Phi (value)** **.326**
	Agree	**18**	**55**	**73**	**df**	**3**	**Cramer's V (value)** **.326**
	Neutral	**3**	**11**	**14**	**P- value**	**.000**	
	Disagree	**4**	**21**	**76**			
	Strongly disagree	**0**	**0**	**0**			
	Total	**72**	**128**	**200**			
AMD should be properly used by following the prescriptions in both animals and humans ***	**Strongly agree**	**36**	**36**	**72**	**χ^2 -Value**	**10.631**	**Phi (value)** **.229**
	Agree	**29**	**75**	**104**	**df**	**3**	**Cramer's V (value)** **.229**
	Neutral	**6**	**11**	**17**	**P- value**	**.014**	
	Disagree	**1**	**6**	**7**			
	Strongly disagree	**0**	**0**	**0**			
	Total	**72**	**128**	**200**			
The AR can stop the effectiveness of AMD* **	**Strongly agree**	**12**	**13**	**25**	**χ^2 -Value**	**13.291**	**Phi (value)** **.258**
	Agree	**33**	**36**	**69**	**df**	**4**	**Cramer's V (value)** **.258**
	Neutral	**19**	**57**	**76**	**P- value**	**.010**	
	Disagree	**7**	**22**	**29**			
	Strongly disagree	**1**	**0**	**1**			
	Total	**72**	**128**	**200**			
Proper antibiotic use according to prescriptions can reduce the AR in animals and human	Strongly agree	11	8	19	χ^2 -Value	4.894	Phi (value) .156
	Agree	39	70	109	df	3	Cramer's V (value) .156
	Neutral	16	37	53	P- value	.180	
	Disagree	6	13	19			
	Strongly disagree	0	0	0			
	Total	72	128	200			
Prolonged AMD use without proper administration poses to AR* **	**Strongly agree**	**13**	**7**	**20**	**χ^2 -Value**	**13.466**	**Phi (value)** **.259**
	Agree	**31**	**48**	**79**	**df**	**4**	**Cramer's V (value)** **.259**
	Neutral	**11**	**42**	**53**	**P- value**	**.009**	
	Disagree	**15**	**25**	**40**			
	Strongly disagree	**2**	**6**	**8**			
	Total	**72**	**128**	**200**			
AMD is used only for treatment to stop AR* **	**Strongly agree**	**2**	**2**	**4**	**χ^2 -Value**	**13.462**	**Phi (value)** **.259**
	Agree	**10**	**24**	**34**	**df**	**4**	**Cramer's V (value)** **.259**
	Neutral	**10**	**40**	**50**	**P- value**	**.009**	
	Disagree	**35**	**52**	**87**			
	Strongly disagree	**15**	**10**	**25**			
	Total	**72**	**128**	**200**			
Using of AMD for the animals	Once	14	27	41	χ^2 -Value	1.537	Phi (value) .088
	More than once	45	86	131	df	2	Cramer's V (value) .088
	Never	13	15	28	P- value	.464	
	Total	72	128	200			
Who do treatment of your animals?* **	**Registered veterinarian**	**61**	**43**	**104**	**χ^2 -Value**	**49.207**	**Phi (value)** **.496**
	Local quack	**7**	**70**	**77**	**df**	**2**	**Cramer's V (value)** **.496**
	Local pharmacy owner	**4**	**15**	**19**	**P- value**	**.000**	
	Total	**72**	**128**	**200**			

Table 6. Contd.

Variables		Media accessibility						
	Category	Yes	No	Total	Pearson chi-square/ Likelihood ratio/ Fisher's exact test		Phi/Cramer's V coefficients	
Do you follow the proper administration of drugs as part of animal treatments?* **	**Yes**	**46**	**40**	**86**	**χ^2 -Value**	**20.028**	**Phi (value)**	**.316**
	No	**26**	**88**	**114**	**df**	**1**	**Cramer's V (value)**	**.316**
	Total	**72**	**128**	**200**	**P- value**	**.000**		
Do you increase the drug application when the animals are not cured?	Yes	48	91	139	χ^2 -Value	.426	Phi (value)	-.046
	No	24	37	61	df	1	Cramer's V (value)	.046
	Total	72	128	200	P- value	.514		
Do you use the same previous prescribed drugs after an interval?* **	**Yes**	**19**	**71**	**90**	**χ^2 -Value**	**15.744**	**Phi (value)**	**-.281**
	No	**53**	**57**	**110**	**df**	**1**	**Cramer's V (value)**	**.281**
	Total	**72**	**128**	**200**	**P- value**	**.000**		
Do you use any drugs for animal growth ?* **	**Yes**	**14**	**48**	**62**	**χ^2 -Value**	**7.023**	**Phi (value)**	**-.187**
	No	**58**	**80**	**138**	**df**	**1**	**Cramer's V (value)**	**.187**
	Total	**72**	**128**	**200**	**P- value**	**.008**		
Do you recommend the drugs to the other farmers when you observe the same signs and symptoms ?* **	**Yes**	**31**	**84**	**115**	**χ^2 -Value**	**9.605**	**Phi (value)**	**-.219**
	No	**41**	**44**	**85**	**df**	**1**	**Cramer's V (value)**	**.219**
	Total	**72**	**128**	**200**	**P- value**	**.002**		
Do you know what is antibiotic ?* **	**Yes**	**50**	**43**	**93**	**χ^2 -Value**	**23.807**	**Phi (value)**	**.345**
	No	**22**	**85**	**107**	**df**	**1**	**Cramer's V (value)**	**.345**
	Total	**72**	**128**	**200**	**P- value**	**.000**		
Do you know what is AR?* **	**Yes**	**38**	**9**	**47**	**χ^2 -Value**	**53.641**	**Phi (value)**	**.518**
	No	**34**	**119**	**153**	**df**	**1**	**Cramer's V (value)**	**.518**
	Total	**72**	**128**	**200**	**P- value**	**.000**		
Do you know how AR occurs?* **	**Yes**	**38**	**7**	**45**	**χ^2 -Value**	**59.145**	**Phi (value)**	**.544**
	No	**34**	**121**	**155**	**df**	**1**	**Cramer's V (value)**	**.544**
	Total	**72**	**128**	**200**	**P- value**	**.000**		
Do you know how AR spreads from livestock to humans? * **	**Yes**	**35**	**7**	**42**	**χ^2 -Value**	**51.698**	**Phi (value)**	**.508**
	No	**37**	**121**	**158**	**df**	**1**	**Cramer's V (value)**	**.508**
	Total	**72**	**128**	**200**	**P- value**	**.000**		
Can you recognize the AMDs?* **	**Yes**	**21**	**3**	**24**	**χ^2 -Value**	**31.395**	**Phi (value)**	**.396**
	No	**51**	**125**	**176**	**df**	**1**	**Cramer's V (value)**	**.396**
	Total	**72**	**128**	**200**	**P- value**	**.000**		
Do you know that AR is a serious global issue right now?* **	**Yes**	**38**	**9**	**47**	**χ^2 -Value**	**53.641**	**Phi (value)**	**.518**
	No	**34**	**119**	**153**	**df**	**1**	**Cramer's V (value)**	**.518**
	Total	**72**	**128**	**200**	**P- value**	**.000**		

***Statistically significant, when α=.05**

The outcomes of the chi-square analysis for observing the consequences of participating in a seminar/ symposium/ course on farm owners' understandings of AR and the appropriate management of AMDs are shown in Table 7. We found that attending a seminar, symposium, or course influence the farmers' perspectives of AR, AMD, AR propagation, and AMD management. However, a similar analytical research in China found no significant effects of training programs on improving farmers' knowledge (Dyar *et al.*, 2020).

Table 7. Association between Training status and perceptions, practices, and knowledge.

Variables		Attending any seminar/ symposium/ course						
	Category	Yes	No	Total	Pearson chi-square/ Likelihood ratio/ Fisher's exact test		Phi/Cramer's V coefficients	
AR in animals is significant for securing public health and animal health	Strongly agree	13	34	47	χ^2 -Value	3.678	Phi (value)	.136
	Agree	11	56	67	df	4	Cramer's V (value)	.136
	Neutral	6	32	38				
	Disagree	7	35	42				
	Strongly disagree	2	4	6	P- value	.451		
	Total	39	161	200				
Using AMD in animals is associated with the emergence of resistance in both humans and animals	Strongly agree	16	66	82	χ^2 -Value	1.146	Phi (value)	.070
	Agree	14	62	76	df	4	Cramer's V (value))	.070
	Neutral	7	21	28	P- value	.887		
	Disagree	2	11	13				
	Strongly disagree	0	1	1				
	Total	39	161	200				
The AR bacteria can be transmitted to humans from animals* **	**Strongly agree**	**28**	**60**	**88**	**χ^2 -Value**	**15.719**	**Phi (value)**	**.278**
	Agree	**7**	**66**	**73**	**df**	**3**	**Cramer's V (value)**	**. .278**
	Neutral	**2**	**12**	**14**	**P- value**	**.001**		
	Disagree	**2**	**23**	**25**				
	Strongly disagree	**0**	**0**	**0**				
	Total	**39**	**161**	**200**				
AMD should be properly used by following the prescriptions in both animals and humans	Strongly agree	14	58	72	χ^2 -Value	.201	Phi (value)	.031
	Agree	21	83	104	df	3	Cramer's V (value)	.031
	Neutral	3	14	17	P- value	.977		
	Disagree	1	6	7				
	Strongly disagree	0	0	0				
	Total	39	161	200				
The AR can stop the effectiveness of AMD	Strongly agree	9	16	25	χ^2 -Value	8.328	Phi (value)	.200
	Agree	15	54	69	df	4	Cramer's V (value)	.200
	Neutral	13	63	76	P- value	.080		
	Disagree	2	27	29				
	Strongly disagree	0	1	1				
	Total	39	161	200				
Proper antibiotic use according to prescriptions can reduce the AR in animals and humans	Strongly agree	7	12	19	χ^2 -Value	6.179	Phi (value)	.180
	Agree	21	88	109	df	3	Cramer's V (value)	.180
	Neutral	6	47	53	P- value	.103		
	Disagree	5	14	19				
	Strongly disagree	0	0	0				
	Total	39	161	200				
Prolonged AMD use without proper administration poses to AR	Strongly agree	5	15	20	χ^2 -Value	3.705	Phi (value)	.136
	Agree	17	62	79	df	4	Cramer's V (value)	.136
	Neutral	9	44	53	P- value	.447		
	Disagree	5	35	40				
	Strongly disagree	3	5	8				
	Total	39	161	200				

Table 7. Contd.

Variables		Attending any seminar/ symposium/ course						
	Category	Yes	No	Total	Pearson chi-square/ Likelihood ratio/ Fisher's exact test		Phi/Cramer's V coefficients	
AMD is used only for treatment to stop AR	Strongly agree	2	2	4	χ^2 -Value	8.239	Phi (value)	.207
	Agree	5	29	34	df	4	Cramer's V (value)	.207
	Neutral	5	45	50	P- value	.083		
	Disagree	19	68	87				
	Strongly disagree	8	17	25				
	Total	39	161	200				
Using of AMD for the animals* **	**Once**	**5**	**36**	**41**	**χ^2 -Value**	**6.199**	**Phi (value)**	**.176**
	More than once	**24**	**107**	**131**	**df**	**2**	**Cramer's V (value)**	**.176**
	Never	**10**	**18**	**28**	**P- value**	**.045**		
	Total	**39**	**161**	**200**				
Who do treatment of your animals?* **	**Registered veterinarian**	**30**	**74**	**104**	**χ^2 -Value**	**12.678**	**Phi (value)**	**.252**
	Local quack	**6**	**71**	**77**	**df**	**2**	**Cramer's V (value)**	**.252**
	Local pharmacy owner	**3**	**16**	**19**	**P- value**	**.002**		
	Total	**39**	**161**	**200**				
Do you follow the proper administration of drugs as part of animal treatments?	Yes	23	63	86	χ^2 -Value	5.044	Phi (value)	.159
	No	16	98	114	df	1	Cramer's V (value)	.159
	Total	39	161	200	P- value	.025		
Do you increase the drug application when the animals are not cured?	Yes	32	107	139	χ^2 -Value	3.600	Phi (value)	.134
	No	7	54	61	df	1	Cramer's V (value)	.134
	Total	39	161	200	P- value	.058		
Do you use the same previous prescribed drugs after an interval?* **	**Yes**	**11**	**79**	**90**	**χ^2 -Value**	**5.521**	**Phi (value)**	**-.166**
	No	**28**	**82**	**110**	**df**	**1**	**Cramer's V (value)**	**.166**
	Total	**39**	**161**	**200**	**P- value**	**.019**		
Do you use any drugs for animal growth?	Yes	11	51	62	χ^2 -Value	.177	Phi (value)	-.030
	No	28	110	138	df	1	Cramer's V (value)	.030
	Total	39	161	200	P- value	.674		
Do you recommend the drugs to the other farmers when you observe the same sign and symptoms?	Yes	23	92	115	χ^2 -Value	.043	Phi (value)	.015
	No	16	69	85	df	1	Cramer's V (value)	.015
	Total	39	161	200	P- value	.836		
Do you know what is antibiotic?* **	**Yes**	**32**	**61**	**93**	**χ^2 -Value**	**24.613**	**Phi (value)**	**.351**
	No	**7**	**100**	**107**	**df**	**1**	**Cramer's V (value)**	**.351**
	Total	**39**	**161**	**200**	**P- value**	**.000**		

Table 7. Contd.

Variables		Attending any seminar/ symposium/ course						
	Category	Yes	No	Total	Pearson chi-square/ Likelihood ratio/ Fisher's exact test		Phi/Cramer's V coefficients	
Do you know what is AR?***	Yes	19	28	47	χ^2 -Value	17.138	Phi (value)	.293
	No	20	133	153	df	1	Cramer's V (value)	.293
	Total	39	161	200	P- value	.000		
Do you know how AR occurs?***	Yes	18	27	45	χ^2 -Value	15.545	Phi (value)	.279
	No	21	134	155	df	1	Cramer's V (value)	.279
	Total	39	161	200	P- value	.000		
Do you know how AR spreads from livestock to humans?***	Yes	18	24	42	χ^2 -Value	18.477	Phi (value)	.304
	No	21	137	158	df	1	Cramer's V (value)	.304
	Total	39	161	200	P- value	.000		
Can you recognize the AMDs?***	Yes	13	11	24	χ^2 -Value	16.854	Phi (value)	.323
	No	26	150	176	df	1	Cramer's V (value)	.323
	Total	39	161	200	P- value	.000		
Do you know that AR is a serious global issue right now?***	Yes	17	30	47	χ^2 -Value	10.876	Phi (value)	.233
	No	22	131	153	df	1	Cramer's V (value)	.233
	Total	39	161	200	P- value	.001		

***Statistically significant, when α=.05

Similar findings were observed across the results presented in Table 8 highlighting the important effects of education on farmers' PPK. A study in 2012 proved that educational qualification has a direct impact on farmers' overall knowledge about AR. (Eltayb *et al.*, 2012).

So, all of the following items and statistical relationships with certain other parameters including the value of Phi and Cramer's V co-efficients from the chi-square analysis section highlighted the significant repercussions of the sources of obtaining knowledge, such as media access and availability, seminar attendance, and academic background, on farmers' PPK.

Because of no funding, the study was carried out with a small sample size consisting of 4 villages in Cumilla district. This small sample size can-not accurately reflect the practices, perceptions and knowledge of all the local farmers both commercial and non-commercial in this area. A more detailed analytical study with larger sample size is strongly suggested to address the knowledge gap and take necessary steps for controlling Antibiotic Resistance in order to prevent AR propagation.

Table 8. Association between education and perceptions, practices and knowledge.

Variables		Education						
	Category	Illiterate	Secondary	Higher secondary	Graduation	Total	Pearson chi-square/ Likelihood ratio/ Fisher's exact test	Phi/Cramer's V coefficients
AR in animals is significant for securing public health and animal health* **	**Strongly agree**	**1**	**0**	**20**	**26**	**47**	**χ^2 - 102.967**	**Phi (value) .688**
	Agree	**19**	**4**	**33**	**11**	**67**	**df 12**	**Cramer's V (value) .398**
	Neutral	**30**	**1**	**6**	**1**	**38**		
	Disagree	**23**	**3**	**15**	**1**	**42**		
	Strongly disagree	**3**	**1**	**2**	**0**	**6**	**P-value .000**	
	Total	**76**	**9**	**76**	**39**	**200**		
Using AMD in animals is associated with the emergence of resistance in both humans and animals ***	**Strongly agree**	**16**	**6**	**34**	**26**	**82**	**χ^2 - 34.739**	**Phi (value) .398**
	Agree	**40**	**3**	**23**	**10**	**76**	**df 12**	**Cramer's V (value)) .230**
	Neutral	**15**	**0**	**11**	**2**	**28**	**P-value .001**	
	Disagree	**5**	**0**	**7**	**1**	**13**		
	Strongly disagree	**0**	**0**	**1**	**0**	**1**		
	Total	**76**	**9**	**76**	**39**	**200**		
The AR bacteria can be transmitted to humans from animals* **	**Strongly agree**	**13**	**2**	**43**	**30**	**88**	**χ^2 - 56.838**	**Phi (value) .505**
	Agree	**36**	**5**	**24**	**8**	**73**	**df 9**	**Cramer's V (value) .292**
	Neutral	**9**	**1**	**3**	**1**	**14**	**P-value .000**	
	Disagree	**18**	**1**	**6**	**0**	**25**		
	Strongly disagree	**0**	**0**	**0**	**0**	**0**		
	Total	**76**	**9**	**76**	**39**	**200**		
AMD should be properly used by following the prescriptions in both animals and humans	Strongly agree	19	3	29	21	72	χ^2 - 15.125	Phi (value) .254
	Agree	46	6	36	16	104	df 9	Cramer's V (value) .146
	Neutral	8	0	7	2	17	P-value .088	
	Disagree	3	0	4	0	7		
	Strongly disagree	0	0	0	0	0		
	Total	76	9	76	39	200		
The AR can stop the effectiveness of AMD* **	**Strongly agree**	**3**	**1**	**11**	**10**	**25**	**χ^2 - 40.794**	**Phi (value) .443**
	Agree	**20**	**1**	**26**	**22**	**69**	**df 12**	**Cramer's V (value) .256**
	Neutral	**39**	**3**	**28**	**6**	**76**	**P-value .000**	
	Disagree	**14**	**4**	**10**	**1**	**29**		
	Strongly disagree	**0**	**0**	**1**	**0**	**1**		
	Total	**76**	**9**	**76**	**39**	**200**		
Proper antibiotic use according to prescriptions can reduce the AR in animals and human	Strongly agree	4	0	8	7	19	χ^2 - 11.021	Phi (value) .231
	Agree	41	6	40	22	109	df 9	Cramer's V (value) .133
	Neutral	25	1	20	7	53	P-value .274	
	Disagree	6	2	8	3	19		
	Strongly disagree	0	0	0	0	0		
	Total	76	9	76	39	200		

Table 8. Contd.

Variables		Education						
	Category	Illiterate	Secondary	Higher secondary	Graduation	Total	Pearson chi-square/ Likelihood ratio/ Fisher's exact test	Phi/Cramer's V coefficients
Prolonged AMD use without proper administration poses to AR* **	**Strongly agree**	**0**	**1**	**7**	**12**	**20**	**χ^2 - 53.143**	**Phi (value) .519**
	Agree	**22**	**3**	**35**	**19**	**79**	**df 12**	**Cramer's V (value) .300**
	Neutral	**33**	**1**	**16**	**3**	**53**	**P-value .000**	
	Disagree	**18**	**2**	**16**	**4**	**40**		
	Strongly disagree	**3**	**2**	**2**	**1**	**8**		
	Total	**76**	**9**	**76**	**39**	**200**		
AMD is used only for treatment to stop AR* **	**Strongly agree**	**1**	**0**	**3**	**0**	**4**	**χ^2 - 39.517**	**Phi (value) .437**
	Agree	**15**	**2**	**15**	**2**	**34**	**df 12**	**Cramer's V (value) .252**
	Neutral	**29**	**2**	**16**	**3**	**50**	**P-value .000**	
	Disagree	**28**	**5**	**33**	**21**	**87**		
	Strongly disagree	**3**	**0**	**9**	**13**	**25**		
	Total	**76**	**9**	**76**	**39**	**200**		
Using of AMD for the animals	Once	17	3	15	6	41	χ^2 - 11.787	Phi (value) .243
	More than once	55	6	46	24	131	df 6	Cramer's V (value) .172
	Never	4	0	15	9	28	P-value .067	
	Total	76	9	76	39	200		
Who do treatment of your animals?* **	**Registered veterinarian**	**18**	**2**	**50**	**34**	**104**	**χ^2 - 62.815**	**Phi (value) .554**
	Local quack	**51**	**4**	**18**	**4**	**77**	**df 6**	**Cramer's V (value) .392**
	Local pharmacy owner	**7**	**3**	**8**	**1**	**19**	**P-value .000**	
	Total	**76**	**9**	**76**	**39**	**200**		
Do you follow the proper administration of drugs as part of animal treatments?* **	**Yes**	**18**	**2**	**38**	**28**	**86**	**χ^2 - 27.867**	**Phi (value) .373**
	No	**58**	**7**	**38**	**11**	**114**	**df 3**	**Cramer's V (value) .373**
	Total	**76**	**9**	**76**	**39**	**200**	**P-value .000**	
Do you increase the drug application when the animals are not cured?	Yes	58	6	47	28	139	χ^2 - 3.899	Phi (value) .140
	No	18	3	29	11	61	df 3	Cramer's V (value) .140
	Total	76	9	76	39	200	P-value .273	
Do you use the same previous prescribed drugs after an interval?* **	**Yes**	**48**	**7**	**29**	**6**	**90**	**χ^2 - 29.289**	**Phi (value) .383**
	No	**28**	**2**	**47**	**33**	**110**	**df 3**	**Cramer's V (value) .383**
	Total	**76**	**9**	**76**	**39**	**200**	**P-value .000**	

Table 8. Contd.

Variables		Education						
	Category	Illiterate	Secondary	Higher secondary	Graduation	Total	Pearson chi-square/ Likelihood ratio/ Fisher's exact test	Phi/Cramer's V coefficients
Do you use any drugs for animal growth?***	Yes	29	4	25	4	62	χ^2 - Value 10.544	Phi (value) .230
	No	47	5	51	35	138	df 3	Cramer's V (value) .230
	Total	76	9	76	39	200	P-value .014	
Do you recommend the drugs to the other farmers when you observe the same sign and symptoms?***	Yes	56	6	41	12	115	χ^2 - Value 20.251	Phi (value) .318
	No	20	3	35	27	85	df 3	Cramer's V (value) .318
	Total	76	9	76	39	200	P-value .000	
Do you know what is antibiotics?***	Yes	15	2	43	33	93	χ^2 - Value 53.714	Phi (value) .499
	No	61	7	33	6	107	df 3	Cramer's V (value) .499
	Total	76	9	76	39	200	P-value .000	
Do you know what is AR?***	Yes	1	0	16	30	47	χ^2 - Value 85.738	Phi (value) .655
	No	75	9	60	9	153	df 2	Cramer's V (value) .655
	Total	76	9	76	39	200	P-value .000	
Do you know how AR occurs ?***	Yes	0	0	15	30	45	χ^2 - Value 91.254	Phi (value) .675
	No	76	9	61	9	155	df 3	Cramer's V (value) .675
	Total	76	9	76	39	200	P-value .000	
Do you know how AR spreads from livestock to humans?***	Yes	0	0	14	28	42	χ^2 - Value 83.553	Phi (value) .646
	No	76	9	62	11	158	df 3	Cramer's V (value) .646
	Total	76	9	76	39	200	P-value .000	
Can you recognize the AMDs?***	Yes	0	0	7	17	24	χ^2 - Value 46.625	Phi (value) .495
	No	76	9	69	22	176	df 3	Cramer's V (value) .495
	Total	76	9	76	39	200	P-value .000	
Do you know that AR is a serious global issue right now?***	Yes	1	0	16	30	47	χ^2 - Value 85.738	Phi (value) .655
	No	75	9	60	9	153	df 3	Cramer's V (value) .655
	Total	76	9	76	39	200	P-value .000	

***Statistically significant, when α=.05

4. Conclusions

Antibiotic Resistance is nowadays an extreme worldwide concern that is spreading quickly across the globe. The poor level of Perceptions, Practices and Knowledge of the livestock farmers was identified both by qualitative and quantitative findings in this research. Since the preponderance of Bangladeshi rural farmers engages in the livestock sector, their lack of comprehension and understanding may contribute to the emergence and spread of a wide range of Antibiotic Resistant pathogens. Therefore, the government must emphasize this

concern and teach farmers about controlling Antibiotic Resistance in order to restrict the AR spread which can assist to safeguard both animal and human health.

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Data availability
The data presented in this study are contained in this manuscript.

Conflict of interest
None to declare.

Authors' Contribution
Abu Sayed: Designed the experiment, reviewed the literature, analyzed the data, figured out, and wrote the draft of this manuscript; Sabiha Akter and Ali Hossain Roni: Assisted in data collection and gathering information; Wahedul Karim Ansari: Supervised and revised the final manuscript. All authors have read and approved the final manuscript.

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