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ORIGINAL RESEARCH

Knowledge, Attitudes, Practices, and Risk Perception of Antimicrobial Use and Antimicrobial Resistance Among Dairy Farm Owners/Workers in Addis Ababa, Ethiopia

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Introduction: Antimicrobial resistance (AMR) is one of the most significant global health threats to the public, animals, and the ecosystem. Inappropriate use of antibiotics in food animals is considered a major driver of AMR in humans. This study was conducted to assess the knowledge, attitude, practices, and risk perception (KAPP) of dairy farm owners/workers in Addis Ababa about antibiotic use and resistance.

Methods: A face-to-face interview using a structured questionnaire was conducted with 281 respondents in four selected subcities of Addis Ababa. The responses provided by each participant were recoded into a binary scale based on the mean score of each domain. Pearson chi-square was used to check the association between the KAPP and sociodemographic characteristics of the respondents and logistic regression analysis was done to explore the factors associated with KAPP.

Results: Overall, more than half of the surveyed dairy farm owners/workers had good knowledge (57.7%) and appropriate practice (53.0%), while less than half of the respondents showed desirable attitudes (47.7%) and positive risk perceptions (42.7%). The findings revealed a strong association between the respondents' KAPP and education and between knowledge and risk perception and farming experience.

Conclusion: This study found that continuous education of dairy farm owners/workers regarding antimicrobial usage and antimicrobial resistance in dairy farms will increase their awareness and perception of risk as well as motivate them to adopt desirable attitudes and appropriate practices, and consequently limit inappropriate use of antimicrobials leading to mitigating emergence of AMR.

Keywords: antimicrobial use, resistance, knowledge, attitude, practices, risk perception, dairy farm owners/workers

Introduction

Antimicrobial resistance (AMR) is among the most serious global challenges to the health of humans, animals and plants, and the environment. This is due to the emergence, spread, and persistence of multidrug-resistant (MDR) bacteria or "superbugs".[1] AMR occurs when microbes, such as bacteria, viruses, fungi, and parasites, adapt over time and no longer respond to drugs to which they are initially sensitive to, making infections more difficult to treat and resulting in an increased risk of disease spread.[2] Antibiotics are widely used in human, animal, and agricultural settings for different purposes, including therapeutic, preventive, metaphylactic, and growth-promotion[3] and this has been correlated with the development and spread of AMR worldwide. AMR is expanding rapidly across national boundaries and is unaffected by political, economic, or geographic differences.[4] In low and middle income countries (LMICs), the situation is magnified by weakly enforced regulations, which

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leads to easy access to veterinary drugs by animal owners, inadequate diagnostic tools and laboratory capacity, and insufficient resourced infection prevention and control.[5]

Despite the fact that AMR is a natural phenomenon, resistance occurs more rapidly when antimicrobials are misused (inappropriate choices, inadequate dosing, poor adherence to treatment guidelines) and overused.[6] Antibiotic-resistant bacteria are thought to have emerged and spread primarily due to the widespread use of antibiotics, particularly for the purpose of promoting the growth of food animals.[7] AMR reduces the effectiveness of antibiotics in preventing or treating infections caused by microorganisms, thereby increasing morbidity and mortality and consequently leading to higher economic costs for livestock producers.[8] AMR can spread in the environment through horizontal and vertical gene transfers via mutation and recombination, and most antimicrobial resistance genes (ARGs) are transferred to pathogenic bacteria through horizontal gene transfer from bacteria living in the environment.[3] AMR transmission from animals to humans can occur by consuming contaminated food of animal origin and direct contact with livestock.[9] Consuming animal products, including meat, milk, and eggs, that contain drug residues might result in low-level exposure to antibiotics used in animals.[10] The disposal of antibiotics used as a footbath on farms, the application of antibiotic-contaminated manure on land,[11] and the feeding of waste milk to calves containing antibiotic residues[12] have also become concerns due to the spread of resistance genes.

Although Ethiopia joined the global community in tackling the threat of AMR with a national strategic framework in 2011, the misuse of antimicrobials by human and animal health care providers, animal husbandry practitioners and drug users is still a common practice in the country.[13] Ethiopia, as in many other developing nations, does not strictly implement regulations regarding antimicrobial use, and farmers have easy access to veterinary drugs. A meta-analysis study of antimicrobial resistance in Ethiopia showed that the pooled prevalence of AMR in bacteria from food-producing live animals was 20%; that in milk, food handlers and environmental samples was 29%, and that in meat was 28%.[14] Another recent meta-analysis also revealed the presence of high MDR in most bacterial species from humans, animals, food, and environmental sources in the country.[15] Addis et al[16] reported that 83% of *Salmonella* isolates were resistant to two or more antimicrobials in lactating cows and in humans that had contact with dairy farms around Addis Ababa. Other studies conducted in Addis Ababa also indicated that 96.2% of *S. aureus* from milk and traditionally processed dairy products were resistant to two or more antimicrobials[17] and 100% of *S. aureus* isolates in dairy farms, abattoirs and humans were resistant to three or more antibiotics in dairy farms, abattoirs and humans.[18]

Among the five strategic plan objectives of the Third AMR Prevention and Containment Strategic Plan of Ethiopia (2021–2025), the first one is improving awareness and understanding of antimicrobial resistance through effective behaviour change communication, education, and training. While there is an indication of the increased awareness and expanded knowledge on AMR by some institutions, awareness and understanding of the problem and the attention given to AMR prevention and containment among communities, livestock stakeholders, professionals and policymakers remain inadequate. Thus, it is critical to assess the KAPP of dairy farm owners/workers to determine their level of knowledge, attitude, practices, and risk perception to raise awareness, encourage responsible use of antibiotics, take appropriate action against antimicrobial resistance, and promote better practices. Therefore, this study aimed to assess the dairy farm owners'/workers' knowledge, attitude, practices, and risk perception about AMU and AMR in Addis Ababa, Ethiopia.

Materials and Methods

Study Area

This study was conducted in the Nefas Silk, Bole, Yeka, and Gulele subcities of Addis Ababa (Figure 1) from March 2023 to September 2023. The subcities were selected using a simple random sampling technique. Addis Ababa is the capital city of Ethiopia, which is situated at 9° 1′48″ N and 38° 44′ 24″E. The city is divided into 11 subcities. There are approximately 5500 large-, medium- and small-scale dairy farms in Addis Ababa, which supply milk and milk products to the residents of the capital.

Sample Size Determination

The sample size was calculated using the following formula, which is recommended by Bartlett et al,[19] with the assumption of a 95% confidence interval, 81.3% of prior prevalence of KAP,[20] and an absolute error of 5% which gave an estimated sample size of 234. Considering an 80% response rate, the total sample size was adjusted to 281.

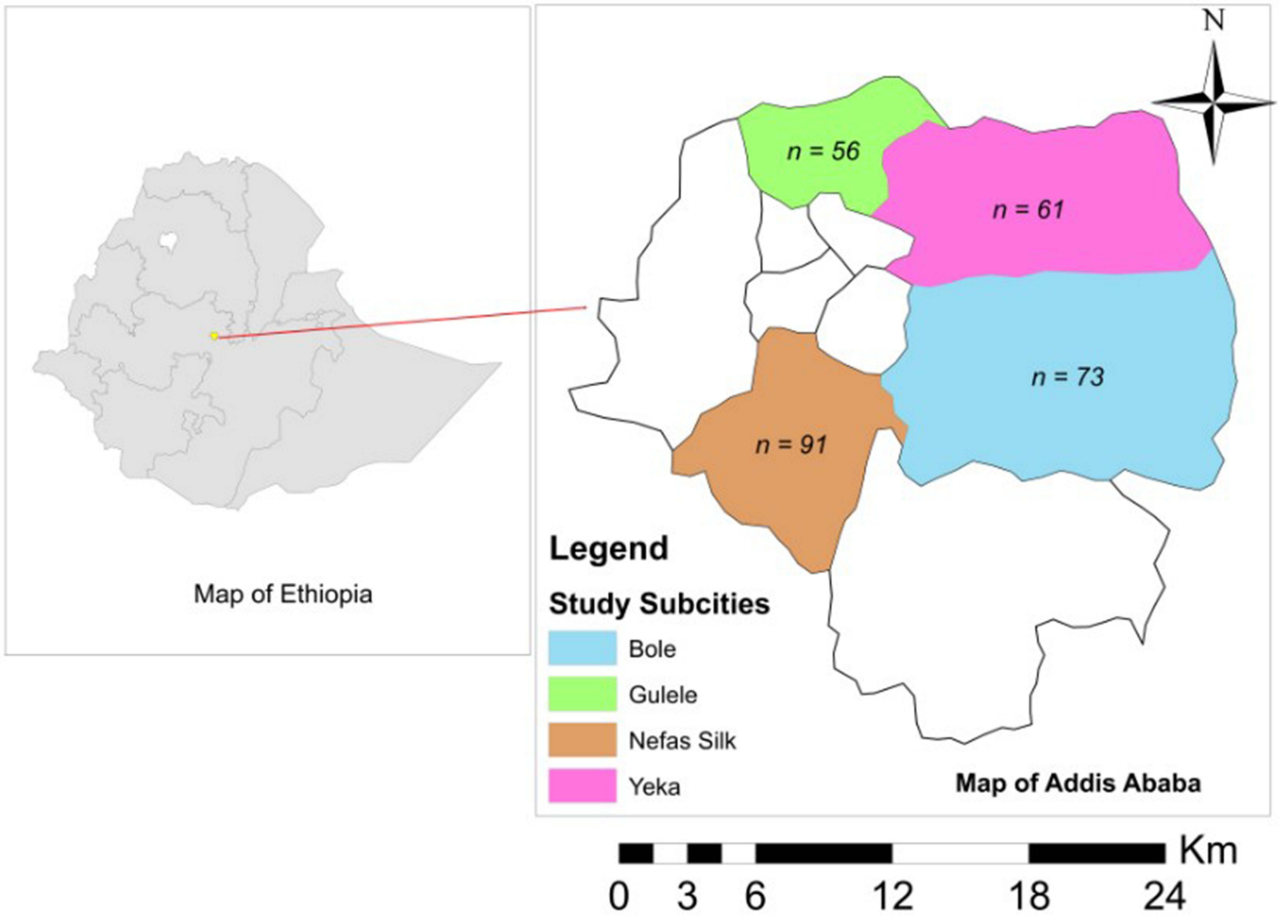

Figure 1 Study Area Map.

Study Design and Sampling

A cross-sectional study design was conducted to determine the KAPP of dairy farm owners/workers towards AMU and AMR in four simple randomly selected subcities of Addis Ababa. After obtaining the estimated number of farms in each selected subcity from Addis Ababa City Administration Farmers and Urban Agriculture Commission, the total number of sampled farms (281) in the study were distributed proportionally to the number of dairy farms in the selected subcities (91 from Nefas Silk, 73 from Bole, 61 from Yeka, and 56 from Gulele). Individual farms included in the study were selected using a systematic random method (by starting from randomly selected farm and selecting every 5th farm until the desired sample size was reached), and then one respondent from each farm was chosen (either the farm owner or the supervisor or any other person who had full information about the farm activities) for the interview. When a selected farm was established within less than six months and the owner/worker was refused to be part of the research, it was then replaced by another dairy farm mostly from the nearby area.

Data Collection Tools and Procedures

A pretested structured questionnaire was used to collect all data related to knowledge, attitude, practices and risk perception from the study participants through face-to-face interviews following written consent from the participants. The questionnaire was prepared after a thorough literature review of comparable studies,[20–23] and then reviewed by experts for its design, relevance and appropriateness. For internal consistency and reliability, a pilot study was performed on 20 participants of the study population who were excluded from the final analysis. Cronbach's alpha coefficients of 0.72, 0.82, 0.85, and 0.87 for knowledge, attitude, practices and risk perception, respectively, were recorded, indicating internal consistency.[24,25]

The questionnaire contained eight sections. In the first section, demographic information such as age, sex, marital status, level of education, monthly income, number of animals, and farming experience were considered. In the second section, the respondents were asked to answer questions about antimicrobial usage for their animals. The third section included questions that assess knowledge, the fourth section presented attitude-related questions, and the fifth section contained questions concerning the practices of the farm owners/workers regarding AMR. The sixth section included items related to risk perception about AMR. Factors contributing to increasing AMR and possible measures to decrease AMR were assessed in the seventh and eighth sections, respectively.

Data Measurement Techniques

The knowledge and practices of respondents were assessed using 8 and 10 questions, respectively, with binary responses of "Yes or No". For knowledge and practices, each correct response was given a score of 1, while a wrong or doubtful response was given a score of 0. The attitude and risk perception of respondents were assessed using a 5-point Likert scale (strongly agree, agree, neutral, disagree and strongly disagree) that was measured using a scoring method ranging from 5 to 1. Attitude was assessed using 18 Likert scale questions with an overall score of 90 (18*5), while risk perception was assessed using seven Likert questions with a total score of 35 (7*5). The scores of each respondent's responses for each item were summed, and the mean score for each domain was calculated. Depending on the mean score, the respondents were further regrouped into two categories for each domain. Those who scored above or equal to the mean were grouped as good knowledge, desirable attitude, appropriate practices, and positive risk perception, while those who scored below the mean were assigned as poor knowledge, undesirable attitude, inappropriate practices, and negative risk perception.[22,26]

Data Analysis

Data were entered into MS Excel® and cleaned and recoded before being exported to R software version 4.1.0[27] for analysis. Descriptive analysis was performed for frequencies and percentages/proportions. Bivariate analysis using the chi-square test (Fisher's exact test when appropriate) was used to assess the associations between the independent variables (subcity, gender, age group, education level, marital status, farm size in number of animals (<20 animals categorised as small-scale, 20–49 animals categorised as medium-scale, and 50 and more animals categorised as large-scale), years of farming experience, and monthly income) and knowledge, attitude, practices, and risk perception. Spearman correlation analysis was conducted to determine the direction and degree of relationship between the mean scores of knowledge, attitude, practices, and risk perception.

To explore the influence of sociodemographic factors on respondents' knowledge, attitudes, practices and risk perceptions, analysis was performed using multivariable logistic regression models. The bivariate analysis outputs were used to screen statistically significant variables that were associated with each of the four KAPP domains at a p value ≤ 0.250. All predictor variables with a $p \leq 0.250$ were included in the multivariable logistic regression analysis. A nonsignificant Hosmer–Lemeshow test ($p > 0.050$) and a significant Omnibus test for model coefficients ($p < 0.050$) were used to check whether the model fit the data. The results are reported as odds ratios (ORs) with 95% confidence intervals. All statistics with a two-sided p value ≤ 0.050 were considered significant.

Results

Sociodemographic Characteristics of the Study Participants

A total of 281 respondents from the Nefas Silk (32.4%), Bole (26.0%), Yeka (21.7%), and Gulele (19.9%) subcities participated in this study. Analysis of the demographic parameters of the respondents showed that the majority were male (84.7%), aged between 31 and 40 years old (48.4%), married (70.1%), and completed primary school (36.7%). Most of the respondents (48.0%) owned small-scale farms and had 6–10 years (39.1%) of farming experience with a monthly income of less than 5000 ETB (57.7%) (Table 1).

Table 1 Sociodemographic Characteristics of the Study Participants

Variable	Categories	Frequency	Percentage (95% CI)
Subcity	Nefas Silk	91	32.4 (27.2–38.1)
	Bole	73	26.0 (21.2–31.4)
	Yeka	61	21.7 (17.3–27.0)
	Gulele	56	19.9 (15.7–25.0)
Gender	Male	238	84.7 (80.0–88.4)
	Female	43	15.3 (11.6–20.0)
Age group (Years)	18–30	55	19.6 (15.4–24.6)
	31–40	136	48.4 (42.6–54.2)
	> 40	90	32.0 (26.8–37.7)
Marital status	Single	57	20.3 (16.0–25.4)
	Married	197	70.1 (64.5–75.2)
	Divorce/Widowed	27	9.6 (6.7–13.6)
Level of Formal Education attained	No education	29	10.3 (7.3–14.4)
	Primary	103	36.7 (31.2–42.4)
	Secondary	84	29.9 (24.8–35.5)
	College/University	65	23.1 (18.6–28.4)
Farm size (based on number of animal)	Small scale	135	48.0 (42.3–53.9)
	Medium scale	103	36.7 (31.2–42.4)
	Large scale	43	15.3 (11.6.1–20.0)
Farming Experience (Years)	≤ 5	49	17.4 (13.4–22.3)
	6–10	110	39.1 (33.6–45.0)
	11–15	54	19.2 (15.0–24.2)
	≥ 16	68	24.2 (19.6–29.5)
Income Level per month (ETB)	<5000	164	58.4 (52.5–64.0)
	5000–15,000	93	33.1 (27.9–38.8)
	>15,000	24	8.5 (5.8–12.4)

Antibiotic Use in Dairy Farms

Of the 281 respondents, the majority of the participants (91.5%) gave antibiotics to their animals. Out of the 257 respondents who gave antibiotics to animals, approximately half of them (49.4%) administered the drugs for the treatment of animal diseases, and the remaining participants used antibiotics for the purpose of increasing production (21.8%), preventing (19.1%), and controlling (9.7%) diseases. Only 31.5% of the respondents used antibiotics with prescriptions from veterinary clinics/veterinarians, while most participants (62.3%) used antibiotics purchased from private pharmacies without a prescription, and some (6.2%) used antibiotic leftovers from the previous course. Regarding the reasons why they used antibiotics without a prescription, most of the respondents (41.5%) stated that they had previous experience. The majority of owners/workers (60.9%) administer antibiotics 2–5 times a month (Table 2).

Table 2 Antibiotic Use in Dairy Farm Owners/Workers

Questions	Responses	N (%)	95% CI
Have you given antibiotics for your animals?	Yes	257 (91.5)	87.6–94.2
	No	24 (8.5)	5.8–12.4
For what purpose did you use antimicrobials most?	Treatment	127 (49.4)	43.4–55.5
	Increase production	56 (21.8)	17.2–27.2
	Prevention (Prophylaxis	49 (19.1)	14.7–24.3
	Control (Metaphylaxis)	25 (9.7)	6.7–14.0
Where did you obtain the antibiotics that you gave for your animals?	Private pharmacy without prescription	160 (62.3)	56.2–68.0
	Prescribed by Veterinarian	81 (31.5)	26.1–37.4
	Left over from a previous course	16 (6.2)	3.9–9.9
Why you used antibiotics for your animal without prescription?	Previous experiences	73 (41.5)	34.5–48.9
	Minimise cost	48 (27.3)	21.2–34.3
	Lack of time	27 (15.3)	10.8–21.4
	Quick relief	24 (13.6)	9.3–19.5
	Lack of Veterinarians	4 (2.3%)	0.9–5.7
How many times have you give antibiotics for your animals in a month?	Never	24 (8.5)	5.8–12.4
	Once	39 (13.9)	10.3–18.4
	2–5 times	171 (60.9)	55.0–66.4
	More than 5 times	47 (16.7)	12.8–21.5

Notes: N, number, CI, Confidence interval.

Knowledge of Dairy Farm Owners/Workers Regarding AMU and AMR

Three-quarters of the respondents (73.3%) had heard about antimicrobials, and 58.0% of them also knew about AMU and AMR from different sources, including doctors (33.8%), veterinarians (28.7%), pharmacists (18.2%), family (8.3%), media (5.8%), and courses (5.4%) (Table 3 and Figure 2). However, only 21.0% and 40% of the respondents were aware of incomplete antibiotic courses, and over- and underdoses of antibiotics can cause AMR, respectively. Additionally, 31.7% of the respondents were aware of antimicrobial residues, and approximately 52.7% had heard about the withdrawal period. Out of 281 respondents, one-third (33.1%) knew that using animal-origin food products before the end of the withdrawal period could promote AMR development in humans (Table 3).

When the respondents were asked if they were aware of the potential impact of AMR in animals and humans, over one-third (34.9%) of them responded that AMR causes treatment failure, and 17.4% stated that AMR killed easily, but the majority (47.7%) did not know about these effects (Figure 3).

Attitude of Dairy Farm Owners/Workers Regarding AMU and AMR

More than one-third of the respondents (38.1%) "agreed" or "strongly agreed" that antibiotic resistance in animals was a concern for public health, while 42.7% of the respondents "agreed" or "strongly agreed" that there was a relationship between antibiotic use in animals and the development of resistance. The majority of the respondents (69.8%) reported that antimicrobial usage for protection against diseases on farms was the most important, but 38% of the respondents "agreed" or "strongly agreed" that restriction of antibiotic use in animals would lead to more benefits than damage. When asked whether antimicrobial residues and drug resistance could occur when antimicrobials were not used prudently, a relatively low proportion of the participants (34.5%)

Table 3 Knowledge of Dairy Farm Owners/Workers Regarding AMU and AMR

Questions	Responses	N (%)	95% CI
Have you heard about antibiotics or antimicrobials?	Yes	206 (73.3)	67.8–78.1
	No	75 (26.7)	21.9–32.2
Have you heard about antimicrobial use and antimicrobial resistance?	Yes	168 (59.8)	54.0–65.4
	No	113 (40.2)	34.6–46.0
Do you know incomplete antibiotic course may lead to AMR	Yes	60 (21.4)	17.0–26.5
	No	43 (15.3)	11.6–20.0
	I do not know	178 (63.3)	57.6–68.8
Do you know overdose/under dose may lead to AMR	Yes	120 (42.7)	37.1–48.5
	No	45 (16.0)	12.2–20.8
	I do not know	116 (41.3)	35.7–47.1
Do you know about antimicrobial residues?	Yes	98 (34.9)	29.5–40.6
	No	183 (65.1)	59.4–70.5
Have you heard about withdrawal period of antibiotics	Yes	148 (52.7)	46.8–58.4
	No	133 (47.3)	41.6–53.2
Do you know antimicrobials have some negative side effects	Yes	174 (61.9)	56.1–67.4
	No	39 (13.9)	10.3–18.4
	I do not know	68 (24.2)	19.6–29.5
Do you know using animal-origin food products before the end of the withdrawal period can promote AMR development in humans?	Yes	94 (33.5)	28.2–39.2
	No	47 (16.7)	12.8–21.5
	I do not know	140 (49.8)	44.0–55.6
Overall Knowledge level	**Good**	**162 (57.7)**	**51.8–63.3**
	Poor	**119 (42.3)**	**36.7–48.2**

"agreed" or "strongly agreed". More than half of the respondents (51.9%) "disagreed" or "strongly disagreed" that stopping antimicrobial treatment once animals feel better would lead to AMR. Likewise, 57.3% of the respondents "disagreed" or "strongly disagreed" that drug withdrawal periods should be adhered to as per the prescription to avoid drug residues in meat or animal products. All the attitude-related questions and the respondents' responses are summarised in Table 4.

Practices of Dairy Farm Owners/Workers Regarding AMU and AMR

Dairy farm owners/workers were asked when their animals got sick and whether they were using their own antibiotics before consulting a veterinarian, and approximately 41% responded correctly. However, only one-third (34.2%) of the respondents read the description of the drugs before using them. More than half of the respondents (53.7%) followed the specified withdrawal period before selling the animals for slaughter, and 63.3% did not sell animal products from animals treated with antibiotics before the withdrawal period. Although 56.9% of the respondents correctly answered the question "Do you increase the dose of antibiotics and frequency of administration as long as animals do not show any signs of recovery?" about 52.0% of the respondents said they stopped giving the antibiotics if animals feel better before the completion of the antibiotic course. All the practice-related questions and the respondents' responses are summarised in Table 5.

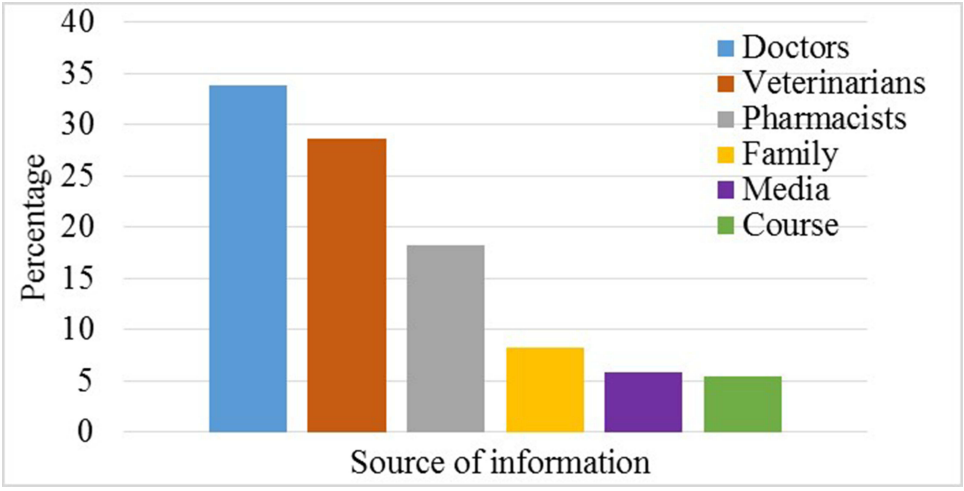

Figure 2 Source of information on AMR.

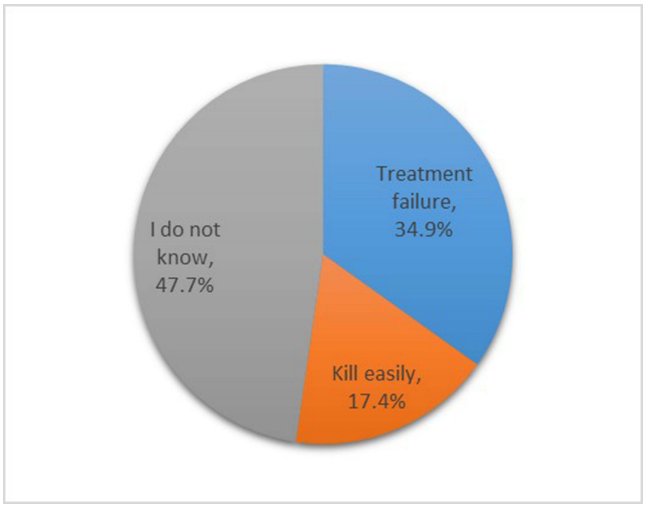

Figure 3 Impact of AMR on dairy farms.

Risk Perception of Dairy Farm Owners/Workers Regarding AMU and AMR

Respondents were asked about their risk perception of AMR, and only 43.1%, 42.3, and 35.9% of them "agreed" or "strongly agreed" that animals could be infected by resistant pathogens from the farm, AMR is a real threat to animal health, and resistant pathogens could be spread from farms to humans, respectively. Additionally, a low proportion of the

Table 4 The Attitude of Dairy Farm Owners/Workers Towards AMU and AMR

Attitude Related Items	Responses N (%)				
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Antibiotic resistance in animals is a concern for public health	43 (15.3)	64 (22.8)	83 (29.5)	74 (26.3)	17 (6.0)
There is relationship between antibiotic use in animals and development of resistance	52 (18.5)	68 (24.2)	40 (14.2)	89 (31.7)	32 (11.4)

(*Continued*)

Table 4 (Continued).

Attitude Related Items	Responses N (%)				
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Antimicrobial usage for protection against diseases on farms is the most important	80 (28.5)	116 (41.3)	25 (8.9)	49 (17.4)	11 (3.9)
Restriction of antibiotic use in animals will lead more benefit than damage	65 (23.1)	42 (14.9)	33 (11.7)	103 (36.7)	38 (13.5)
Antimicrobial residues and drug resistance will occur when antimicrobials are not used prudently	39 (13.9)	58 (20.6)	69 (24.6)	85 (30.2)	30 (10.7)
Antimicrobials can be used to treat any kind of disease in animals	72 (25.6)	104 (37.0)	45 (16.0)	47 (16.7)	13 (4.6)
Misuse of antibiotics in animals causes the emergence of resistant bacteria which cause diseases in humans	25 (8.9)	63 (22.4)	108 (38.4)	66 (23.5)	19 (6.8)
The most important reason for choosing AMD on my farm is its effectiveness	90 (32.0)	100 (35.6)	43 (15.3)	41 (14.6)	7 (2.5)
Stopping antimicrobial treatment once animals feel better leads AMR	32 (11.4)	46 (16.4)	57 (20.3)	117 (41.6)	29 (10.3)
Drug withdrawal periods should be adhered to as per the prescription to avoid drug residues in meat or animal products	15 (5.3)	30 (10.7)	75 (26.7)	111 (39.5)	50 (17.8)
Sale and distribution of Antimicrobials shall only be done by persons permitted to do so by law	84 (29.9)	111 (39.5)	35 (12.5)	40 (14.2)	11 (3.9)
To get better response alter the doses by consulting the prescribers	73 (26.0)	96 (34.2)	55 (19.6)	38 (13.5)	19 (6.8)
Usage of antimicrobials may be reduced by maintaining proper biosecurity, vaccination and good management	25 (7.8)	54 (18.9)	97 (35.9)	79 (27.0)	26 (10.3)
Antibiotics be used only when needed	94 (33.5)	130 (46.3)	43 (15.3)	8 (2.8)	26 (10.3)
Antibiotics should be prescribed only by veterinarians	54 (19.2)	95 (33.8)	38 (13.5)	58 (20.6)	36 (12.8)
Usage of antibiotics as nontherapeutic reasons leads to AMR	19 (6.8)	45 (16.0)	91 (32.4)	93 (33.1)	33 (11.7)
Antimicrobial usage regulations will be a solution for the irrational use of antimicrobials in animal production?	21 (7.5)	59 (21.0)	80 (28.5)	90 (32.0)	31 (11.0)
Overall attitude	**Desirable**				**134 (47.7%)**
	Undesirable				**147 (52.3%)**

Table 5 The Practice of Dairy Farm Owners/Workers Towards AMU and AMR

Questions	Responses	N (%)	95% CI
When animals get sick, do you use your own antibiotics before consulting a veterinarian?	Yes	166 (59.1)	53.2–64.7
	No	115 (40.9)	35.3–46.8
Do you consult a veterinarian to ask whether you need to use antibiotics or not?	Yes	109 (38.8)	33.3–44.6
	No	172 (61.2)	55.4–66.7
Are you ready to go for laboratory test before choosing antimicrobial drugs for use in animals?	Yes	111 (39.5)	34.0–45.3
	No	170 (60.5)	54.7–66.0

(*Continued*)

Table 5 (Continued).

Questions	Responses	N (%)	95% CI
Do you read the prospectus/description before using antimicrobials?	Yes	96 (34.2)	28.9–39.9
	No	185 (65.8)	60.1–71.1
Do you follow the specified drug withdrawal period before selling the animal for slaughter?	Yes	151 (53.7)	47.9–59.5
	No	130 (46.3)	40.5–52.1
Do you increase the dose of antibiotics and frequency of administration as long as animals do not show any signs of recovery?	Yes	121 (43.1)	37.4–48.9
	No	160 (56.9)	51.1–62.6
Do you stop giving the antibiotics, if animals feel better before the antibiotic course is completed?	Yes	146 (52.0)	46.1–57.7
	No	135 (48.0)	42.3–53.9
Do you sell animal products from animals treated with antimicrobial drugs before the withdrawal period?	Yes	103 (36.7)	31.2–42.4
	No	178 (63.3)	57.6–68.8
Do you feed the milk from cows with withdrawal period after being treated with antibiotics to calves?	Yes	224 (79.7)	74.6–84.0
	No	57 (20.3)	16.0–25.4
Do you use/sell manure as a natural fertiliser before the withdrawal period ends when an animal is treated with antibiotics?	Yes	207 (73.7)	68.2–78.5
	No	74 (26.3)	21.5–31.8
Overall Practice level	**Appropriate**	**149 (53.0)**	**47.2–58.8**
	Inappropriate	**132 (47.0)**	**41.2–52.8**

respondents "agreed" or "strongly" agreed that resistant pathogens could be spread from the farm to the environment (22.4%), farm workers may be infected by resistant pathogens from the farm (25.6%), AMR is a threat to the environment (21.3%), and AMR is a threat to public health (29.9%) (Table 6).

Table 6 The Risk Perception of Dairy Farm Owners/Workers Towards AMU and AMR

Risk Perception Related Items	Responses	N (%)
Resistant pathogens can be spread from farm to human	Strongly agree	31 (11.0)
	Agree	69 (24.6)
	Neutral	45 (16.0)
	Disagree	99 (35.2)
	Strongly disagree	1. (13.2)
Resistant pathogens can be spread from farm to the environment	Strongly agree	13 (4.6)
	Agree	48 (17.1)
	Neutral	73 (26.0)
	Disagree	111 (39.5)
	Strongly disagree	36 (12.8)

(*Continued*)

Table 6 (Continued).

Risk Perception Related Items	Responses	N (%)
Animals can be infected by resistant pathogens from the farm	Strongly agree	41(14.6)
	Agree	78 (27.8)
	Neutral	58 (20.6)
	Disagree	82 (29.2)
	Strongly disagree	22 (7.8)
Farm workers may be infected by resistant pathogens from the farm	Strongly agree	17 (6.0)
	Agree	52 (18.5)
	Neutral	43 (15.3)
	Disagree	114 (40.6)
	Strongly disagree	55 (19.6)
AMR is a threat for the environment	Strongly agree	11 (3.9)
	Agree	49 (17.4)
	Neutral	61 (21.7)
	Disagree	120 (42.7)
	Strongly disagree	40 (14.2)
AMR is a real threat for animal health	Strongly agree	32 (11.4)
	Agree	84 (29.9)
	Neutral	37 (13.2)
	Disagree	95 (33.8)
	Strongly disagree	33 (11.7)
AMR is a threat for public health	Strongly agree	23 (8.2)
	Agree	62 (22.1)
	Neutral	49 (17.4)
	Disagree	102 (36.3)
	Strongly disagree	45 (16.0)
Overall risk perception	**Positive risk perception**	**120 (42.7)**
	Negative risk perception	**161 (57.3)**

Contributing Factors to Increased AMR and Interventions Reducing AMR

Respondents were asked questions about the contributing factors to increased antibiotic resistance. Although a considerable number of respondents agreed that the majority of factors contributed to the emergence of AMR, poor awareness of AMR (70.8%), lack of rapid and effective diagnostic techniques (62.9%), substandard quality of antibiotics (58.6%), and use of antimicrobials for animal growth promotion (53.5%), were the most significant factors (Figure 4).

The majority of owners/workers perceived that most of the strategies significantly contributed to decreasing antibiotic use and consequently AMR, including education on antimicrobial therapy (78.7%), the establishment of rapid and effective

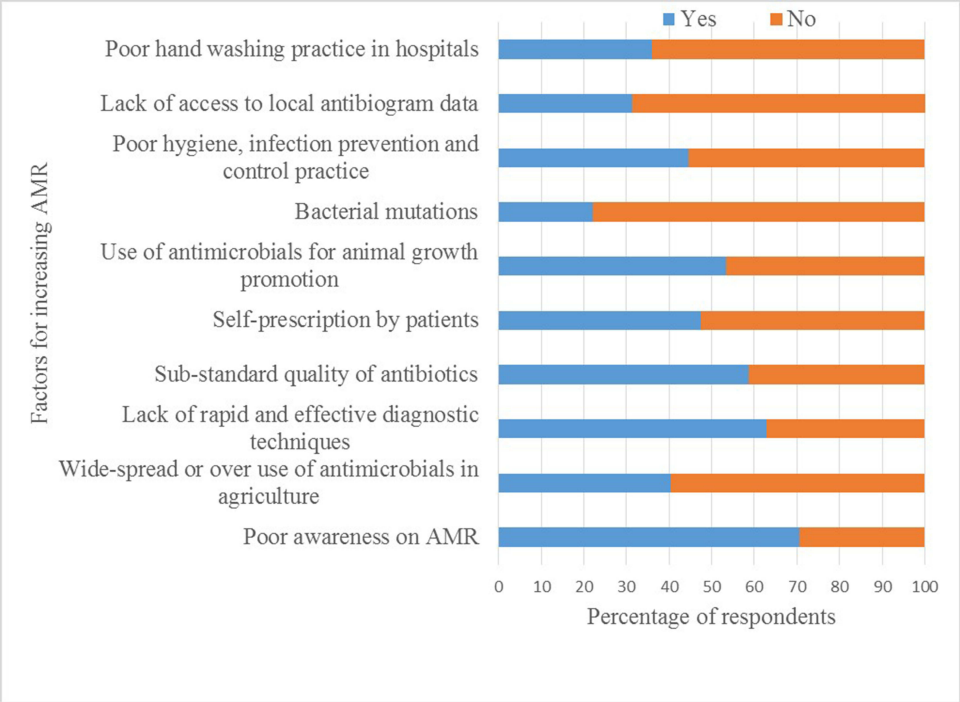

Figure 4 Owners/workers' perceptions of the factors that contribute to increased AMR.

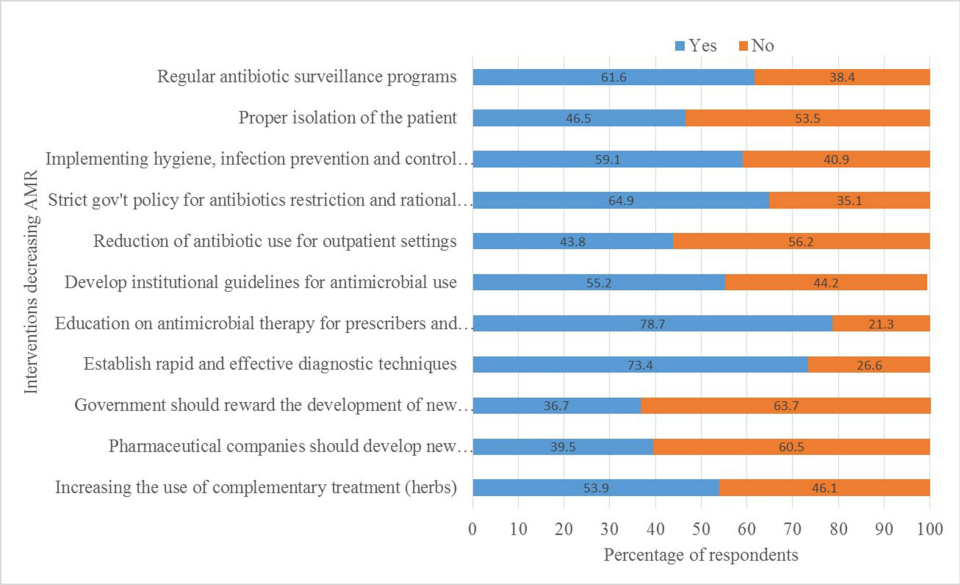

Figure 5 Owners/workers' perceptions about interventions that contribute to reducing AMR.

diagnostic techniques (73.4%), strict government policy for antibiotic restriction and rational antibiotic use in humans and animals (64.9%), and regular antibiotic surveillance programs (61.6%), were the most critical strategies (Figure 5).

Associations Between Knowledge, Attitudes, Practices and Risk Perception Across Respondents' Sociodemographic Characteristics

The mean knowledge score of the participants was 3.80±2.78 (mean ±SD). Using this mean knowledge score as a cut-off, 57.7% of the respondents had good knowledge about AMR. The chi-square test analysis indicated that there was

a statistically significant association between knowledge and level of education, farm size, and farming experience, but there was no statistical association between knowledge and subcity, gender, age group, and marital status (Table 7).

The overall mean attitude score was 54.71±9.80 (mean ±SD). Based on the mean score as a cut-off, less than half of the respondents (47.7%) had a desirable attitude toward antibiotic use and resistance. The results indicated that there was a statistically significant difference between the level of attitude and education level, farm size, farming experience, and monthly income, whereas no statistical difference between the attitude and subcity, gender, age group, and marital status (Table 8).

Table 7 Association of Sociodemographic Characteristics with Respondents' Knowledge of AMR

Demographic Variables	Categories	Knowledge Categories		Chi-square	p value
		Good	Poor		
Subcity	Nefas Silk	51	40	0.43	0.934
	Bole	44	29		
	Yeka	34	27		
	Gulele	33	23		
Gender	Male	142	96	2.58	0.108
	Female	20	23		
Age group (Years)	18–30	34	21	1.18	0.555
	31–40	74	62		
	> 40	54	36		
Marital status	Single	29	28	2.01	0.366
	Married	115	82		
	Divorce/Widowed	18	9		
Formal Education level attained	No education	9	20	17.25	0.001
	Primary	56	47		
	Secondary	48	36		
	College/University	49	16		
Farm size (based on animal number)	Small scale	59	76	21.08	<0.001
	Medium	71	32		
	Large	32	11		
Farming Experience (Years)	≤ 5	7	42	56.43	<0.001
	6–10	62	48		
	11–15	38	16		
	≥ 16	55	13		
Income Level per month (ETB)	<5000	81	83	11.42	0.003
	5000–15,000	63	30		
	>15,000	18	6		

Table 8 Association of Sociodemographic Characteristics with Respondents' Attitudes Towards AMR

Demographic Variables	Categories	Attitude Categories		Chi-square	p value
		Desirable	Undesirable		
Subcity	Nefas Silk	47	44	1.09	0.779
	Bole	32	41		
	Yeka	28	33		
	Gulele	27	29		
Gender	Male	117	121	1.35	0.245
	Female	17	26		
Age group (Years)	18–30	31	24	2.74	0.254
	31–40	65	71		
	> 40	38	52		
Marital status	Single	29	28	0.36	0.833
	Married	93	104		
	Divorce/Widowed	12	15		
Formal Education level attained	No education	6	23	38.48	<0.001
	Primary	32	71		
	Secondary	50	34		
	College/University	46	19		
Farm size (based on animal number)	Small scale	49	86	29.40	<0.001
	Medium	49	54		
	Large	36	7		
Farming Experience (Years)	≤ 5	18	31	8.15	0.043
	6–10	47	63		
	11–15	28	26		
	≥ 16	41	27		
Income Level per month (ETB)	<5000	62	102	23.58	<0.001
	5000–15,000	51	42		
	>15,000	21	3		

The overall mean score of practices was 5.02±3.10 (mean ±SD), and based on this score as a cut-off, more than half of the respondents (53.0%) had adopted appropriate practices. Using the chi-square test analysis to check whether there was a relationship between respondents' practices and their demographic characteristics, there was an association between practices and level of education, farm size, gender, age group, and farming experience, whereas no statistical association between practices and subcity and marital status (Table 9).

The overall mean score of risk perception regarding AMR was 19.34±7.07 (mean ±SD). A chi-square analysis was performed to show the relationship between sociodemographic factors and the respondent's risk perception. The results demonstrated that a statistically significant association was observed between risk perception and level of education, farm

Table 9 Association of Sociodemographic Characteristics with Respondents' Practices Regarding AMU and AMR

Demographic Variables	Categories	Practice Categories		Chi-square	p value
		Appropriate	Inappropriate		
Subcity	Nefas Silk	55	36	3.60	0.308
	Bole	34	39		
	Yeka	30	31		
	Gulele	30	26		
Gender	Male	130	108	1.59	0.207
	Female	19	24		
Age group (Years)	18–30	36	19	4.32	0.116
	31–40	69	67		
	> 40	44	46		
Marital status	Single	28	29	0.862	0.650
	Married	108	89		
	Divorce/Widowed	13	14		
Formal Education level attained	No education	7	22	26.10	<0.001
	Primary	43	60		
	Secondary	54	30		
	College/University	45	20		
Farm size (based on animal number)	Small scale	59	76	9.36	0.009
	Medium	65	38		
	Large	25	18		
Farming Experience (Years)	≤ 5	19	30	10.65	0.014
	6–10	54	56		
	11–15	30	24		
	≥ 16	46	22		
Income Level per month (ETB)	<5000	79	85	3.81	0.149
	5000–15,000	55	38		
	>15,000	15	9		

size, farming experience, and monthly income. However, there was no statistically significant association observed between risk perception and subcity, gender, age group, or marital status (Table 10).

Correlations Between Knowledge, Attitudes, Practices and Risk Perception Scores

Spearman correlation was used to assess the bivariate associations between knowledge, attitude, practices, and risk perception scores. Each pair of respondents' KAPP scales was significantly associated ($p < 0.010$), with the strongest positive correlation being between knowledge and risk perception (0.646). Significant positive correlations were also

Table 10 Association of Sociodemographic Characteristics with Respondents' Risk Perception Regarding AMR

Demographic Variables	Categories	Perception of Risk Categories		Chi-square	p value
		Positive risk perception	Negative risk perception		
Subcity	Nefas Silk	36	55	1.53	0.675
	Bole	29	44		
	Yeka	29	32		
	Gulele	26	30		
Gender	Male	104	134	0.63	0.429
	Female	16	27		
Age group (Years)	18–30	22	33	0.50	0.779
	31–40	57	79		
	> 40	41	49		
Marital status	Single	23	34	0.24	0.885
	Married	86	111		
	Divorce/Widowed	11	16		
Formal Education level attained	No education	5	24	26.06	<0.001
	Primary	40	63		
	Secondary	31	53		
	College/University	44	21		
Farm size (based on animal number)	Small scale	40	95	18.96	<0.001
	Medium	54	49		
	Large	26	17		
Farming Experience (Years)	≤ 5	7	42	37.67	<0.001
	6–10	39	71		
	11–15	28	26		
	≥ 16	46	22		
Income Level per month (ETB)	<5000	57	107	10.42	0.005
	5000–15,000	49	44		
	>15,000	14	10		

observed between attitude and risk perception (0.498), knowledge and practices (0.469), knowledge and attitude (0.446), and attitude and practices (0.361) (Table 11).

Predictors of Factors Associated with Knowledge, Attitude, Practices, and Risk Perception to AMU and AMR

Sociodemographic variables associated with knowledge, attitude, practices, and risk perception in the bivariate analysis with $p \leq 0.250$ were included in the multivariable logistic regression analysis (Table 12).

Table 11 Correlations Between Dairy Farm Owners/Workers' Knowledge, Attitudes, Practices and Risk Perception

	Correlations		Knowledge	Attitude	Practice
Spearman's rho	Attitude	Correlation coefficient	0.446**		
		p-value	< 0.001		
	Practice	Correlation coefficient	0.469**	0.361**	
		p-value	< 0.001	< 0.001	
	Risk perception	Correlation coefficient	0.646**	0.498**	0.439**
		p-value	< 0.001	< 0.001	< 0.001

Notes: **Correlation significant at p < 0.01 (two tailed).

Table 12 Factors Associated with Good Knowledge, Desirable Attitudes, Appropriate Practices, and Positive Risk Perceptions Regarding Antibiotic Use and Resistance Among Dairy Farm Owners/Workers

Categorical Predictor Variables	Knowledge		Attitude		Practices		Risk Perception	
	aOR (95% CI)	p-value	aOR (95% CI)	p-value	aOR (95% CI)	p-value	aOR (95% CI)	p-value
Gender								
Male	r							
Female	0.9 (0.4–2.0)	0.793	1.3 (0.6–3.0)	0.478	1.0 (0.5–2.2)	0.934		
Level of Education								
No education	r							
Primary	3.0 (1.1–8.2)	0.037*	2.6 (0.8–8.2)	0.115	2.4 (0.9–6.5)	0.100	3.6 (1.2–11.3)	0.028*
Secondary	4.2 (1.5–11.8)	0.007*	9.6 (3.0–30.9)	<0.001*	6.6 (2.2–19.5)	0.001*	3.9 (1.2–12.0)	0.020*
College/University	9.0 (2.9–28.1)	<0.001*	12.8 (3.8–43.0)	<0.001*	6.7 (2.3–19.8)	<0.001*	12.5 (3.8–40.8)	<0.001*
Farm size								
Small-scale	r		r					
Medium-scale	1.3 (0.4–4.0)	0.647	1.7 (0.6–4.6)	0.322	2.1 (0.8–5.6)	0.156	1.1 (0.4–3.1)	0.883
Large-scale	1.4 (0.3–8.2)	0.688	10.5 (1.8–60.3)	0.009*	1.5 (0.3–6.9)	0.634	1.4 (0.3–6.7)	0.706
Farming experience								
≤ 5	r							
6–10	9.0 (3.5–23.1)	<0.001*	1.3 (0.6–3.0)	0.462	1.4 (0.7–3.1)	0.366	3.7 (1.4–9.6)	0.007*
11–15	14.8 (4.8–46.0)	<0.001*	1.1 (0.4–2.8)	0.930	1.5 (0.6–3.8)	0.406	6.5 (2.1–19.5)	0.001*
≥ 16	27.7 (8.4–91.1)	<0.001*	1.3 (0.5–3.4)	0.671	2.6 (1.0–6.8)	0.055	13.3 (4.2–42.0)	<0.001*
Level of Income								
<5000	r		r					
5000–15,000	1.0 (0.3–3.0)	0.930	1.0 (0.4–2.7)	0.982	0.9 (0.3–2.5)	0.831	1.3 (0.45–3.46)	0.674
>15,000	0.6 (0.1–4.4)	0.641	1.2 (0.1–9.7)	0.893	0.8 (0.2–4.5)	0.806	0.6 (0.1–3.5)	0.577

Notes: *statistically significant difference from the reference group.
Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; r, reference category.

The analysis showed that respondents' education level was significantly associated with knowledge. Those who attended a primary, secondary, and college/university level education were three times, four times, and nine times more likely to have good knowledge of antimicrobial use and AMR, respectively, than those who did not attend a formal education. The analysis also revealed that respondents' farming experience was significantly associated with knowledge. Those who had 6–10, 11–15, and ≥ 16 years of farming experience were nine, 14.8, and 27.8 times more likely to have good knowledge, respectively, than those who had five years or less farming experience. Other variables, such as gender, farm size, and monthly income level, were not significantly associated with knowledge ($p > 0.050$) (Table 12).

A statistically significant association was found between the respondent's education level and their attitude. Respondents who had achieved secondary and college/university level education were 9.6 and 12.8 times, respectively, more likely to have a desirable attitude towards AMR than those who had not attained a formal education. With regard to farm size, the analysis showed that large-scale farm owners/workers were 10.5 times more likely to have a desired attitude than those from small-scale farms (Table 12).

In terms of practices, the results indicated that having attained secondary and college/university level education were significantly associated with practices. Those who had attained secondary school were 6.6 times and college/university were 6.7 times more likely to adopt appropriate practices compared with those who had not attained a formal education (Table 12).

The predictor factors associated with positive risk perception regarding AMR were education level and farming experience. Compared with those who had not attained a formal education, those who achieved primary education were 3.6 times, secondary education were 3.9 times, and college/university were 12.5 times more likely to have a positive risk perception. With respect to farming experience, those with 6–10, 11–15, and ≥ 16 years of farming experience were 3.7, 6.45, and 13.3 times more likely to have positive risk perception, respectively, than those with ≤ 5 years of farming experience (Table 12).

Discussion

The inappropriate use of antimicrobials in animal production and the associated development of AMR have detrimental effects on public, animal, and the environmental health.[28] To effectively address and mitigate the dangers associated with antibiotic resistance at national and global levels, it is essential to understand the driving forces behind and factors affecting livestock producers' usage of antibiotics.[29] This study aimed to determine the knowledge, attitudes, practices, and risk perceptions (KAPP) of dairy farm owners/workers in Addis Ababa and assess the factors associated with their KAPP. The majority of dairy farm owners/workers in the current study used antibiotics on their farms, and approximately two-thirds of them received their antibiotics from private pharmacies without a veterinarian's or other animal health professional's approval, which may have contributed to the development of AMR. This finding is similar to the 72.5% recorded in northwestern Ethiopia,[22] where livestock producers use antibiotics without a prescription to reduce veterinary costs and use their previous experience of antibiotic use. Additionally, a comparable finding was reported in a previous study from Peru, where 71.0% of the farmers purchased their antibiotics without a veterinarian prescription.[30]

Of the total respondents in this study, 57.7% of dairy farm owners/workers had good knowledge about antibiotic use and AMR, which is comparable with previous findings, including 50.5% of animal farm owners/workers in northwest Ethiopia,[22] 66.53% of farmers in Kellem Wollega, Ethiopia,[31] 60.8% of ruminant farmers in Malaysia,[32] and 53.25% of rural poultry farmers in Cameroon.[29] However, the level of knowledge in the present study is higher than that reported in animal producers in northeastern Ethiopia (19.79%),[20] extensive livestock keepers in Ethiopia (30%),[21] farmers in eastern Turkey (10%),[33] veterinarians and para-veterinarians in Bhutan (38.8%),[26] large animal farmers in Bangladesh (41.5%),[34] and livestock and aquaculture producers in Vietnam (42.1%).[35] The level of knowledge in the current study was lower than the 72% reported from eastern Algeria.[36]

Although a higher proportion of respondents had heard about antibiotic use and AMR, only a small percentage of them knew that incomplete antibiotic course and over/under dosage of antibiotics were associated with the emergence of AMR. In addition, more than half of the respondents had heard about withdrawal periods of antibiotics, but only a quarter of them knew that using animal-origin food products before the end of the withdrawal period could promote AMR in humans. Majority of owners/workers who participated in this study knew that antibiotics have side effects. This result was in line with previous

findings by Geta and Kibret[22] and Ozturk et al,[33] who reported nearly 57% and 62%, respectively, of the producers/farmers knew that antibiotics had some side effects. However, this result was lower than the 84.9% report from Bangladesh.[34]

Although the findings in this study showed that a higher proportion of participants had adequate knowledge of antibiotic use and resistance, several responses suggested possible antibiotic misuse, which included nearly half of the respondents using antibiotics either to increase production, prevention, or control of diseases and only a few of the participants using veterinarian prescriptions to purchase the antibiotics. While limiting antibiotic use is a significant step towards mitigating AMR, most respondents in this study gave antibiotics to their animals two to five times a month, which could instead facilitate the development of AMR.

A significant relationship between knowledge of antibiotic use and resistance and level of education and years of farming experience was found. Owners/workers with primary, secondary, and college/university level education knew about antibiotics and AMR more than those without a formal education. This result was in agreement with previous findings.[20,22,30,33,35] Owners/workers with a higher level of education might have more access to veterinary care, farm management, and biosecurity protocols, in addition to having a better understanding of the usage of antibiotics and their withdrawal times. Therefore, the current study suggests that owners'/workers' awareness must be increased through effective educational campaigns to improve the appropriate use of antibiotics. In addition to education, owners/workers with 6–10, 11–15, and ≥ 16 years of farming experience had better knowledge than those with less than five years of farming experience. This result might imply that knowledge about antibiotic use and resistance is also more likely to be acquired through practical experience. Experienced farm owners/workers can impart best practices and their knowledge about using antimicrobials to their peers by establishing farmer cooperatives or other collaborative platforms. Such initiatives can improve overall knowledge dissemination and encourage responsible antimicrobial usage and mitigate antimicrobial resistance within the dairy farming community.

The level of desirable attitudes regarding the use of antibiotics and AMR in dairy farms in this study was comparable with previous findings, such as 52.8% in northwest Ethiopia,[22] 42.5% in Bangladesh,[34] and 49% in Thailand.[37] The present study finding was higher than the 14.7% reported in northeastern Ethiopia.[20] While nearly half of the study participants had a generally desirable attitude, there were concerning instances where respondents' attitudes were favorable to the emergence of AMR. Specifically, only a few of the respondents believed that stopping antimicrobial treatment could cause AMR, about a quarter of them thought that misusing antibiotics in animals leads to the emergence of resistant bacteria that cause diseases in humans, and believed that there was a connection between the use of antibiotics in animals and the development of resistance. Corresponding to this study finding, a prior study conducted in Thailand found that 70% of participants believed that biosecurity measures were less significant than the use of antimicrobials to prevent disease.[37] This finding opposes the significance of adopting alternative strategies such as vaccination, maintaining appropriate biosecurity, and good farm management to reduce antimicrobial use in livestock production. The respondents' attitude was strongly associated with their education level, and those who attained secondary and college/university levels had better desirable attitudes (have an attitude of reducing AMR) than those who had not attained a formal education. Compared to those at small-scale dairy farms, owners/workers of large-scale dairy farms are more likely to have a desirable attitude towards prudent antimicrobial usage. Similar findings were found in other countries, including Bangladesh,[34] California,[38] and Lebanon,[39] where they indicated that people working in larger farms tend to have more desirable attitudes than those working in smaller farms.

The level of appropriate practices in the present study was higher than the 21.5% in northeastern Ethiopia,[22] 27.7% in extensive livestock farming in Ethiopia,[21] and 21.7% in Bangladesh[34] that had adopted appropriate practices. On the other hand, the result was lower than the 61.74% reported from Kellem Wollega, Ethiopia.[31] Although more than half of the respondents were adopting appropriate practices, this study revealed that the majority of the respondents were using antibiotics without consulting a veterinarian. This finding was supported by the finding of Ozturk et al,[33] who reported that approximately half of the respondents used readily available antibiotics before contacting a veterinarian. A significant majority of the owners/workers did not read the drug's prospectus or description before administering it to their animals, and 60.5% did not choose the usage of antimicrobial medications based on laboratory testing. Studies have indicated that the use of antimicrobials without laboratory tests is the driver of antimicrobial misuse and further exacerbates the emergence and spread of AMR.[40] In addition, more than half of the respondents stopped giving antibiotics if the animals felt better before the antibiotic course was completed, and 43.1% of the respondents increased

the dose of antibiotics and frequency of administration as long as the animals did not show any signs of recovery. This result was in accordance with the 59% and 45% findings from eastern Turkey.[33] It appears that the practice of obtaining veterinary antibiotics from drug stores without prescription leads producers to alter the doses, which may increase the misuse of antibiotics and the risk of AMR emergence.

Adherence to withdrawal periods is often recommended to avoid drug residues in animal origin food products.[41] Accordingly, the current results showed that more than half of the owners/workers followed the withdrawal period of antibiotics. However, more than a quarter of the respondents sell animal products, and 73.7% use/sell manure as a natural fertiliser after the animal is treated with antibiotics. These data suggested that rather than decreasing the emergence of AMR, the respondents' practices favoured it. Noncompliance with the withdrawal periods and consumption of milk and meat after antibiotic treatment may pose the risk of regularly ingested residues modifying the intestinal microbiota and promoting the establishment and selection of resistant bacteria in the human gastrointestinal tract.[42,43] Furthermore, approximately 80% of the owners/workers feed calves milk from cows after being treated with antibiotics, which could be a cause of the development of AMR. Previous studies proved that feeding antimicrobial residue containing milk to calves is the cause for the selection of antimicrobial-resistant pathogens.[12,44] Sharing of current knowledge to owners/workers about best practices to minimise antimicrobial use while maintaining animal health and productivity has been proposed to encourage owners/workers of the potential of production with less antimicrobial use.[45]

In this study, approximately 42% of owners/workers were shown to have a positive risk perception of antimicrobial resistance. Approximately 35% of owners/workers perceived that resistant pathogens might spread from farm to human, and only 21.7% of them perceived that resistant pathogens could spread from farm to the environment. In addition, a relatively low proportion of the respondents (24.5%) perceived that farm workers could be infected by resistant microorganisms from the farm. Moreover, among the owners/workers, 21.3%, 30.3%, and 41.3% perceived AMR as a risk to the environment, public and animal health, respectively. Sadiq et al[32] in Malaysia found a similar result, where the majority of ruminant farmers were not concerned about the impact of antimicrobial resistance on animal and public health. The current study results indicated that although dairy farm owners/workers in the study area frequently use antibiotics to keep their animals healthy and productive, there is a lack of understanding regarding the risk and emergence of AMR pathogens. The results of the current study showed that positive risk perception towards AMR was significantly associated with their level of education and farming experience.

Limitations of the Study

Even though the study was piloted with 20 participants and attempts were made that the dairy farm owners/workers understood all items correctly before they responded, no instrument was available to independently assess the participants' honesty and recall ability. A thorough comprehension of participants' AMR-related behaviours and attitudes may be hampered by the use of quantitative methods that dichotomize data into binary categories. It is imperative that both qualitative and quantitative methodologies be used in future research. Like with other survey studies, there's also a chance of social desirability bias that respondents are over-reporting or under-reporting their antibiotics use. This study was conducted in Addis Ababa the capital city of the country and inevitably constraints the generalizability of the findings for the entire country due to differences in socioeconomic characteristics from other parts of the country. Another limitation of this study is the cross-sectional study design may influence the cause and effect relationship of the predictor variables and the dependent binary variables (knowledge, attitude, practices, and risk perception) of dairy farm owners/workers.

Conclusion

This study has provided information on the levels of knowledge, attitudes, practices and risk perceptions of dairy farm owners/workers regarding antimicrobial use and resistance. The results showed that their education level and farming experience were associated with their knowledge and risk perception, whereas their attitude and practice were associated only with their education level. As a result, raising awareness and sensitisation campaigns about antibiotic stewardship and the impact of AMR is critical. It is also equally important to encourage dairy farm owners/workers to employ alternative methods such as vaccination, biosecurity, and good management. Furthermore, authorities should take necessary measures to limit and control veterinary drug use in dairy farms. The findings are necessary to guide policy

formulation and implementation of antimicrobial use and AMR, particularly those targeting the awareness, education, and sensitisation of the community in the dairy sector. Continuous awareness creation and sensitisation campaigns of dairy farm owners/workers are necessary to increase understanding of the important role that they play in prudent use of antibiotics and protecting public health. The application of strict regulation and control of antibiotic usage and enacting antibiotic prescription legislation to minimise their widespread use and mitigate the impact of AMR are also strongly recommended, and integrated antimicrobial use governance be implemented with the involvement of all stakeholders using a one-health perspective.

Abbreviations

AMR, Antimicrobial resistance; AMU, Antimicrobial use; LMICs, Low-and middle income countries; MDR, Multidrug resistance; OIE, World organization for animal health; WHO, World health organization.

Data Sharing Statement

All the datasets used and/or analysed in this study are available from the corresponding author on reasonable request.

Ethics Approval

Ethical approval for this study was obtained from Addis Ababa University, Aklilu Lemma Institute of Pathobiology Institutional Research Ethics Review Committee (Ref. No: ALIPB IRERC/107/2015/23). Recruitment of study participants for the interview was completely voluntary, and they had the freedom to withdraw from the study at any time of the study period. The purpose of the study and confidentiality of the information were made clear to the participants, and those willing to participate were interviewed. Written informed consent was obtained from each participant who agreed to participate in this study, and confidentiality of the information collected was ensured and used only for this research. This study was conducted in accordance with the Declaration of Helsinki.

Acknowledgments

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Disclosure

The authors declare that they have no competing interests.

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