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Original Article

Knowledge and practice regarding antibiotic usage in dogs among pet owners in a district in South India

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Abstract

Introduction: Antimicrobials are vital for human and animal health; however, their improper use leads to antimicrobial resistance. Shared living spaces and close bonds between humans and pets raise concerns about transferring resistant pathogens from pets to humans. This study assessed antibiotic usage among dog owners in a South Indian district to understand their knowledge and practices.

Methodology: A quantitative cross-sectional study was conducted among 427 dog owners in a district in South India using snowball sampling. A semi-structured questionnaire was administered using telephonic interviews. The responses were expressed in frequencies and percentages, and Chi-square analyses were performed to establish significant associations between variables.

Results: Most of the respondents were aware of antibiotics, less than half were aware of antibiotic resistance, and 4% were aware of antibiotic stewardship. More than half of the respondents followed correct practices in accessing, using, and storing antibiotics. The majority said that the use of antibiotics in dogs would not affect them indirectly, but scientific evidence shows a causal effect between antibiotic use and the development of antibiotic resistance. A significant association was found between awareness about antibiotics and socio-demographic factors such as education, area of residence, and years of experience as a pet owner.

Conclusions: This study emphasizes the urgency of educating dog owners about antibiotic usage and resistance. It warns against the risks of inappropriate antimicrobial use in pets, stressing its impact on public health and promoting responsible antibiotic stewardship to curb antimicrobial resistance in both veterinary and human medicine.

Key words: anti-bacterial agents; antimicrobial resistance; dogs; pets; pet owner; sustainable development goals.

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Introduction

Antimicrobial resistance (AMR) is a crucial public health issue as it can affect people of all ages, and has implications on human and animal medicine, and agricultural industries [1,2]. The World Health Organization (WHO) has identified AMR as one of the top 10 global public health threats. AMR is a natural process, representing the ability of microorganisms to adapt and evolve over time. While this natural process has been ongoing for centuries, human activities, particularly the widespread and sometimes inappropriate use of antimicrobials in medicine and agriculture, have accelerated the emergence of resistant strains [3,4].

AMR is mostly caused by antibiotics usage. When bacteria evolve methods to resist the effects of antibiotics designed to kill them, it's called antibiotic resistance (ABR) [5]. More than 25% of antibiotic prescriptions in outpatient settings in the United States are considered unnecessary, which raises serious concerns about ABR and puts everyone at risk. According to the Centers for Disease Control and Prevention (CDC), over 2.8 million antibiotic-resistant bacterial infections occur in the United States each year, and result in over 35,000 fatalities. This resistance results in an additional $20 billion in direct healthcare costs annually [6].

India was the world's leading user of antibiotics for human health in 2010 [7]. The rapid rise in diseases caused by resistant pathogens in India is aided by a number of variables, such as a lack of public health infrastructure, rising earnings, a high rate of sickness, and accessibility to cheap, uncontrolled antibiotics [8,9]. India has the highest rate of over-the-counter, nonprescription carbapenem sales in the world, which adds to the rise in carbapenem resistance in Gram-negative bacteria [10].

Alarmingly, at present globally, approximately 700,000 human lives are lost annually due to drug-resistant diseases, with multidrug-resistant tuberculosis alone accounting for 230,000 of these fatalities [4]. If left unaddressed, these drug-resistant diseases can have a devastating toll of 10 million deaths each year by 2050. This poses a significant danger, not only to public health but also to the worldwide economy, possibly equalling the catastrophic impact of the financial crisis

in 2008–2009. Moreover, the fallout from AMR could be severe by 2030, potentially leading to up to 24 million people in extreme poverty [4]. The transfer of AMR bacteria between humans and animals makes it challenging, mainly when resistance is towards antibiotics used in human medicine [11,12]. Action plans were endorsed at the global, national, and state levels to tackle the emerging threat of AMR [13]. In 2020, the sustainable development goals (SDGs) incorporated two new indicators related to AMR into the framework for monitoring the health target, which aimed to enhance the preparedness of all countries, especially those in the developing world, to detect, mitigate, and manage health risks at both national and global levels [14]. In line with the global commitment to address AMR and to attain the SDGs, India developed a comprehensive National Action Plan on AMR in 2017 [15]. The recently updated 2023 Action Plan, however, reaffirms India's strong commitment to tackling AMR in a thorough way. This plan introduces labelling rules that specify when animal products can be used after antibiotic treatment, promoting their responsible use in animals raised for food. Additionally, there is renewed emphasis on using antibiotics responsibly when treating sick animals raised for food, aligning these practices with the broader goal of containing AMR [15]. These modifications in the global and national frameworks for AMR were indicative of the response that these frameworks have brought about due to the impending threat of AMR.

According to a 2017 scoping review report on AMR in India, there were a total of 2,152 studies that were authored by researchers associated with Indian institutions [16]. Among these, only 70 studies were related to AMR in animals. Specifically, 21 (30%) of these studies focused on AMR in livestock, 17 (24.3%) on poultry, 11 (15.7%) on fish, and an additional 21 (30%) were categorized under "other". However, relatively little attention has been given to the use of antimicrobials in companion animals and the potential risks associated with AMR in this context [16]. Moreover, the focus has been mainly on farm animals, resulting in the formulation of numerous policies and implementation of actions for the same [17]. The fact that companion animals can serve as potential reservoirs for AMR determinants was often overlooked [11,17].

Companion animals, like dogs and cats, have evolved from utility roles to cherished companions over time [18]. This shift has significantly increased their population, altering the dynamics of their relationship with humans, and bringing them indoors, fostering close human-animal contact over time. The increase in physical contact from touching, petting, and licking poses a significant threat for infections and transfer of AMR determinants [19].

Among the companion animals, dogs are potential reservoirs of AMR pathogens that can spillover to humans through direct or indirect contact. The literature has provided insights into the transmission of resistant pathogen from dogs and cats to humans. but the extent to which this happens is still largely unknown [17].

Pathogens like *Staphylococcus pseudintermedius*, an opportunistic pathogen that tends to infect or colonize dogs and cats, have also been observed in humans, particularly in individuals who have had close contact with dogs [20,21]. The worldwide occurrence of carbapenem-resistant Enterobacterales (CRE) was widely recognized as a significant global public health concern. A total of 29 carbapenem-resistant isolates were detected from 237 canine specimens collected from veterinary clinics in India. The discovery of CRE in pet dogs in India, is surprising because carbapenems were not typically prescribed for animals [22].

This discovery highlights the imperative need for proactive surveillance to gain a comprehensive understanding of the mechanisms through which these pathogens were transmitted to animals. Investigating such instances is crucial not only for veterinary concerns but also for public health, as it provides insights into the potential routes of transmission and the risk factors associated with the emergence of AMR in companion animals.

The use of broad-spectrum antimicrobial drugs is widespread in small animal practice throughout Europe. Antimicrobials such as amoxicillin and clavulanic acid, generally used for humans, were also being used in dogs and cats in countries like Denmark, Finland, Italy, Sweden, Norway, and the UK [23]. A study conducted in India found that 3rd and 4th generation cephalosporins and sulphonamides were preferred by pet practitioners for reproductive infections and gastrointestinal tract (GIT) infections respectively, which does not comply with the guidelines [24]. Frequent use of antimicrobials for therapeutic and prophylactic purposes in companion animals can lead to loss of efficacy of antimicrobials in veterinary medicine, as seen in human medicine [17,23]. In recent years there has been growing global attention on the prudent use of antimicrobials in veterinary practice due to the increasing threat of AMR. To address this concern, the European Medicines Agency (EMA) has developed a comprehensive categorization system that classifies antibiotics into four categories—A (Avoid), B (Restrict), C (Caution),

and D (Prudence). This classification is based on the antibiotics' importance to human medicine and the potential risk of AMR development from their use in animals. The categorization serves as a critical tool for veterinarians, including those treating companion animals, to guide evidence-based prescribing practices and reduce the risk of AMR transmission between animals and humans. Incorporating such frameworks into national and local veterinary guidelines can significantly strengthen global antimicrobial stewardship efforts [25].

AMR is an inherent natural process that cannot be completely averted. However, the advancement of this process can be decelerated by employing thoughtful antimicrobial practices. This strategy is crucial for preserving public health, animal health, and general welfare [17]. Though studies show the presence of ABR among pets, there is a dearth of documented literature on the knowledge and practices of the pet owners regarding the use of antibiotics for pets. Therefore, this study aimed to assess the knowledge and practices on antibiotic use for dogs among pet owners. The study also intended to assess the knowledge of pet owners regarding ABR.

Methodology

Study period and location

A cross-sectional study was carried out for a duration of 6 months, from January 2021 to June 2021 in the South Indian district in a state which was one of the first states in India to implement an action plan on AMR.

Sample size

The sample size was calculated using the formula:

$$n = Z\alpha/2^2 \times p \times (1-p)/d^2$$

considering 95% confidence interval, population proportion (p) 50%, and allowable error (d) 5%. The final sample size was estimated to be 427 after considering non-response rate of 10%.

Sampling technique

Dog owners across the district were recruited to the study through the snowball sampling technique. Dog owners who were residents of the South Indian district, who have had a dog for more than one year, and with telephone access were selected for the study. Only one eligible member of the household was chosen. A total of 427 responses were obtained with the help of volunteers from the organization People for Animals (PFA), in the district.

Data collection

A semi-structured validated questionnaire covering the following areas was used to evaluate the knowledge and practice of dog owners regarding antibiotic use and ABR: a) socio-demographic characteristics of dog owners, b) knowledge about antibiotics for dogs, c) practices related to antibiotic use in dogs, d) knowledge regarding ABR. The questionnaire was designed by the researchers based on literature reviews and was then validated by the veterinary public health experts of the related field. The principal investigator interviewed the participants through telephone calls after taking prior appointment. The responses from each participant were recorded in an individual questionnaire.

Statistical analysis

The data was collected using the CDC Epi Info software, and analysis was done using the Statistical Package for the Social Sciences (SPSS) version 21 (SPSS South Asia , Bangalore, India). The categorical variables were expressed in frequency and percentage, and a Chi square test was performed to establish significant associations between variables.

Table 1. Association between awareness on antibiotics and socio-demographic characteristics (n = 427).

Variable	Category	Awareness on antibiotics		*p* value
		Yes	No	
Gender	Male	143 (54.0%)	122 (46.0%)	0.027
	Female	105 (64.8%)	57 (35.2%)	
Age	18–27 years	129 (56.6%)	99 (43.4%)	0.501
	> 27 years	119 (59.8%)	80 (40.2%)	
Residential area	Rural	75 (47.5%)	83 (52.5%)	0.001
	Urban	173 (64.3%)	96 (35.7%)	
Education	Higher secondary and below	23 (39.7%)	35 (60.3%)	0.002
	Graduate and above	225 (61.0%)	144 (39.0%)	
Employment status	Employed	163 (62.9%)	96 (37.1%)	0.012
	Unemployed	85 (50.6%)	83 (49.4%)	
Field of study	Medical	45 (77.6%)	13 (22.4%)	0.001
	Non-medical	203 (55.0%)	166 (45.0%)	
Years of experience as a pet owner	1–10 years	147 (51.6%)	138 (48.4%)	< 0.001
	> 10 years	101 (71.1%)	41 (28.9%)	

Figure 1. Distribution of participants based on knowledge about antibiotics for dogs (n = 427).

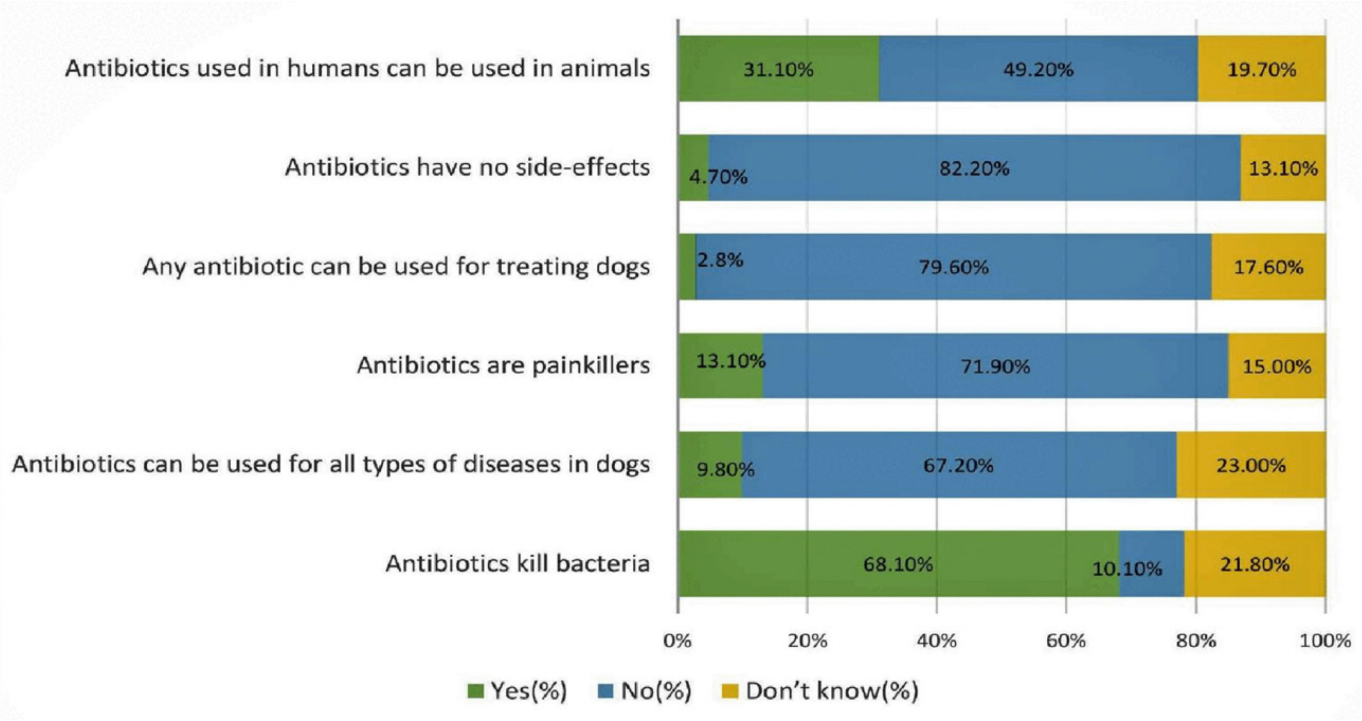
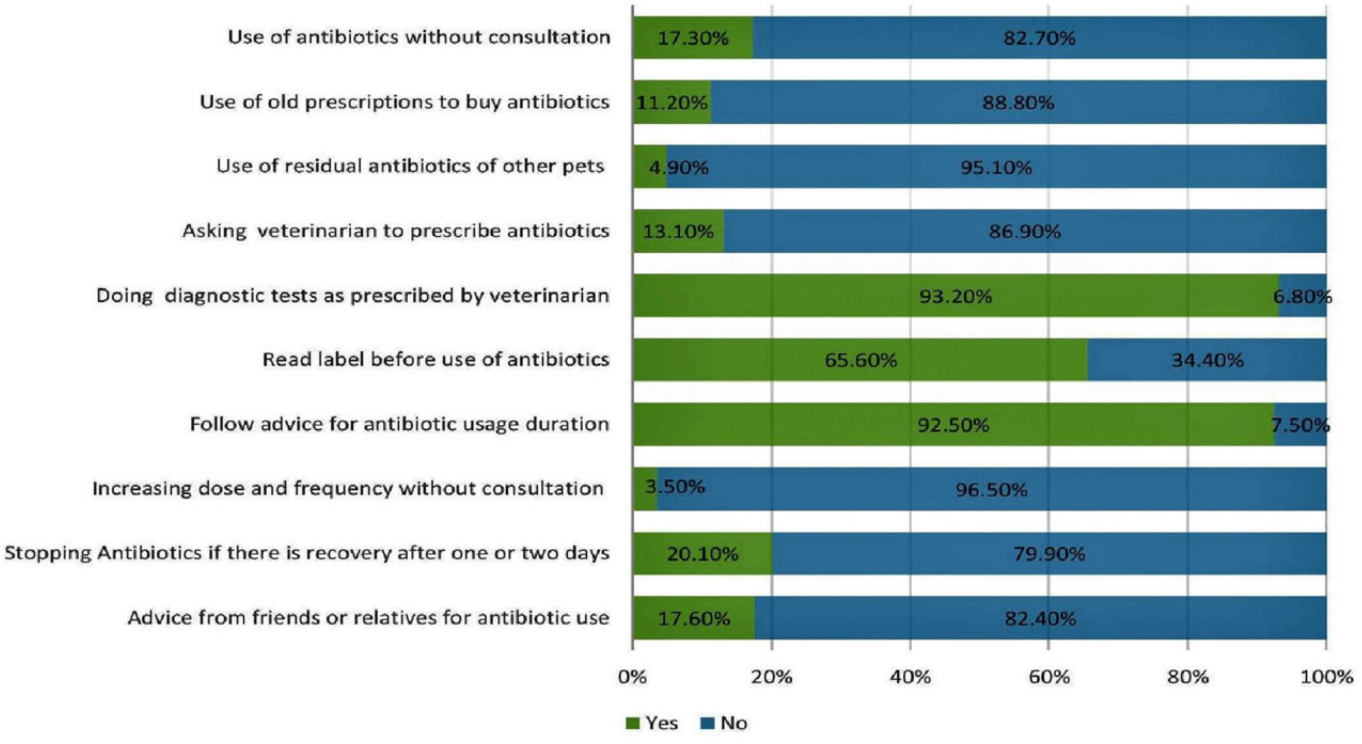


Figure 2. Distribution of participants based on practices related to the use of antibiotics (n = 427).



Results

Demographics

Among the 427 participants, 62.1% were males. The mean age of the male participants was 29.4 ± 8.88 years, while the mean age of female participants was 31 ± 9.86 years. More than half of the participants (57.8%) were undergraduate, and 13.6% had education related to the medical field. In addition, 53.0% of the participants were employed, and 86.4% belonged to the middle-income level. More than half of the participants (63%) were residing in urban areas, and 33.2% of the respondents had been pet owners for more than 10 years.

Knowledge about antibiotics

Awareness about antibiotics was higher among females (64.8%), among those in the age group of above 27 years (59.8%), urban residents (64.3%), those who had completed graduation and above level of education (61%), those who were employed (62.9%), medical personnel (77.6%), and pet owners with more than 10 years of experience (71.1%). There was a significant association between awareness about antibiotics and socio-demographic characteristics, except for age (Table 1).

Majority of the 427 participants knew the following: antibiotics kill bacteria (68.1%), antibiotics cannot be used for all diseases (67.2%), antibiotics are not painkillers (71.9%), just any antibiotic cannot be used for treatment (79.6%), and antibiotics have side effects (82.2%). However, 31.1% responded incorrectly regarding antibiotics use in humans and animals. Some participants did not know about antibiotics (Figure 1).

Figure 3. Distribution of participants based on awareness about antibiotic resistance (n = 427).

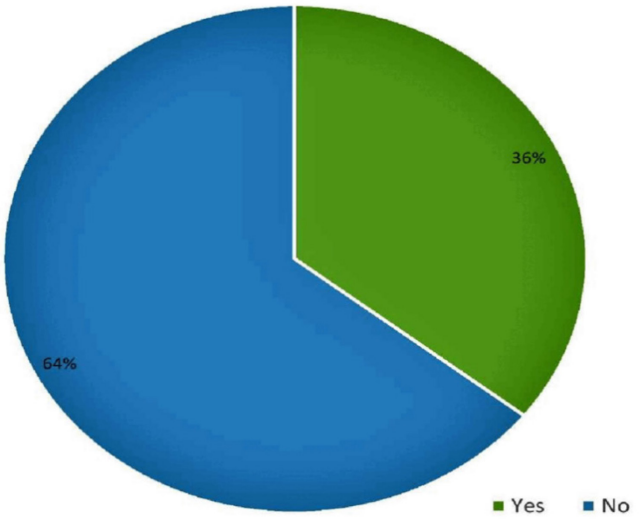


Table 2. Relation between awareness about antibiotics and awareness about medicine given to the dog (n = 427).

Awareness about antibiotics	Awareness about antibiotics given to the dog	
	Yes	No
Yes	170 (68.5%)	78 (31.5%)
No	75 (41.9%)	104 (58.1%)

The pet owners chose veterinary doctors (66%) as their primary source of knowledge about antibiotics.

Even though 57% said they were aware of the medicines given to their dogs, only less than half of the respondents (14.5%) were able to identify both amoxicillin and gentamicin as antibiotics, while identifying others as nonantibiotics. A positive relationship was found between those who knew about antibiotics and awareness of the medicine given to their dogs. (Table 2).

Practice related to antibiotic usage

Out of 427 pet owners, 82.7% said that they used antibiotics for their pets only after consultation from a veterinarian, 88.8% said they did not use old prescriptions to buy antibiotics, and 95.1% said they did not use residual pet antibiotics for their pets. Among the pet owners, 86.9% said that they did not ask the veterinarian to prescribe antibiotics, and 93.2% said that they did all the tests as recommended by the veterinarian. Out of all 427, 92.5% said that they completed the course of antibiotics, and 96.5% administered them correctly at the dose and frequency as prescribed. Only 17.6% of them took advice from friends or relatives regarding antibiotic use. Only 79.9% did not stop giving antibiotics even if the dog became better after the first day of treatment.(Figure 2).

Figure 4. Distribution of participants based on awareness on antibiotic stewardship (n = 427).

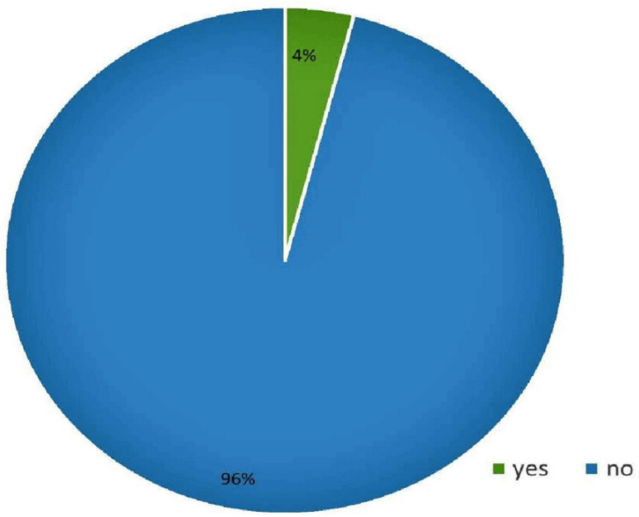
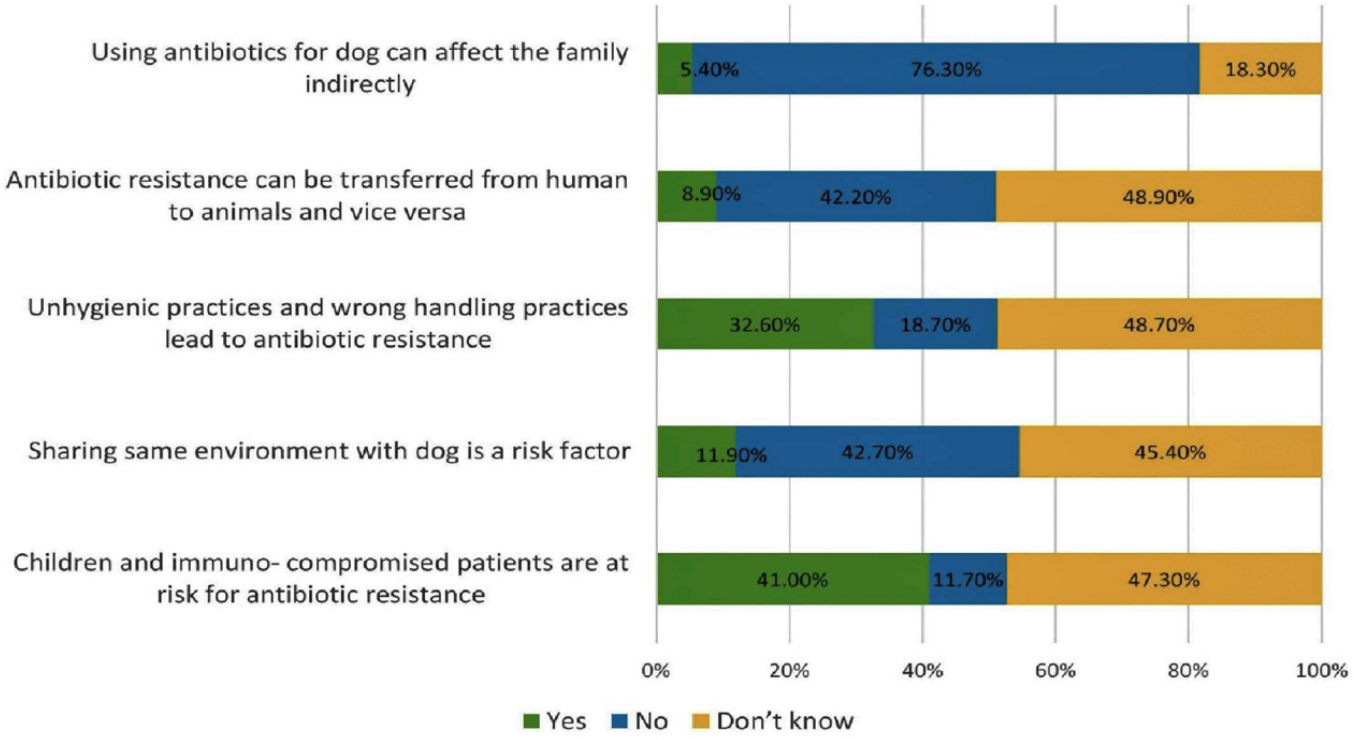


Figure 5. Distribution of participants based on knowledge about antibiotic resistance (n = 427).



Awareness about ABR

Less than half (36%) of the dog owners were aware of ABR (Figure 3), and 4% were aware of antibiotic stewardship (Figure 4). Only 8 of the 58 medical personnel were aware of antibiotic stewardship.

Majority of the participants were not aware of ABR. Among the 427 participants, 76.3% said that using antibiotics in their dogs will not affect their families indirectly. About 48.9 % did not know that there could be a transfer of ABR from humans to animals and vice versa, 45.4% said they did not know that sharing the same environment with their dog could pose a risk of disease transmission between humans and dogs, and 47.3% said they did not know that children and immunocompromised patients were at risk for ABR (Figure 5).

Awareness of ABR was higher among females (37%), those in the age group of 18–27 years (38.6%), urban residents (40.9%), those who were graduates and postgraduates (39%), those who were employed (37.8%), medical personnel (82.8%), and pet owners with more than 10 years of experience (43.7%). There was a significant association between awareness of ABR and residential area, education, field of study, and years of experience as a pet owner (Table 3).

Discussion

There were very few studies focused on pet owners'

Table 3. Association between awareness on antibiotic resistance and socio-demographic characteristics (n = 427).

Variable	Category	Awareness on antibiotic resistance		*p* value
		Yes	No	
Gender	Male	92 (34.7%)	173 (65.3%)	0.627
	Female	60 (37.0%)	102 (63.0%)	
Age	18–27 years	88 (38.6%)	140 (61.4%)	0.166
	> 27 years	64 (32.2%)	135 (67.8%)	
Residential area	Rural	42(26.6%)	116(73.4%)	0.003
	Urban	110(40.9%)	159(59.1%)	
Education	Higher secondary and below	8 (13.8%)	50 (86.2%)	< 0.001
	Graduate and above	144 (39.0%)	225 (61.0%)	
Employment status	Employed	98 (37.8%)	161 (62.2%)	0.230
	Unemployed	54 (32.1%)	114 (67.9%)	
Field of study	Medical	48 (82.8%)	10 (17.2%)	< 0.001
	Non-medical	104 (28.2%)	265 (71.8%)	
Years of experience as a pet owner	1–10 years	90 (31.6%)	195 (68.4%)	0.014
	> 10 years	62 (43.7%)	80 (56.3%)	

knowledge and practice in South India. This study aimed to assess the knowledge and practice of pet owners regarding antibiotic use. The study revealed that factors like gender, education level, and employment status had influenced their awareness of antibiotics significantly. It was observed that those from the medical field were more aware of antibiotics than those from the non-medical field. Research conducted in diverse countries and among various communities revealed a correlation between education levels and awareness regarding antibiotics usage [26].

A study conducted in the greater Philadelphia area among pet owners showed that 80% expressed neutrality on using the same antimicrobials for humans and animals [27]. In the study, 31.1% believed that the same antibiotics could be used in humans and animals. This belief can pose significant risks as it can lead to inappropriate use of antibiotics in pets. Administering antibiotics intended for humans to animals without proper guidance from veterinarians can result in ineffective treatment, and contribute to the development of ABR [27].

Even though more than half of the pet owners said they knew the medicines given to their dogs, very few identified the antibiotics. Among the 427 participants, 68.1% knew antibiotics kill bacteria, however some antibiotics are bacteriostatic rather than bactericidal. It was observed that dogs were taken to the hospital for the administration of antibiotics, because of which the participants were not aware of the name of the antibiotics or other medicines. A factor that helped them identify the medicine or antibiotics was the prior use of antibiotics or medicines at the household level. In studies conducted in Nepal and Bhutan, 32.3% and 69.6% of the participants, respectively, identified amoxicillin as an antibiotic [28,29]. Doctors, though not specifically veterinary doctors, were the major source of knowledge regarding antibiotic use. The respondants regarded information from the veterinarians as credible. In such situations, the doctors could play a significant role in communicating and educating the pet owners. This could help in reducing the emergence and transmission of resistant bacteria due to misuse of antibiotics and wrong practices, and help implement a stewardship program.

Among the study participants, 58 were medical personnel who had degrees in MBBS, Ayurveda, Yoga, Naturopathy, Unani, Siddha, and Homeopathy (AYUSH), and veterinary medicine (1 participant). The majority were aware of antibiotics (77.6%) and ABR (82.8%); however, only 13.8% were aware of antibiotic stewardship.

The majority of pet owners said that the use of antibiotics in their dogs would not affect them indirectly. However, studies show a possible association between the use of antibiotics and the development of ABR in pets [30,31]. Close contact with them could create a supportive environment for the transmission of resistant pathogens [32]. According to the Centers for Disease Control and Prevention (CDC), children who are 5 years old or less, immuno-compromised people, pregnant women, and those who are 65 years and above are more likely to be affected by zoonotic diseases [33]. The participants said they considered pets as their family members, which led to sharing of the environment with dogs and contact of dogs with children. Majority of the participants followed appropriate practices in accessing and using antibiotics, and 32% of the participants reported keeping antibiotics at home. However, 20.1% of participants discontinued antibiotics when they noticed signs of recovery in their dogs, and 79.9% indicated that they did not discontinue antibiotic usage even if they noticed improvement after the initial few doses. This was concordant with the finding that 92.5 % of the pet owners followed the advice given by the veterinary doctor for the duration of usage of the antibiotics. Furthermore, the participants who said they store antibiotics at home mentioned that they dispose of the antibiotics if it crosses the expiry date, but the disposal methods used by them were not explored in the study. Studies reveal that unused and expired antibiotics are frequently tossed in the garbage, flushed down in toilets, or thrown into water bodies [34,35]. Improper disposal results in these medicines winding up in landfills, poisoning water bodies and drainage systems, causing environmental pollution and posing numerous threats to humans, animals, and marine ecosystems. It is essential to educate people on the proper disposal of antibiotics, as improper disposal can be a potential driver for AMR [36].

As mentioned earlier, there was a significant association between education and awareness of pet owners. The high literacy rate and the positive attitude towards imbibing awareness create a conducive environment for spreading proper antibiotic usage and preventing ABR. Educating the medical personnel about antibiotic usage and ABR was required as they play a significant role in initiating stewardship programs for educating and creating awareness among general public. The use of antibiotics in companion animals is an area that needs to be explored and documented. Though companion animals have been identified as a reservoir of AMR, more research is

required to understand their role in AMR transmission. Identifying all the sources and formulating stricter policies to access, use, and store antibiotics are essential to reduce the rise of AMR and threats caused. Improved awareness and understanding of AMR can be achieved through effective communication, education, and training, and this can lead to reduction in AMR and its transmission.

Conclusions

Antimicrobials, including antibiotics, are essential for both human and animal medicine. Humans engage with animals for a multitude of reasons, including occupation, companionship, emotional support, therapeutic advantages, cultural symbolism, and recreation. The indiscriminate use of antibiotics among animals facilitates the development of AMR. This study brought to light the negligence related to antimicrobial usage in pets and the lack of awareness among pet owners regarding AMR. Socio-demographic factors like gender, education, and residential area also played a crucial role in the awareness generation among pet owners. The years of their experience as a pet owner was a major factor that influenced awareness. Despite participants' literacy, some individuals continued to obtain antibiotics without seeking consultation or by relying on outdated prescriptions. In the realm of animal health, it is imperative to regulate and minimize the use of antibiotics in domestic animals to prevent the risk of AMR. The transfer of AMR from pathogens in pet animals to humans in close contact with them poses a concerning public health issue. As humans and pets share living spaces and close bonds, the exchange of microbes is inevitable. Unfortunately, this includes the potential transmission of antibiotic-resistant pathogens. Veterinarians have an irreplaceable role in the fight against AMR. Their involvement in the care of both companion and farm animals is critical in ensuring responsible antibiotic use. This highlights the interconnected nature of human and animal health, emphasizing the need for education and awareness both among veterinarians and pet owners for responsible antimicrobial use in veterinary practices and the promotion of hygiene measures to reduce the risk of resistance transfer. Addressing this issue is crucial in safeguarding both human and animal well-being and in combating the broader challenge of AMR.

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Ethical approval

All research activities were conducted with permission from People for Animals (PFA), a non-governmental organization that works for the welfare of animals in the South Indian district. The study was conducted after obtaining approval from the Institutional Ethics Committee (IEC) of Kasturba Medical College and Kasturba Hospital (KMC&KH), Manipal (IEC reference No.785/2020 Dated 21-01-2021). Informed consent for telephonic interview was obtained from each participant and the interviews were scheduled at times convenient for the participants.

Availability of data and materials

The datasets used or analyzed in this study are available from the corresponding author upon reasonable request.

Authors' contributions

Design and conceptualization: all authors; data collection: SES; literature review, data analysis, manuscript writing: SES, NV, RD; proof reading: NV. All authors approved the final version of the manuscript.

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Conflict of interest

No conflict of interest is declared.

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