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Prevalence and Intensity of Zoonotic Gastrointestinal Helminths, Bacteria and Antimicrobial Resistance among Dogs and Their Owners in Buea, Southwest Region of Cameroon

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Abstract

Dogs are popular pets that play integral roles in human societies worldwide. Unfortunately, they can carry potential zoonotic infections that can be transmitted to humans. However, data on the Gastrointestinal (GI) helminth and bacteria affecting dogs and their owners in Buea, Cameroon, are currently lacking. This study aimed to investigate the prevalence of GI helminth, bacteria and Antimicrobial Resistance (AMR) in feces of dogs and their owners in this area using a community based cross sectional study design. Fecal samples from dogs and their owners were tested for helminths and bacterial infections. Flotation technique was used to identify eggs of nematodes and cestode while sedimentation technique was used to identify trematode eggs. Bacteria analysis was done by growing feces on culture media and AST was done using some antibiotic disk to check for the rate of resistance across different localities. The data were analyzed with respect to age, sex, and locality using IBM SPSS Statistics version 27. A total of 402 samples were examined for dogs and humans. Out of 253 dogs examined, 196 dogs were infected with at least one parasite (77.5%) and bacterial infections (17.0%). For humans, out of 149 samples examined 47 individuals were infected with at least one parasite (31.5%) and bacterial infections (6.7%). Among 13 parasites examined in dogs, *A. caninum* recorded the highest prevalence 51.4%, followed by *T. canis* 17.0%. 6 parasites were identified in humans. *A. lumbricoide* has the highest prevalence 10.2% followed by *T. canis spp*. Generally, in both dogs and humans, *E. coli* was more prevalent compared to *Salmonella spp*.

There was high resistance to antibiotics in some localities like Muea, Bonduma and Bova 1. *E. coli* and *Samonella spp* isolates showed high resistance for AMC-20ug and AM-30ug across all localities for both dogs and humans with a prevalence ranging from 33.3% to 100%. The discovery of zoonotic helminth parasites and bacteria in dogs and their owners from Buea with the high rate of resistance observed across most localities, raises concerns for the inhabitants. Initiatives will be required to inform pet owners about prevention strategies for these parasitic infections, bacterial infections and antimicrobial resistance.

Keywords

Gastrointestinal Helminths, Bacteria, Dogs, AMR, Zoonosis, Buea

1. Introduction

Zoonotic diseases (ZDs), which are diseases that are transmitted from animals to humans, represent a significant and growing public health challenge globally. These infectious diseases are caused by pathogens that can naturally transmit between animals and humans, either directly through contact with bodily fluids such as saliva, blood, mucous, and feces, or indirectly through environmental sources or vectors like insects and contaminated water. Studies indicate that approximately 61% of all known human pathogens, including viruses, bacteria, fungi, and parasites, are zoonotic. Alarmingly, around 73% of emerging and re-emerging infectious diseases are zoonosis, highlighting the critical role of animal-human interactions in the spread of infections [1].

In Cameroon, the close relationship between humans and animals, particularly dogs, raises concern about the transmission of zoonotic pathogens. Many Cameroonians keep dogs for various purposes: protection and security of their homes, as companions, for hunting, and for commercial or cultural purposes. Despite their benefits, dogs also pose potential risks to human health. In some cases, they are viewed negatively due to concerns over cleanliness, the risk of bites, and their role in transmitting diseases or causing nuisances [2]. However, pets specifically dogs and cats also act as reservoirs of a large number of pathogens of parasitic zoonoses, such as toxoplasmosis (from *Toxoplasma gondii*) [3], giardiasis (from *Giardia duodenalis*) [4], toxocariasis (from *Toxocara canis*) [5] and ancylostomiasis (from *Ancylostoma caninum*) [6]. Their roles in transmitting human infections have been recognized worldwide [7] [8]. The pervasive presence of dogs in these rural communities, combined with insufficient knowledge about disease transmission, exacerbates the threat of zoonotic infections, making them a significant public health concern.

It is estimated that more than 6 out of 10 infectious diseases originate from animals, with 3 out of 4 new or emerging infectious diseases in humans coming from animal sources [9]. Animals, particularly dogs, often serve as reservoirs for patho-

genic microbes. While many of these pathogens reside in the gastrointestinal tracts of animals as harmless commensals, they can become pathogenic when transmitted to humans under the right conditions. Zoonotic diseases are among the most recurrent and feared risks to human health, with the emergence and re-emergence of these diseases continuing to be a major concern for public health worldwide [10].

In addition to zoonotic diseases, Antimicrobial Resistance (AMR) has become one of the most significant global health threats. AMR occurs when pathogens evolve to resist the effects of drugs that once killed them or inhibited their growth, leading to untreatable infections. The World Health Organization (WHO) estimates that 700,000 people die each year from drug-resistant diseases, including 230,000 deaths from multidrug-resistant tuberculosis alone [11]. The widespread use of antibiotics in both humans and animals, including dogs, has contributed significantly to the rise of AMR, creating a dangerous environment where infections are more difficult and sometimes impossible to treat.

In rural communities of Cameroon, where access to healthcare and veterinary services is limited, the spread of zoonotic diseases and antimicrobial-resistant pathogens presents a significant challenge. This study aims to investigate the risk factors for the transmission of zoonotic pathogens (specifically gastrointestinal helminths and bacteria) and antimicrobial resistance among dog owners in Buea, South West region of Cameroon. By exploring the interplay between dog ownership, hygiene practices, and the spread of zoonotic diseases and AMR, this research seeks to identify key interventions that can help mitigate these risks, improve public health, and raise awareness about the growing concerns of zoonotic infections and drug resistance [11].

Buea, being located in the South West Region of Cameroon, presents a unique blend of urban and rural communities where dogs are frequently kept as pets or for security purposes. This close human-dog relationship increases the potential for exposure to zoonotic diseases, including rabies, leptospirosis, and various parasitic infections. These zoonotic pathogens, which are infectious agents transmissible from animals to humans, pose significant public health challenges, especially in settings with limited access to veterinary care and health education [12].

Furthermore, the misuse and overuse of antibiotics in both veterinary and human medicine contribute to the rise of antimicrobial resistance. This growing problem complicates the treatment of infections arising from zoonotic sources, leaving communities more vulnerable to severe health outcomes [13]. This knowledge gap makes it difficult to formulate effective control strategies and public health interventions.

Poor knowledge, attitudes, and practices (KAP) among dog owners further aggravate the problem. Without adequate awareness and preventive behavior, the risk of infection and resistance development remains high [14]. Therefore, a comprehensive study assessing the prevalence and intensity of zoonotic helminths and bacteria, their resistance profiles, and the KAP of dog owners is needed to help guide both veterinary and public health policy. Thus, the aim of this study which

is to investigate the Prevalence and Intensity of zoonotic gastrointestinal Helminth, bacteria, and Antimicrobial Resistance among dogs and their owners in Buea, South West Region of Cameroon. Specifically, by checking the prevalence of zoonotic gastrointestinal helminths and bacteria present in dogs and their owners in Buea, secondly to assess the rate of antimicrobial resistance in zoonotic bacteria isolated from dogs and their owners. Lastly, to assess the knowledge, attitudes, and practices (KAP) of dog owners regarding zoonotic disease prevention, antibiotic use, and hygiene practices.

2. Materials and Methods

2.1. Study Area

The study was conducted from February 2025 to May 2025 in Buea, the administrative capital of South West Region, Cameroon. The sites included 13 communities within Buea, known for high rate of dog ownership. Buea, is located in Fako Division on the eastern slopes of Mount Cameroon. As of 2023, Buea has a population of approximately 800,000 inhabitants, including the villages of Bokwaongo, Muea, Bomaka, Tole, Mile 16 (Bolifamba), Mile 17, Mile 15, Mile 14 (Dibanda), Bova, Bonjongo, Likombe, Buasa, Great Soppo, Molyko, Small Soppo, Bwitingi, Mile 18 (Wonyamavio), Lower Farms, Bokwai, Bonduma, Sandpit, Bulu, Bokova, and surrounding areas [15].

2.2. Study Population

The study population consisted of all dog owners and their dogs in selected areas in Buea sub division. First, some communities were visited to carry out a preliminary study. The chiefs and quarter heads were visited to seek for permission to work in their community and we also asked few members of the community on the prevalence of dog within that community. Some of the communities we visited were; Bova 1&2, Buea Town, Bokwango, Sandpit, Bakweri Town, Bokwai, Bitingi Bokova, Wokaka, Muea, Likoko Membea, Mile 16, Bomaka and Mile 15. From all this communities, 13 different communities were finally visited for sample collection which were; Bova 1&2, Buea Town, Bokwango, Sandpit, Bakweri Town, Bonduma, Bokwai, Bitingi, Wokaka, Muea, Mile 16 and Bomaka.

2.3. Inclusion and Exclusion Criteria

2.3.1. Inclusion Criteria

All households in Buea with at least 1 dog that gave their concern to be part of the study.

2.3.2. Exclusion Criteria

Stray dogs.

2.4. Study Design, Sampling Method and Sample Size

A community based cross-sectional study design was deployed to investigate the

prevalence of zoonotic GI Helminths, Bacteria and antimicrobial resistance among dog owners and their families in selected communities in Buea Municipality. Fecal samples were collected from households with at least one dog (dogs, bitches and puppies between ≥1 months and above). These households were selected randomly from the visited communities in Buea.

The sample size was determined using Cochran's formula (1977) for estimating a single population proportion. Using a prevalence of 80% for dogs and 90% for humans reported by Mulugeta [16].

$$\text{Sample size (n)} = \frac{Z^2 \times P \times (1-P)}{E^2}$$

$$\text{Sample size dogs (n)} = \frac{(1.96)^2 \times 0.8 \times (1-0.8)}{0.05^2} = 246 \text{ samples}$$

$$\text{Sample size humans (n)} = \frac{(1.96)^2 \times 0.9 \times (1-0.9)}{0.05^2} = 138 \text{ samples}$$

where n = sample size which is 246 dog samples and 138 human samples, Z = Z-value (1.96 for 95% confidence level), P = Expected Prevalence (80% and 90%) and E = Margin error (5.0%).

The required sample simple size was approximately 246 samples for dogs 138 samples, giving a total of 384 samples.

2.5. Ethical Considerations

An ethical clearance was gotten from the Faculty of Health Sciences, Institutional Review Board, University of Buea (FHS-IRB-UB) for humans and another from University of Buea-Institutional Animal Care and Use Committee (UB-IACUC) for animals. Administrative clearance was gotten from the Regional Ethics Committee for Human Health Research in the South-West region (CRERSH-SW) and a community clearance from Ministry of Livestock, Fisheries and Animal Industries for South-West Region. Inform consent forms were filled by all participants who took part in the study.

2.6. Data Analysis

Laboratory and field data were recorded in a log book daily and data were subsequently entered into Microsoft Excel 2021 and then exported to statistical software (SPSS, Version 27) for analysis. Computation of descriptive statistics was conducted using SPSS version 27. Descriptive statistics such as percentages, proportions, and frequency distributions were applied to compute some of the data. Chi-square (χ^2) was used to check association between the prevalence of parasitic and bacterial infections infection and associated factors.

2.7. Questionnaire and Survey

Data was collected through a structured questionnaire comprising of demographic Information (Age, gender, education level, and household income). Dog Owner-

ship Practices (Number of dogs, vaccination status, deworming practices, and frequency of veterinary care), Zoonotic Exposure (History of zoonotic diseases in family members, dog handling practices, and sanitation behaviors), Antimicrobial Use (Types of antibiotics used for dogs, reasons for usage, and awareness of antimicrobial resistance).

2.8. Animal Sample Collection

Fecal samples were collected directly from the rectum using sterile hand gloves in the morning and put in sterile vials, labeled with the age of the animal, sex, date, time and month of collection, and taken to the laboratory of Veterinary Parasitology, Faculty of Agriculture and Veterinary Medicine, University of Buea where they were analyzed immediately or stored in the refrigerator at 4˚C and analyzed within the 48 hours. For the analysis of feces, the flotation technique using saturated sodium chloride solution (NaCl), and sedimentation technique as described by Euzeby [17] and Thienpont [18] were used to identify the eggs of parasites [19] [20]. The feces were also grown on different culture media to identify the species of bacteria present.

2.9. Human Sample Collection

Well labelled sterile containers were distributed to dog owners and their families in these areas to provide about 5 g of fecal matter from the young children or adults. The samples were transported to the laboratory of Veterinary Parasitology, Faculty of Agriculture and Veterinary Medicine, University of Buea immediately and kept at 40 C until it is used for examination. Parasitological and bacteriological analysis was conducted on the same samples collected to check for common zoonotic infections that are prevalent in dogs that have affected humans.

2.10. Identification of Parasite Eggs

Identification of parasite eggs was based on the morphological characteristics which include the size of the egg, number of blastomeres in the egg and the nature of the egg shell [21].

2.11. Laboratory Analysis

Fecal samples were collected from dogs and dog owners to identify the bacteria and helminthic parasites found in them and to assess drug resistance patterns according to CLSI [22]. The parasite analysis was done to have a quantitative and qualitative appreciation of the prevalence of infection of the parasites. To this effect, macroscopic and microscopic examination of feces will be carried out.

2.12. Parasitological Examination

2.12.1. Flotation Technique Procedure

2 g of feces was accurately weighed and placed in a mortal and crushed with a pistle. The floatation medium was prepared by dissolving 400 g of NaCl in 1000 ml of warm distilled water, and 60 mls of the floatation medium was measured and

added to the fecal sample in the universal bottle and stirred with a rod.

The mixture was filtered through a 95 um sieve and a 45 um sieve into a test tube until a meniscus was formed.

A coverslip was placed gently on the test tube and allowed to stand on a level surface for at least 10 - 15 minutes. The coverslip was then carefully removed and placed on a glass slide and examined immediately for parasite eggs under ×10 and ×40 objective lens. Identification and confirmation of eggs were aided as per the guide by Soulsby [21].

2.12.2. Sedimentation Technique Procedure

About 5 g of fecal sample was thoroughly mixed with distilled water to ensure uniformity. Large debris was removed by filtering the sample through fine mesh or filter paper to avoid interference during the sedimentation process.

The prepared sample was transferred into a graduated cylinder, ensuring the vessel was tall enough to allow particles sufficient space to settle at the bottom, enabling clear separation of particles from the liquid phase. The sample was centrifuged twice and the supernatant was discarded carefully, not disturbing the sediment.

After decanting the supernatant, about 0.1ml of methylene blue was added to the sediment and it was viewed under a microscope at 10× for trematode eggs.

2.12.3. Egg per Gram (The McMaster Technique)

For the quantitative analysis or determination of the number of eggs per gram of feces (EPG), the Mc Master technique described by Euzeby [17] and also by Thienpont [18] was used. To this effect, 0.30 ml of the fecal suspension was removed with the help of a Pasteur pipette and placed in the 2 chambers of the Mc Master Slide (0.15 ml/chamber). After 5 minutes, the Mc Master Slide chambers were examined under a microscope at 10× objective. All the eggs found in the engraved region inside each chamber of the Mc Master slide were counted. The EPG of feces was calculated as follows:

$$\text{EPG} = \frac{(\mathbf{N}1 + \mathbf{N}2) \times 200}{2}$$

where N = Average of the number of eggs counted in the 2 chambers.

N1 = Number of eggs counted in the first chamber.

N2 = Number of eggs counted in the second chamber.

For each sample, 2 analyses were carried out to determine the EPG and the average of these two trials taken into consideration.

2.13. Bacteriological Analysis

2.13.1. Inoculation of Culture Media

Standard microbiological methods as described in Cheesbrough [23] were used to identify *Escherichia coli* and *Salmonella spp.*

2.13.2. Urea Indole Test

This test was conducted to differentiate *Salmonella spp* from other Gram-negative

enteric bacteria based on their urease and tryptophanase activity. The Urea-Indole Broth was prepared following the manufacturer's instructions. Suspected colonies of *Salmonella spp* were aseptically transferred into sterile test tubes containing the medium and incubated at 37˚C for 24 hours.

After incubation, Kovac's reagent was added and a red or pink ring at the surface of the medium indicated a positive result, while a yellowish or colorless appearance indicated a negative result. *Salmonella spp* are Urea-Indole negative, meaning no color change was observed.

2.13.3. Enterosystem 18R

Pure colonies of the target organisms were first prepared on Nutrient Agar. A few colonies were then suspended in distilled water to achieve a turbidity equivalent to 0.5 McFarland standard. Using a micropipette, 100 µL of the suspension was put into each well of the Enterosystem 18R. Three drops of immersion oil were added to some wells, following manufacturer's instructions. The Enterosystem was incubated at 37˚C for 24 hours. After incubation, activator reagents were added to some wells according to the manufacturer's instructions, and the results were interpreted manually using the manual.

2.14. Antimicrobial Susceptibility Testing (AST)

AST was done following the Clinical and Laboratory Standards Institute [20] guidelines. The disk diffusion method was done to evaluate the effectiveness of various antibiotics against specific bacterial pathogens. This method involved exposing bacterial isolates to different antimicrobial agents and assessing their response to determine the most appropriate treatment options. Pure colonies prepared on Nutrient Agar were selected, and a few were suspended in distilled water to achieve a turbidity equivalent to 0.5 McFarland standard. A sterile inoculation loop was used to spread the bacterial suspension evenly on the surface of Mueller-Hinton Agar.

Commercially prepared paper disks impregnated with known concentrations of antimicrobial agents were placed at equal distances on the inoculated agar surface. The plates were incubated at 37˚C for 24 hours.

After incubation, the zones of inhibition surrounding each antibiotic disk were measured using a ruler and compared to the standard interpretive charts provided by CLSI to determine the susceptibility of the bacterial isolates.

Table 1. Antibiotic disk and the break point used following CLSI guide [20].

Antibiotic (disk µg)	Susceptible (S, mm)	Intermediate (I, mm)	Resistant (R, mm)
Chloramphenicol (30)	≥18	15 - 17	≤14
Ampicillin (30)	≥18	15 - 17	≤14
Amoxicillin Clavulanate (30)	≥18	15 - 17	≤14
Ceftriaxone (5)	≥21	14 - 20	≤13
Trimethoprim Sulfamethoxazole (25)	≥16	11 - 15	≤10
Imipenem (10)	≥16	14 - 15	≤13

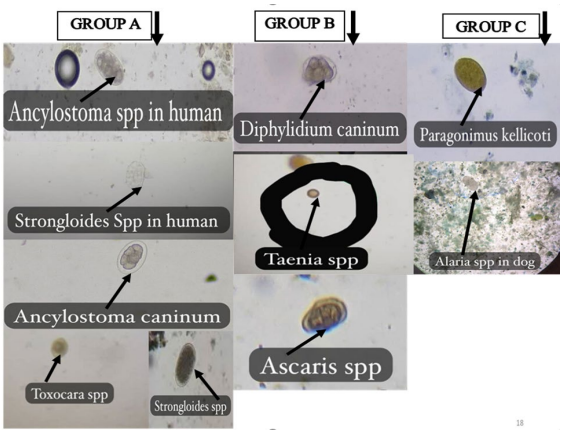
Interpretation of results was based on the size of the inhibition zones:

- Susceptible (S): The antibiotic effectively inhibited bacterial growth.
- Intermediate (I): The antibiotic exhibited partial inhibition and may be effective under certain clinical conditions (e.g., higher concentrations or localized treatment).
- Resistant (R): The antibiotic was ineffective at standard clinical concentrations and failed to inhibit bacterial growth. As seen in Table 1.

3. Results

3.1. Sociodemographic Data

This study to investigate the Prevalence and Intensity of zoonotic gastrointestinal helminth, bacteria, and Antimicrobial Resistance among dogs and their owners in Buea, South West Region of Cameroon was conducted from February 2025 to May 2025 under the Department of Biomedical Sciences at Faculty of Health Sciences, University of Buea. 119 households were visited from 13 different communities within Buea, 102 members of 102 household answered the questionnaire. Out of 253 dogs examined, 196 dogs were infected with at least one parasite giving an overall prevalence of 77.5%. For humans, out of 149 samples examined 47 individuals were infected with atleast one parasite giving an overall prevalence of 31.5%. The total number of male dogs examined was 127 giving a prevalence of 50.2% and for female dogs was 126 giving a similar prevalence of 50.2%. For humans, the total for male was 94 giving a prevalence of 63.1% and female was 55 giving a prevalence of 36.9%. Overall, 13 parasites were identified in the animals with the highest prevalence coming from *A. caninum* (130) at 51.4% prevalence followed by *T. canis* (43) at 17.0% prevalence and *S. stercoralis* (34) with 13.4% prevalence. 6 parasites were identified in human with Taenia Spp (12) having the highest prevalence 7.6% followed by *A. canis* (11) and *A. lumbricoides* (11) with 7.1% prevalence and *T. canis* with 6.0% prevalence. Figure 1 presents some of the parasites eggs identified under the microscope.



Group A: Nematodes, Group B: Cestodes, Group C: Trematodes NB: Identification of parasite eggs was based on the morphological characteristics which include the size of the egg, number of blastomeres in the egg and the nature of the egg shell *dispensable*.

Figure 1. Parasites eggs identified under the microscope.

For bacteria analysis, out of 253 dogs examined 40 dogs were positive for *E. coli* (93.0%) and 3 dogs were positive for *Salmonella spp* (7.0%) with 18 males and 22 females for *E. coli* and 1 male, 2 females for *Salmonella spp*. For humans out of 149 samples, there were 9 positve samples for *E. coli* (90%) and 1 positve for *Salmonella spp* (10%) with 5 males and 4 females infected with *E. coli* and 1 female infected with *Salmonella Spp*.

3.2. Prevalence of Gastrointestinal Helminths of Dogs and Humans per Locality

Independent of localities, for dogs Figure 2, *Ancylostoma caninum* (52.9%) had the highest prevalence followed by *Toxocara canis* (18.5%), *Strongyl Spp* (17.6%), *Strongloides stercoralis* (13.6%), *Uncinaria stenocephala* (11.9%), *Toxocara cati* (9.7%), *Ascaris lumbricoides* (3.8%), *Diphylidium caninum* (3.4%), *Diphyllobotrium latus* (3.3%), *Alaria Spp* (3.2%), *Taenia Spp* (2.4%), *Paragonimus kellicoti* (1.5%) and *Toxoascaris leonine* (1.5%). The prevalence of parasitic infections varied significantly across different localities. For example, *Toxocara canis* had a high prevalence in Bova 1 (40.0%) and same prevalence in Bitingi (33.3%) and Bonduma (33.3%), it was absent in several other communities like Bakweri Town, Bomaka, Buea Town and Mile 16. *Ancylostoma caninum* was most prevalent in Mile 16 (93.3%) followed by Bakweri Town (79.0%) and least prevalent in Bonduma (14.3%).

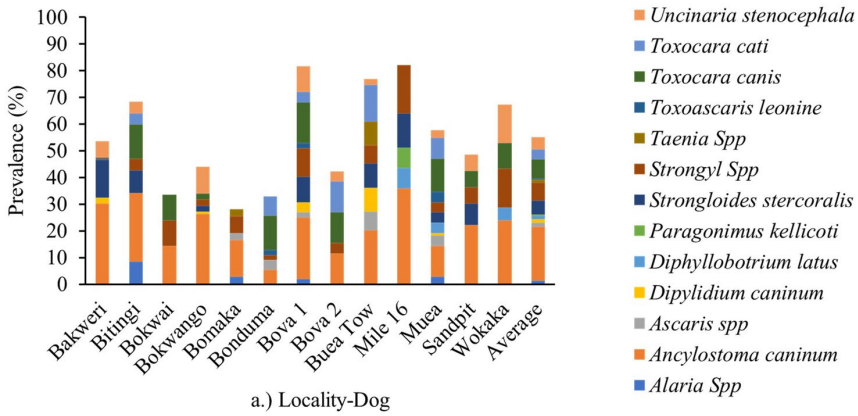


Figure 2. Prevalence of gastrointestinal helminths of dogs per locality.

For humans, Figure 3, *Ascaris lumbricoides* (10.2%), had the highest prevalence followed by *Toxocara canis* (8.4%), *Ancylostoma caninum* (6.3%), *Taenia Spp* (6.1%), *Strongloides stercoralis* (5.6%) and the least was *Uncinaria stenocephala* (2.2%). There was a significant difference between parasitic infections across the different localities. *Toxocara canis* had high prevalence in Bitingi (55%) and Bakweri Town (22.2%), while being absent in several other areas like Bokwai, Bokwango, and Mile 16. *Ancylostoma caninum* was most prevalent in Bitingi (23.3%), followed by Bokwango (14.3%) and Bakweri Town (11.1%). *Ascaris lumbricoides* was very high in Wokaka (50%) and low in Buea Town (5.3%) *Strongloides stercoralis* had the

highest prevalence in Mile 16 (55.6%) and similar prevalence in Muea (5.6%) and Buea Town (5.3%). *Taenia Spp* was higher in Mile 16 (22.22%) compared to Bova 1 (8.7%) with the least prevalence.

In dogs, Ancylostoma spp had the highest prevalence (52.9%), followed by *Strongyl spp* (18.9%) and *T. canis* (18.5%).

In humans, *A. lumbricoides* had the highest prevalence (10.2%) followed by *T. canis* (8.4%) and *A. caninum* spp (6.3%). Bokwai, Sandpit and Wokaka had just Ascaris spp and Bova 2 had just *Taenia spp.*

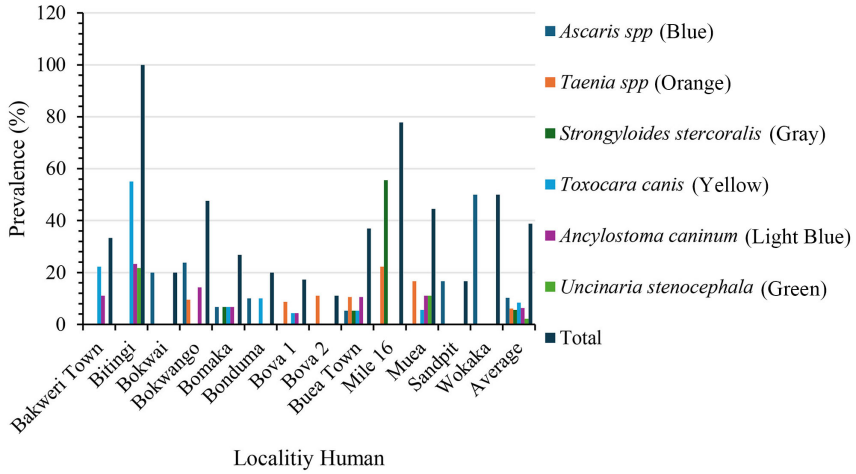


Figure 3. Prevalence of Gastrointestinal Helminths of humans per locality.

3.3. Prevalence of Gastrointestinal Parasites per Age for Dogs and Humans

Independent of the age in dogs **Figure 4**, for the total prevalence, *Ancylostoma caninum* (47.0%) had the highest prevalence followed by *Toxocara canis* (19.3%), *Strongyl Spp* (13.8%), *Strongloides stercoralis* (14.9%), *Toxocara cati* (11.7%), *Uncinaria stenocephala* (8.6%), *Diphyllobotrium latus* (6.3%), *Diphylidium caninum* (4.3%), *Ascaris lumbricoides* (3.4%), *Alaria Spp* (3.0%), *Taenia Spp* (1.9%), *Toxoascaris leonine* (1.6%), *Paragonimus kellicoti* (0.9%). The prevalence of *Ancylostoma caninum* was highest in young dogs, <1 year (55.3%), decreasing slightly in adults, 1 - 5 years (49.61%) and significantly in older dogs, >5 years (36%). *Toxocara canis* prevalence was higher in older dogs (26.67%) compared to young (14.89%) and adult (16.28%) dogs. *Strongloides stercoralis* showed an increase with age, from 10.64% in young dogs to 20% in old dogs. *Diphyllobotrium latus* was only observed in adult (2.33%) and old (16.67%) dogs, with a much higher prevalence in the old dogs. Generally, in dogs, *A. caninum* had the highest prevalence in all age groups (47%) followed by *T. canis* (19.3%) and *Strongyl spp* (16.5%).

For humans with respect to age for total prevalence **Figure 5**, *Ancylostoma caninum* (11.6%) had the highest prevalence followed by *Taenia spp* (11.3%), *Toxocara canis* (10.2%), *Ascaris lumbricoides* (8.6%), *Strongloides stercoralis* (3.3%)

and the least *Uncinaria stenocephala* (0.7%). *Ascaris lumbricoides* showed an increasing trend with age, from 5.5% in young individuals (<19 years) to 10.4% in adults (20 - 50 years) and 10% in older individuals (>50 years). *Taenia Spp* was most prevalent in the old age group (>50 years) at 20%, followed by young individuals (7.7%) and adults (6.3%). *Toxocara canis* was significantly higher in older individuals at 20%, compared to young (4.4%) and adult (6.25%) groups. *Ancylostoma caninum* was most prevalent in adults (10.4%) and older individuals (20%), with a lower rate in young individuals (4.4%). *Strongloides stercoralis* was highest in young individuals (7.7%) and absent in the old age group. Generally, in humans per age, *A. caninum* had the highest prevalence (11.6%) across all age groups followed by *Taenia spp* (11.3%) and *T. canis* (10.2%).

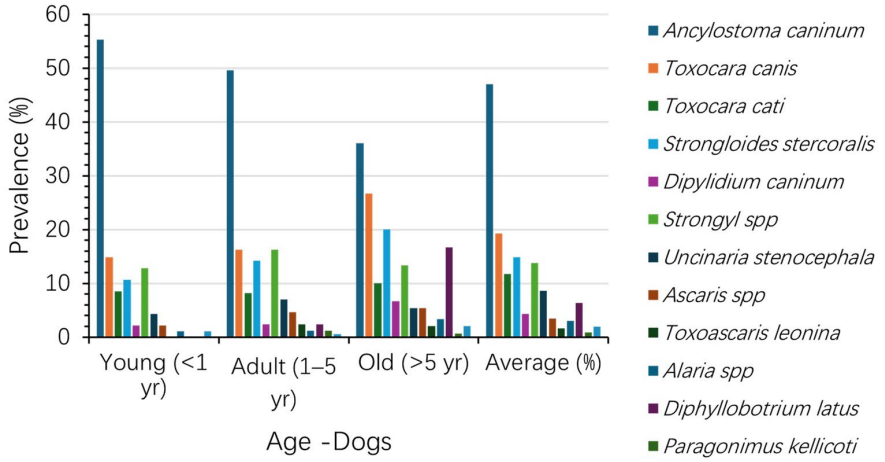


Figure 4. Prevalence of gastrointestinal parasites per age (Dogs).

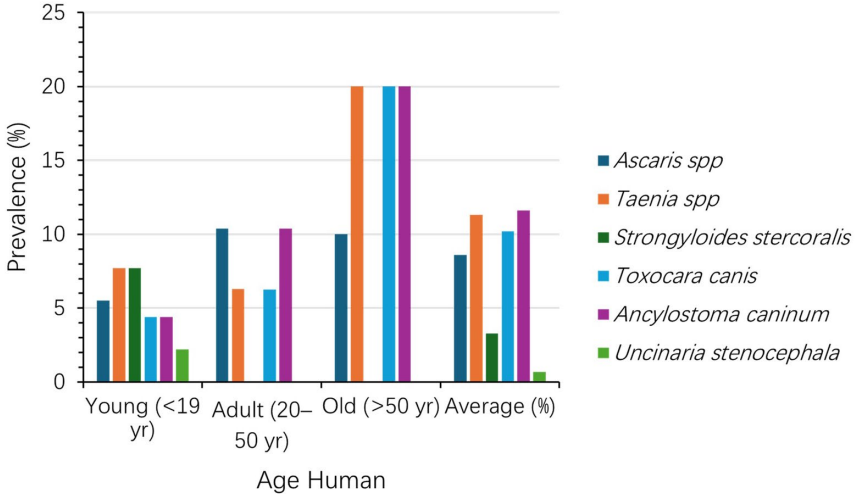


Figure 5. Prevalence of gastrointestinal parasites per age (Humans).

3.4. Prevalence of Gastrointestinal Helminths per Sex in Dogs and Humans

The highest average prevalence per sex in dogs (**Figure 6**) was seen in *Ancy-*

lostoma caninum (51.4%) followed by *Toxocara canis* (17.0%), *Strongyl Spp* (13.5%), *Strongloides stercoralis* (13.4%), *Uncinaria stenocephala* (11.9%), *Toxocara cati* (9.5%), *Ascaris lumbricoides* (4.8%), *Diphylidium caninum* (3.6%), *Diphyllobotrium latus* (3.2%) and *Alaria Spp* (3.2%) had same average prevalence, *Taenia Spp* (2.4%) and *Toxoascaris leonine* (2.4%) also had same average prevalence, while *Paragonimus kellicoti* (1.2%) had the least prevalence. *Ancylostoma caninum* prevalence was similar between females (50.8%) and males (52.0%). *Toxocara canis* was slightly more prevalent in females (18.25%) than males (15.75%). *Ascaris lumbricoides* showed a higher prevalence in females (5.56%) compared to males (3.94%). Conversely, *Dipylidium caninum* was more common in males (4.72%) than females (2.38%). *Taenia Spp* also exhibited a higher prevalence in males (3.94%) than females (0.79%).

For humans (Figure 6), the overall total prevalence was highest in *Taenia Spp* (7.6%) followed by *Ascaris lumbricoides* (7.1%), *Ancylostoma caninum* (6.2%), *Strongloides stercoralis* (5.9%), *Toxocara canis* (4.7%), and *Uncinaria stenocephala* (1.1%) was the least. Comparing the prevalence between sexes, males generally showed higher rates for most parasites. For *Ascaris lumbricoides*, the prevalence was 8.6% in males compared to 5.6% in females. *Taenia Spp* was 9.7% in males and 5.6% in females. *Toxocara canis* was more prevalent in males (7.5%) than in females (1.9%). Similarly, *Ancylostoma caninum* affected 8.6% of males and 3.7% of females. *Strongloides stercoralis* was observed to be higher in females (7.4%) compared to males (4.3%). *Uncinaria stenocephala* was present in 2.2% of males and absent in females.

A caninum was highest in dogs across all age groups (51.4%), the rate of infection was almost the same in male and female. In humans, Males showed higher rate of infections as compared to females.

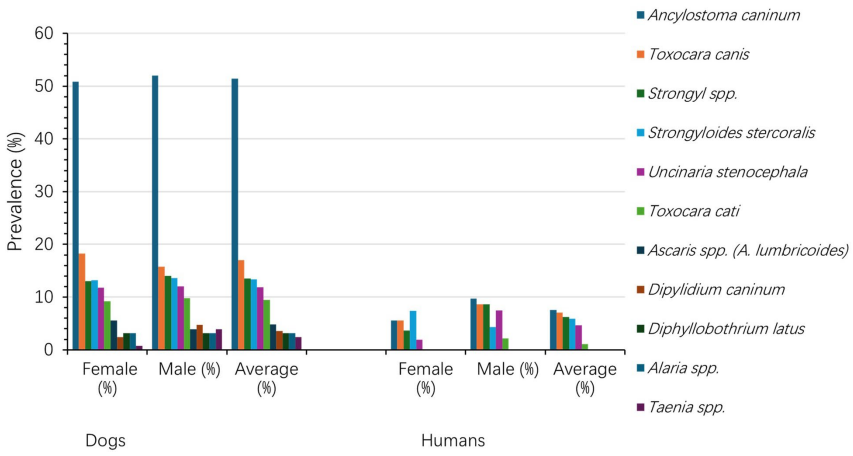


Figure 6. Prevalence of gastrointestinal parasites per sex for dogs and humans respectively.

3.5. Gastrointestinal Parasite Risk Factor Assessment

A chi-square test of independence was done comparing the age, locality, and sex against the prevalence of parasitic infection where $p < 0.05$ was considered to be

significant Table 2.

For animals, the prevalence per locality was statistically significant ($p < 0.001$) while the prevalence per Age and sex was not significant.

Table 3 presents the association between selected demographic factors and the prevalence of gastrointestinal parasites among the study participants. None of the assessed risk factors showed a statistically significant association with gastrointestinal parasite infection ($p > 0.05$).

Table 2. Assessment of potential risk factors for gastrointestinal parasites in dogs.

Risk factor	Category	Total	Infected (%)	χ^2	p-value	Significance
LOCALITY	Bakweri	19	18 (94.74)	48.99	<0.001	+
	Bitingi	9	9 (100.0)			
	Bokwai	8	5 (62.50)			
	Bokwango	38	30 (78.95)			
	Bomaka	28	12 (42.86)			
	Bonduma	21	9 (42.86)			
	Bova 1	20	18 (90.0)			
	Bova 2	10	6 (60.0)			
	Buea Town	17	17 (100)			
	Mile 16	16	16 (100)			
	Muea	40	27 (67.5)			
	Sandpit	19	13 (68.42)			
	Wokaka	8	6 (75.0)			
AGE	Young	94	77 (81.91)	5.45	0.065	-
	Adult	129	88 (68.22)			
	Older	30	21 (70.0)			
SEX	Female	126	92 (73.02)	0.03	0.85	-
	Male	127	94 (74.02)			

With respect to locality, infection prevalence varied considerably across communities, ranging from 10.0% in Bonduma to 100% in Bitingi. Other relatively high prevalence rates were observed in Mile 16 (55.56%), Wokaka (50.0%), and Bokwango (42.86%), whereas

Bova 2 (11.11%) and Bova 1 (13.04%) recorded comparatively lower prevalence. Although locality showed substantial variation in infection rates, the association was not statistically significant ($\chi^2 = 19.85$, $p = 0.07$).

Regarding profession, the highest prevalence was observed among housewives (80.0%), followed by farmers (41.18%), while security personnel (0.0%) had no recorded infections. Businesspersons, students, pupils, and teachers had infection prevalences of 27.59%, 24.49%, 30.0%, and 14.29%, respectively. However, profession was not significantly associated with gastrointestinal parasite infection ($\chi^2 =$

11.91, p = 0.21).

For age, older participants had the highest prevalence (100%), followed by adults (29.17%) and young participants (26.37%). Despite this apparent trend, age was not significantly associated with infection ($\chi^2 = 2.45$, p = 0.29).

Similarly, sex was not significantly associated with gastrointestinal parasite infection ($\chi^2 = 2.10$, p = 0.14). Males had a higher prevalence (32.98%) than females (21.82%), but this difference did not reach statistical significance.

Overall, the findings indicate that locality, profession, age, and sex were not significant predictors of gastrointestinal parasite infection among the study population (p > 0.05), although notable differences in prevalence were observed across some categories.

Table 3. Assessment of potential risk factors for gastrointestinal parasites in human.

Risk factor	Category	Total	Infected (%)	χ^2	p-value	Significance
LOCALITY	Bakweri	9	3 (33.33)	19.85	0.07	-
	Bitingi	3	3 (100)			
	Bokwai	5	1 (20.0)			
	Bokwango	21	9 (42.86)			
	Bomaka	15	4 (26.67)			
	Bonduma	10	1 (10.0)			
	Bova 1	23	3 (13.04)			
	Bova 2	9	1 (11.11)			
	Buea Town	19	5 (26.32)			
	Mile 16	9	5 (55.56)			
	Muea	18	6 (33.33)			
	Sandpit	6	1 (16.67)			
	Wokaka	2	1 (50.0)			
PROFESSION	Business	58	16 (27.59)	11.91	0.21	-
	Farmer	17	7 (41.18)			
	House wife	5	4 (80.0)			
	Pupil	10	3 (30.0)			
	Security	3	0 (0.0)			
	Student	49	12 (24.49)			
	Teacher	7	1 (14.29)			
AGE	Young	91	24 (26.37)	2.45	0.29	-
	Adult	48	14 (29.17)			
	Older	5	5 (100)			
SEX	Female	55	12 (21.82)	2.10	0.14	-
	Male	94	31 (32.98)			

3.6. Types of Associations Dogs and Human

Analysis of multiple infections in dogs revealed (Figure 7) that 74.4% (n = 188) of the dog population experienced at least one infection. Specifically, 27.3% (n = 69) of dogs had one infection, while 34.4% (n = 87) presented with two infections, indicating a higher prevalence of double infections. A decrease in prevalence was observed for three and four infections, which were 9.5% (n = 24) and 2.4% (n = 6) respectively. Furthermore, a small proportion of the population, 0.4% (n = 1), experienced five infections, and another 0.4% (n = 1) had seven infections.

In humans, analysis of multiple infections was more distinct compared to dogs. A total of 22.1% (n = 33) of individuals presented with a mono-infection, indicating more prevalence of single parasite infection. In contrast, a significantly lower proportion, 6.9% (n = 9), was identified with double infections.

In dogs, double parasitic infection was the most prevalent compared to the other parasitic associations while with humans, mono infection was higher than double infection.

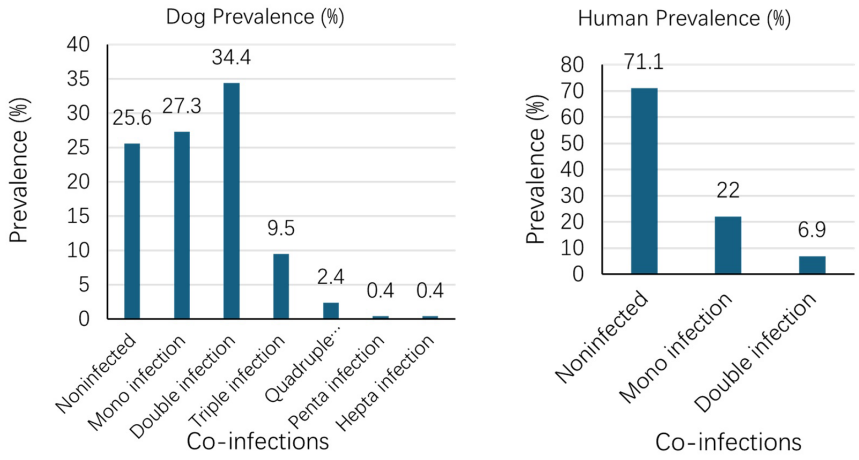


Figure 7. Types of associations in dogs and humans.

3.7. Intensity of Parasitic Infections in Dogs and Humans

3.7.1. Intensity of Infection per Age in Dogs and Humans

For the average infection intensity per age in dogs (Figure 8), *Toxocara cati* (12,872) had the highest infection intensity followed by *Toxocara canis* (8984) and *Toxoascaris* (8113). The least infection intensity was observed in *Taenia Spp*. *A. caninum* had a higher mean intensity in old (>5 years) (5214) as compared to Adults (1 - 5 years) (4903) and young (<1 year) (4013).

Taenia Spp decreased with an increase in age from 2175 in young to 1250 in Adults and absent in old. *T. canis* intensity increased with an increase in age from 10,500 in old to 9738 in adults and 6714 in young. The infection intensity was generally higher across the Adult age group compared to the old and young.

For humans (Figure 8), the total average infection intensity was highest in *A. caninum* (255) and *T. canis* (255) followed by *Taenia Spp* (161), *A. lumbricoides* (160), *S. stercoralis* (138) and least in U. stenosephala (83). *A. caninum* was higher in the adult age group (20 - 50 years) (325) compared to the young (<19) (240) and old (>50 years) (200). *T. canis* was higher in the young (300) and old (200) compared to adults (175). *U. stenocephala* infected just adults and was absent in young and old.

For intensity of infection in dogs, the adult age group (1 - 5 years) had higher intensity compared to the other age groups while in humans, the adult age group (20 - 50 years) also experienced the highest infection intensity.

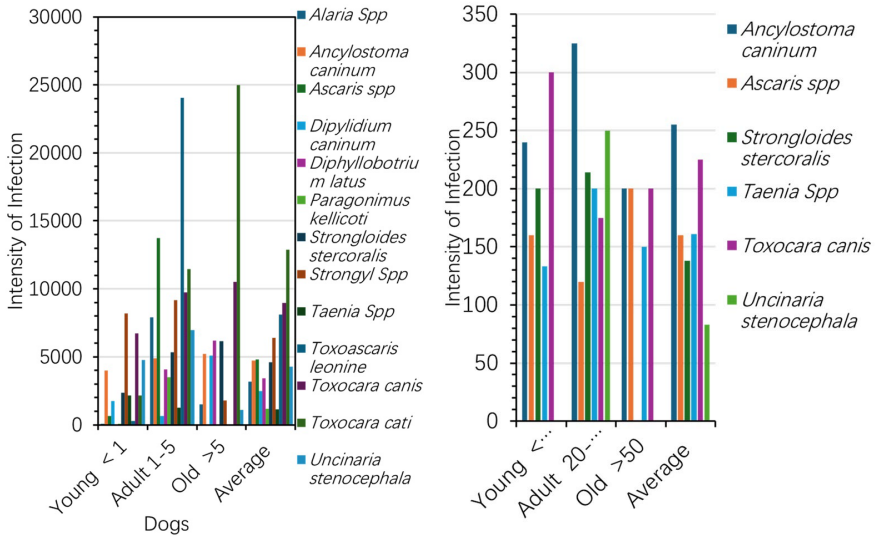


Figure 8. Representation of intensity of infection per age in dogs and humans.

3.7.2. Intensity of Infection per Sex in Dogs and Humans

For infection intensity per sex in dogs (Figure 9), *T. leonine* (18813) generally had the highest intensity followed by *A. lumbricoides* (9937) and *T. cati* (9875). The least mean intensity was observed in *D. caninum* (1550) and *Taenia Spp* (1200). *T. leonine* was higher in female dogs (22625) compared to male dogs (15000). On a contrary, *Taenia Spp* had higher intensity in male dogs (2200) compared to female dogs (200). Generally, the intensity was higher in female across compared to males.

For humans, the highest intensity for both males and females was observered in *A. caninum* (233) followed by *S. stercoralis* (212), *T. canis* (196), *Taenia Spp* (183), *A. lumbricoides* (141) and lastly *U. stenocephala* (125). *A. caninum* was higher in males (300) than in Females (166). *Taenia Spp* was higher in females (200) compared to males (166). *U. stenocephala* had an intensity of (250) in males but it was absent in females. Generally, males had a higher intensity across compared to females.

For Infection intensity with respect to sex, Females had higher intensity in dog while males had higher intensity in humans.

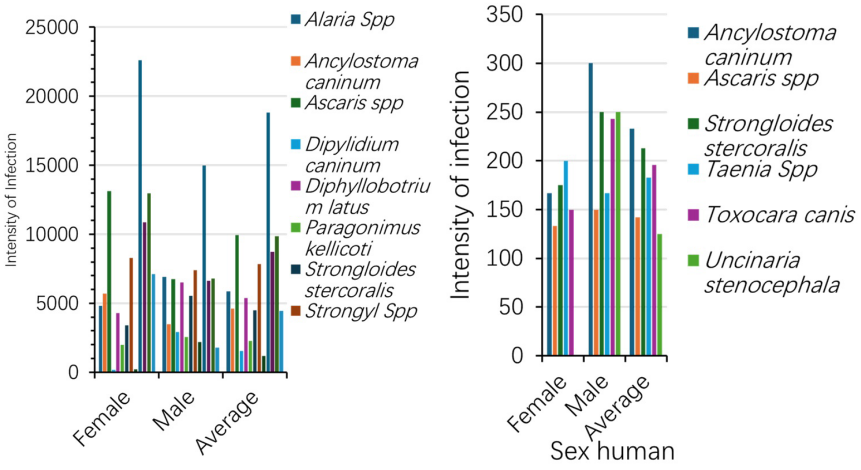


Figure 9. Representation of intensity of infection per sex in dogs and humans.

3.8. Prevalence of Bacteria Infection in Dogs and Humans

3.8.1. Prevalence of *E. coli* and *Salmonella spp* per Locality in Dogs and Humans

The prevalence of bacteria in dogs, specifically *E. coli* and *Salmonella spp* (**Figure 10**), varied per locality. *E. coli* showed a very high prevalence in many areas: 100% prevalence in Bitingi, Bonduma, Bova 2, Mile 16, and Sandpit. Other localities such as Bakweri Town and Bokwango recorded 50% *E. coli* prevalence, while Bomaka and Bova 1 had 66.7%. Muea also showed a high *E. coli* prevalence at 93.3%. *Salmonella spp* was less prevalent, it had a prevalence of 33.3% in Bova 1 and 25% in Buea Town, along with 6.7% in Muea. All other listed localities did not report *Salmonella spp*. The overall total prevalence for *E. coli* across all localities was approximately 77.1%, and for *Salmonella spp*, was 5%.

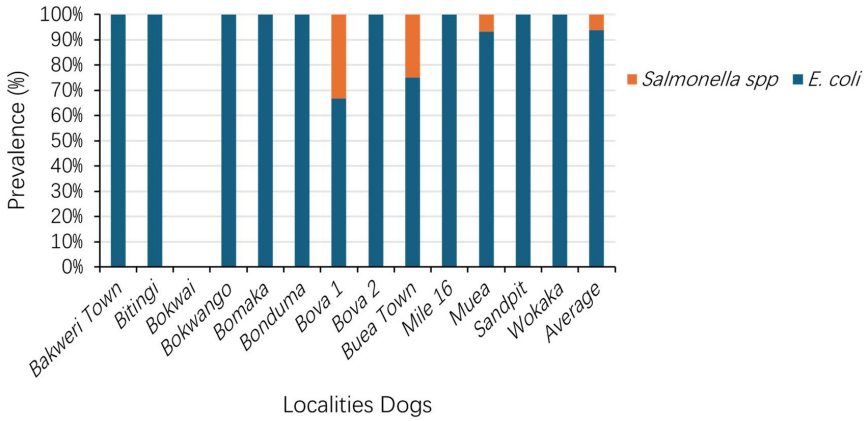


Figure 10. Prevalence of *E. coli* and *Salmonella spp* per locality in dogs.

The prevalence of *E. coli* in humans (**Figure 11**) was high in some localities. Bakweri Town, Bokwai, Bokwango, Bomaka, and Buea Town all showed a 100% prevalence of *E. coli*. Muea had an *E. coli* prevalence of 75%. Bova 1 showed a 50% prevalence for *E. coli*. *Salmonella spp* was not frequently observed; it was present

only in Bova 1 at 50%, with all other listed localities showing 0% prevalence. Overall, the total prevalence for *E. coli* across these localities was approximately 89.29%, while for *Salmonella spp*, it is 7.14%.

Salmonella spp was found in 3 localities which were, Bova 1, Buea Town and Muea while in. Generally, *E. coli* was more prevalent in both dogs *Salmonella spp* across all localities.

In Humans, *Salmonella spp* was found only in Bova 1. Generally, *E. coli* was more prevalent than *Salmonella spp.*

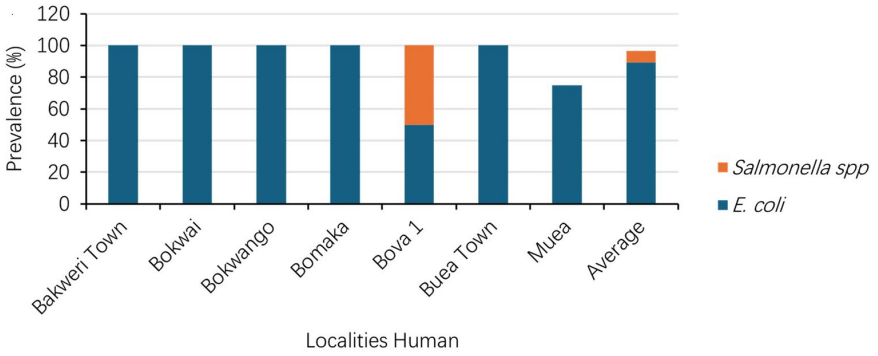


Figure 11. Prevalence of *E. coli* and *Salmonella spp* per locality in humans.

3.8.2. Prevalence of *E. coli* and *Salmonella spp* per Age in Dogs and Humans

The prevalence of bacteria also varied per age groups as seen in **Figure 12**. *E. coli* was most prevalent in adult dogs (1 - 5 years) at 91.3%, followed by young dogs (<1 year) at 81.25%, and older dogs (>5 years) at 75%. *Salmonella spp* showed its highest prevalence in older dogs (>5 years) at 12.5%, compared to young dogs (6.25%) and adult dogs (4.35%). The overall total prevalence for *E. coli* across all age groups was approximately 82.52%, and for *Salmonella spp*, was 7.7%.

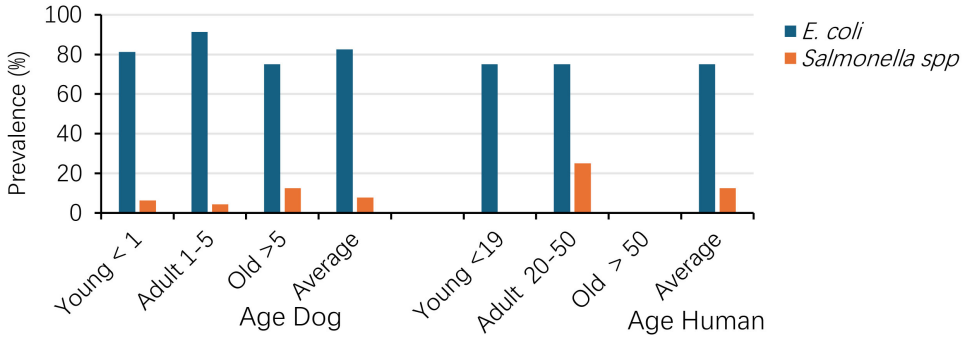


Figure 12. Prevalence of *E. coli* and *Salmonella spp* per age in dogs and humans.

Based on age in humans, *E. coli* showed a prevalence of 75% in both young individuals (<19) and adults (>20). *Salmonella spp* was not found in young individuals (0%), but it was present in 25% of adults (>20). The total prevalence across these age groups for *E. coli* was 75%, and for *Salmonella spp*, it was 12.5%.

With the prevalence of Bacteria per age, *Salmonella spp* was found in all age groups in dogs though *E. coli* still registered the highest prevalence across all age groups. In humans, both *E. coli* and *Salmonella spp* were found in the Adult age group while the young had just *E. coli*.

3.8.3. Prevalence of *E. coli* and *Salmonella spp* per Sex in Dogs and Humans

When considering the sex of the dogs (Figure 13), *E. coli* was more prevalent in males at 90% compared to females at 81.5%. On the contrary, *Salmonella spp* was observed in females at 11.1% but was not found in males (0%). Overall, the total prevalence for *E. coli* was approximately 85.7%, and for *Salmonella spp*, it was 5.6%.

For human bacteria prevalence by sex (Figure 13), *E. coli* had 80% prevalence in females and 71.4% of males. *Salmonella spp* had a prevalence of 20% in females but was absent in males. The overall total prevalence for *E. coli* was 75.7%, and for *Salmonella spp*, was 10%.

With respect to sex, *Salmonella spp* infected only females in both dogs and humans. Males were infected only with *E. coli* in both dogs and humans.

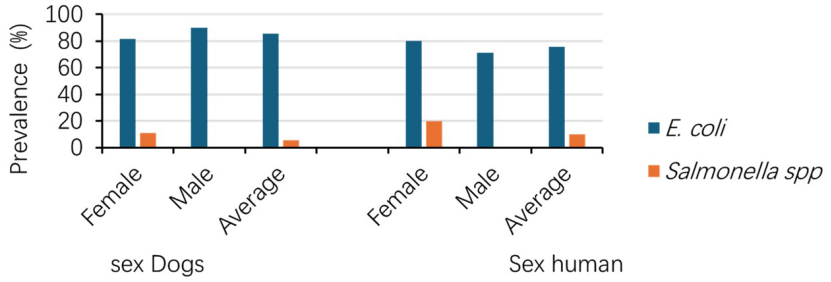


Figure 13. Prevalence of *E. coli* and *Salmonella spp* per sex in dogs and humans.

3.8.4. Bacteria Infection Risk Factor Assessment

A chi-square test of independence was also done to compare the age, locality, and sex against the prevalence of parasitic infection (Table 4) where $p < 0.05$ was considered to be significant while $p > 0.05$ not statistically significant. For animals, the prevalence per locality, age and sex were statistically significant ($p < 0.001$).

Table 4. Assessment of potential risk factors for bacteria infection in dogs.

Risk factor	Category	Total	Infected (%)	χ^2	p-value	Significance
LOCALITY	Bakweri	3	2 (66.6)	74.14	<0.001	+
	Bitingi	2	2 (100.0)			
	Bokwai	1	0 (0)			
	Bokwango	2	100 (100.0)			
	Bomaka	3	2 (66.6)			
	Bonduma	7	7(100.0)			

Continued

	Bova 1	3	3 (100.0)			
	Bova 2	1	1 (100.0)			
	Buea Town	4	4 (100)			
	Mile 16	1	1(100)			
	Muea	15	100 (100.0)			
	Sandpit	1	1(100.0)			
	Wokaka	5	5 (100.0)			
AGE	Young	16	14 (87.50)	49.02	<0.001	+
	Adult	24	22 (91.60)			
	Older	8	7 (87.50)			
SEX	Female	27	25 (92.59)	48.10	<0.001	+
	Male	21	18 (85.71)			

Table 5 presents the association between selected demographic factors and multiple gastrointestinal parasite infections among humans. None of the assessed risk factors showed a statistically significant association with multiple infections ($p > 0.05$).

Table 5. The association between selected demographic factors and multiple gastrointestinal parasite infections among humans.

Risk factor	Category	Total	Infected (%)	χ^2	p-value	Significance
LOCALITY	Bakweri town	1	1 (100.0)	19.85	0.07	-
	Bokwai	1	1 (100.0)			
	Bokwango	1	1 (100.0)			
	Bomaka	1	1 (100.0)			
	Bonduma	1	0 (0.0)			
	Bova 1	2	2 (100.0)			
	Buea Town	1	1 (100.0)			
	Muea	4	3 (75.0)			
AGE	Young	8	6 (75.00)	1.20	0.27	-
	Adult	4	4 (100.00)			
SEX	Female	5	5 (100.0)	1.71	0.19	-
	Male	7	5 (71.42)			

With respect to locality, the prevalence of multiple infections ranged from 0.0% in Bonduma to 100.0% in Bakweri Town, Bokwai, Bokwango, Bomaka, Bova 1, and Buea Town. In Muea, 75.0% (3/4) of participants had multiple infections. Although marked differences were observed across localities, the association was not statistically significant ($\chi^2 = 19.85$, $p = 0.07$).

Regarding age, all adult participants (100.0%; 4/4) had multiple infections compared with 75.0% (6/8) of young participants. However, the association between age and multiple infections was not statistically significant (χ^2 = 1.20, p = 0.27).

Similarly, sex was not significantly associated with multiple gastrointestinal parasite infections (χ^2 = 1.71, p = 0.19). Female participants had a higher prevalence (100.0%; 5/5) than males (71.42%; 5/7), although the difference was not statistically significant.

Overall, the findings indicate that locality, age, and sex were not significant predictors of multiple gastrointestinal parasite infections among the study participants (p > 0.05). Despite the observed variations in prevalence across demographic groups, none of the differences reached statistical significance.

3.9. Prevalence of Same Infection in Dogs and Humans per Household

One member with same infection as the dog was randomly selected from each of the households visited for analysis. Out of 119 households visited, 17 households had common parasitic infections with their dogs giving a general prevalence of 14.3% while 10 households had common bacterial infection with their dogs giving a general prevalence of 8.4%. From these 18 households, Ancylostoma spp and Strongloides spp had the highest prevalence of 23.5% followed by *Toxocara canis* with 17.6%.

For all humans that had bacterial infections, their dogs had same bacterial infection but molecular identification of bacteria species was not done to confirm if the strain present in the dog was same strain present in humans as seen in **Table 6**.

Table 6. Prevalence of parasites and bacteria common between dogs and owners per infected households.

Microbes	N° of household Infected	Frequency (%)
Parasites (total households = 17)		
Taenia spp	1	5.9
Strongloides spp	4	23.5
Ancylostoma spp	4	23.5
Uncinaria spp	1	5.9
Toxocara canis	3	17.6
Toxocara canis + *Ancylostoma*	3	17.6
Taenia spp + *Ascaris spp*	1	5.9
Bacteria (total households = 10)		
E. coli	9	90
Salmonella spp	1	10

Table 7. Prevalence of parasites found in humans from animal sources but not found in their dogs.

Parasites (total households = 20)	N˚ of Households Infected	Frequency (%)
Ancylostoma spp	4	20
Toxocara canis	3	15
Strongloides spp	1	5
Uncinaria	1	5
Taenia spp	5	25
Ascaris spp	5	25
Taenia spp + *Ascaris spp*	1	5

Out of 119 households, 20 households had parasitic infections that are known to come from animal sources though their dogs were not infected with same parasites. Out of these 20 households, 9 households had parasitic infections that are confirmed to be from dog sources with Ancylostoma spp having the highest prevalence of 20% followed by *Toxocara canis*. 11 households had *Taenia spp* and Ascaris spp which were not confirmed to be from dog sources. This was common in household where dogs are dewormed regurlary while the humans were dewormed rarely or never. As seen in Table 7.

3.10. Antimicrobial Susceptibility Testing (AST)

3.10.1. Percentage Resistance of *E. coli* for Each Antibiotic per Locality in Dogs

Table 8. Resistance of *E. coli* for each antibiotic per locality in dogs.

QUARTERS	N˚ of Isolates	C-30 (%)	CRO-5 (%)	AMC-30 (%)	SXT-25 (%)	CIP-5 (%)	AM-30 (%)	IMP-10 (%)
Bokwango	1	0	0	0	0	0	(1R) 100	0
Bakweri Town	1	100	(1R) 100	(1R) 100	(1R) 100	0	(1R) 100	(1R) 100
Buea Town	3	0	(1R) 33.3	(2R) 66.7	(3R) 100	0	(3R) 100	(1R) 33.3
Bokwai	1	0	0	(1R) 100	(1R) 100	0	(1R) 100	0
Bomaka	3	0	(2R) 66.7	(2R) 66.7	(2R) 66.7	(2R) 66.7	(1R) 33.3	(3R) 100
Muea	14	(7R) 50.0	(8R) 57.1	(11R) 78.6	(9R) 64.3	(6R) 42.9	(13R) 92.9	(11R) 78.6
Bova 1	2	(1R) 50	(1R) 50	(2R) 100	(1R) 50	0	(2R) 100	0
Bova 2	1	0	0	(1R) 100	(1R) 100	0	(1R) 100	0
Sandpit	1	0	0	(1R) 100	(1R) 100	0	(1R) 100	0
Mile 16	1	0	(1R) 100	(1R) 100	(1R) 100	0	(1R) 100	0
Wokaka	5	(2R) 40	(3R) 60	(5R) 100	(5R) 100	(2R) 40	(4R) 80	0
Bonduma	5	(1R) 20	(3R) 60	(3R) 60	(2R) 40	(3R) 60	(3R) 60	(5R) 100
Bitingi	2	(1R) 50	(1R) 50	0	(1R) 50	0	(1R) 50	0

C-30-Chloramphenicol, CRO-5-Ceftriaxone, AMC-30-Amoxicillin-Clavulanate, SXT-25 Trimethoprim-Sulfamethoxazole, CIP-5-Ciprofloxacin, AM-30-Ampicillin, IMP-10 Imipenem. (R) = Number of Resistance *E. coli* isolates.

The percentage resistance of some antibiotic in dogs (Table 8) was high across all the localities. For example, the Resistance percentage of AM-30ug was high in all localities ranging from 33.3% to 100% followed by SXT-25ug and AMC-30ug. Muea recorded the highest number of *E. coli* (14) followed by Wokaka (5) and Bonduma (5). Most of the Antibiotics were resistant for dogs from Muea and Bonduma. Dogs from Bokwango showed high percentage of susceptibility to the drugs except for AM-30ug that was resistant (R) on the contrary, dogs from Bakweri Town showed high resistance to all the Antibiotics except for CIP-5ug that was susceptible (S), as seen in Table 8.

3.10.2. Percentage Resistance of *Salmonella spp* for Each Antibiotic per Locality in Dogs

The percentage resistance for *Salmonella spp* was generally high in all the localities with the highest resistance observered in Muea followed by Buea town and lastly Bova (Table 9). The dog from Muea showed 100% resistance for all antibiotic used while Bova was susceptible to 4 antibiotics and resistant to 3 of the antibiotics. As seen in Table 9.

Table 9. Resistance of *Salmonella spp* for each antibiotics per locality in dogs.

Quarters	N˚ Of Isolates	C-30 (%)	CRO-5 (%)	AMC-30 (%)	SXT-25 (%)	CIP-5 (%)	AM-30 (%)	IMP-10 (%)
Buea Town	1	(1R) 100	(1R) 100	(1R) 100	(1R) 100	0	(1R) 100	(1R) 100
Muea	1	(1R) 100	(1R) 100	(1R) 100	(1R) 100	(1R) 100	(1R) 100	(1R) 100
Bova 1	1	0	0	(1R) 100	0	0	(1R) 100	(1R) 100

C-30-Chloramphenicol, CRO-5-Ceftriaxone, AMC-30-Amoxicillin-Clavulanate, SXT-25 Trimethoprim-Sulfamethoxazole, CIP-5-Ciprofloxacin, AM-30-Ampicillin, IMP-10 Imipenem. (R) = Number of Resistance *Salmonella spp* isolates.

3.10.3. Percentage Resistance of *E. coli* for Each Antibiotic per Locality in Humans

In humans (Table 10) AMC-30ug and AM-30ug generally showed the highest resistance (100%) across all the localities followed by SXT-25ug and IMP-10ug both ranging from 66.7% - 100%. Bomaka had 100% R for all antibiotics that were used Buea with 6 resistances out of 7. One human was infected with *Salmonella*. Out of 7 antibiotics tested, 3 was susceptible and 4 resistant antibiotics (Table 11).

In humans, AMC-30μg and AM-30μg generally exhibited the highest resistance rates, reaching 100% in most localities. This was followed by SXT-25μg and IMP-10μg, with resistance ranging from 66.7% to 100% across the study areas.

Among the localities**,** Bomaka recorded the highest level of antimicrobial resistance, with 100% resistance to all antibiotics tested**.** Buea Town followed, showing resistance to 6 of the 7 antibiotics evaluated. Muea exhibited variable resistance levels, with resistance ranging from 33.3% to 100% depending on the antibiotic tested.

The lowest resistance was observed in Bokwango, where isolates showed 100% resistance to only three antibiotics, while remaining susceptible to the other four

antibiotics tested. The percentage resistance of *E. coli* isolates to each antibiotic by locality in humans is presented in Table 10.

Table 10. Resistance of *E. coli* for each antibiotic per locality in human.

Quarters	N° of Isolates	C-30 (%)	CRO-5 (%)	AMC-30 (%)	SXT-25 (%)	CIP-5 (%)	AM-30 (%)	IMP-10 (%)
Bowango	1	0	0	0	(1R) 100	0	(1R) 100	(1R) 100
Bakweri Town	1	0	(1R) 100	(1R) 100	(1R) 100	0	(1R) 100	(1R) 100
Buea Town	1	0	0	(1R) 100	(1R) 100	0	(1R) 100	(1R) 100
Bokwai	1	(1R) 100	0	(1R) 100	(1R) 100	0	(1R) 100	(1R) 100
Bomaka	1	(1R) 100	(1R) 100	(1R) 100	(1R) 100	(1R) 100	(1R) 100	(1R) 100
Muea	3	0	(1R) 33.3	(3R) 100	(2R) 66.7	(2R) 66.7	(3R) 100	(2R) 66.7
Bova 1	1	(1R) 100	(1R) 100	(1R) 100	(1R) 100	0	(1R) 100	0

C-30-Chloramphenicol, CRO-5-Ceftriaxone, AMC-30-Amoxicillin-Clavulanate, SXT-25 Trimethoprim-Sulfamethoxazole, CIP-5-Ciprofloxacin, AM-30-Ampicillin, IMP-10 Imipenem, (R) = Number of Resistance *E. coli* isolates.

3.10.4. Percentage Resistance of *Salmonella spp* for Each Antibiotics per Locality in Human

Only one *Salmonella spp*. isolate was recovered from the human samples, and it originated from Bova 1**.** The isolate exhibited 100% resistance to chloramphenicol (C-30), ceftriaxone (CRO-5), amoxicillin-clavulanate (AMC-30)**,** and ampicillin (AM-30)**.** However, it was susceptible to trimethoprim-sulfamethoxazole (SXT-25), ciprofloxacin (CIP-5), and imipenem (IMP-10). Owing to the recovery of only a single isolate, resistance percentages should be interpreted with caution, as they represent the susceptibility profile of one isolate rather than the resistance pattern of a larger population. The percentage resistance of *Salmonella spp*. to each antibiotic by locality in humans is presented in Table 11.

Table 11. Resistance of *Salmonella spp* for each antibiotics per locality in human.

Quarters	N° Of Isolates	C-30 (%)	CRO-5 (%)	AMC-30 (%)	SXT-25 (%)	CIP-5 (%)	AM-30 (%)	IMP-10 (%)
Bova 1	1	(1R) 100	(1R) 100	(1R) 100	0	0	(1R) 100	0

C-30-Chloramphenicol, CRO-5-Ceftriaxone, AMC-30-Amoxicillin-Clavulanate, SXT-25 Trimethoprim-Sulfamethoxazole, CIP-5-Ciprofloxacin, AM-30-Ampicillin, IMP-10 Imipenem (R) = Number of Resistance *Salmonella spp* isolates.

3.11. Knowledge Attitude and Practice of Dog Owner

3.11.1. Demographic Characteristics of Respondents

The study involved 101 dog owners, predominantly male (64.4%) with a diverse age range, though respondents around 15 - 20 years constituted a significant portion. Education levels varied, with Degree holders representing the largest group (29.7%), followed closely by A/L and FSLC levels. A near-even split was observed between married (50.5%) and single (49.5%) individuals. Respondents reported varied occupations, with students (24.8%) being the most common, alongside housewives, farmers, and business owners. The average household size was approximately 6 in-

dividuals, indicating multi-person households. As seen in Table 12.

Table 12. Demographic characteristics of respondents.

Variable	Category	Frequency (%)
Sex	Male	64.4
	Female	35.6
Age Group	Young (<19)	27
	Adult (20 - 50)	65
	Old (>50)	10
Education Level	FSLC	25.7
	A/L	25.7
	Degree	29.7
	O/L	18.9
Marital Status	Married	50.5
	Single	49.5
Occupation	Student	24.8
	Housewife, Farmer, Business, Hunter, teacher, security, tailor	71.2
Household Size	Mean	6 individuals

3.11.2. Dog Ownership and Management Practices

All respondents (100%) confirmed dog ownership, with an average of 2.34 dogs per household. Dog gender distribution was almost equal between female (51.7%) and male (48.3%) animals. Veterinary check-ups were reported as "occasionally" (39.6%) or "rarely" (30.7%) more often than "regularly" (29.7%). For fecal waste management, disposing in trash was the most common practice (36.6%), while leaving feces in the yard (19.8%) or dogs going and stooling freely (16.8%) were also noted. As seen in Table 13.

Table 13. Dog ownership and management practices.

Variable	Category	Frequency (%)
Dog Ownership	Yes	100.0
Average Dogs/Household	Mean	3
Dog Gender	Female	51.7
	Male	48.3
Vet Check-Ups	Occasionally	39.6
	Rarely	30.7
	Regularly	29.7
Fecal Waste Management	Disposed in trash	36.6
	Left in yard	19.8
	Free stooling	16.8
	Others	Remaining

3.11.3. Awareness and Practices Related to Zoonotic Pathogens

Table 14 presents the Awareness and Practices on Zoonotic Pathogens. Just over half of the respondents (53.5%) reported awareness of zoonotic diseases transmissible from dogs to humans. However, awareness regarding gastrointestinal (GI) parasites or bacteria transmitted by dogs was lower, with 65.3% reporting no awareness. A majority (56.4%) stated they had never been infected with a zoonotic parasite/bacterium, while 42.6% were unsure. Common measures taken to reduce infection risk included avoiding contact with feces and handwashing.

Table 14. Awareness and practices on zoonotic pathogens.

Variable	Category	Frequency (%)
Aware of Zoonotic Diseases	Yes	53.5
	No	46.5
Aware of GI Parasites/Bacteria	No	65.3
	Yes	34.7
Self-Reported Infection History	No	56.4
	Not Sure	42.6
	Yes	1.0
Infection Prevention Practices	Handwashing, Avoid feces	Common

3.11.4. Drug Use and Antimicrobial Resistance Awareness

Drug Use and Antimicrobial Resistance Awareness is presented on Table 15. Regarding antibiotic administration to dogs, responses were mixed, with "No" (31.7%) being the most frequent answer, followed by "yes" (27.7%) and "not sure" (25.7%). Medication for dogs was primarily obtained from veterinarians (48.5%) or vet clinics (20.8%). Adherence to dog prescriptions was often "sometimes" (47.5%), with "No" (28.7%) being more common than "Yes" (23.8%). A significant majority (59.4%) of respondents reported no awareness of AMR as seen in Table 15.

Table 15. Drug use and antimicrobial resistance awareness.

Variable	Category	Frequency (%)
Gave Antibiotics to Dogs	No	31.7
	Yes	27.7
	Not Sure	25.7
Drug Source	Veterinarian	48.5
	Vet Clinic	20.8
Prescription Adherence	Sometimes	47.5
	No	28.7
	Yes	23.8
Awareness of AMR	No	59.4

3.11.5. General Health Practices

The general health practices of the respondents are presented in Table 16. Nearly half of the respondents (48.5%) reported that they and their family members occasionally visited a healthcare provider, while 28.7% reported rarely seeking healthcare services. These findings are consistent with the reported frequency of deworming among household members.

Regarding dog management, 45.5% of respondents kept their dogs indoors, 28.7% kept them outdoors, and 25.8% reported that their dogs lived in both indoor and outdoor environments. Cleaning of dog living areas varied, with 26.7% of respondents cleaning the area daily and 22.8% cleaning it monthly.

More than half of the respondents (52.5%) allowed their dogs to roam freely outside the home. Furthermore, a majority (56.4%) perceived that dog ownership posed a potential health risk to their families.

The distribution of respondents according to their general health practices is presented in Table 16.

Table 16. General health practices.

Variable	Category	Frequency (%)
Healthcare Visits	Occasionally	48.5
	Rarely	28.7
Dog Living Area	Indoors	45.5
	Outdoors	28.7
	Both	25.8
Dog Area Cleaning Frequency	Daily	26.7
	Monthly	22.8
Dogs Roam Freely Outside	Yes	52.5
Perceived Health Risk to Family	Yes	56.4

4. Discussion

The first objective of this study was to check the prevalence of zoonotic gastrointestinal helminths and bacteria present in dogs and their owners in Buea. There was a high overall prevalence of parasitic infections in dogs, with 77.5% of the 253 examined dogs infected with at least one parasite. In contrast, human prevalence was considerably lower, with 31.5% of 149 examined individuals infected. This difference in prevalence rates between dogs and humans is a common observation in zoonotic helminth studies, often attributed to varying exposure risks, immunological responses, and differences in hygiene practices between species. For example, a study conducted on dogs in four districts of central Ethiopia reported an overall prevalence of gastrointestinal parasites of 53.1% [24]. While that study focused primarily on dogs, other research highlights that dog parasite burdens are frequently higher than human burdens in similar settings due to factors like unrestricted roaming and less veterinary care [25] [26].

Among the helminths identified in dogs, *Ancylostoma caninum* (51.4%) was the most prevalent, followed by *Toxocara canis* (17.0%) and Strongyloides stercoralis (13.4%). According to Anteson and Cockish [27], *Ancylostoma caninum* and *Toxocara canis* are the two intestinal parasites commonly diagnosed in dogs in Ghana. In recent studies in Ghana, Toxocara spp was reported in rodents [28] and cats [29]. In that study, *Ancylostoma caninum* was identified as the most prevalent parasite in dogs examined followed by *Toxocara spp* with prevalence of 11.3% and 2.4%, respectively. The wide range of variations in the prevalence of the GI parasites was attributed to geographical location, the presence or absence of intermediate hosts of the correlating parasites, the status of animal ownership, sampling protocols, demographic factors, the use of anthelmintic, and diagnostic methods and access to veterinary clinic [29]. In particular, during the study period, lack of an adequate waste disposal system, the community's high trends of raw meat consumption, sample collection from clinical case suspected dogs, and poor sanitation practices of dog owners may all contribute to an overestimation of the prevalence of this study [30].

The bacterial analysis revealed a 93.0% prevalence of *E. coli* among dogs, with 90% in humans. This is consistent with findings from other studies that noted high rates of *E. coli* in canine populations studies carried out by Albrechtova *et al.* [31] and Wedley *et al.* [32] examined a dog population in a rural and semirural area with different outstanding prevalence of 75% and 0.5%. Focusing on these two extremes, the region of living could be quite relevant regarding the carriage *E. coli*. *Salmonella spp* had a prevalence of 7% in dogs and 10% in humans which is slightly higher that the prevalence of *Salmonella spp* (2.5%) found in dog fecal in a study carried out in the United States between 2012 to 2014 [31]. Past studies also suggest that, trends in *Salmonella spp* prevalence in dogs are parallel to those of the human population with respect to prevalence [31]. The difference in prevalence in the two studies could be due to differences in climate, environmental temperature and rate of exposure due to poor waste management and suboptimal knowledge on risk factors.

The second objective was to assess the rate of antimicrobial resistance in zoonotic bacteria isolated from dog and their owners. Antimicrobial resistance (AMR) is a global health challenge, this study revealed findings concerning trends within the Buea dog and human populations. For dogs, *E. coli* isolates showed widespread resistance to several antibiotics across various localities. Notably, *E. coli* from Muea and Bonduma dogs demonstrated high resistance to most antibiotics tested. For instance, Ampicillin (AM-30ug) resistance in *E. coli* was notably high in all localities, ranging from 33.3% to 100%. Similarly, *Salmonella spp* from dogs also exhibited high resistance, with isolates from Muea showing 100% resistance to all antibiotics used, while Bova isolates were resistant to three antibiotics.

In humans, *E. coli* resistance was equally a concern, with Amoxicillin-Clavulanate (AMC-30ug) and Ampicillin (AM-30ug) generally showing 100% resistance across all localities. *E. coli* resistance had also been reported by Saputra *et al.* [33]

on from companion animals. Trimethoprim-Sulfamethoxazole (SXT-25ug) and Imipenem (IMP-10ug) also exhibited high resistance, ranging from 66.7% to 100%. Bomaka, in particular, recorded 100% resistance for *E. coli* to all tested antibiotics. The single Salmonella isolate from a human also demonstrated resistance to four out of seven tested antibiotics, including Chloramphenicol (C-30), Ceftriaxone (CRO-5), Amoxicillin-Clavulanate (AMC-30), and Ampicillin (AM-30).

Comparing these results to past research, the high rates of AMR observed in both dogs and humans in Buea are not entirely surprising. Many studies globally have reported increasing antimicrobial resistance in *E. coli* and *Salmonella spp* isolates from both animal and human sources, particularly in regions with less regulated antibiotic use [34] [35]. For example, a study in Ethiopia also reported high resistance of *E. coli* from dogs to commonly used antibiotics [36]. The observed high resistance to drugs like Ampicillin and Amoxicillin-Clavulanate could be attributed to their widespread and sometimes indiscriminate use in both human and veterinary medicine in the region, leading to significant selective pressure for resistant strains [37]. The complete resistance of *Salmonella spp* from Muea dogs to all antibiotics is particularly alarming and suggests the presence of highly resistant strains, potentially due to factors such as inadequate waste management and close contact between animals and humans, facilitating the spread of resistant bacteria [38]. The lower resistance observed in some localities for specific drugs like Bokwango dogs showing susceptibility to most drugs except AM-30ug for *E. coli* might be due to variations in local antimicrobial stewardship practices or lower exposure to antibiotics.

Concerning awareness, just over half of the respondents (53.5%) reported being aware of zoonotic diseases transmissible from dogs to humans. However, a significant gap exists regarding specific knowledge, as 65.3% reported no awareness of gastrointestinal (GI) parasites or bacteria transmitted by dogs. This disparity highlights a need for targeted educational campaigns. Furthermore, a substantial majority (59.4%) of respondents were unaware of Antimicrobial Resistance (AMR), indicating lack of knowledge that could contribute to the spread of resistant strains.

In terms of practices, veterinary check-ups for dogs were often "occasionally" (39.6%) or "rarely" (30.7%) rather than "regularly" (29.7%). This irregular veterinary care could contribute to the high prevalence of parasite and bacterial in dogs, limited parasite control, vaccination, and professional guidance on antibiotic use. Fecal waste management practices were also concerning, with disposing in trash being the most common (36.6%), but a notable percentage still leaving feces in the yard (19.8%) or allowing dogs to stool freely (16.8%). These practices can directly contribute to environmental contamination and the transmission of zoonotic pathogens. While handwashing and keeping the dog area clean were reported as key household hygiene practices, allowing dogs to roam freely outside the home (52.5%) and the belief that owning a dog poses a health risk (56.4%) suggest a need to improve risk awareness.

Regarding antibiotic use, responses were mixed, with "No" (31.7%) being the most frequent answer for antibiotic administration to dogs, followed by "yes" (27.7%) and "not sure" (25.7%). Medications were primarily obtained from veterinarians (48.5%) or vet clinics (20.8%), which is a positive sign for professional guidance. However, adherence to dog prescriptions was often "sometimes" (47.5%), indicating inconsistent treatment that can contribute to drug resistance. A similar finding in other regions where adherence to antibiotic prescriptions, both human and veterinary, is often suboptimal due to various socio-economic factors and lack of awareness [39].

When comparing these KAP findings to other studies, the lack of comprehensive awareness regarding zoonotic diseases and AMR is a common theme in many developing regions [40]. Inadequate waste management practices, such as leaving feces in the yard, are also frequently reported in studies investigating zoonotic transmission risk in areas with high human-animal interaction [41]. The inconsistent veterinary visits and adherence to prescriptions align with challenges faced in promoting responsible pet ownership and antibiotic stewardship in resource-limited settings [42]. The slightly more than half of respondents allowing their dogs to roam freely is a significant risk factor, as free-roaming dogs have greater exposure to pathogens and can facilitate their spread within the community, a finding consistent with other studies on stray and owned dog populations [43].

5. Conclusions

This study first aimed to determine the prevalence of zoonotic gastrointestinal helminths and bacteria in dogs and their owners in Buea. The results showed a high infection rate among dogs (77.5%) compared to humans (31.5%). *Ancylostoma caninum* and *Toxocara canis* were the most common parasites in dogs, while *Taenia spp* and *A. caninum* were most common in humans. *E. coli* was the most prevalent bacterium in both dogs and humans. These findings confirm that dogs serve as a reservoir for zoonotic infections and may serve as a major source of transmission to humans in the area.

The second objective assessed antimicrobial resistance (AMR) in bacterial isolates from dogs and their owners. The findings revealed that both *E. coli* and *Salmonella spp* showed resistance to several antibiotics, especially Ampicillin and Amoxicillin. This resistance pattern suggests that there may be misuse or overuse of antibiotics in both animals and humans. The presence of drug-resistant bacteria in these communities poses a serious public health threat, making it harder to treat infections and control outbreaks of infections.

Finally, the third objective explored the knowledge, attitudes, and practices (KAP) of dog owners regarding zoonotic diseases and hygiene. The results showed that many dog owners had poor knowledge and unsafe practices, including irregular deworming, allowing dogs to roam freely, and poor disposal of dog feces. These behaviors increase the risk of infection, environmental contamination and spread of diseases. Therefore, there is a need for education programs to improve

public awareness and promote responsible dog ownership to reduce the spread of zoonotic diseases.

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Author Contributions

Mbafor Fidelia Lem: Supervision, Conceptualization, data collection, formal analysis, and writing original draft preparation. Nahvoma Kusamia Kaspa: Methodology, investigation, laboratory analysis, data curation. Asongalem Emmanuel Acha: supervision. Ngeh Frankline Konfor: Sample collection, laboratory analysis, and writing review and editing. Archille Paguem: Data analysis, interpretation of results, and writing review and editing. Arrey Oben Ebob Ashu: writing review and editing, methodology, interpretation of results. All authors contributed to the study, critically reviewed the manuscript, approved the final version, and agreed to be accountable for all aspects of the work.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Simpson, G.J.G., Quan, V., Frean, J., Knobel, D.L., Rossouw, J., Weyer, J., *et al.* (2018) Prevalence of Selected Zoonotic Diseases and Risk Factors at a Human-Wildlife-Livestock Interface in Mpumalanga Province, South Africa. *Vector-Borne and Zoonotic Diseases*, **18**, 303-310. https://doi.org/10.1089/vbz.2017.2158

[2] Tong, J.C. (1992) Dog Population Studies and Epidemiology of Rabies in Cameroon. MVSc Thesis, Ahmadu Bello University.

[3] Elmore, S.A., Jones, J.L., Conrad, P.A., Patton, S., Lindsay, D.S. and Dubey, J.P. (2010) *Toxoplasma Gondii*: Epidemiology, Feline Clinical Aspects, and Prevention. *Trends in Parasitology*, **26**, 190-196. https://doi.org/10.1016/j.pt.2010.01.009

[4] Ballweber, L.R., Xiao, L., Bowman, D.D., Kahn, G. and Cama, V.A. (2010) Giardiasis in Dogs and Cats: Update on Epidemiology and Public Health Significance. *Trends in Parasitology*, **26**, 180-189. https://doi.org/10.1016/j.pt.2010.02.005

[5] Won, K.Y., Kruszon-Moran, D., Schantz, P.M. and Jones, J.L. (2008) National Seroprevalence and Risk Factors for Zoonotic Toxocara Spp. Infection. *The American Journal of Tropical Medicine and Hygiene*, **79**, 552-557. https://doi.org/10.4269/ajtmh.2008.79.552

[6] Landmann, J.K. and Prociv, P. (2003) Experimental Human Infection with the Dog Hookworm, *Ancylostoma Caninum*. *Medical Journal of Australia*, **178**, 69-71. https://doi.org/10.5694/j.1326-5377.2003.tb05066.x

[7] Traub, R.J., Robertson, I.D., Irwin, P., Mencke, N. and Thompson, R.C.A. (2002) The Role of Dogs in Transmission of Gastrointestinal Parasites in a Remote Tea-Growing

Community in Northeastern India. *The American Journal of Tropical Medicine and Hygiene*, **67**, 539-545. https://doi.org/10.4269/ajtmh.2002.67.539

[8] Weese, J.S., Peregrine, S.A., Anderson, C.E.M. and Fulford, B. (2011) Parasitic Diseases. In: *Companion Animal Zoonoses*, Blackwell Publishing Ltd., 119-218.

[9] Centers for Disease Control and Prevention (CDC) (2007) Zoonotic Diseases. https://www.cdc.gov/one-health/about/about-zoonotic-diseases.html

[10] Woolhouse, M.E.J. and Gowtage-Sequeria, S. (2005) Host Range and Emerging and Reemerging Pathogens. *Emerging Infectious Diseases*, **11**, 1842-1847. https://doi.org/10.3201/eid1112.050997

[11] Grace, D., Lindahl, J., Wanyoike, F., Bett, B., Randolph, T. and Rich, K.M. (2017) Poor Livestock Keepers: Ecosystem-Poverty-Health Interactions. *Philosophical Transactions of the Royal Society B: Biological Sciences*, **372**, Article ID: 20160166. https://doi.org/10.1098/rstb.2016.0166

[12] Yasmeen, N., Jabbar, A., Shah, T., Fang, L., Aslam, B., Naseeb, I., *et al.* (2022) One Health Paradigm to Confront Zoonotic Health Threats: A Pakistan Prospective. *Frontiers in Microbiology*, **12**, Article ID: 719334. https://doi.org/10.3389/fmicb.2021.719334

[13] Van Boeckel, T.P., Brower, C., Gilbert, M., Grenfell, B.T., Levin, S.A., Robinson, T.P., *et al.* (2015) Global Trends in Antimicrobial Use in Food Animals. *Proceedings of the National Academy of Sciences*, **112**, 5649-5654. https://doi.org/10.1073/pnas.1503141112

[14] Cleaveland, S., Laurenson, M.K. and Taylor, L.H. (2001) Diseases of Humans and Their Domestic Mammals: Pathogen Characteristics, Host Range and the Risk of Emergence. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, **356**, 991-999. https://doi.org/10.1098/rstb.2001.0889

[15] Helders, S. (2008) Buéa [Internet]. World Gazetteer.

[16] Mulugeta, Y., *et al.* (2019) Intestinal Parasites in Dogs and Humans, Environmental Egg Contamination and Risk of Human Infection with Zoonotic Helminth Parasites from Dog in Hosanna Town. *International Journal of Biomedical Materials Research*, **7**, 24-36. https://doi.org/10.11648/j.ijbmr.20190701.14

[17] Euzeby, J. (1982) Diagnostic expérimental des helminthoses animales: Travaux pratiques. Informations Techniques des Services Vétérinaires.

[18] Thienpont, D., Rochette, F. and Vanparijs, O.F.J. (1986) Diagnosis of Helminthiasis by Coprological Examination. 2nd Edition, Janssen Research Foundation.

[19] Mapagha-Boundoukou, K., Boundenga, L., Mohamed-Djawad, M.H., Longo-Pendy, N.M., Makouloutou-Nzassi, P., Said, M.B., *et al.* (2025) Diversity and Prevalence of Gastrointestinal Parasites in Small Ruminants in Franceville, Gabon. *Parasite Epidemiology and Control*, **31**, e00465. https://doi.org/10.1016/j.parepi.2025.e00465

[20] Adewoga, T.O.S., Adesuyi, S.O., Bello, L.H. and Inuwa, Y. (2026) Prevalence of Helminth Parasites in Four Cattle Breeds in Three Local Government Areas of Ogun State, Nigeria. *Kashere Journal of Animal Science*, **2**, 365-370. https://journals.fukashere.edu.ng/index.php/kajas/article/view/1323

[21] Soulsby, E.J.L. (1982) Helminths, Arthropods, and Protozoa of Domesticated Animals. 7th Edition, Baillière Tindall.

[22] CLSI Clinical and Laboratory Standards Institute (CLSI) (2023) Performance Standards for Antimicrobial Susceptibility Testing (M100-S33). CLSI.

[23] Cheesbrough, M. (2006) District Laboratory Practice in Tropical Countries. Cam-

bridge University Press, 143-157. https://doi.org/10.1017/cbo9780511543470

[24] Bayou, K., Terefe, G. and Kumsa, B. (2025) Epidemiology of Gastrointestinal Parasites of Dogs in Four Districts of Central Ethiopia: Prevalence and Risk Factors. *PLOS ONE*, **20**, e0316539. https://doi.org/10.1371/journal.pone.0316539

[25] Anim-Baidoo, I., Adorkor, A.C.N., Johnson, S.A.M., Tingan, T.K., Forson, A.O., Owusu, E., *et al.* (2025) Prevalence of Gastrointestinal Parasites in Dogs and Potential Implications to Human Health in Accra, Ghana. *Journal of Parasitology Research*, **2025**, Article ID: 3973074. https://doi.org/10.1155/japr/3973074

[26] Mukaratirwa, S. and Singh, V.P. (2010) Prevalence of Gastrointestinal Parasites of Stray Dogs Impounded by the Society for the Prevention of Cruelty to Animals (SPCA), Durban and Coast, South Africa. *Journal of the South African Veterinary Association*, **81**, 123-125. https://doi.org/10.4102/jsava.v81i2.124 https://pubmed.ncbi.nlm.nih.gov/21247022/

[27] Anteson, R.K. and Corkish, J.D. (1975) An Investigation of Helminth Parasites in Well-Cared for Dogs in Accra. *Ghana Medical Journal*, **14**, 193-195.

[28] Amoah, L.A.O., Oppong, M., Amoah, S.K. and Bimi, L. (2023) Toxocariasis in Ghanaian Neighbourhoods: A Need for Action. *Science in One Health*, **2**, Article ID: 100018. https://doi.org/10.1016/j.soh.2023.100018

[29] Amissah-Reynolds, P.K. and Ofori, S.A. (2023) Preliminary Survey of Feline Intestinal Parasites in Ghana. *The Asia Journal of Applied Microbiology*, **10**, 1-9. https://doi.org/10.18488/33.v10i1.3250

[30] Reimschuessel, R., Grabenstein, M., Guag, J., Nemser, S.M., Song, K., Qiu, J., *et al.* (2017) Multilaboratory Survey to Evaluate Salmonella Prevalence in Diarrheic and Nondiarrheic Dogs and Cats in the United States between 2012 and 2014. *Journal of Clinical Microbiology*, **55**, 1350-1368. https://doi.org/10.1128/jcm.02137-16

[31] Albrechtova, K., Kubelova, M., Mazancova, J., Dolejska, M., Literak, I. and Cizek, A. (2014) High Prevalence and Variability of CTX-M-15-Producing and Fluoroquinolone-Resistant *Escherichia coli* Observed in Stray Dogs in Rural Angola. *Microbial Drug Resistance*, **20**, 372-375. https://doi.org/10.1089/mdr.2013.0177

[32] Wedley, A.L., Maddox, T.W., Westgarth, C., Coyne, K.P., Pinchbeck, G.L., Williams, N.J., *et al.* (2011) Prevalence of Antimicrobial-Resistant *Escherichia coli* in Dogs in a Cross-Sectional, Community-Based Study. *Veterinary Record*, **168**, 354-354. https://doi.org/10.1136/vr.d1540

[33] Saputra, S., Jordan, D., Mitchell, T., Wong, H.S., Abraham, R.J., Kidsley, A., *et al.* (2017) Antimicrobial Resistance in Clinical *Escherichia coli* Isolated from Companion Animals in Australia. *Veterinary Microbiology*, **211**, 43-50. https://doi.org/10.1016/j.vetmic.2017.09.014

[34] World Health Organization (2014) Antimicrobial Resistance: Global Report on Surveillance 2014. World Health Organization.

[35] Zegene, G.M., Ango, T.S., Bambo, G.M., Mereta, S.T. and Mekonen, S. (2025) Prevalence and Antimicrobial Resistance Patterns of *Escherichia coli* Isolates from Humans and Animals in Ethiopia: A Systematic Review and Meta-Analysis. *BMC Infectious Diseases*, **26**, Article No. 166. https://doi.org/10.1186/s12879-025-12326-y

[36] Levy, S.B. (2002) The Antibiotic Paradox: How Miracle Drugs Are Destroying the Miracle. 2nd Edition, Perseus Books.

[37] Michael, G.B. and Schwarz, S. (2016) Antimicrobial Resistance in Zoonotic Nontyphoidal Salmonella: An Alarming Trend? *Clinical Microbiology and Infection*, **22**, 968-974. https://doi.org/10.1016/j.cmi.2016.07.033

[38] Grigoryan, L., Haaijer-Ruskamp, F.M., Cousins, R., Di Matteo, A., Edelstein, H., Van Dijk, L., *et al.* (2011) Adherence to Antibiotic Prescribing Guidelines in Patients with Acute Respiratory Tract Infections: A European Study. *Clinical Infectious Diseases*, **52**, 174-180.

[39] Munyaneza, C., Bizimana, F., Mukumbo, F., Gatesi, S., Sibomana, E., Munyampuhwe, S., *et al.* (2025) Knowledge, Attitudes, Practices (KAP), and Risk Factors toward Zoonotic Diseases among Smallholder Livestock Farmers in Bugesera District of Rwanda. *Frontiers in Public Health*, **13**, Article ID: 1569682. https://doi.org/10.3389/fpubh.2025.1569682

[40] Khaliq, S., Aziz, M.T., Safdar, B., Siddiq, U., Nawaz, F. and Khan, M.O. (2026) Zoonotic Parasites in Stray Dogs and Their Public Health Implications. *Journal of Health, Wellness and Community Research*, **4**, 1-10. https://doi.org/10.61919/r16cm079

[41] Nuangmek, A., Rojanasthien, S., Yamsakul, P., Tadee, P., Eiamsamang, T., Thamlikitkul, V. and Patchanee, P. (2021) Perspectives on Antimicrobial Use in Pig and Layer Farms in Thailand: Legislation, Policy, Regulations and Potential. *Veterinary Integrative Sciences*, **19**, 1-21.

[42] Joffe, D., Van Niekerk, D., Gagné, F., Gilleard, J., Kutz, S. and Lobingier, R. (2011) The Prevalence of Intestinal Parasites in Dogs and Cats in Calgary, Alberta. *The Canadian Veterinary Journal*, **52**, 1323.

[43] Oliveira-Sequeira, T.C.G., Amarante, A.F.T., Ferrari, T.B. and Nunes, L.C. (2002) Prevalence of Intestinal Parasites in Dogs from São Paulo State, Brazil. *Veterinary Parasitology*, **103**, 19-27. https://doi.org/10.1016/s0304-4017(01)00575-1