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Prevalence and risk factors associated with zoonotic gastrointestinal parasites of dogs in Kitui Central Sub-County, Kitui, County, Kenya

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Abstract

Introduction: *dogs are popular pets around the world and have always had a very close relationship with humans. In the last decade, Kenya has had an increasingly significant interaction between dogs and humans. Today, pets are often considered family members. Although dogs bring many advantages to human life, they are associated with many potentially zoonotic organisms of parasitic origin. Some of these parasites are very serious. They circulate in various dog–human and dog–animal cycles. Kitui Central Sub-County is known for having a high number of dogs, and this study was designed to establish the prevalence of zoonotic gastrointestinal (GIT) parasites in dogs, risk factors involved, as well as the knowledge, attitudes, and practices (KAP) of dog owners regarding deworming.* ***Methods:*** *a cross-sectional design was used. One-hundred-and-ninety (190) dogs were sampled from October 2024 to December 2024 using a proportional stratified sampling technique across the five administrative wards of Kitui Central Sub-County. Dogs were picked through a random sampling procedure. A dog fecal sample and a corresponding human sample of the dog owner or handler were collected in every homestead visited. Fecal analysis for zoonotic GIT parasites was conducted at the University of Nairobi parasitology laboratories. Additional data on KAP was collected by use of questionnaires.* ***Results:*** *a prevalence of 76/190 (40.0%) zoonotic GIT parasites was detected in dogs sampled in this study. Kyangwithya East (KE) ward had the highest percentage prevalence, 25/45 (55.55%). Ancylostoma caninum (A caninum)was the most prevalent, 39/76 (51.3%). Non zoonotic oocysts (Cytoisospora and Eimeria) accounted for 13/76 (17.1%). Higher prevalence of zoonotic GI parasite was observed in roaming dogs 38/50 (76.0%) compared to those with approximately 12 hours access to outdoor environment 32/128 (25%) and those always confined 6/12 (50.0%). Dogs that were dewormed every 3 months had the lowest prevalence of 9/51 (15.3%) compared to those dewormed every 6 months, 17/37 (45.9%). On knowledge of Dogs GIT parasites, 182/190 (95.7%) were not aware, only 8/190 (4.3%) were aware. 42/190 (22.1%) of humans were positive for GIT parasites. Protozoan infections (E histolyticaand G. lamblia) were the most prevalent.* ***Conclusion:*** *zoonotic dogs' GIT parasites are prevalent in Kitui Central. The study highlights existing gaps in their prevention, control practices, and knowledge. It recommends further one-health community campaigns to enhance awareness of causation, prevention, and control practices.*

Introduction

Dogs harbor zoonotic GIT parasites that cause serious infections in humans. The worldwide dog population has been estimated to be more than 900 million [1]. Although dogs bring many advantages to human life, they are associated with many potentially zoonotic organisms of parasitic origin [2]. The gastrointestinal helminth parasites (GIHPs) are a great threat to both stray and pet dogs. Most of them are zoonotic parasites e.g. Taenid egg infection, Toxocara canis (*T canis*), Trichuris vulpis (*T vulpis*), *Cryptosporidium spp*, Dipylidium caninum (*D caninum*), *Ancylostoma spp* [3]. Some of these parasites are very serious, e.g. Taenid eggs of *Echinococcus*, which circulate in various dog-human and dog-animal cycles.

There are two major modes of transmission for dog gastrointestinal parasites, indirect and direct. Indirect includes consumption of foods and water contaminated with dogs´ secretions and excretions, particularly parasite eggs, cysts, and oocysts, shed through animal feaces into the environment. The latter includes direct contact with dogs since the majority of intestinal parasites have a fecal-oral transmission cycle. Parasitic forms such as eggs, cysts, larvae, and oocysts excreted through dog feaces can remain infectious for a long time in the environment, depending on different conditions. They comprise a risk factor for animal and human infection. Infection by these parasites may show clinical symptoms or remain asymptomatic over a long period of time [4]. Since dogs play an important role in the epidemiology of these zoonotic parasitic infections, control of those parasites in dogs becomes a public health concern [5].

While some dogs are caged with adequate care by their owners, there are still some large populations of free-roaming domestic dogs without control and care from animal health specialists. An increase in roaming dogs in our areas of residence increases environmental pollution with dog feaces, thereby constituting a potential risk for human health due to the possibility of transmission of zoonotic parasites. Wind, rain, arthropods, human and vehicular traffic aid the spread of infective stages of parasites present in dog faeces to human food and water sources [6]. Children are at a higher risk of infections due to their frequent interactions with dogs, as well as the fact that they play frequently in open areas such as parks, playgrounds, public gardens, and by the roadsides with poor cleanliness standards [7]. Symptoms displayed by parasitized dogs vary depending on the type and density of the parasites. Risk factors associated with transmission and persistence of canine parasites include stray dogs, open defecation and improper fecal disposal, improper meat inspection, and lack of canine deworming and awareness of zoonotic transmission.

Understanding the epidemiology of these zoonotic parasitic infections is important in minimizing the risks to humans. With the high number of dogs in Kitui Central and their close interactions with humans, the risk for zoonotic GIT parasitic infection is high. Several studies have reported a high prevalence of zoonotic gastrointestinal parasites in dogs in several countries: Portugal, South Africa, Egypt, Ethiopia, and Nigeria. The study was informed by a lack of adequate published reports in Kenya and Kitui County in particular. The need to tackle neglected zoonotic diseases in a multidisciplinary approach aimed at eliminating the disease in the animal reservoir also advised the need for this study.

Methods

Study area: the study was conducted in Kitui Central Sub-County, Kitui county, Kenya. It is one of the 8 subcounties that make up the County of Kitui. Kitui Central is located at the heart of the County, covering an area of 636.2 km^2. The Sub-County is divided into five administrative wards, namely: Kyangwithya East (KE), Miambani (MB), Kyangwithya West (KW), Mulango (ML), and Kitui Township (TWN). It hosts the County headquarters and various government departments, and it is the most populous administrative region in Kitui County, 105,991 [8]. The main economic activity amongst the locals is subsistence farming of crops such as maize, beans, pigeon peas, sorghum, millet, cassava, etc. Livestock keeping is also popular, especially goats and cattle. They are involved in hunting and gathering, where they use dogs in this venture. Dogs are also widely used as security agents.

Study design and sampling: cross-sectional study design was used. The study was conducted from October to December 2024 to determine the prevalence, risk factors of zoonotic GIT parasites, and residents' KAP on dog handling in the five wards of Kitui Central Sub-County. Dogs of different ages, groups, breeds, and sex from different households in the Sub-County were selected randomly. Stratified sampling was employed, which ensured that each ward got a representative number of dogs sampled. Fecal samples were collected from restrained dogs' rectum using a gloved hand with the assistance of a veterinary surgeon and an animal health assistant. Dogs were muzzled and handled in the presence of their owners to prevent any bites to the handlers. Dogs in every third homestead were sampled. This also applied in the collection of human samples human fecal sample of the person who regularly handles the dog was collected in every homestead where a dog was sampled. These are the individuals with a higher risk of contracting dog zoonotic GIT parasites.

Sample size: one hundred and-ninety (190) dogs and their handlers/owners were included in the study. This was based on a prevalence of 39.8% as per the recent study conducted in Nigeria on canines [9]. Five percent (5%) precision and 95% confidence interval.

$$N = \frac{1.962[p\ expected\ (1\text{-}pexpected)]}{d^2}$$

Where; N = total sample size; p expected= expected prevalence; d^2= despaired absolute precision.

Only dogs with known owners were included in the study. Stray dogs were excluded. Human samples were strictly collected from dog owners/handlers.

Data collection: close-ended questionnaires were administered to all dog owners whose dogs were sampled. The questions captured dog´s categorical variables (age, sex and breed), deworming information, knowledge, attitude and practices of dog owners in relation to dog´s zoonotic GIT parasites. Fecal laboratory analysis also yielded data.

Laboratory analysis: all samples collected from both dogs and humans were analyzed at the Department of Veterinary Pathology, Microbiology, and Parasitology laboratories, University of Nairobi. The formal ether concentration method was used on all samples [10]. All positive samples were subjected to a further quantitative test, the Modified Mac Master Test [11]. All eggs recovered were cultured for ten days at 37°C. On hatching, larvae were harvested through the Baermann technique [12]. The larvae were used to identify the helminth eggs to the species level. Sporulation of oocysts to differentiate between Cytoisospora and Eimeria was done by culturing all positive samples in 2.5% potassium dichromate in a petri dish at room temperature for three days [13] (Figure 1).

Data analysis: data collected during the study through questionnaires and laboratory analysis were entered into an Excel spreadsheet and analyzed accordingly. Risk factors for GI parasite infection in dogs were determined by analyzing the statistical association between parasitism and the variables: age, sex, breed of dogs, and deworming practices. Data were analyzed using the ANOVA statistical technique in MS Excel 2016. The level of significance was set at $p \leq 0.05$.

Ethical consideration: ethical approval was sort from the JKUAT institutional scientific and ethics review comitte (ISERC) JKU/ISERC/02317/1382. Kitui County Directorate of Veterinary Services and Kitui County Department of Health Services CGKTI/MOH/ADM/8/4(245). A research permit was obtained from the National Commission for Science, Technology and Innovation (NACOSTI). NACOSTI/P/24/39576. In addition, verbal consent to participate in the study was sought from all dog owners in the study area before examination and sampling of the dogs and questionnaire interviews. A written consent was sought from the humans whose samples were collected. When dealing with children, an ascent was obtained.

Results

A total of 190 dogs were sampled in the five wards of Kitui Central Sub-County from October to December 2024. Number of dogs sampled was as follows Kyangwithya East 45, Kyangwithya West 30, Miambani 30, Township 55, and Mulango 30 (Figure 2). Overall, a prevalence of 76/190 (40.0%) zoonotic GIT parasites was detected in dogs sampled in this study (Table 1). Kyangwithya East ward had the highest percentage prevalence, 25/45 (55.55%), followed by Miambani ward with 14/30 (46.66%), Mulango 11/30 (36.66%), Township 17/55 (30.9%), and KW at 9/30 (30.0%) (Figure 3). Six species of zoonotic GIT parasites; *A caninum, T canis, T vulpis, Taenia spp, D caninum*and *Capillaria*were detected in the dog fecal samples examined either as single or multiple infections.

Ancylostoma *caninum*was the most prevalent, 39/76 (51.3%), followed by *T. canis*23/76(30.2%), *Trichuris vulpis*11/76 (14.5%), *D caninum*2/76 (2.6%), while Capillaria and *Taenia spp*each had a 0.7% prevalence. Non-zoonotic oocysts, Cytoisospora and Eimeria, accounted for 17.4% (Figure 4). Prevalence of GIT parasites was higher in male than female dogs, 54/117 vs 22/73 (46.2% vs 30.1%). Significantly higher prevalence of parasites, 20/45 (44.4%), was observed in puppies less than 6 months, followed by adults > 1 year 47/120 (39.2%), and young adults 7-12 months, with 9/25 (36.0%). The crossbreeds were more infected 4/7 (57.1%), followed by the local breed 42/104 (40.4%) and the pure breed 30/79 (38.0%). Higher prevalence of zoonotic GI parasite was observed in roaming dogs, 38/50 (76.0%), compared to those with approximately 12 hours access to the outdoor environment 32/128 (25%), and those always confined, 6/12 (50.0%). Dogs that were dewormed every 3 months had the lowest prevalence of 9/51 (15.3%) compared to those dewormed every 6 months, 17/37 (45.9%), and those whose deworming frequency was beyond 6 months 50/102 (49.0%) (Table 2).

The prevalence of zoonotic GIT parasites was significantly ($p < 0.04$) associated with sex, age, breed, and deworming practice. On dog owners using PPEs-gloves to clean the kennel, 29/88 (33.0%) used PPEs-gloves to clean the kennel, while 59/88 (67.0%) did not use any PPEs. About 113/190 (59.3%) of dog owners fed their dogs on raw meat. Some of dog keepers 105/190 (55.3%) disposed off dog feces in the garden, 35/190 (18.4%) in pits/pit latrines, 4/190 (2.1%) burned the feces, while 46/190 (24.2%) buried the feces. Respondents 88/109 (80.7%) cleaned the kennel while 21/109 (19.3%) did not. About 36/88 (40.9%) were cleaned daily, 34/88 (38.6%) weekly, and 18/88 (20.5%) monthly (Figure 5). On knowledge of dogs GIT parasites,182/190 (95.7%) were not aware, only 8/190 (4.3%) were aware. Some humans 42/190 (22.1%) were positive for GIT parasites. Protozoan infections (*E. histolytica*and *G. lamblia*) were the most prevalent (Table 3).

Discussion

This survey reported a prevalence of 40.0%. This agrees with a similar study that was conducted in Nigeria on canines [9]. Gastrointestinal parasite percentage prevalence differed significantly across geographic regions/wards. Kyangwithya East and Miambani are rural, remote areas. This agrees with Tylkowska *et al.* findings on geographical locations, inadequate hygiene practices, substandard housing conditions, and environmental contaminations by dog feces [14]. Ancylostoma *caninum*was the most identified zoonotic GIT parasite (51.1%) followed by Toxocara (29.8%). These results agreed with various studies in Ethiopia [15].

The highest percentage of infected dogs (56.3%) in this study were those allowed to roam. These dogs are left to eat whatever they find, thereby exposing them to several pathogens. In their roaming in search of food or mates, they contaminate the environment with their feces, leading to public health risks. This is in agreement with the previous report [16] and justifies the need to restrict dogs and give them veterinary care in order to minimize the risk of zoonotic parasite transmission to humans. Fifteen-point-three percent (15.3%) of dogs reported to have been dewormed every three months were shedding GIT parasite eggs/ova in their feces. This could be associated with the use of substandard deworming drugs, anthelmintic resistance, or respondents giving inaccurate information. A study in Brazil reported cases of falsification of data on the provision of veterinary care by dog owners [17]. Therefore, caution should be exercised during the interview and interpretation of dog owner responses. (79.1%) of the dogs in this study had single parasite infections while 20.1% had multiple parasite infections. This finding was in agreement with an earlier report from South Africa [18], suggesting a higher prevalence of single parasite infections in dogs.

The statistical significance of risk factors such as sex, age, and breed (p-value < 0.05) were in line with the previous reports from Ethiopia [19] and in the World, including in Brazil [20]. Nevertheless, the findings disagreed with the findings of T.M Savilla [21], who found that the occurrence of zoonotic parasites in dogs was not statistically significant with sex, age, and breeds of the dogs. The sporulation of coccidian oocysts helped in the identification of *Cystoisospora canis*and *Eimeria spp*infecting dogs. *Eimeria spp.* oocyst infection may be through coprophagy and may not be of any relevant clinical significance [22].

Findings on more puppies being infected than adult dogs agreed with a study that was done in Enugu state in Nigeria [23], puppies have not developed an immune response may be the reason; thus, it is a major source of soil contamination and transmission of infection to humans [24]. Most humans were not infected with GIT nematodes since there was an active ongoing deworming practice supported by the county government of Kitui through community health promoters. Hookworm and Toxocara infections in human are accidental, and their diagnosis cannot be done through laboratory analysis of a human fecal sample. In humans, they present as visible tracks with red, painful, and swollen advancing ends, usually associated with intense itching [25].

Conclusion

The findings of this study reveal a significant prevalence (40%) of gastrointestinal zoonotic parasites in dogs within Kitui Central Sub-County. This high infection rate, coupled with close human-dog interactions, indicates a potential public health risk. However, the study did not provide direct evidence of human infection linked to canine parasites, highlighting a critical gap in zoonotic correlation. Despite the low prevalence of gastrointestinal parasites observed in the human population, the risk of transmission cannot be ruled out-particularly considering that some zoonotic infections may be asymptomatic or present with non-specific clinical signs such as pruritic, erythematous tracks. The results underscore the urgent need for a One Health approach involving community sensitization campaigns focused on parasite transmission, risk mitigation strategies, and integrated control measures. Future studies should consider surveillance and molecular diagnostics to better establish causal links between canine and human infections in the region.

What is known about this topic

- *Dogs' GIT parasites are classified as neglected diseases;*
- *The prevalence of the disease is frequently observed in remote rural settlements with poor dog husbandry;*
- *Frequent deworming helps in the control of zoonosis.*

What this study adds

- *This study provides crucial epidemiological data that can be used to influence policymakers within the county regarding the prevalence of dog GIT parasites.*
- *The study highlights the gaps in knowledge, practices, and attitudes on dogs' GIT parasites in Kitui Central.*

Competing interests

The authors declare no competing interests.

Authors' contributions

Richard Kihara conceptualized and developed the research. Amos Mbugua and Samuel Maina Githigia supervised the research. Nichodemus Mutinda Kamuti assisted in samples and data collection, while Beatrice Mutende Munde assisted in laboratory analysis. All the authors have read and agreed to the final manuscript.

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Tables and figures

Table 1: distribution of parasites identified per ward

Table 2: the prevalence of zoonotic GIT parasites of dogs with associated risk factors

Table 3: distribution of human GIT parasites

Figure 1: some of the identified parasites: A) unsporulated oocyst; B) toxocara *canis* egg; C) ancylostoma *caninum* larvae; D) trichuris *vulpis* egg; E) ancylostoma *caninum* egg; F) dipylidium *caninum* egg; G) ancylostoma *caninum* larvae (tail portion)

Figure 2: Kitui Central sampling distribution

Figure 3: percentage prevalence per ward

Figure 4: an illustration of the most prevalent GIT parasite

Figure 5: respondents' common practices in dog handling: A) faecal matter disposal; B) kennel cleaning frequency

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Table 1: distribution of parasites identified per ward							
Variables	**Kyangwithya East**	**Kyangwithya West**	**Mulango**	**Miambani**	**Township**	**Total**	**%**
Positive dog samples	25	9	11	14	17	76	40
Negative dog samples	20	21	19	16	38	114	60
Total number	45	30	30	30	55	190	100
Positive human samples	10	6	7	6	13	42	22.1
Negative human samples	35	24	23	24	42	148	77.9
Total number	45	30	30	30	55	190	100

Table 2: the prevalence of zoonotic GIT parasites of dogs with associated risk factors					
Variable	**Category**	**Number sampled**	**Positive**	**Negative**	**% Prevalence**
Age	Adult	120	47	73	39.2
	Young Adult	25	9	16	36.0
	Puppy	45	20	25	44.4
Gender	Male	117	54	63	46.2
	Female	73	22	51	30.1
Breed	Local	104	42	62	40.4
	Pure breed	79	30	49	38.0
	Crossbreed	7	4	3	57.1
Deworming	3 months	51	9	42	15.3
	6 months	37	17	20	45.9
	> 6 months	102	50	63	49.0
Restriction	12 hrs	128	32	96	25
	Roaming	50	38	12	76
	24 hrs	12	6	6	50
GIT: gastro intestinal					

Table 3: distribution of human GIT parasites		
Parasite	**Number of persons infected**	**% Prevalence**
A lumbricoides	5	2.63
Trichuris	3	1.6
Taenia spp	1	0.5
A duodenale	3	1.6
E hist	20	10.5
G lamblia	10	5.3
Total	42	22.1
GIT: gastro intestinal		

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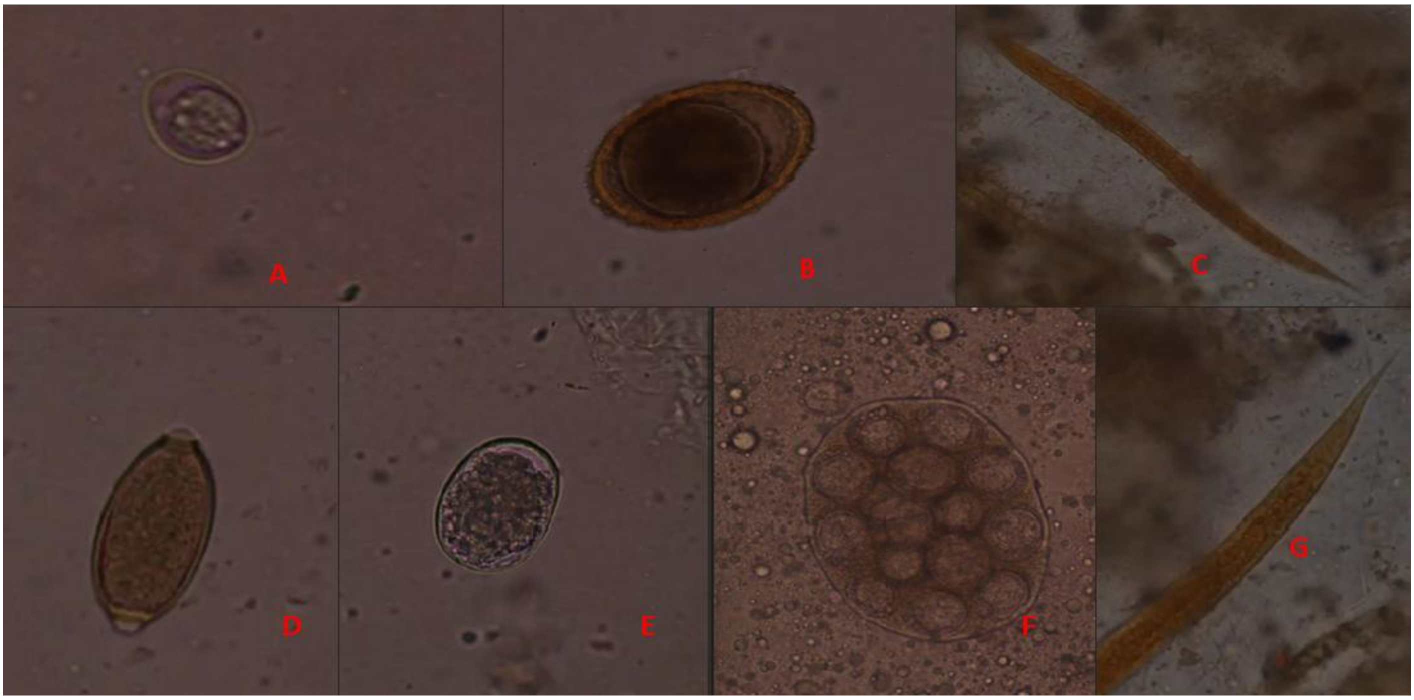

Figure 1: some of the identified parasites: A) unsporulated oocyst; B) toxocara *canis* egg; C) ancylostoma *caninum* larvae; D) trichuris *vulpis* egg; E) ancylostoma *caninum* egg; F) dipylidium *caninum* egg; G) ancylostoma *caninum* larvae (tail portion)

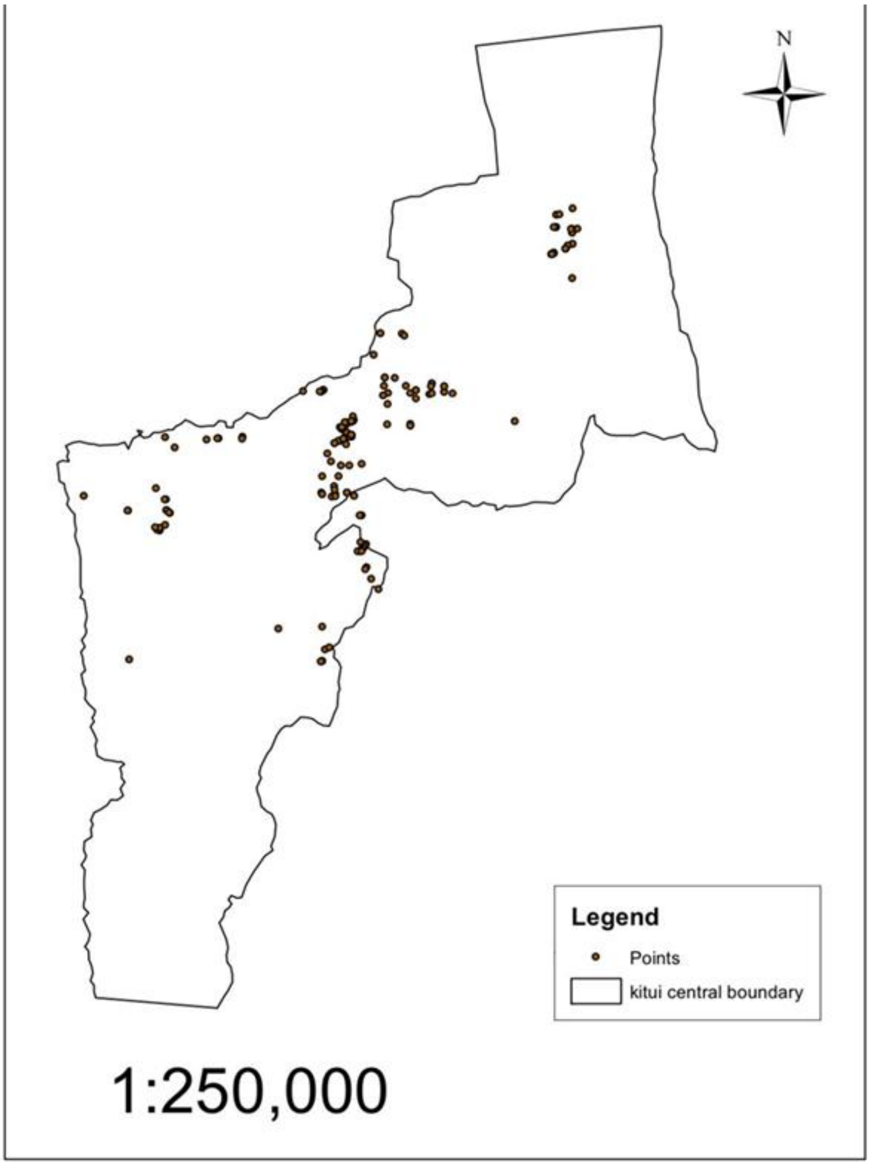

Figure 2: Kitui Central sampling distribution

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Figure 3: percentage prevalence per ward

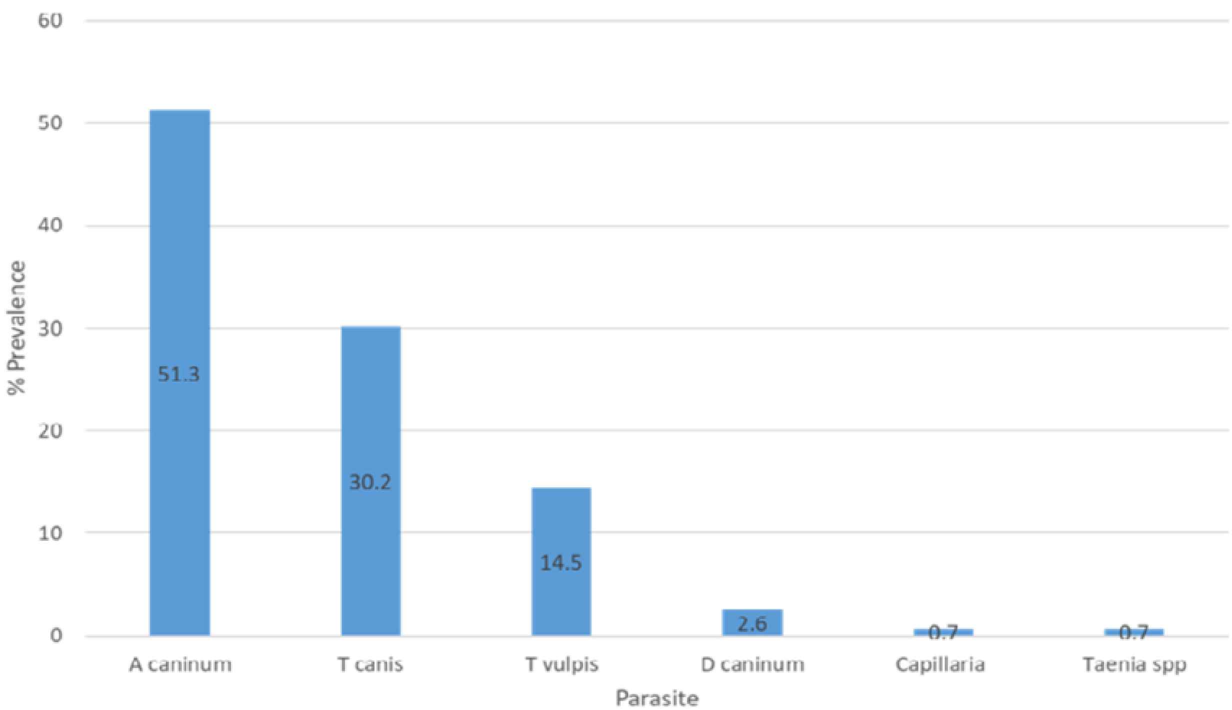

Figure 4: an illustration of the most prevalent GIT parasite

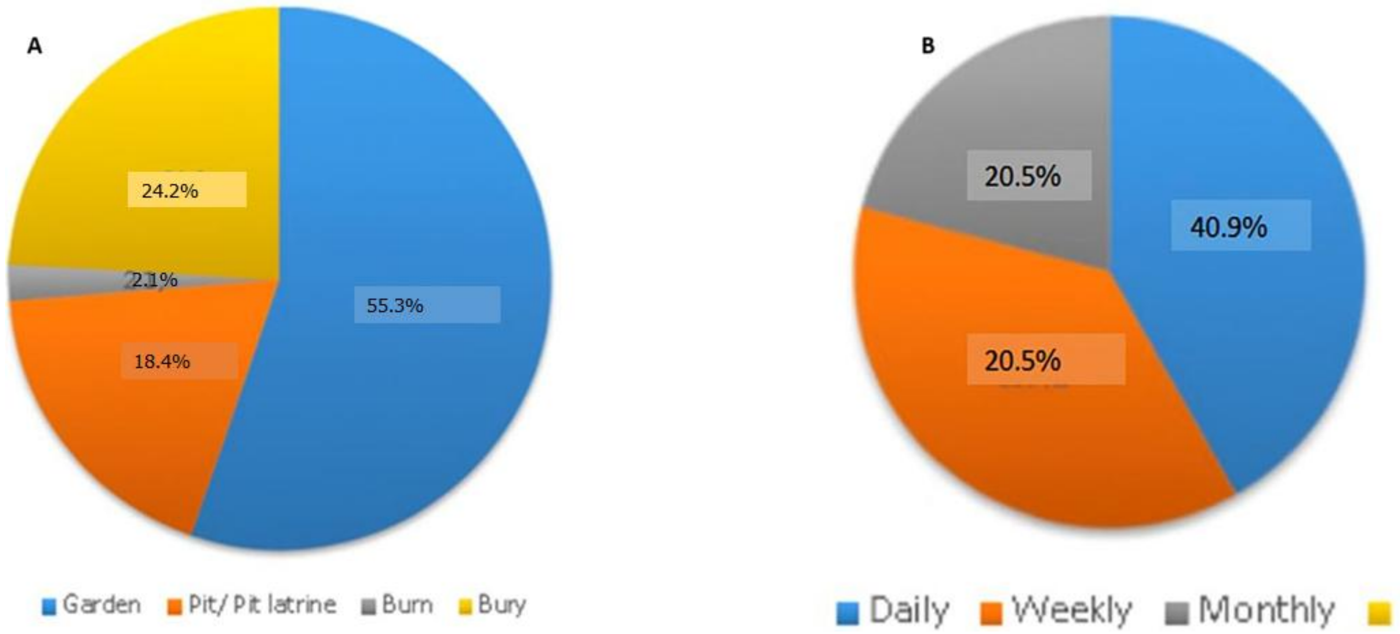

Figure 5: respondents' common practices in dog handling: A) faecal matter disposal; B) kennel cleaning frequency