Canine helminthiases and associated risk factors in Kigali city, Rwanda

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Research article

Keywords: dogs, helminths, prevalence, risk factors, Kigali, Rwanda

Posted Date: May 14th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-26155/v1>

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Abstract

Background

Despite that canine helminthiases pose a public health risk to humans and livestock, the prevalence of canine helminthiases in Rwanda is unknown. This study aimed to determine the prevalence of canine helminthiases and to identify the risk factors of such infections in Kigali, the capital city of Rwanda. A cross-sectional study involved 93 dogs selected across Kigali city. Faecal samples were collected from clinically healthy dogs and eggs worms were identified using McMaster technique. Risk factors for canine helminthiases were analysed by multivariable binary logistic regression analysis.

Results

The overall prevalence of intestinal helminthiases in dogs was 39.8%. The most prevalent species was *Ancylostoma spp* (32.3%, n = 93). About 41.9% (n = 31) of dogs suffering from ancylostomosis and/or toxocarosis had high egg counts per gram (EPG) of faeces (≥ 550). Approximately 97.3% (n = 37) of dogs infected with helminths had mono-infection. Logistic regression analysis showed that dog's age and location were significantly associated with the prevalence of canine helminthiases. The adjusted odds ratio (AOR) of dogs suffering from helminthiases was more than 61% lower in dogs dewormed once to twice a year compared to those who were never dewormed. The AOR was more than 42% lower for restricted dogs compared to non-restricted ones.

Conclusions

All the identified helminths are zoonotic and they pose a public health risk to humans. There is urgent need of awareness among dog owners on the role of dogs in transmitting zoonotic helminthiases to other animals and humans as well as effective control measures.

Background

Although the dog has become an indispensable companion of the man, it also constitutes a potential source of a variety of human infections. For many communities, dogs participate in a wide range of cultural, social and economic activities [1]. Dogs play a considerable role in helping the man to improve the quality of life [2]. It has been demonstrated that pet dog owners are healthier than non-owners [3, 4, 5]. Pet dogs can help people under stressful conditions in enjoying their recreation and curing some pathological conditions such as high blood pressure [6]. In addition, people can own dogs for various reasons such as business, hunting, herding livestock, and guarding. Dogs also offer a variety of services such as helping the disabled live independently, search and rescue missions as well sniffing drugs and explosive [7].

On the other hand, dogs can harbour parasitic infections that can be transmitted to livestock and humans including helminths and protozoa [8, 9]. Ascarids and Ancylostomatids have been repeatedly reported to be the main helminths of dogs and cats with a global significance [10]. Dogs contract ancylostomosis through skin penetration or oral ingestion of larvae. Oral transmission occurs through ingesting milk or paratenic hosts or suckling [11]. Canine toxocarosis can be transmitted horizontally or vertically, that is through ingesting earthworms, milk and soil contaminated with viable embryonated eggs or direct maternal foetal transmission during gestation [12].

Human zoonotic helminthiasis is transmitted directly or indirectly via an infected dog or ingestion of contaminated items [13]. Studies conducted around the world reported canine helminthiasis prevalence that varies between 5.9% and 75.26% [14, 15].

A wide range of factors can influence prevalence of helminthiasis in dogs. These factors can be intrinsic such as age, sex and breed or extrinsic like feeding, environment, accuracy of testing, regular deworming and geographical location [16, 17, 18, 14, 19]. The control of helminthiasis in dogs consists of proper hygiene, regular preventive deworming and treatment of clinically ill individuals [15, 20]. However, misuse of anthelmintic drugs may lead to anthelmintic resistance in the treatment of worms infections in both animals and humans [15]. Anthelmintic resistance is primarily prevented through laboratory testing based treatment and respect of drug dosage [10].

Despite that canine helminthiasis are a public and a one health concern; there are no reports on canine helminthiasis in Rwanda. The aim of this study was to determine the prevalence of intestinal helminths in dogs and associated risk factors in Kigali, Rwanda.

Results

Characteristics of study dogs

Faecal samples were taken from 93 clinically healthy dogs. The dogs were of different years of age, sex, breeds and were in different locations (districts). Furthermore, some were regularly or irregularly dewormed. Some dogs were also scavengers or fed on food prepared for them or leftovers from household food or restaurants. In addition some dogs were restricted while others were not-restricted (Table 2). The occurrence of intestinal helminths in study dogs is indicated (Table 1).

Table 1
Results of faecal analysis

Categories of helminths	Frequency	Percentage
<i>Ancylostoma spp</i>	30	32.3
Tapeworms	6	6.5
<i>Toxocara spp and Ancylostoma spp</i>	1	1.0
Sub-total	37	39.8
Non-infected	56	60.2
Total	93	100

Table 2

Frequency distribution and test of associations of canine helminthiases according to selected sample characteristics (n = 93)

Sample characteristics	Canine helminths			P-Value
	Present (%)	Absent (%)	Total (%)	
Deworming frequency				0.588
Never	23(24.7)	27(29.0)	50 (53.8)	
Once to twice a year	4 (4.3)	10(10.8)	14 (15.1)	
At least three times per year	3 (3.2)	5(5.4)	8 (8.6)	
Irregularly	7(7.5)	14(15.1)	21 (22.6)	
Total	37 (39.8)	56(60.2)	93(100)	
Feeding practices				0.153
Food prepared for dogs	9 (9.7)	21 (22.6)	30 (32.3)	
Raw animal origin supplements, leftovers from household family food and restaurants	19 (20.4)	29 (31.2)	48 (51.6)	
Scavenging and leftovers from household food	9 (9.7)	6 (6.5)	15 (16.1)	
Total	37 (39.8)	56 (60.2)	93 (100)	
Control of movements				0.407
Non-restricted	15 (16.1)	18 (19.4)	33 (35.5)	
Restricted	22 (23.7)	38 (40.9)	60 (64.5)	
Total	37 (39.8)	56 (60.2)	93 (100)	
Breed				0.949

The results in Table 2 show that deworming frequency, feeding practices, control of dog movements, breed, age and sex were not statistically significant risk factors of canine helminthiases in dogs while location of dog owners was significantly associated with the prevalence of canine helminthiases in Kigali city.

Local	11 (11.8)	17 (18.3)	28 (30.1)	
Pure or cross	26 (28)	39 (41.9)	65 (69.9)	
Total	37 (39.8)	56 (60.2)	93 (100)	
Age				0.140
< 1 year	2 (2.2)	12(12.9)	14(15.1)	
1-2.5 years	14 (15.1)	13(14)	27(29)	
2.5-5 years	12(12.9)	17(18.3)	29(31.2)	
Overs 5 years	9(9.7)	14(15.1)	23(24.7)	
Total	37(39.8)	56(60.2)	93(100)	
Sex				0.791
Female	28(30.1)	15(16.1)	24(25.8)	
Male	9(9.7)	41(44.1)	69(74.2)	
Total	37(39.8)	56(60.2)	93 (100)	
Study district				0.054
Nyarugenge	13(14)	34(36.6)	47(50.5)	
Gasabo	10(10.8)	9(9.7)	19(20.5)	
Kicukiro	14(15.1)	13(14)	14(29)	
Total	37(39.8)	56(60.2)	93(100)	
The results in Table 2 show that deworming frequency, feeding practices, control of dog movements, breed, age and sex were not statistically significant risk factors of canine helminthiasis in dogs while location of dog owners was significantly associated with the prevalence of canine helminthiasis in Kigali city.				

The prevalence of helminthiasis in dogs was 39.8%. The predominant species was *Ancylostoma spp* (32.3%, n = 93). Of all infected dogs (n = 37), 97.3% were parasitised with one category of helminths whilst 2.7% were infected with two categories of helminths (Table 1). Parasitic load in dogs suffering from ancylostomosis and toxocarosis in Kigali city, Rwanda is shown (Fig. 1).

The univariate analysis of the association of the occurrence of helminthiasis in dogs with the selected potential risk factors in Kigali city is presented in Table 2.

Potential risk factors were considered for multivariable analysis presented in Table 3 in order to detect the extent to which variable categories explain the difference in prevalence of canine helminthiases.

Table 3
Factors influencing helminthic infections among dogs in Kigali city

Variable	Categories	Adjusted Odds	95% C.I. for AOR	
		Ratio (AOR)	Lower	Upper
Dog's deworming frequency	Never	1	Reference	
	Once to twice a year	0.383	0.058	2.511
	At least three times per year	1.504	0.122	18.483
	Irregularly	0.893	0.179	4.449
Dog's feeding practices	Food prepared for dogs	1	Reference	
	Raw animal origin supplements, leftovers from household food and restaurants	4.552	0.747	27.743
	Scavenging and leftovers from household food	8.891	0.802	98.614
Control of dog's movements	Non-restricted	1	Reference	
	Restricted	0.573	0.125	2.632
Dog's breed	Local	1	Reference	
	Pure or cross	1.372	0.389	4.843
Dog's age	< 1 year old	1	Reference	
	1-2.5 years old	14.099	1.938	102.594
	2.5-5 years old	6.860	0.980	48.002
	At least 5 years old	9.166	1.194	70.383
Dog's sex	Female	1	Reference	
	Male	1.230	0.370	4.091
Location	Nyarugenge	1	Reference	
	Gasabo	17.084	3.061	95.356
	Kicukiro	8.756	1.744	43.952
	Constant	0.010		

Variable	Categories	Adjusted Odds	95% C.I. for AOR	
		Ratio (AOR)	Lower	Upper
The results in Table 3 show that dog's age and location (district) were significantly associated with the prevalence of canine helminthiases in Kigali City. The adjusted AOR of having helminthic infection was more than 14, 6 and 9 times higher for dogs that were between the ages of 1–2.5 years, 2.5–5 years, and at least 5 years, respectively compared to those who were younger than one year old. Further, the AORs of infection were more than 17 and 8 times higher in dogs sampled in Gasabo and Kicukiro districts respectively, compared to those sampled in Nyarugenge district. Deworming frequency, control of dog movements, feeding practices, breed, and dog's sex did not directly correlate with canine helminthiases.				
However, the results indicate important differences between categories of the sample characteristics, especially dog deworming frequency, dog feeding practices, control of dog movements, and dog's breed.				
The AOR of dogs suffering from helminthiases was more than 61% lower in dogs dewormed once to twice a year compared to those who were never dewormed. In addition, the AOR was more than 50% higher in dogs dewormed at least three times a year compared to those who were never dewormed. The AOR was more than 42% lower for restricted dogs compared to non-restricted ones. Furthermore, the AOR was more than 5 times higher for dogs fed on raw animal origin supplements, leftovers from family food and restaurants compared to those who were fed on food prepared for them. Besides, the AOR was more than 8 times higher for dogs that lived on leftovers from household food and scavenging compared to those who were fed on food prepared for them.				

Discussion

This study overall prevalence of canine helminthiases in Kigali city was 39.8% and dog's age and location influenced the prevalence. The prevalence was relatively higher than 5.9% found by Pullola *et al.* [15] in Finland. However, it was lower than 75.26% reported by Abere *et al.* [14] in Ethiopia. Husbandry practices such as application of anthelmintics as well as sensitivity of coprological tests may have affected the prevalence. About 86% of dogs investigated by Pullola *et al.* were dewormed at least once a year whilst 46.2% of dogs involved in this study received anthelmintics at different frequencies per year.

In addition, difference in laboratory techniques used may have contributed to these differences. Both the present study and the study by Pullola *et al.* used flotation technique for detecting helminths eggs. However, Abere *et al.* processed samples using direct smear, flotation and sedimentation. Climatic conditions might have also affected difference in prevalences. Rwanda is in Africa whilst Finland is in Europe. The climate for Africa is generally warm while Europe has a temperate climate.

The prevalence of *Ancylostoma spp* (32.3%) was comparable to 31.9% reported by Onyeabor [21] in Nigeria. However, it was higher than 3.8% found by Ilić *et al.* [16] in Serbia. Difference in prevalences may be related to methods used during data collection. In the present study, faecal samples were collected by the authors and processed on the day of sampling. However, faecal samples processed by Ilić *et al.* were collected by dog owners and the sampling was done in three consecutive days.

This sampling procedure might have influenced biology of *Ancylostoma*. Probably, the samples were not processed soon after being taken and might have been analysed after eggs of *Ancylostoma spp* hatched out and larvae could not be detected using floatation technique. Variation in study design did not affect the prevalence of *Ancylostoma spp*: this study was a cross-sectional prospective study whilst Onyeabor conducted a retrospective study.

The prevalence of cestodes (6.5%) was higher than 0.4% and 0.5% reported by Swai et al. [1] in Tanzania and by Barutzki and Schaper [17] in Germany, respectively. However, it was lower than 33% found by Minnaar et al. [22] in South Africa. This could possibly be related to difference in techniques applied during the collection and examination of samples. In this study, the samples were collected from living dogs, whilst Minnaar et al. [22] killed dogs prior to sampling. Furthermore, proglottids or live cestodes were detected macroscopically whilst Minnaar et al. [22] identified eggs of cestodes under microscope. During data collection, Minnaar et al. used tape swabs to retrieve cestode eggs. The swabs were adhered on perianal skin of euthanized dogs.

The prevalence of *Toxocara spp* (1%) reported in this study was lower than 5.1% and 6.1% reported by Neves et al. [18] in Portugal and Barutzki and Schaper [17] in Germany, respectively. Possibly, ages of dogs sampled in this study might have influenced difference in prevalences of *Toxocara*. In our study, 15.1% (n = 93) of the dogs were aged < 1 year whilst 58.3% and 36.1% of dogs investigated by Neves et al. and Barutzki and Schaper, were aged < 1 year each. A dog infected with *Toxocara spp* in this study was older than 2.5 years and was also infected with *Ancylostoma spp*.

The dog had a high level of infection that is EPG of faeces of 750 and 2950 for *Toxocara spp* and *Ancylostoma spp*, respectively. In this study, 41.9% of dogs infected with *Ancylostoma* or *Toxocara* had a high level of infection (EPG $\geq$ 550). This indicates that the dogs could shed a high number of eggs in the environment and put people at risk of contracting zoonotic helminthiases caused by the two groups of helminths.

Similar to previous studies, this study found that dog's age is significantly associated with the prevalence of helminthiases [16, 17, 18]. In addition, it is consistent with the research by Neves *et al.* [18] and Idika *et al.* [23] who found that dog's sex and breed did not statistically influence the prevalence of helminthiases. Furthermore, Awadallah and Salem [24] and Abere et al. [14] found that feeding practices did not impact on the prevalence of canine helminthiases in Egypt and Ethiopia. The present study found a direct correlation between dog's location and the prevalence of canine helminthiases.

Difference in husbandry practices across study sites might have affected the prevalence of canine helminthiases. For example, 50.5% of the sampled dogs were in Nyarugenge district and part of the three sectors selected across Nyarugenge was suburban. The sampled dogs from Gasabo and Kicukiro districts accounted for 20.5% and 29%, respectively and part of study area across the districts was urban. Majority of dogs fed on food cooked for them were in urban study sites. Furthermore, majority of scavenging dogs was in suburbs.

Single time point faecal sampling in this study may have impacted the prevalence of canine helminthiases. Thus, the data in this study is a snapshot prevalence which may not necessarily represent the true burden of canine helminthiases. A kinetic study could shed some light on the prevalence and the dynamics of the disease.

Due to limited resources, researchers could not fully investigate the main canine helminths.

Further study using molecular laboratory technique would be most welcome.

Conclusion

This study findings show that the prevalence of intestinal helminths in the dogs represented 39.8%. All the identified helminths are zoonotic and they constitute a public health risk to humans. Dog's age and residential location influenced the prevalence of canine helminthiases in Kigali city. There is urgent need of awareness among dog owners on the role of dogs in transmitting zoonotic helminthiases to other animals and humans as well as effective control measures.

Methods

Study sites

This study was carried out in Kigali city, the capital city of Rwanda from September 2016 to March 2017. Kigali city is administratively subdivided into three Districts and each district is in turn subdivided into administrative sectors [25]. The present study covered total of nine sectors that were selected from all the three districts of Kigali city (Fig. 2).

Study design

This cross-sectional study involved collecting data on husbandry practices and faecal samples from dogs. Sample size was determined based on dogs' population of 18,117 estimated in 2016 [26]. The number of dogs in Kigali represented 2,157, thus 11.9% of the national dog population [27]. Cluster sampling was used to select three sites (administrative sectors) from each of the three districts and thus nine sites were selected across Kigali city. Systematic random sampling was applied to choose households owning dogs from their lists that were available at sector-level.

Given some households owned many dogs; only one dog per household was randomly selected for data collection. Due to lack of previous studies on canine helminthiases in Rwanda, the prevalence of helminthiases in dogs was assumed to be 50%. Thus, considering a 95% level of confidence, we anticipated a 10% non-response and a level of precision of 10%. The minimal sample size (n) of dogs needed for testing hypothesis on risk factors of helminthiases in the present study was thus estimated using Cochran's formula for determining sample size for proportions [28], as follows: dogs

$$n = \frac{\frac{Z^2 \cdot p(1-p)}{e^2}}{1 + \left(\frac{Z^2 \cdot p(1-p)}{e^2 N} \right)} = 92 \text{ dogs}$$

Where N is the population size and e is the level of precision. Adjusting for 10% non-response rate, the present study targeted an effective sample of 101 dogs.

Data collection

Some study dogs were aggressive and data were successfully collected from 93 dogs. A questionnaire was used to collect data on dogs (age, sex, breeds and location), dog keeping practices (frequency of deworming, feeding practices and control of dog movements) (Additional file 1). The samples were collected directly from the rectum using a gloved finger and kept in faecal jars. Sample was temporarily stored in a cool box pending analysis. Samples were analysed at the laboratories of Rwanda Agriculture and Animal Resources Development Board (RAB) on the day of collection.

Faecal Analysis

The analysis was done on the day sampling using the McMaster technique as previously described by Hansen and Perry [29]. The preparation of float fluid involved dissolving sodium chloride (Park Scientific Limited, UK) in tap water [30]. Cestodes either worms or segments were detected in fresh faecal samples with the naked eye at time of the collection. Cestodes were identified based on a protocol by Bowman and Nelson; Baron; Ballweber; Roberts and Janovy [31, 32, 11, 33]. Various helminth eggs were identified by examining the sample under the light microscope at 10x magnification. Identification of helminth eggs based on shape, thickness of shell and presence of morulae [34].

Data Processing And Analysis

Data were entered in SPSS Version 20. Data were cleaned, organized and then analysed using the Statistics module of SPSS. EPG of faeces were obtained by multiplying the number of eggs by a factor of 50 [29]. In order to quantify levels of infection, EPG of faeces were categorised into three groups: low (50–100), moderate (150–500) and high (≥ 550) [35]. The analysis of faecal samples resulted into a binary response variable that indicated whether a sampled dog was infected or not infected. These data were used to determine the infection prevalence. To investigate associations between selected factors and prevalence of canine helminthiases, data were analysed using a multivariable binary logistic regression model as described by Peng and So [36]. The 95% confidence intervals for the AORs were used to assess the significance and direction of the associations.

Abbreviations

AOR
Adjusted Odds Ratio
EPG
Egg counts Per Gram
RAB
Rwanda Agriculture and Animal Resources Development Board
SPSS
Statistical Package for Social Sciences
BHEARD
Borlaug Higher Education for Agricultural Research and Development
RNEC
Rwanda National Ethics Committee

Declarations

Ethics approval and consent to participate

The study was approved by Rwanda National Ethics Committee (Ethical approval 115/RNEC/2017). Dog owners were explained about this study and signed written consents before participating in the study.

Consent for publication

Not applicable

Availability of data and materials

All data generated or analysed during this study are included in this article.

Competing interests

The authors declare that they have no competing interests

Funding

Part of this work has been funded by BHEARD, award number BFS-G-11-00002, and the predecessor fund the Food Security and Crisis Mitigation II grant, award number EEM-G-00-04-00013. The funder sponsored data collection that is buying reagents and materials and paying transport costs during the collection of faecal samples.

Authors' contributions

PN and PNN conceptualised the work. PN, PNN, FN designed the work. PN collected data and analysed faecal samples. PN and FN analysed and interpreted the data. PN drafted original manuscript. HG, PNN and FN revised the manuscript. All authors read and approved the final manuscript.

Acknowledgements

The authors would like to thank the management of the districts of Kigali city for authorising data collection. We are also grateful to dog owners for frank collaboration during data collection. Furthermore, the authors acknowledge the leadership of Rwanda Agriculture and Animal Resources Development Board for authorising use of the facilities of National Veterinary Laboratory.

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Figures

Figure 1

Parasitic load in dogs suffering from ancylostomosis and toxocarosis in Kigali city. EPG levels in dogs infected with *Ancylostoma* spp or *Toxocara* spp showed that 41.9% had high egg load whilst 35.5% and 22.6% had moderate and low egg load, respectively. Data on egg counts per gram of faeces were not available for dogs infected with cestodes. In these dogs, the worms or their segments were detected macroscopically.

Figure 2

Supplementary Files

- AdditionalFile2.pdf
- Additionalfile1.docx