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Prevalence of Zoonotic Parasites in Stray Dogs in Rural Communities, Tanzania

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Abstract

The aim of this study was to identify and establish the baseline information on the prevalence of zoonotic parasites in stray dogs in Tanzania. A cross sectional study was conducted in Katavi, Arusha and Rukwa Regions in Tanzania. Intestinal parasites were analyzed from faecal samples collected from 364 dogs using modified sedimentation technique. Sixty-six percentage (66%) of the faecal samples were positive for gastrointestinal parasites while 7% had mixed infections, 27% were negative for the parasites. Higher proportions of the faecal samples were positive for gastrointestinal parasites in Arusha and Rukwa compared to Katavi ($p < 0.0001$). The prevalence of *Ancylostoma caninum* (49%) was higher compared to that of other parasites ($p < 0.0001$). Prevalence of *A. lumbricoides* was significantly higher compared to that of *E. granulosus* and *S. stercoralis* ($p = 0.0046$). There was a positive association between parasite positivity rates and collecting dog's faecal samples near domestic animals ($p < 0.00001$). Parasite diversity was higher in stray dogs from Katavi and Arusha ($p > 0.05$). There was no association between parasite diversity and parasite positivity rates. Strategies to control the number of stray dogs should be established to minimize the potential health risks to humans, animal populations and environmental health.

Keywords: Zoonotic parasites, Stray dogs, Prevalence, Tanzania

Introduction

Africa is afflicted by zoonotic diseases whose burden is largely unknown due to lack of specific studies and surveillance programmes. Dogs are excellent companion animals to humans and livestock, and this association may pose a serious threat to public health by increasing risks of infections with zoonotic pathogens originating from the animals (Prociv and Croese 1996, Eslami and Hosseini 1998, Eke et al. 2015, Salomão et al. 2017). Gastrointestinal parasites emanating from dogs can cause significant morbidity to humans, particularly among young people and adults (Payment and Hunter 2001). Studies have shown growing environmental and public health problems associated with stray dogs in cities and suburban areas in different parts of the world (Reese 2005, Strand 2017). In Tanzania, there are neither regulations nor organizations that keep the number of stray dogs in check. This creates potential infection reservoirs for zoonotic pathogens of parasitic, bacterial and viral origins, imposing public health concerns. Early detection of these diseases will provide an opportunity for carrying out appropriate interventions. It is therefore important to investigate the types and distribution of pathogens infecting stray dogs for developing effective intervention programs.

Several studies on the prevalence of soil-transmitted helminths in canines have been reported in many parts of the world (Katagiri and Oliveira-Sequeira 2008, Himsworth et al. 2010, Mateus et al. 2014) including Africa

(Ugbomoiko et al. 2008, Degefu et al. 2011, Swai et al. 2010). All kinds of dogs are involved in the transmission of soil transmitted parasites (Vanparijs et al. 1991). Interaction between humans, wild and domestic animals with stray dogs in Tanzanian communities may augment the risks of infections by endemic and emerging zoonotic infections including parasites zoonoses. To date, in Tanzania there are neither sentinel animal population nor syndromic surveillance approaches for zoonotic diseases. In addition, no data exist on the types of zoonotic infections in urban or rural human populations in Tanzania. Studies suggest that dogs can serve as good sources and sentinels for a wide spectrum of zoonotic diseases (Day et al. 2012, Schurer et al. 2014). In the present study, the prevalence of zoonotic intestinal parasites among stray dogs in three regions of Tanzania was investigated.

Material and Methods

Study area and design

Most of family-owned dogs in rural communities in Tanzania are left free to search for food. In this study, stray dogs were defined as free ranging family-owned dogs. A cross-sectional study was conducted targeting stray dogs from three regions in Tanzania including Rukwa, Katavi and Arusha. Data were collected from Nkasi and Sumbawanga Districts in Rukwa region as well as Mpanda and Arumeru Districts in Katavi and Arusha Regions, respectively. Faecal samples shed by dogs from a total of 8 villages were investigated. The villages included Oldonyowasi, Lemongo and Lesinoni in Oldonyonyosambu, Arumeru District; Chala, Mkwamba and Kipeta in Rukwa District and Mishamo and Kabungu in Katavi (Figure 1). The study was carried out from June 2016 to February 2017.

Sample collection and analysis

Faecal samples shed by family owned-free ranging dogs were collected using convenient sampling technique. Briefly, faecal samples were collected based on availability and proximity of the dogs to the field assistants. Fresh faecal samples were collected using separate wooden sticks around homes, farms and fields and kept in unbuffered 10% formalin (3:7 v/v) and then stored under room temperature for one month after collection and transported to University Dar es Salaam for subsequent analysis. A modified formol-ether sedimentation technique was used to analyze the presence of intestinal parasite stages (trophozoites, ova (eggs), larvae, cysts or oocysts) as described by Casemore (1991). Briefly, faecal samples were emulsified in formol-water using applicator stick to break up stool. About 3 ml of ether was added and the mixture shaken vigorously for 30-seconds, then 15 ml of formol-water mix was added to the mixture. The mixture was then poured into coning Falcon 15 ml conical centrifuge tube through gauze/sieve to separate parasites from faecal debris. The filtrate was then centrifuged at 1000 for 1 minute.

Using a disposable plastic bulb pipette, a column of fluid formed between the ether layers after centrifugation was removed and deposited into a second tube. Formol-water was added to the tube containing sediments and the solution centrifuged at 1000 x g for 10 minutes. The supernatant was then discarded and the deposit divided into two portions; one stained with Lugol iodine for visualizing cysts and oocysts and other portion left unstained for identification of the types of parasites present. Parasite identification was done based on morphological characteristics of eggs, cysts and oocysts (size, shape, colour and thickness of the egg coat).

Data analysis

Data analysis was performed using Graph Prism version 5. Specific parasite prevalence was calculated as the percentage (proportion) of the number of faecal samples testing positive for intestinal parasites over the total number of samples investigated. The significance of the variations between proportions was analyzed using Z-test.

Parasite diversity was obtained using Shannon Wiener diversity index. The variations of parasite diversity between study sites were analyzed using T-test while the associations between parasite positive rates and the environment where the samples were collected were assessed by Chi-square test.

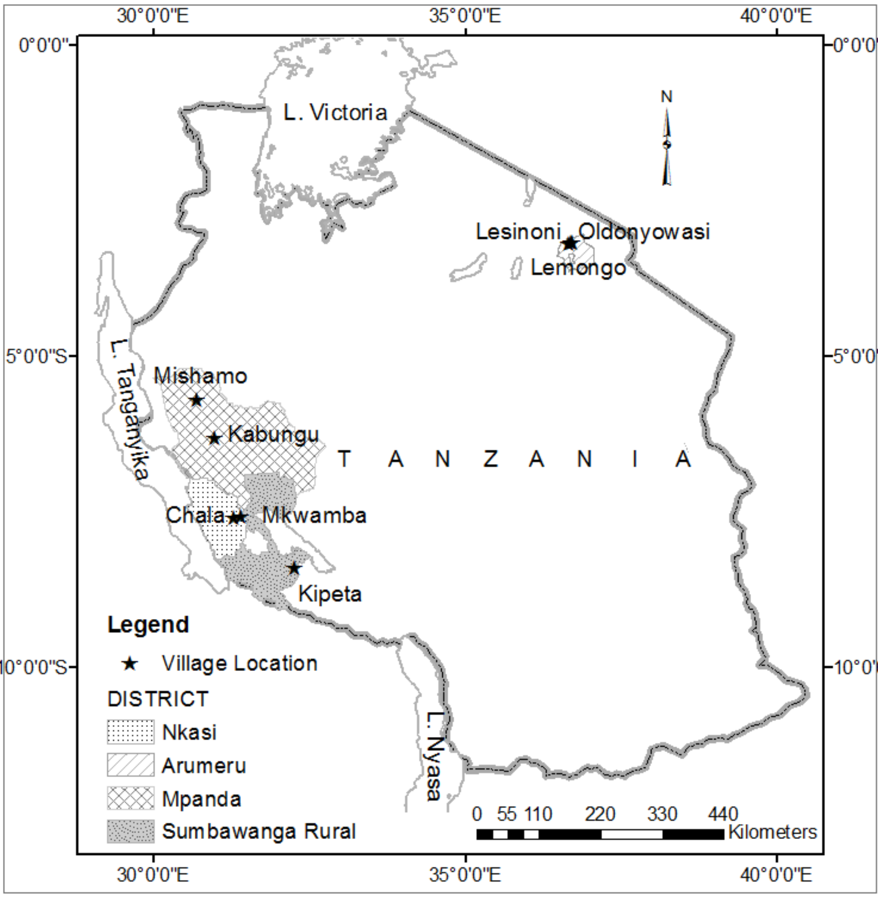

Figure 1: Map of Tanzania showing the study sites.

Results

Proportions of faecal samples positive for parasites and parasite diversity

A total of 364 faecal samples from dogs were collected from the districts of Nkasi (51), Sumbawanga (65), Mpanda (158) and Arumeru (90). Majority of dogs sampled in Mpanda and Arumeru districts were living in close proximity to domestic animals (Table 1). Overall, 66% of the faecal samples were positive for gastrointestinal parasites, which included *Ancylostoma caninum*, *Echinococcus granulosus*, *Ascaris lumbricoides*, *Strongyloides stercoralis*, *Toxocara canis* and *Hymenolepis nana*. Parasite positive rates and individual parasite prevalences are shown in Table 1 and Figure 2, respectively. The positivity *of A. caninum* (49%) was significantly higher than of *A. lumbricoides* (8.8%), *E. granulosus* (6.4%) and *Toxocara canis* (2.4%). Furthermore, the proportion of faecal samples positive for *A. caninum* was the highest in all the study sites compared to other parasite species ($p < 0.0001$, 95% CI and 16.44 to 26.68) (Figure 2).

Table 1: Parasite positive rates, diversity and percentage of faecal samples collected in vicinity of domestic animals

	Parasite positive faecal samples % (n)	Shannon Wiener index (S)	Faecal samples collected in vicinity to domestic animals (%)
Mpanda (Katavi)	83 (131/158)	3.6	65
Sumbawanga (Rukwa)	65 (42/65)	1.7	25
Nkasi (Rukwa)	80 (41/51)	2.8	28
Arumeru (Arusha)	80 (72/90)	4	100

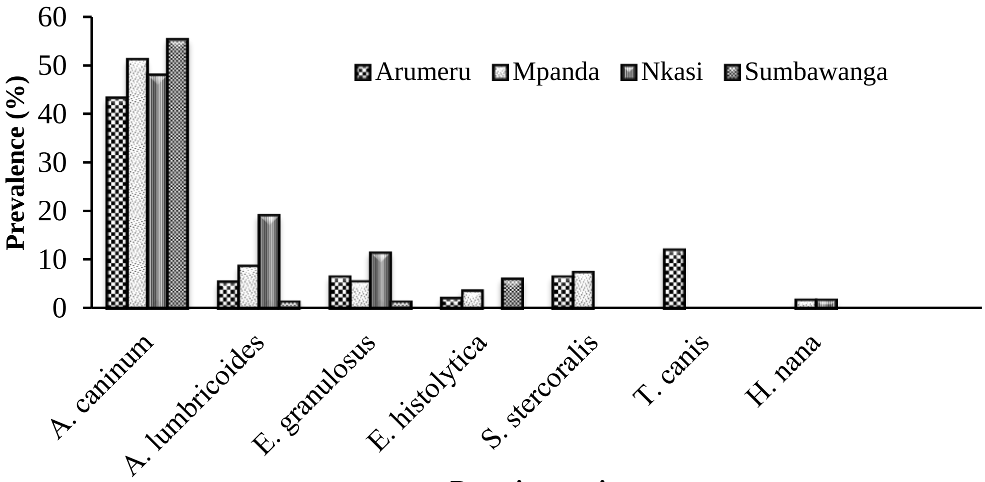

Figure 2: Parasites positivity rates in dogs faecal samples from four sites.

The percentages *of A. lumbricoides* and *E. granulosus* were highest in the faecal samples collected from Nkasi, while *T. canis* was only detected in Oldonyosambu, Arusha (Figure 1). Parasite diversity was significantly higher in the stray dogs from Katavi and Arusha ($p > 0.05$). However, there were no associations between parasite diversity and parasite positivity rates (Chi-square test, $p = 0.93$). There was a positive association between parasite positivity rates and collecting dogs' faecal samples near domestic animals (Chi square test, $p < 0.00001$). Faecal samples that tested positive for multiple gastrointestinal parasites were 14% from Arumeru (Arusha), 5% Mpanda (Katavi), 1% Nkasi (Rukwa) and 6% Sumbawanga (Rukwa).

Discussion

Major parasitic zoonoses associated with stray dogs in Tanzania have not been well documented. This is the first study to analyze and provide baseline data on the prevalence of intestinal parasites in stray dogs from three geographical areas in the country. The common parasites in all the sites were *A. caninum A. lumbricoides and E. granulosus* with *A. caninum* being the most prevalent. Although the public health burden of zoonotic diseases associated with cestodes of dogs (*Echinococcus sp*) and nematodes (*A. caninum* and *T. canis*) in human in Tanzania has not been established, the presence of these parasites in stray dogs suggest risks of parasitic infections to humans as well as to domestic animals through contaminated environment with infective larvae, oocysts and eggs.

There was an overall high proportion of dogs' faecal samples harbouring hookworm infections (*A. caninum*) in all of the study sites. These observations are consistent with studies by Swai et al. (2010) who found high rates of hookworm infections among dogs in Arusha, Tanzania. The elevated proportions of hookworm infections in the dogs may be attributed to the availability of paratenic hosts for the parasites, acquisition of infection by puppies through nursing and potentially though vertical transmission of the parasites *in utero.* The incidence and prevalence of hookworm (*A. caninum*)-associated infection in humans have not been established in Tanzania. However, experimental studies by Landman and Prociv (2003) have shown that oral infection with the hookworm larvae (*A. caninum*) may lead to variation of clinical symptoms including eosinophilic enteritis. It follows therefore that contamination of the environment with *Ancylostoma* eggs from dogs poses high risks of zoonotic infections to humans through either accidental ingestion by geophagia, eating raw vegetables or poor personal hygiene. Children are more at risk of infection due to their unsafe and inherent unhygienic behaviour (such as walking barefoot and eating without washing hands) compared to adults. Further studies on the incidence of eosinophilic enteritis in humans (Alter and Turcios 2009) are needed to establish the burden of *A. caninum* infection.

According to the WHO (2017), about 1 million people are infected with *Echinococcus* parasites. In some parts of Africa, *E. granulosus* has been ranked as the most important zoonotic disease impacting both human and animal health in the areas (Pieracci et al. 2016). In addition, studies on *Echinococcus* infections in dogs in the northern parts of Tanzania have found high seropositivity rates of *E. multilocularis* (Khan et al. 2014). In the present study, faecal samples from all sites tested positive for *E. granulosus* with those from Nkasi District demonstrating higher positive rates. It has been documented that treatment for *Echinoccocus* infection in human is costly and difficult. One of the major challenges in controlling echinococcosis is the requirement for deworming dogs, the definitive hosts for the disease. There are also other issues such as improved meat inspection, slaughterhouse hygiene and public education campaigns that may be difficult to carry out effectively, largely due to lack of sufficient resources and cooperation from various sectors involved. Apart from *Echinoccocus, s*tudies have documented high rates of *T. canis* infections amongst dogs in Arusha (Swai et al. 2010). In the present analysis, *T. canis* was detected only in samples from one study site of Oldonysambu in Arusha Region. Human infection with *T. canis* from embryonated eggs in the environment or larvae from paratenic host may lead to asymptomatic and symptomatic infections associated with vital visceral organs as well as brain and eyes. Further studies to establish patent *Toxocara* infection in dogs and seroprevalence studies in humans in other parts of Tanzania are needed.

In the present study, some faecal samples tested positive for *E histolytica* cysts. The *Entamoeba histolytica, Cryptosporidium spp* together with *Giardia lamblia,* are some of the most important protozoans causing diarrhoea in humans worldwide (Amin 2002, Stauffer et al. 2006, Afriyie and Ryan 2017). *Cryptosporidium* and *G. lamblia* for instance cause cryptosporidiosis and giardiasis, respectively, and the two parasite species have been identified as some of the major causes of water related zoonoses in Tanzania (CDC 2017). According to the surveillance reports, *C. parvum, E. histolytica and Giardia sp* from dogs caused severe syndromes with significant morbidity in humans (Day et al. 2012). According to the 2016 Demographic Health Surveillance (DHS) report, about 86% of rural households in Tanzania mainland use unimproved toilet facilities or have no toilets at all (MoHCDGEC 2016). Being coprophagic, dogs can easily pick up infections from humans and maintain them in the environment. The present study has confirmed the previously known fact that dogs are good sources of *E. histolytica* infections. However, absence of samples positive for *Cryptosporidium* and *G. lamblia* in areas covered by the present study might have been caused by the inability of their stages (oocysts and cysts, respectively) to be isolated from the stool during laboratory analysis. It is thought that the cysts and oocysts of these parasites are trapped in ethyl-acetate plug during centrifugation, one of the steps in the sedimentation technique used to analyse samples in this study. Furthermore, *Giardia* trophozoites might have disintegrated in formalin during storage of faecal samples (Truant et al. 2016).

Domestic animals such as cattle and pigs serve as intermediates or paratenic hosts for gastrointestinal parasites of dogs, some of which are zoonotic such as *Toxocara spp, Echinococcus spp. Granulosus* and *Toxoplasma gondii*. Studies have documented the existence of environmental contamination with gastrointestinal helminths eggs from dogs (Mateus et al. 2014). To date, the estimated number of stray dogs in Tanzania is not known, hence raising difficulty in assessment of health risks related to them. Nevertheless, it is essential to elevate public awareness about dog-related risks of zoonotic diseases and promote improvement of water quality and hand-washing habits and launch interventions to reduce human contact with dog faeces. The “One health" approach and disease prevention strategies suggest possible welfare for animals, humans and the environment. Nevertheless, the present study has revealed that dogs could be sources of intestinal parasites capable of infecting humans. The study can be further investigated by evaluating the burden of canine-borne parasitic infections that pose a threat to human health. Incidentally, the WHO’s one health approach calls for cooperation between governmental institutions such as the Ministries of Education, Agriculture, Health and Natural Resources working together to control zoonotic diseases. More data on regional prevalences for such diseases is essential for developing control measures for animals and public health.

Conclusion

To conclude, stray dogs from rural areas in Tanzania are infected with gastrointestinal parasites of zoonotic importance. Strategies to control the number of stray dogs should be established to minimize the potential risks to human and animal health.

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