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Full Length Research Paper

A cross-sectional study on the prevalence and risk factors associated with *Toxocara canis* infections in dogs

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The objective of this cross-sectional study was to determine the prevalence and risk factors associated with *Toxocara canis* infections in dogs. The study was conducted in three communities in Southwest Nigeria between January, 2011 and February, 2012. Faecal samples (n=474) were processed by modified Kato-Katz procedure. Multiple logistic regression analysis was used to assess risk factors for *T. canis*. An overall prevalence of 34.6% was recorded for *T. canis* . Intensity of infection, determined by the mean number of eggs per gram of faeces (±standard error of mean [SEM]) was 4301.2 ± 348.4. Age of dogs and the mode of life were identified as the significant risk factors for *T. canis*. The odds of being infected with *T. canis* decreased with age. Dogs aged 0 to 6 months were 7.9 times more likely to harbour *T. canis* than dogs aged 31 months and above. The odds of harbouring *T. canis* by stray dogs were 2.7 times more than the kennel dogs. This study shows that *T. canis* infection is high in puppies and stray dogs. There is the need for establishment of deworming program to improve the health status of the dogs and to reduce the risk of zoonotic infection in humans.

Key words: Parasitism, epidemiology, pets, toxocariasis, larva migrans.

INTRODUCTION

Toxocara canis is a widespread gastrointestinal parasite of dogs and a causative agent of zoonotic disease in humans (Barutzi and Schaper, 2003; Ramirez-Barries et al., 2004). Infected dogs can shed large number of eggs into the environment causing infection in other dogs and in paratenic hosts including small mammals and humans (Holland and Smith, 2006). High prevalences of this parasite had been reported by various researchers both in stray dogs and wild canids such as foxes (O'Lorcain, 1994; Dubinsky et al., 1995). Studies have also shown that well-cared for dogs are also infected with *T. canis* (Sowemimo and Asaolu, 2008).

Previous studies conducted in tropics and sub- tropics including Nigeria have reported *T. canis* as one of the most frequently encountered canine parasites. In a study investigated by Degefu et al. (2011) to determine the gastrointestinal parasites among 334 household dogs in Jimma town, Ethiopia. They reported *T. canis* as the second most frequently observed parasite with a prevalence of 27.3%. In another study, Swai et al. (2010) examined faecal samples collected from 241 non-descript healthy dogs in and around Arusha municipality, Tanzania for gastrointestinal helminth infections.

They reported an overall prevalence of 73.8% for helminth parasites. Further, it was reported that *T. canis* was the second most frequently observed parasite with a prevalence of 13.7%.

In Nigeria, Kutdang et al. (2010) examined faecal samples collected from 1000 dogs from two Local Government Area (LGA), Jos North and Jos South LGAs, Plateau State, Nigeria for eggs of intestinal helminth parasites. They reported an overall prevalence of 66.1% for helminth parasites. In addition they reported a prevalence of 31.8% for *T. canis*. In another study, Biu et al. (2012) investigated gastrointestinal helminth infections among 138 dogs resident on the University of Maiduguri campus, Borno State, Nigeria. They reported *T. canis* as the second most frequently observed parasite with a prevalence of 27.3%.

T. canis infections have, because of their zoonotic significance, important public health consequences especially in developing countries and communities that are socioeconomically disadvantaged (Craig and Macpherson, 2000). There are factors which have been reported to play a role in the epidemiology of *Toxocara* infections in dogs and they include age of dogs, sex, breed type and dog breeding kennels (Habluetzel et al., 2003; Senlik et al., 2006; Pullola et al., 2006). The risk of *T. canis* infection has also been reported in people who suffer from pica, a compulsion to eat mainly non-nutritive items, and particularly soil (Holland et al., 1995; Mizgajska- Wiktor and Uga, 2006). In Nigerian dogs, age and sex of dogs have been reported as risk factors for *T. canis* transmission (Sowemimo and Asaolu, 2008).

There is the need to investigate whether there are other factors that can contribute to the prevalence of *T. canis* infections in Nigerian dogs. In attempt to fill this gap, a cross-sectional study was conducted to determine the prevalence, intensity and the associated risk factors for *T. canis* infection in dogs in three communities in Southwest, Nigeria.

MATERIALS AND METHODS

Study area

This study was carried out in Ile-Ife, Ede and Ondo communities, Ile-Ife has been described in earlier report (Sowemimo, 2007). Ede is in Ede South Local Government Area in Osun State. It has a population of 76,035 according to National Population Commission (NPC) census 2006 estimates. It is located on Latitude 7° 42'N and Longitude 4° 27'E. The climate is typically tropical with well-defined wet (April-October) and dry (November-March) seasons, a mean annual precipitation of over 1100 mm, mean annual temperature of 27°C and relative humidity of 85% (Ayoade, 1982).

Ondo (Latitude 7° 05'N; Longitude 4° 50'E) is located within the humid region of Nigeria. Ondo lies in the rainforest zone with an annual rainfall range between 1300 and 1600 mm and a temperature range between 21 and 29°C. The tropical climate is broadly of two seasons'; rainy season (April to October) and dry season (November to March). The vegetation is typical rainforest and sub-savannah forest (Ayoade, 1982).

The inhabitants of the three communities are a mixture of people from different ethnic groups in Nigeria, although the majority is the Yoruba-speaking people of the Southwest. They are mainly peasant farmers growing cocoa, vegetables, maize, yam, and cassava. Traders, civil servants, artisan workers fishermen (common among Ondo people) and transport workers are found in smaller numbers.

Faecal sampling

Individuals owning dogs in each of the community were visited between January 2011 and February 2012 and the purpose of the study was explained. Questionnaires were then distributed to owners of dogs for the collection of demographic and socio-economic information which include the approximate age of dog, sex, mode of life, type of breed (African and exotic) type of food, anthelminthic regimen, occupation of owners of dog, place of defecation and awareness and knowledge of canine parasite zoonoses. Thereafter, clean specimen bottles were distributed to owners of dogs for the collection of specified quantity of faecal sample. The specimen bottles containing the faecal specimen were collected from owners of dogs and transported immediately to the Department of Zoology, Obafemi Awolowo University for preservation. About 10 g of faeces from each dog was mixed thoroughly with 10% aqueous solution of formaldehyde for preservation. Samples were processed for egg concentration in the laboratory using modified Kato-Katz method (Forrester and Scott, 1990) and examined for *T. canis* eggs using a light microscope at a magnification of ×100. In addition to qualitative diagnosis, an indirect measure of parasite intensity was obtained by counting eggs, expressed as eggs per gram of faeces (epg).

Statistical analysis

Version 16.0 of the SPSS for Windows Software Package (SPSS Inc, Chicago, IL) was used for all the data analysis. Chi-squared analysis was used to determine whether the prevalence of *T. canis* varied significantly among communities, and between age and sex. A Mann-Whitney U test was used to test the difference in intensity (epg) between sexes, modes of life and breeds while Kruskal-Wallis tests were used to test the difference in epg among age groups and communities. Multivariate logistic regression was further carried out to assess the predictive effect of the various variables measured on the prevalence of *T. canis* infection in the communities. All the variables were initially entered into the analysis and stepwisely removed (Backward Method, Wald) or added (Forward Method, Wald) until only the significant variables remained in the analysis. P-value less than 0.05 were taken as statistical significant association between dependent and independent variables.

RESULTS

An overall prevalence of 34.6% was recorded for *T. canis* infection in the dogs examined (n = 474). The prevalence of *T. canis* in relation to different factors is shown in Table 1.

The highest prevalence (56.6%) of *T. canis* infection was recorded in dogs age 0 to 6 months old and significantly higher than those of older age groups (P<0.05). The prevalence showed a decreasing trend with increasing age with the lowest recorded in dogs aged 19 to 24 months.

Male dogs were more frequently infected (37.0%) than females (32.3%) (P>0.05). The prevalence of *T. canis* infections was significantly higher in stray (42.4%) than in domiciliated dogs (20.6%). Similarly, the prevalence of infection was significantly higher in African (African shepherd) breed (39.3%) than in exotic breeds (24.3%) (Labrador, Mongrel, Alsatians, Ridgeback, Doberman) (P<0.05).

Table 1. Prevalence (%) and intensity (I) of *T. canis* infection in relation to age, gender, breed types and mode of life in the three communities combined' Nigeria, 2014.

Variable	No. examined	No. (%) infected	I (Mean ± SEM)
0 – 6	205	116 (56.6)	7588.4 ± 638.9
7 – 12	118	24 (20.3)	2152.3 ± 489.2
13 – 18	51	11 (21.6)	2178.4 ± 654.8
19 – 24	33	2 (6.1)	601.5 ± 474.3
25 – 30	17	3 (17.6)	1140.7 ± 702.5
≥ 31	50	8 (16.0)	1576.3 ± 752.2
Total	474	164 (34.6)	4301.2 ± 348.4
P-value	-	< 0.05	< 0.05
Sex			
Male	243	90(37.0)	4415.2 ± 500.0
Female	231	74(32.3)	4181.2 ± 485.0
P-value	-	>0.05	>0.05
Mode of life			
Stray	304	129 (42.4)	5438.5 ± 497.6
Kennel	170	35 (20.6)	2267.3 ± 421.2
P-value	-	< 0.05	< 0.05
Breed type			
Local	326	128 (39.3)	4827.4 ± 429.7
Exotic	148	36 (24.3)	3142.1 ± 581.5
P-value	-	< 0.05	< 0.05

I: Intensity; SEM: Standard Error of Mean.

Intensity of infection

The overall mean intensity recorded for *T. canis* infection among the infected dogs was 4301.2 ± 348.4 (Table 1). The intensity pattern was similar to that of prevalence with intensity of infection being the highest in dogs aged 0 to 6 months old and significantly higher than in older age groups (P<0.05). The intensity of *T. canis* infection was higher among the males than female dogs, however, there was no significant difference between the intensities of the two sexes (P>0.05). The intensity of *T. canis* infections was significantly higher in stray than in domiciliated dogs (U=19920, df=1: P=0.000). Similarly, the intensity of infection was also significantly higher in African breed than in exotic breed (U=20580, df=1; P=0.003) (P<0.05).

Questionnaire analysis

The responses received to the questionnaire showed that 304 (64.1%) of the dogs defecate outside of which 42.4% were infected with *T. canis*, while 170 (35.9%) of the dogs defecate inside out of which 20.6% were infected (Table 2). 395 (83.3%) of the respondents were aware that dogs harbour worms, while 181 (38.2%) respondents know that dogs have zoonotic parasites. Among the respondents who have knowledge of canine zoonotic parasites, 23.2% of their dogs were infected with *T. canis*, while 41.6% of the dog's whose owners have no idea were infected.

Logistic regression analysis

Based on the results from the chi-squared analysis identifying potential risk factors, we specified a maximal logistic regression model comprising the following explanatory factors: mode of life, age of dogs, dog breed type, place of defecation, anthelminthic treatment, knowledge of dog harbouring worms and awareness of canine parasite zoonoses (Table 2). After adjusting for the effect of individual variables, *T. canis* infection in dogs can be explained by two of the variables entered into the model (Table 3). These are the age of dogs and mode of life. The risk factors analysis showed that the odds of being infected with *T. canis* decreased as the age of dogs increased. Dogs aged 0 to 6 months were 7.9 times more likely to harbour *T. canis* than dogs aged 31 months and above. Stray dogs were 2.7 times more likely to harbour *T. canis* eggs than kennel dogs.

DISCUSSION

The overall prevalence of *Toxocara canis* obtained in this study (34.6%) was comparable to 41.7% reported from Ilorin, Kwara State with a similar ecological and epidemiological settings in Nigeria (Ugbomoiko et al., 2008), 33.6% from Italy (Habluetzel et al., 2003), but higher than the prevalence of 14.54% reported from USA (Blagburn, 2011), 12.5% from Japan (Yamamoto et al., 2009), 8.7% from Fortaleza Brazil (Klimpel et al., 2010), 3.1% from Finland (Pullola et al., 2006) and 4.4% from Northern Belgium (Claerebout et al., 2009). This variation may be due to differences in management systems, health care and degree of environmental contamination with infective

Table 2. Chi-squared (^{2}) analysis for factors significantly associated ($p<0.05$) with *T. canis* infections among dogs.

Variable	Group	N	Prevalence	^{2}	P-value
Age (Months)	0 – 6	205	56.6	79.91	<0.001
	7 – 12	118	20.3		
	13 – 18	51	21.6		
	19 – 24	33	6.1		
	25 – 30	17	17.6		
	≥ 31	50	16.0		
Mode of life	Stray	304	42.4	22.99	<0.001
	Domiciliated	170	20.6		
Breed origin	African	326	39.3	10.04	0.002
	Exotic	148	24.3		
Place of defecation	Outside	304	42.4	22.99	<0.001
	Inside	170	20.6		
Anthelminthic treatment	Yes	215	28.8	5.77	0.02
	No	259	39.4		
Aware that dog harbor worm	Yes	395	31.1	12.54	<0.001
	No	79	51.9		
Aware of canine zoonoses	Yes	181	23.2	16.80	<0.001
	No	293	41.6		

[a]The prevalence of *T. canis* positive cases to show the direction of association.

stages and exposition to natural infection more than owned dogs. Studies have shown that dog's well cared for by their owners and given veterinary attention has lower prevalence of intestinal parasites than dogs lacking such priviledges (Hendrix, 2006; Sowemimo and Asaolu, 2008).

In this study, age was the most significant risk factor for *T. canis* infection in the logistic regression model. The prevalence pattern also shows that it was age-dependent; *T. canis* decreased with age of dog. The ex-pected high prevalence of *T. canis* recorded in dogs aged 0 to 6 months is in accordance with the transmission pattern of the parasite, which is mainly by transplacental and transmammary routes; acquired age-dependent immunity may be caused by repeated exposure (Sprent, 1957, 1961). The high prevalence of *T. canis* (56.6%) in dogs aged 0 to 6 months compares well with studies under-taken in Netherlands (48%) (Overgaauw and Boersema, 1998), Ile-Ife Nigeria (51.4%) (Sowemimo, 2007) and UK (65.8%) (Jalaya, 1969).

Stray dog was significantly associated with the prevalence of *T. canis* and was retained as a significant risk factor in the logistic regression model. The high pre-valence of *T. canis* infection in stray dogs is a reflection of the fact that stray dogs roam freely without proper care such as the regular administration of anthelminthic drugs. They are more susceptible to *T. canis* infection through the ingestion of paratenic hosts as food sources as a result of their scavenging habits. Several other studies have reported high prevalence of intestinal parasites among stray and uncared for dogs than in kennel dogs (Pandey et al., 1987; Minaar et al., 2002; Martinez-Moreno et al., 2007; Sowemimo, 2009). These findings are clear indications of the serious public health challenges attributable to stray dogs in Nigeria and many other third world nations where dog control laws are non-existing or loosely enforced by government agencies. Therefore, appropriate control laws and stricter enforcement are therefore inevitable components of any control initiatives in endemic societies.

Our questionnaire data on defecation sites revealed that over 40% of the dogs who defecate outside were infected with *T. canis* . The implication of this is that since dogs are left to roam the streets unhindered, there is the possibility of contaminating the environments with *T. canis* eggs which are voided with faeces. Many public places including children playing grounds are likely to be contaminated with these eggs, thereby exposing children

Table 3. Result of logistic regression analysis showing the effect of age and mode of life on the prevalence of *T. canis* in the three communities in Southwest, Nigeria.

Parameter[a]	No. examined	Odds ratio (95% CL)	P-value
Dog's age (months)			
0 – 6	205	7.87 (3.33 – 18.58)	0.00
7 – 12	118	1.45 (0.58 – 3.65)	0.43
13 – 18	51	1.48 (0.52 – 4.23)	0.46
19 – 24	33	0.32 (0.06 – 1.65)	0.17
25 – 30	17	1.21 (0.27 – 5.47)	0.81
≥31[b]	50		
Mode of life			
Stray	304	2.75 (1.30 – 5.84)	0.008
Kennel[b]	170		

95% CL, 95% Confidence Limit; [a]Variables are arranged in the order they were removed by the Backward Stepwise method (Wald); [b]Reference group. ^{2} = Chi^2.

to accidental ingestion of the eggs through their habits of playing with soil.

Questionnaire results also showed that even though more than half of the individuals surveyed are aware that dog harbour worms, they lacked awareness and knowledge of canine parasitic zoonosis. The high prevalence of *T. canis* recorded among dogs whose owners have no knowledge of canine zoonosis calls for great concern. There is the need for greater awareness of the problem among the population in the area of study. Awareness of the possible infection routes need to be raised: for children and adults egg intake can be the consequence of soil related activities such as playing, gardening, sweeping or of contaminated vegetable consumption (Genchi et al., 1990)

From the results of this study, stray dogs and puppies (aged 0 to 6 months) have been identified as important source of *T. canis* infections in dogs. In addition to the health implications for dog with patent infections one might consider the health hazard to humans. In view of the fact that *T. canis* has been implicated as the causative agent of visceral larva migrans in humans, there is the need for intervention measures to reduce the risk of transmission of the parasite from dogs to humans. Interventions should focus on health education provided to dog owners such as using effective anthelminthic for deworming and establishment of a program based on zoonotic diseases.

Limitations

One of the limitations to this study includes a single stool sample collected from each dog examined; because only a single stool sample was collected on each dog in this study, using the Kato-Katz preparation to determine infection status, there is likely to be a significant underestimation of infection in individual dog.

Conflict Interests

The authors declare that there is no conflict of interests regarding the publication of this article.

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