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Prevalence of *Toxocara canis* eggs in hairs of dogs in Saki Southwestern Nigeria

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Toxocara canis is one of the most prevalent gastrointestinal parasites of dogs and other canids worldwide. The closeness shared between humans and their companion animals (dogs) exposes humans to high risk of T. canis eggs, which leads to Visceral Larva Migrans (VLM) and Ocular Larval Migrans (OLM). This cross-sectional study was design to determine the prevalence and intensity of Toxocara canis eggs on the hair of dogs in Saki town, Oyo State. Six hundred and twenty seven (627) hair samples were collected from three regions (neck, dorsum, and peri-anal regions) of 209 dogs between July 2019 and January 2020. Socio-demographic data, associated risk factors and knowledge about the T. canis were obtained from dog owners using a structured questionnaire. Hair samples from 84 dogs were infected with eggs of T. canis giving an overall prevalence of 40.2%. Generally, a significantly higher ($p<0.05$) prevalence of T. canis eggs was recorded among female dogs (47.4%) than male dogs (34.2%), also among the adult dogs (48.8%) than puppies (41.6%) and the juveniles (21.3%). Higher prevalence of infection was recorded among stray (67.4%) than kenneled (20.0%). A generally low knowledge of T. canis was observed among dog owners. A bivariate logistic regression analysis showed a significant association between the age, sex and mode of life of the dogs examined. The study concluded that dogs in the study area harbour T. canis eggs on their body especially the stray dogs and puppies hence direct contact with infected dogs could be a potential risk factor for the transmission of T. canis eggs to humans

Key words: Prevalence, Eggs, *Toxocara canis*, Nigeria, Dogs, Saki, Zoonoses, Intensity.

INTRODUCTION

Pet keeping is beneficial to human in terms of socialization, mental health and even physical wellbeing (Paul et al., 2010). Alongside these benefits, pets harbour a wide variety of parasites, some of which have zoonotic potentials to human. *Toxocara canis* Werner, 1782, a parasitic ascarid nematode of dogs, is considered to be one of the most common gastrointestinal helminth parasites of dogs and other canids. It has been reported

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in dogs worldwide (Overgaauw et al., 2009; Akeredolu and Sowemimo, 2014; Sowemimo and Ayanniyi, 2016) in purely terrestrial habitats (Xi and Jin, 1998). Infection has not only been reported in small mammals and other other paratenic hosts but also in human and it is majorly through fecal-oral transmission route which is usually common in a poor neighborhood where stray dogs are wide spread (Overgaauw and Knapen, 2012). In human, infection occur through ingestion of infective *T. canis* eggs through contaminated soil, fruits or vegetables; through unwashed hands contaminated by direct contact with puppies or coat of dogs. The infection can also be contracted through ingestion of larvae in undercooked infected organs or muscle tissues (Wolfe and Wright, 2003). Human infection with *T. canis* may results in any of these three syndromes depending on the part of the body affected; Visceral Larva Migrans, Covert toxocariasis and Ocular toxocariasis (Taylor and Holland, 2001). Human infection with *Toxocara* species is considered to be primarily through contact with contaminated soil (Overgaauw, 1997). This is because the eggs once released with the dog faeces are not infective and thus requires suitable environmental conditions to develop to infectivity (Keegan and Holland, 2010). However, recent detection of eggs of *T. canis* in hairs of dogs has implicated it as a possible route of transmission to man in different parts of the world (Roddie et al., 2008; Overgaauw et al., 2009). The presence of both embryonated and unembryonated eggs on the hair of dog as reported from studies from different parts of the world further implicates dog hair or coats as a possible transmission route from dogs to human Maria et al. (2019). Although Sowemimo and Ayanniyi (2016) and a few other researchers have carried out studies on the prevalence of *T. canis* on the hair of dogs in Nigeria, there is still a paucity of information on the prevalence of *Toxocara canis* eggs in the hair of dogs in Nigeria. Therefore, this study was carried out with the aim of providing information about the current status of *Toxocara canis* on the hair of stray and domestic dogs in Saki, Southwestern Nigeria. It will also provide more information about the developmental stages of the eggs recovered from the hair of the dogs and the level of intensity in relation to the dog's age, sex, mode of keeping, and breed.

MATERIAL AND METHODS

Study Area

This cross- sectional study was carried out in Saki Town, Saki West Local Government Area of Oyo State. The study area is located in the South-west geo-political zone and has an equatorial climate with dry and wet seasons and relatively high humidity (Salawu et al., 2014). The inhabitants are predominantly Yoruba speaking people of the Southwest with a mixture of people from different ethnic origin in Nigeria which include Hausa, Fulani and Ibo. Farming is the main occupation of the people but some inhabitants are traders, transport workers, artisans and civil servants. Majority of the inhabitants are involved in the rearing of domestic animals which include goat, sheep, dog, cat, chicken and duck (Salawu et al., 2014)

Questionnaire approach

Dog owners were identified and house to house visits were made in the study area between July, 2019 and January, 2020. The dog owners were adequately informed on the purpose and significant of the study. Written informed consents were obtained and a well – structured, open ended and pre-tested questionnaires were administered to those interested in participating in the survey. Information about educational level of dog owners, dog management practices such as anthelminthic treatment regimen, mode of life, type of food, place of defecation, breed type as well as the knowledge of the dog owners about parasites of dogs and their zoonotic potentials were asked. The age, sex and other morphometric parameter of each dog was recorded.

Sample collection and egg recovery technique

Hair samples were taken with the aid of small scissors from three different parts of dog's body; the neck, dorsum, and peri-anal regions. The scissors was washed with detergent solutions and disinfected with a halogenated organic compound in-between each hair sample collection. Each hair sample was placed in a labeled re-sealable prescription bags containing the identification number assigned to each dog on their owners questionnaires. The hair samples were transported to the Parasitology Laboratory, Obafemi Awolowo University Ile-Ife, stored at 4°C and examined within 2 weeks. Eggs were recovered from the hair using a modified technique by Bakhshani et al. (2019) that was previously described by Overgaauw et al. (2009). The recovered eggs from the hair sample of the dogs were classified into four groups depending on stage of development: non-viable (egg wall disrupted or egg not intact), viable (intact egg with contents), embryonating egg (egg with two or more cell divisions) and embryonated (containing a larva) as described by Roddie et al. (2008)

Statistical analysis

All statistical analyses were performed using SPSS for windows version 21.0. Hair contamination in different sex, age groups, breed and mode of life was analyzed using chi-square test. One-way Anova was used to test differences in egg number of *T. canis* in different groups. Statistical difference was assigned at $P \leq 0.05$. Bivariate logistic regression was further carried out to assess the predictive effect of the various variables on the presence of *T. canis* eggs on hair of dogs in the study area.

RESULTS

A total of 627 hair samples were examined from 209 dogs within seven months of sampling. The prevalence of *T. canis* eggs in the hair of the dogs in relation to age, sex, breed and mode of life in the study area is shown in Table 1. As shown in the table, the overall prevalence of *T. canis* eggs was 40.2% in the hair samples of the dogs examined. *T. canis* eggs were significantly higher ($p<0.05$) among female dogs (47.4%) than among male

Table 1. Prevalence of *T. canis* eggs in dogs in relation to age, sex, breed, and mode of life in Saki Township.

Variable	Category	No. examined	No. Infected	Prevalence (%)
	Puppy (0-6)	72	30	41.6
	Juvenile (7-12)	47	10	21.3
Age(months)	Adult (>12)	90	44	48.8
	Total	209	84	40.2
	P-value	-		<0.05
	Male	114	39	34.2
Sex	Female	95	45	47.4
	P-value	-		<0.05
	Local	137	55	40.1
Breed	Exotic	72	29	40.3
	P-value	-		>0.05
	Stray	89	60	67.4
Mode of life	Kenneled	120	24	20.0
	P-value	-		<0.05

Source: Salawu and Akeredolu, 2022; Prevalence of Toxocara canis eggs in hairs of dogs in Saki Southwestern Nigeria

dogs (34.2%) in this study. Significantly higher prevalence of 48.80% and 41.6% of *T. canis* were also recorded in the hair samples collected from adult and puppies respectively while lower prevalence (21.3%) was recorded among the juvenile ($p<0.05$). Similar prevalence of *T. canis* eggs were recorded in the hair of both the local breed (40.1%) and exotic ones (40.3%). However, significantly higher ($p<0.05$) prevalence of *T. canis* eggs was recorded in stray dogs (67.4%) as compared to kenneled (20.0%). Table 2 shows the dog's hair intensity of infection of each body region in relation to the dog's mode of life and age-group. A total of 1,103 eggs were recovered from different regions of the hair on the dogs in this study out of which 20.1% were not viable, 38.8% were viable, and 23.6% were observed embryonating; while 17.4% were embryonated (Table 2). From the different regions of the dogs' body that were examined, 353 (32.0%) eggs were recovered from the neck, 457 (41.4%) eggs recovered from the dorsum and 293 (26.5%) eggs recovered from the perianal region (Table 2). There was a significant difference ($p<0.05$) in intensity of *T. canis* with respect to dog's body region. In all the eggs that were recovered, 44.4% of eggs were from puppies, 21.5% from juveniles and 34.1% were recovered among the adult dogs (Table 2). It was also observed that puppies' habour more embryonated eggs on the dorsum (29.7%) and peri-anal (35.6%) regions of the body, while juveniles habour more embryonated eggs in the neck region (18.5%) than the puppies and adult dogs.

Analysis on the dog's mode of life showed that 80.1% of total *T. canis* eggs were recovered from stray dog's hair sample while 19.8% were recovered from domesticated or kenneled dogs (Table 2). Also, stray dogs harbour more embryonated eggs on all the body regions with the highest (29.8%) on the peri-anal region of the body (Table 2). There was a significant difference ($P<0.05$) in prevalence of *T. canis* with respect to dog's body region. The mean intensity of total *T. canis* egg recovered on the hair sample of the dogs in this study is 12.98±0.874epg per dog (Table 3). Considering the intensity of embryonated eggs, puppies had the highest number of eggs (110) with mean intensity of 12.22±2.047epg while both juvenile and adult dogs respectively had 43 (13.00±4.359epg) and 39 (10.73±2.136 epg) (Table 3). Knowledge about Toxocariasis was assessed among the participants which are dog owners through the use of questionnaire and the results are summarized on Table 4. One hundred and twenty (57.47%) of the participants claimed to keeping dogs basically for security reasons while most of them (180, 86.12%) claimed to like touching and playing with dogs. Majority of the participants (197, 94.25%) claimed not to wash their hands after playing or touching different parts of dog's body. A total of 51(24.40%) of the participants confessed to touching or rubbing all parts of dogs body while 19(9.09%) like touching the head region alone. Majority of the participants (146, 69.85%) do not see need to bathe their dogs.

The participants in the study area displayed total ignorance about canine zoonoses most especially *T. canis*, its biology, transmission or prevention. None of the

Table 2. The number and state of eggs found on the dog's hair in each body region in relation to dog's mode of life and age-group.

Body Region	Mode of life	Non-viable (%)	Viable (%)	Embryonating (%)	Embryonated (%)	All eggs (%)
	Stay	116(40.3)	144(50.0)	6(2.1)	22(7.6)	288
Neck	kenneled	15(23.1)	39(60.0)	11(16.9)	-	65
	Total	131(37.1)	183(51.8)	17(4.8)	22(6.2)	353
	Stay	34(9.3)	153(41.9)	94(25.7)	84(23.0)	365
Dorsum	kenneled	31(33.7)	31(33.7)	30(32.6)	-	92
	Total	65(14.2)	180(39.3)	124(27.1)	84(18.4)	457
	Stay	13(5.6)	61(26.4)	88(38.1)	69(29.8)	231
Per-anal	kenneled	13(20.9)	-	32(51.6)	17(27.4)	62
	Total	26(8.8)	61(20.8)	120(40.9)	86(29.4)	293
	Grand Total	222(20.1)	428(38.8)	261(23.6)	192(17.4)	1103
	P-value					<0.05
Body Region	**Age group**					
	Puppy	73(38.8)	94(50.0)	11(5.8)	10(5.3)	188
Neck	Juvenile	22(33.8)	31(47.6)	-	12(18.5)	65
	Adult	36(36.0)	58(58.0)	6(6.0)	-	100
	Total	131(37.1)	183(51.8)	17(4.8)	22(6.2)	353
	Puppy	9(6.8)	45(34.4)	38(29.0)	39(29.7)	131
Dorsum	Juvenile	13(10.2)	54(42.5)	29(22.8)	27(21.3)	127
	Adult	43(21.6)	81(40.7)	57(28.6)	18(9.0)	199
	Total	65(14.2)	180(39.3)	124(27.1)	84(18.4)	457
	Puppy	26(15.2)	12(7.0)	72(42.1)	61(35.6)	171
Peri-anal	Juvenile	-	9(20.0)	36(80.0)	-	45
	Adult	-	40(51.9)	12(15.6)	25(32.5)	77
	Total	26(8.8)	61(20.8)	120(40.9)	86(29.4)	293
	Grand Total	222(20.1)	428(38.8)	261(23.6)	192(17.4)	1103
	P-value					<0.05

Source: Salawu and Akeredolu, 2022; Prevalence of Toxocara canis eggs in hairs of dogs in Saki Southwestern Nigeria

participants claimed to have heard about toxocariasis and majority of them (194, 92.82%) claimed not to be aware of canine zoonoses (Table 4). The risk factor analysis showed that the odds of being infected with *T. canis* eggs on the hair of dogs is approximately 2 times more likely among the female dogs than their male counterpart (Table 5). It was also observed that the odds of been infected is 3times more among the stray dogs than the kenneled. Also, the odds of being infected on the hair by *T. canis* eggs is 6 times more among the younger dogs than the older ones (Table 5).

DISCUSSION

In this study, overall prevalence of 40.2% of *T. canis* eggs were recorded from hair samples of 209 dogs. This result is higher than 18.0% earlier reported by Sowemimo and Ayanniyi (2016), 12.16% reported by Overgauw et al. (2009), 8.8% by Keegan and Holland (2010), and 25% by Wolfe and Wright (2003), in Nigeria, Netherlands, United Kingdom and Ireland respectively; but lower than 67% and 49% reported by Roddie et al. (2008) and Oge et al. (2014) in Ireland and Turkey respectively. The variation in prevalence of *T. canis* eggs recovered from hair of dogs in different studies might be due to different geographical location, management systems, healthcare, degree of environmental contamination and methodology employed (Akeredolu and Sowemimo, 2014). The presence of *T. canis* eggs in the hair of dogs have been reported by many authors from various parts of the world (Wolfe and Wright, 2003; Rogosz, 2007; Roddie et al. 2008; Keegan and Holland, 2010; El-Tras et al., 2011; Sowemimo and Ayanniyi, 2016) and it has suggested that direct contacts,

Table 3. Intensity of *T. canis* eggs found on egg-positive hair samples in relation to age- group of dogs.

Age-groups	Non-viable	Viable	Embryonating	Embryonated	All-eggs
Puppy, n=54					
Mean±SEM	10.80±0.987	10.79±1.187	11.00± 0.953	12.22±2.047	14.00±1.549
Median	12.00	11.00	10.00	10.00	11.00
Total	108	151	121	110	490
Juvenile, n=12					
Mean±SEM	17.50±7.500	8.91±1.540	10.83±2.372	13.00±4.359	11.29±1.441
Median	17.50	9.00	9.00	12.00	10.00
Total	35	98	65	39	237
Adult, n=18					
Mean±SEM	15.80±2.332	11.93±2.329	12.50±2.861	10.73±2.136	12.97±1.466
Median	12.00	10.00	12.00	10.00	12.00
Total	79	179	75	43	376
All dogs, n=84					
Mean±SEM	13.06±1.267	10.70±1.048	11.35±1.019	12.00±1.414	12.98±0.874
Median	12.00	10.00	10.00	10.00	11.00
Total	222	428	261	192	1103

Mean and median values are all per gram of hair, SEM: standard error of mean.
Source: Salawu and Akeredolu, 2022

with dogs may be important risk factor for human (Oge et al*.,* 2014, Sowemimo and Ayanniyi, 2016). In this study a significantly higher prevalence of *T. canis* eggs was recorded in the hair of female dogs than their male counterparts. This was similar to the report of Amaral et al. (2010), El-Tras et al. (2011), Semih et al. (2013), Merigueti et al. (2017), and Roddie et al. (2008) but disagrees with the report of Tavassoli et al. (2013), Aydenizöz-Özkayhan et al. (2008), Rojas et al. (2017) who reported higher prevalence of *T. canis* eggs among male dogs and Sowemimo and Adeniiyi, 2016, who reported similar prevalence among both sexes. The reasons for female having higher prevalence to Toxocariasis in this study may be due to the fact that female dogs especially the lactating ones become easily contaminated with the feaces of their puppies. Moreover, female dogs may have more inclination to develop dormant *T. canis* larva especially near their parturition period (Tavassoli et al., 2013).

In this study, a significantly difference *Toxocara* eggs were recovered from dogs among age groups. Higher prevalence of *T. canis* eggs was recovered among the adult and the puppies. The result showed that contamination of dog's hair with *T. canis* eggs was not age dependent. This result was in line with the findings of Overgaauw et al. (2009), Akao et al. (2000) and Keegan and Holland (2010) but disagrees with Anene et al. (2000), Oliveira et al. (2002) and Fontanarrosa et al. (2006). Although the dogs live in the same environment but the means of getting contaminated by *T. canis* eggs differs. The factors that predispose puppies and adult dogs to varying degree of hair contamination with eggs of *T. canis* has been extensively discussed by Roddie et al. (2008) and Semih et al. (2013). Also, from this study, a non-significantly higher prevalence of *Toxocara* eggs was recorded among local dogs than exotic ones when breed type of the dog was considered. The findings of this study is not consistent with previous report from studies conducted in Nigeria by Sowemimo and Ayanniyi (2016) and Anene et al. (1996) in two towns in Southwest and Enugu State respectively. In this study, contamination of hair with eggs of *T. canis* was observed to be significantly higher in stray dogs than kenneled. This result is in line with previous reports of Amaral et al. (2010), El-Tras et al. (2011) and Roddie et al. (2008). The authors attributed this to frequent exposure of stray dog's hair to contaminated soil in the environment, lack of hygienic care and grooming because these categories of animals are allowed to wander about freely. Different developmental stages of *Toxocara* eggs based on morphological characteristics with varying prevalences were recovered in this study. This confirms the work of Maria et al. (2019) that it is possible to recover the four stages of *T. canis* eggs on hair of dogs. Although most of the earlier studies reported different developmental stages in their work, viable and embryonating eggs were recovered by Wolfe and Wright (2003), Aydenizöz-Özkayhan et al. (2008), Roddie et al. (2008), Amaral et al. (2010) and Merigueti et al. (2017); while embryonating eggs were reported by Keegan and Holland (2010) and

Table 4. Questions on knowledge and risk factors about Toxocariasis among the Participants in the study area.

Questions on knowledge and risk factors about Toxocariosis among the participants	N (n=209)	%
Reason for keeping dog		
Pet	40	9.14
Security	120	57.42
Hunting games	49	23.44
Do you play with dogs		
Yes	180	86.12
No	29	13.87
Which age-group of dog do you like to play with?		
Puppy	116	55.50
Juvenile	24	11.48
Adult	40	19.14
None	29	13.87
Which part of the dog's body do you like to touch while playing with it?		
Head	19	9.09
Back	110	52.63
All the body	51	24.40
None	29	13.87
Do you normally wash your hand after touching/playing with dog?		
Yes	12	5.74
No	197	94.25
How often do you bath your dog?		
Bi-monthly	30	14.43
Weekly	12	5.74
Once in a while	21	10.05
Not at all	146	69.85
Aware of any canine Zoonoses?		
Yes	15	7.17
No	194	92.82
Heard of Toxocariosis before?		
Yes	0	-
No	209	100

Source: Salawu and Akeredolu, 2022; Prevalence of Toxocara canis eggs in hairs of dogs in Saki Southwestern Nigeria

Oge et al. (2014).

Embryonated eggs were reported by Wolfe and Wright (2003), Roddie et al. (2007), Aydenizöz-Özkayhan et al. (2008) and El-Tras et al. (2011); while unembryonated eggs were reported by Overgaauw et al. (2009), Paoletti et al. (2015) and Sowemimo and Ayanniyi (2016). In this study, highest number of *T. canis* egg was recovered was on the dorsum with the least recovered in the perianal region. The findings are in line with Keegan and Holland (2010) and Roddie et al. (2008). A possible explanation for this could be due the dog's playing behaviour which results in increased soil contact as well as scent rolling habits most especially on loose soil. Also analysis of results showed that puppies harbored more embryonated eggs on the dorsum and perianal region in this study. Reason for this could be that shorter hairs on puppies provide better heat transfer to the eggs thereby providing a more favourable environment for eggs development (Roddie et al., 2008; Amaral et al., 2010). Moreover, the presence of embryonated *T. canis* eggs on the dorsum of

Table 5. Result of logistic regression showing the effect of sex, breed type mode of life and age on the prevalence of *T. canis* eggs on hair of dogs in the study area.

Parameter [a]	No Examined	Odds ratio (95% CI)	p-Value
Sex			
Female	95	1.98 (1.983-3.106)	0.05
Male[b]	114		
Breed type			
Local	137	1.30 (2.661-3.163)	0.104
Exotic[b]	72		
Mode of life			
Stray	120	3.89(3.22-3.507)	0.05
kenneled[b]	79		
Age			
Puppy	72	6.03 (1.223-3.171)	0.01
Juvenile	47	3.45 (3.002-3.234)	1.043
Adult[b]	90		

[a] Variable are arranged in order they were remove by backward stepwise method (Wald);
[b] Reference group, 95%CL: 95% Confidence Limit.
Source: Salawu and Akeredolu, 2022; Prevalence of Toxocara canis eggs in hairs of dogs in Saki Southwestern Nigeria

puppies is an indication that direct contact with these animals may put humans at risk of developing toxocariasis. Low awareness and knowledge about zoonotic parasites among pet owners that was observed in this study has been previously reported by some authors in their studies (Ugbomiko et al., 2008; Akeredolu and Sowemimo, 2014; Sowemimo and Asaolu, 2008; Somemimo, 2012; Schwartz et al., 2022). Low awareness about zoonoses and *T. canis* infection among dog owners in the study area is likely to be due to poverty, religion believe, poor personal hygiene and illiteracy. These findings are clear indication that low awareness and knowledge about the zoonotic potential of their pets tend to put more people at risk to becoming infected with toxocariasis or any other related diseases.

Conclusion

This study concludes that the trend in prevalence of *T. canis* eggs in hair of studied dogs reflect the degree of environmental contamination in the study areas; thus showing that direct human infection from dogs is also possible. This further reinforces the importance of good animal management practices as well as improvement on proper hygiene practice around domesticated animals especially those that are kept as pets. In addition, risk of toxocariasis or any other related infection might be mitigated if policies are made to enforce pet owners or animal owners to attend mandatory health talk and check-ups organized by veterinary and health workers in the community.

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CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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