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Prevalence and Associated Risk Factors of *Toxocara canis* Eggs in Dogs in Tripoli, Libya

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Abstract | Studies on toxocariasis in dogs in Tripoli, Libya are limited and little information is available on the prevalence and the risk factors associated with this zoonosis.In this study, the prevalence infection was determined by coprological examination of fecal samples obtained from 110 males and 61 female household dogs with different ages brought to veterinary clinics in Tripoli. The overall prevalence of *T. canis* eggs in the dogs was 27.5% (47/171). The prevalence decreased significantly with age from 56.7% in age group 1-6 months to 5.5% in age group > 12 months (X2 = 23.8; p < 0.05). The prevalence in dogs that had received anthelmintic treatment (7.8%; 8/102) was significantly lower (X2 = 48.9; p = 0.0001) than in untreated dogs (56.5%; 69/39. The prevalence of *T. canis* infection in dogs kept in boxes was 37.5% (33/88), significantly at more than that in dogs living in the open (16.9%; 14/83) (X2 = 9.12; p = 0.0025). The prevalence rates of *T. canis* infection in the four regions of Tripoli ranged between 20.0% and 31.3%. The main risk factors for *T.canis* infection of dogs were younger age and lack the treatment with anthelmintic. Our findings show a high prevalence of *T. canis* in household dogs.

Keywords | *Toxocara canis*, Dogs, Faeces, Risk factors, Tripoli Libya

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INTRODUCTION

Dogs are associated with zoonotic diseases and the most important parasitic diseases are toxocariasis and echinococcosis. Many of these zoonotic parasites are harmful to public health, particularly in developing countries and in communities that are socioeconomically challenged (Traub et al., 2002). Although pet parasitic zoonoses are well recognized and studied in developed countries, they are given low priority among the public health problems in developing countries (Traub et al., 2005). Dogs and other candies are the definitive hosts for *Toxocara canis*. The mature worms in the intestines shed large numbers of unembryonated eggs into the feces, and the eggs become embryonated in the external environment. Therefore, the infection is commonly take place after ingestion of embryonated *T. canis* eggs which present in soil contaminated with dog feces. Several studies from all over the world demonstrated high rates (10-30%) of soil contamination with *Toxocara* eggs in parks, playgrounds, sandpits and other public places (Tavassoli et al., 2008). In Tripoli Libya, the overall prevalence of *Toxocara* spp. in soil from public parks was 59.0% (Belhage et al., 2016). The study of the prevalence and zoonotic importance of *T. canis* remains a major concern for scientists in both developed and under-developed countries (Klimpel et al., 2010). *T. canis*, is the most relevant canine helminths in terms of geographic distribution and clinical importance (Soulsby, 1986). Studies from various countries have demonstrated a high rate of soil and grass contamination with infective parasitic elements in public and urban areas (green areas, playgrounds and parks). Owned dogs and stray animals may defecate in these areas. Therefore, lead to environmental contaminating with parasites and favoring zoonotic transmission

and re- infection for other animals. Patent infection with *Toxocara* spp. is commonly diagnosed by demonstrating the presence of the characteristic eggs in feces. A flotation technique has been recommended because centrifugation consistently recovers more eggs than other methods (Dryden et al., 2005).

In Libya, data on the prevalence of pet parasitic infections and zoonosis are sparse. Kaal et al. (2007) reported that 43.5% of housed dogs were infected with *T. canis*. A recent study reported that 14% of housed and stray dogs were positive (Mansour et al., 2013). So, this study will highlight the importance of the prevalence and risk factors of *T. canis* in dogs for the benefit of the animals and humans in contact with them. Aims of present study was to investigate the prevalence of *T. canis* infection in household dogs and determine the risk factors associated with the infected dogs in Tripoli city, Libya.

MATERIALS AND METHODS

Study Area

This study was done in the metropolitan area of Tripoli, the largest city and capital of Libya. It has a population of about 1.1 million people and a population density of 4,500/km^2. Tripoli located in the north-western part of Libya at 32° 54' north and 20° 4' east. It has a hot subtropical semi-arid climate with long, hot, dry summers and relatively wet, mild winters with a Mediterranean rainfall pattern. In summer, temperatures often exceed 38°C and can reach into the forties. In December, temperatures can reach as low as 0°C, but the average is between 9 and 18°C. The average annual rainfall is less than 400 mm, but it can be very erratic and humidity between 85–95% (LNMC, 2014-2015).

Participant Recruitment

The veterinary services for Tripoli are divided into government and private clinics. Most owners of small animals (dogs and cats) usually visit private clinics. The area has good veterinary facilities, a sizeable dog population, and a growing stray-dog problem. The study was undertaken in the four key districts of Tripoli (Centre, East, West and South).

Sample Size

Sample size was calculated based on a previous study that reported a prevalence rate of toxocariasis of 14% in Tripoli (Mansour et al., 2013). Our expected prevalence to be between 10% and 20% but calculated sample size based on a prevalence rate of 10% because the 14% rate included both household and stray dogs and was determined using different sampling and diagnostic methodologies.

Collection of Fecal Samples

During the period between January 2014 to June 2015, one hundred and ninety-two rectal feacal samples of dogs (household, guard, and police dogs) from different locations in Tripoli area (32º 54 North latitude and 13º 11 East longitude) (Private and government clinic) were collected and examined at the laboratory of parasitology, Faculty of Veterinary Medicine University of Tripoli. One fecal sample from each dog was examined for *T. canis* eggs using centrifugation fecal flotation technique. The Age, sex and breed of each dog were recorded in addition to previous deworming and defecation site for private dogs (Box) or public garden or green areas (open), and if the owner's had knowledge about of toxocariasis and its mode of transmission.Due to lack of records, number of dogs and great difficulty to obtain dog owners list (sample frame), samples were obtained from veterinary practices in Tripoli which actively involved in the vaccination and treatment of dogs, were taken into consideration according to the geographical distribution of veterinary clinics. in Tripoli area.

Examination of Fecal Samples for *T.canis* Eggs

Qualitative technique

Centrifugation/ flotation: Common parasite eggs have specific gravities between 1.06 and 1.20, and *T. canis* eggs 1.09. The flotation solution Zinc sulphate (aqueous $ZnSO_4$) was made with a specific gravity of 1.18–1.20 as measured with hydrometer. Feces (4-5 g) were mixed to a uniform consistency with approximately 10 ml of aqueous flotation solution in a disposable cup. The mixture was strained and poured into a 15-ml conical centrifuge tube, which was then filled with flotation solution to form a slight positive meniscus, and a cover slip was floated on top of the meniscus. Centrifugation was carried out at 1200 rpm for 5 min. After leaving the tube to stand for 10 min, the cover slip was lifted directly upward and placed on a microscope slide. The entire area under the cover slip was examined at 10× magnification (Dryden et al., 2005).

Quantitative technique

McMaster counting technique: Egg counts in samples found to be positive for *Toxocara* eggs by microscopic examination were obtained. Two aliquots of 0.15 ml of the fecal suspension were placed in a McMaster counting chamber and examined microscopically to determine the number of eggs per gram of faeces (epg). Samples of faeces (4 g) were suspended in 56 ml of flotation fluid ($ZnSO_4$) and filtered through sterile surgical gauze. While the filtrate was being stirred, two samples were obtained with a Pasteur pipette and placed in the compartments of a McMaster counting chamber. The counting chamber allowed to stand for 5 min to allow the eggs to float to the surface and the debris to sediment (Soulsby, 1986).

Table 1: The prevalence of *T. canis* eggs in dogs in Tripoli area 2014-2016.

Risk factors	Category	No. of samples	No. of infected dog	Prevalence (%)
Age	≤ 6 months	67	38	56.7
	7-12 months	49	6	12.2
	> 12 month	55	3	5.5
Sex	Male	110	33	30.0
	Female	61	14	23.0
Housing	Open	83	14	16.9
	Box	88	33	37.5
Anthelmintic treatment	No	69	39	56.5
	Yes	102	8	7.8
Dog breed	German shepherd	117	29	24.8
	Rottweiler	17	4	23.5
	Pit bull	12	6	50.0
	Mixed	9	4	44.4
	Poodle	8	3	37.5
	Local	4	0	0.0
	Boxer	3	1	33.3
	Labrador	1	0	0
Tripoli region	Center	25	5	20.0
	East	16	5	31.3
	South	113	32	28.3
	West	17	5	29.4
Total		171	47	27.5

Table 2: Univariate analysis of association of age with the prevalence of *T. canis* infection

Age (months)	Infected	Uninfected	Total	Prevalence %	X^2 (p value)*	OR (CI 95%)
≤ 6	38	29	67	56.7	23.8	9.39 (3.5-25.1)
7-12	6	43	49	12.2	(0.0000)	22.7 (6.4-80.1)
> 12	3	52	55	5.5		
Total	47	124	171	27.5		

*p value in comparison to age group 1-6 months

Table 3: Univariate association of sex with the prevalence of *T. canis* infection

Sex	Infected	Uninfected	Total	Prevalence %	X^2 (p value)
Male	33	77	110	30.0	0.98 (0.3226)
Female	14	47	61	23.0	
Total	47	124	171	27.5	

Statistical Data Analysis

The data were entered in a Microsoft Excel spreadsheet. SPSS Statistical Package Social Sciences software program (2007) was used for descriptive analysis as well as for Chi-square analysis, odds ratios and logistic regression.

RESULTS

A total of 192 questionnaires were distributed to dog owners, only 171 agreed to participate, giving a response rate of 93%.

The Prevalence of *T. Canis* Infection in Dogs

The prevalence of *T. canis* infection was determined in 110 males and 61 female dogs sampled from four areas of Tripoli. The overall prevalence of *T. canis* eggs in the dogs was 27.5% (47/171). The prevalence varied with age, sex, defecation habits, dog class, and anthelmintic treatment (Table 1).

Univariate Analysis of Risk Factors

The association between the prevalence rate of *T. canis* infection and each of the six risk factors was examined by univariate analysis. The results of these six analyses are described in the following sections.

Age: There was a statistically significant association between the prevalence of *T. canis* eggs in dogs and age (X^2 = 23.8; p< 0.05) (Table 2).

Table 4: Univariate analysis of association housing type with prevalence of *T. canis* infection

Housing	Infected	Uninfected	Total	Prevalence %	X^2(p value)	OR (95% CI)
Open	14	69	83	16.9	9.12 (0.0025)	2.96 (1.4-6.1)
Box	33	55	88	37.5		
Total	47	124	171	27.5		

Table 5: Univariate association of antihelmitic treatment with the prevalence of *T. canis* infection

Anthelmintic treatment	Infected	Uninfected	Total	Prevalence %	X^2 (p value)	OR (95% CI)
No	39	30	69	56.5	48.9	15.3
Yes	8	94	102	7.8	(0.0001)	(6.4-36.3)
Total	47	124	171	27.5		

Table 6: Univariate analysis association of dog breed with prevalence of *T. canis* infection

Dog breed	Infected	Uninfected	Total	Prevalence %	X^2 (p value)
German shepherd	29	88	117	24.8	5.79 (0.2151)
Rottweiler	4	13	17	23.5	
Bit bull	6	6	12	50.0	
Mixed	4	5	9	44.4	
Poodle	3	5	8	37.5	
Local	0	4	4	0.0	
Boxer	1	2	3	33.3	
Labrador	0	1	1	0.0	
Total	47	124	171	27.5	

Table 7: Univariate analysis of the association of region with the prevalence of *T. canis* infection

Tripoli Region	Infected	Noninfected	Total	Prevalence %	X^2 (p value)
Center	5	20	25	20.0	0.89 (0.8284)
East	5	11	16	31.3	
South	32	81	113	28.3	
West	5	12	17	29.4	
Total	47	124	171	27.5	

Sex: Though the prevalence of *T. canis* in males (30%; 33/110) was higher than in females (23%; 14/61), the difference was not statistically significant (X^2= 0.98; p = 0.3226) (Table 3).

Housing: The prevalence of *T. canis* infection in dogs kept in boxes was 37.5% (33/88), more than that in dogs living in the open (16.9%; 14/83).(Table 4).

Anthelmintic treatment: The prevalence of *T. canis* infection in dogs treated with anthelmintic was 7.8% (8/102), which was significantly lower than in non-treated dogs (56.5%; 39/69) (X^2= 48.9; p = 0.0001) (Table 5).

Dog breed: The prevalence of *T. canis* infection varied with dog breed, but the differences were not statistically significant (X^2= 5.79; p = 0.2151) (Table 6).

Region: The prevalence rates of *T. canis* infection in the four regions of Tripoli ranged between 20.0% and 31.3%, but the differences between the regions were not statistically significant (X^2 = 0.89; p = 0.8284) (Table 7).

Table 8: Logistic regression model of the risk factors for the presence *T. canis* eggs in dogs

Steps	Risk factor	p value
1	Region	0.805
	Age	0.000
	Sex	0.65
	Anthelmintic treatment	0.000
	Housing	0.321
2	Age	0.000
	Sex	0.057
	Anthelmintic treatment	0.000
	Housing	0.305
3	Age	0.000
	Sex	0.052
	Anthelmintic treatment	0.000
4 (Final model)	Age	0.000
	Anthelmintic treatment	0.000

Logistic regression model for dog infection with *T. canis*: The final statistical analysis of the variables influencing infection was done by using logistic regression. Only age and treatment with anthelmintic were statistically significant

Table 9: Prevalence of *T. canis* infection in dogs treated with anthelmintic and in untreated dogs of different ages.

Age (months)	Anthelmintic treatment	Infected	Non-infected	Total	Infected %	X^2 (p value)	OR 95% CI
≤ 6	No	30	8	38	78.9	17.67 (0.000)	9.8
	Yes	8	21	29	27.6		3.2-30.4
7-12	No	6	10	16	37.5	14.10 (0.000)	-
	Yes	0	33	33	0.0		
> 12	No	3	12	15	20.0	8.46 (0.004)	-
	Yes	0	40	40	0.0		

Table 10: Prevalence of *T. canis* infection in male and female dogs treated with anthelmintic or left untreated

Sex	Anthelmintic treatment	Infected	Noninfected	Total	Prevalence %	X^2 (p value)	OR (95% CI)
Male	No	27	18	45	60.0	32.6	14.8
	Yes	6	59	65	9.2	(0.0000)	(5.3-41.3)
Female	No	12	12	24	50.0	16.4	17.5
	Yes	2	35	37	5.4	(0.0000)	(3.4-89.7)

Table 11: Prevalence of *T. canis* infection in dogs treated with anthelmintic or left untreated and living in the open or in boxes

Housing	Treatment	Infected	Noninfected	Total	Prevalence %	X^2 (p value)	OR (95% CI)
Open	No	14	14	28	50.0	33.1	–
	Yes	0	55	55	0.0	0.0000	
Box	No	25	16	41	61.0	18.1	7.6
	Yes	8	39	47	17.0	0.0000	(2.8-20.4)

Table 12: Prevalence of *T. canis* infection in dogs treated with anthelmintic or left untreated in different areas of Tripoli

Tripoli Region	Anthelmintic treatment	Infected	Noninfected	Total	Prevalence %	X^2	p value	OR (95% CI)
East	No	5	5	10	50.0	4.4	0.0367	-
	Yes	0	6	6	0.0			
South	No	27	18	45	60.0	57.0	0.0000	18.9 (6.4-56.1)
	Yes	5	63	68	7.4			
Center	No	3	4	7	42.9	3.2	0.07	-
	Yes	2	16	18	11.1			
West	No	4	3	7	57.1	4.4	0.0357	12 (0.94-145)
	Yes	1	9	10	10.0			

factors (Table 8; step 4; p value < 0.005).

Effect of Anthelmintic Treatment on the Prevalence Level t All Risk Factor

Age: Anthelmintic treatment reduced the infection rate in each of the three age groups (Table 9). In age group ≤ 6 months it reduced the infection rate from 78.9% to 27.6% (X^2 = 17.67; p = 0.000). In the other age groups, it reduced it to zero.

Sex: The prevalence of *T. canis* infection in treated dogs was significantly lower by several folds than in untreated-dogs, whether males or females (Table 10).

Table 13: Frequency of different levels of infection

Level of infection	Frequency	Percent
Low	24	51.1
Medium	13	27.7
Heavy	10	21.3
Total	47	100.0

Housing in boxes versus in the open yard: In dogs kept in the open, untreated dogs had a 50% infection rate where as treated dogs had negative results by *T.canis* eggs, and the

Table 14: Effect of anthelmintic treatment on the level of infection

Anthelmintic treatment	Infection degree N and (%)			Total	X^2	(*p* value)
	Low	Medium	Heavy			
No	20 (51.3)	9 (23.1)	10 (25.6)	39	3.793	0.150
Yes	4 (50.0)	4 (50.0%)	0 (0.0%)	8		
Total	24 (51.1)	13 (27.7)	10 (21.3)	47		

difference was statistically significant (X^2 = 33.1; p = 0.0000) (Table 11). The same significant trend was observed in dogs kept in boxes, where the infection rate was reduced from 61.0% to 17.0% (X^2 = 18.1; p = 0.0000). (Table 11).

Region: No significant differences were noted between the four regions, in which treatment reduced the prevalence of infection several folds (Table 12).

Level of *T. canis* infection in dogs: The level of infection was defined based on the number of *T. canis* eggs per gram of feces. The level of infection was classified as low (150-1000 eggs), medium (1001-5000 eggs) or heavy (> 5000 eggs).The log number of eggs ranged from 1 to 3 eggs per gram. The median was 1.62 eggs per gram and the geometric mean was 1.70 eggs ± 0.805 standard deviation (Table 13). Over half of the samples (51.1%) had a low infection level.

The effect of anthelmintic treatment on level of infection: There was no statistically significant effect of anthelmintic treatment on the level infection in treated dogs or in untreated dogs (X^2 = 3.793; p = 0.150) (Table 14).

Dog owners' knowledge of toxocariasis: When the dog owners were asked about their knowledge of toxocariasis and the parasite that causes it, it turned out that they had no such knowledge. When they were asked why they were purchasing deworming pills, their degree of unawareness was emphasized by their response that they do that so that their lean dogs would get fatter. In one case, the dog owner said that he was giving his dog these pills almost every week.

DISCUSSION

Prevalence of *T. Canis* Infection in Dogs

Patent *T. canis* infections in dogs are considered as public health risk because of their zoonotic potential. The overall prevalence of *T. canis* infection in 171 dogs examined was 27.5%, where the most of dog's samples (67/38) 56.7%, received in the clinic were at young ages, where the percentage of male dogs was (110/33) 30% and most of dogs were received from the southern part of Tripoli. despite lack of dog records and sample frame, that is why we used a convenience sample in this study.

Most of dog owners have health interest in their dogs, this kind of sample is biased because it includes only individual animals (dogs) that happen to be presented in the veterinary clinics for treatment or periodic vaccination. A special concern was taken for pups during the vaccination time, thus bias in young dogs was greater than the aged dogs so, prevalence percentage will be under estimate than the actual estimation, because this sort of information does not include the stray dogs. Ignorance of breed from this study was due to sample size. The prevalence in current study of *T. canis* infections is very similar to that reported in Italy (26.2%) (Habluetzel et al., 2003). However, the prevalence rates reported in different countries vary widely. For example, the prevalence rate was 3.6 % in Ireland (Osullivan, 1995), while *T. canis* eggs were found in 24.3% of the dogs in a Hungarian study (Fok et al., 2001). In Pisa, Italy, the prevalence of *T. canis* infection was intermediate at 11.1% (Legrottaglie et al., 2003). A study in Germany (Barutzki and Schaper, 2011) detected an infection rate of 6.1%, What is perhaps more interesting is that a previous study conducted on enteric parasite infection in dogs in Tripoli, Libya (Kaal et al., 2007) found that 43.5% of housed dogs were positive for *T. canis*, whereas a more recent study (Mansour et al., 2013) reported that 14% of housed and stray dogs were positive. Large differences are found in reported results concerning the prevalence of infection with *T. canis,* even in surveys conducted in the same country. This is mostly attributed to differences in sampling protocols, including source and age of dogs, prior anthelmintic treatment of sampled dogs, and different demographics of the dog populations, as well as animal health-care, animal management practices, and environmental conditions (Robertson and Thompson, 2002). For example, the dog populations that are studied vary widely and may include household dogs from urban or rural areas, or stray dogs. Moreover, the number of sampled dogs varies from only a few dozens to several thousands. Finally, the different techniques used for fecal examination vary in their sensitivity, and it could be advisable to standardize the coprological methods used.

Association of Infection Prevalence Rate with Various Factors

The association between age and infection prevalence was analyzed by Chi-square test: and the association was significant (X^2 = 23.8; p< 0.05). The risk of getting infected with eggs of *T.canis* for the age group less than 6 months

was about nine folds higher (OR = 9.39) than for age group 7-12 months and almost 23 folds higher (OR = 22.7) compared to age group > 12 month. These results agree with similar results obtained in other studies concluded that puppies aged ≤ 6 months have a higher rate of infection than adult dogs. *T. canis* infection inutero is a life-cycle characteristic that is thought to be largely responsible for the high prevalence of infection with ascarids in puppies (Little et al., 2009). However, although ascarids are seen more frequently in young puppies, they are identified in dogs of all ages. In the current study, the infection rate seemed to with increasing of age. This finding of *Toxocara* infection in adult dogs agrees with the findings of a current study that clearly demonstrated that dogs of any age can become infected with *T. canis*, even when exposed to a small number of eggs (Fahrion et al., 2008). Consequently, though patent toxocariasis occurs more frequently in puppies, dogs of all ages may be passing eggs into the environment. The age of the dog affects the fate of larvae that hatch from ingested eggs and migrate to the lungs in young dogs and especially in puppies (tracheal migration). The low rate of infection in dogs aged more than one year may be attributed to the somatic type of migration in older dogs, where larvae may remain in the somatic tissue for months or even years without developing into mature worms. The likelihood of somatic migration progressively increases from the age of three months onwards.

No significant difference in prevalence of *T. canis* infection between male and female dogs ($X^2 = 0.98$; $p = 0.3226$). Most prevalence studies have not seen any difference between male and female dogs (Daryani et al., 2009; Gingrich et al., 2010), which is supported by our findings. The results in this study indicate that how dogs are housed influences the probability of becoming infected. The prevalence of *T. canis* in dogs kept in boxes was considerably higher than in dogs kept in the open. This represents an almost three-fold (OR = 2.96) greater chance of getting ($X^2 = 9.12$; $p = 0.0025$). Dog owners were probably paying insufficient attention to sanitation of the bedding on which the dogs were sleeping or were not disposing of excrement properly, which leads to contamination. It is noteworthy most that live in boxes are more than a dog, and that dog owners place soil or wood shavings as bedding, especially for puppies, which are more susceptible to infection than adult dogs, and put pups in boxes or rooms until they grow up. Poor sanitation exacerbates the risk of disease transmission, including parasitic disease transmission (Traub, et al., 2005). The obtained study found that the owners of household dogs treated them with anthelmintic frequently, and they may have become more motivated when they knew that their pets were infected with helminths. However, they were not properly informed about these parasites or which drugs should be administered, and they did not have analyses done regularly to identify the medical problem. This practice can be harmful if the wrong type of treatment is given.

In this study, the prevalence of *T. canis* in dogs treated with anthelmintic was significantly lower ($X^2 = 48.9$, $p = 0.0001$) than in non-treated dogs. Treated dogs were 15 times less likely to develop the disease (OR = 15.3). That clearly shows the importance of anthelmintic treatment for reducing *T.canis* infections and contamination of the environment. The use of anthelmintic should consider some important considerations. First, after infective eggs of *T. canis* are ingested by adult dogs, second stage larvae are found in various tissues of the body (*e.g.*, liver, lung and kidney). At this stage, they had undergone no development (Ramsey, 2011). These larvae become resident in the somatic tissue of adult dogs, where they are much less susceptible to anthelmintic. In this situation, a drug that is active against larval stages must be given frequently in markedly increasing doses, Second, resistance to anthelmintic is a major concern that must be considered and evaluated locally (Thompson and Roberts, 2001). Third, failure to routinely deworm pet dogs with anthelmintic products may account for the prevalence of higher rates of these intestinal helminths than expected by the researcher and the dog owners.

Analysis of The Effect of The Variables on The Infection by Logistic Regression Model

In our final statistical analysis, we used logistic regression to determine the variables that influence infection. Despite the statistical significance of some variables such as sex, region and housing, when confounding variables were controlled it turned out that they were not significant. The only variables that had such an influence on infection were age and use of anthelmintic drugs. Therefore, drug treatment is the only option for attempting to control or limit infection with *T. canis*. In this study, a significant association between age and infection was confirmed by logistic regression analysis. Age is an uncontrollable risk factor, but it would be useful to take it into consideration in treatment. We found that treatment of dogs aged ≤ 6 months reduced the risk of infection almost tenfold (OR 9.8; 95% CI 3.2-30.4;). Nevertheless, though the prevalence dropped considerably with treatment, 27.6% of the treated pups were infected. In contrast, none of the treated older dogs (0/76) was infected. This indicates that preventive and therapeutic measures should focus more on pups. The results also show that prevention and treatment of *T. canis* infection should pay special attention to dogs housed in boxes. Among the dogs kept in the open, 50.0% (14/28) of untreated dogs were infected, but none of the 55 treated dogs were infected. In contrast, treatment of dogs housed in boxes did not eliminate infections, but it did reduce the infection rate from 61.0% to 17.0%. However, the efficacy of treatment in reducing infections did not seem to vary with the sex of the dogs or the region in which they lived.

Likewise, the degree or level of infection in infected dogs did not seem to vary significantly regardless of whether the infected dogs had or had not received treatment.

Three published studies in Tripoli, Libya, investigated gastrointestinal parasites among dogs and cats. One of these studies (Swehli, 1995), carried out on stray dogs, reported that the overall prevalence was 52.3%. Another study (Kaal et al., 2007) was on housed doges and revealed an overall prevalence of 93%. Though the prevalence we observed is lower, that could be due to methodological differences as there are no published findings indicating that there has been an improvement in prevention and/or treatment. In addition to the factors contributing to infections discussed above, other potential factors are poor management practices and frequent mixing of pets with infected stray animals. The high infection rate in pups of both stray and pet dogs may be due to parental and neonatal infections, lack of immunity, and high susceptibility to toxocariasis.

Comparison of the current study with worldwide published studies indicates that great differences exist in the prevalence of *T. canis*, perhaps due to regional, environmental or climatic differences. On the other hand, most intestinal parasites cause disease when the infection level is high, whereas low infection levels are usually asymptomatic. In this study, the quantified the number of *T. canis* eggs in the infected dogs and classified the infection level as low (150-1000 eggs/g feces), medium (1001-5000 eggs/g feces) or heavy (> 5000 eggs/g feces). In this quantitative analysis, almost all the fecal samples contained eggs, showing lack of sufficient control, treatment and prevention. What might make the situation in Tripoli even worse is that many owners are not aware of or are not interested in gastrointestinal parasites in general and particularly *T. canis*. From the responses to the questionnaire, there is a lack of knowledge of the importance of zoonotic diseases that may infect their pets. Moreover, there are no government control programs in Libya focused on gastrointestinal parasites in dogs and cats, and removal of dog and cat feces from public places is not a common habit of owners. These factors lead to environmental contamination and increase the risk of infection to other animals and humans.

CONCLUSIONS

The results of this study indicated that the younger dogs are important source of infection. Therefore, it is of paramount importance to adopt strategic deworming of dogs using broad-spectrum anthelmintic and to undertake public education in the care and management of dogs to create awareness of the transmission and control of zoonotic diseases. In addition, further investigations are needed for *Toxocara* and other nematodes.

CONFLICT OF INTEREST

There is no conflict of interest.

AUTHORS CONTRIBUTION

All the authors contributed equally.

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