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Presence of *Toxocara* spp. in Domestic Cats in the State of Mexico

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ABSTRACT

***Background*:** *Toxocara* spp. is a gastrointestinal nematode with cosmopolitan distribution and is the most common parasite in domestic cats, which can deposit fertilized eggs in the environment with feces. Egg maturation starts in the soil, concluding two to three weeks after cat defecation, but eggs can remain viable in the soil for years and spread onto vegetables and into water. Infection of cats and paratenic hosts (among them humans) occurs through ingestion of infected eggs from the environment, through ingestion of paratenic hosts and, in puppies, through milk from infected mothers. The objective of the present study was to evaluate the presence of Toxocara spp. in domestic cats.

***Materials Methods & Results*:** In this study, 229 fecal samples from domestic cats were collected in the state of Mexico, Mexico. All of cats had an owner, and fresh feline feces were collected in previously labeled sterile bottles. Coproparasitological examinations were performed on these samples using a flotation technique with sodium hydroxide (NaOH) and sodium nitrate (NaNO3), *Toxocara* spp. eggs were identified under the microscope, in accordance with the morphological descriptions. The data were analyzed by means of Fisher's exact test in order to compare the presence of *Toxocara* eggs according to cat age and sex. The chi-square test was used to determine associations between variables and odds ratios (OR) were calculated to determine the risk factors. Presence of *Toxocara* spp. eggs was identified in 42% (96/229) of the cats, of which 23% were males and 19% females. We did find an association between cats under the age of six months ($P = 0.01$) and the presence of *Toxocara* spp. eggs, and therefore age was determined to be a risk factor (OR = 1.69) for the presence of *Toxocara* spp. eggs in feces, cats over one year old showed a statistically significant association ($P = 0.02$) with the presence of parasite eggs in feces. The presence of *Toxocara* spp. was found to be a risk factor (OR = 1.57) among male cats aged less than 6 months, while among female cats a statistically significant association was found ($P = 0.03$) for the presence of *Toxocara* spp. Meanwhile, comparing positive cats of both sexes with age, a statistically significant difference ($P = 0.02$) was found regarding cats over one year old.

***Discussion*:** It were identified *Toxocara* spp. eggs in 42% of the feces of domestic cats from the state of Mexico. These results are similar to those reported by other studies in Mexico City, they also reported that there was a larger number of infected cats under one year of age and that males had higher infection rates. Comparison of both sexes with age showed a statistically significant association ($P = 0.01$) between cats under six months old and the presence of *Toxocara* eggs in feces. This age was also considered to be a risk factor (OR = 1.69) for parasite eggs in feces, during the first months of life, the larvae migrate and finish their cycle, but when the cat has reached its mature stage, the larvae may become entrenched and avoid finishing their life cycle. Male sex was identified as a risk factor for the presence of *Toxocara* spp. The prevalence of *Toxocara* spp. in domestic cats in the state of Mexico is high, and represents a potential risk of human toxocariasis. From the results found, it can be considered that cats are a major source of dissemination of environmental pollution and *Toxocara* spp.

Keywords: *Toxocara*, cats, zoonosis, risk factor.

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INTRODUCTION

Pets play an important role in welfare and human health in different countries [12,18]. Dogs and cats are the domestic animals that are most preferred, even though they present risks as hosts and transmitters of zoonotic diseases, including those caused by parasites [19]. *Toxocara cati* is the most common parasite in domestic cats [10], although cats can also host other species such as *Toxocara canis* [14], *Toxocara malaysiensis* [31] and other nematodes like *Toxascaris leonina* [15], which can end their life cycle and deposit fertilized eggs in the environment. All of these have the capacity to infect other mammals, including humans [22]. *Toxocara* spp. females can oviposit up to 200,000 eggs a day, with up to 200 grams of eggs in one gram of feces. Egg maturation starts in the soil, concluding two to three weeks after cat defecation [29,9], but eggs can remain viable in the soil for years and spread onto vegetables and into water [3]. Infection of cats and paratenic hosts (among them humans) occurs through ingestion of infected eggs from the environment, through ingestion of paratenic hosts and, in puppies, through milk from infected mothers [2].

Domestic cats are considered to be one of the most efficient parasite disseminators, because of their habit of roaming outside the home, entering distant spaces and defecating in them [1]. In humans, infection with *Toxocara* spp. is known as toxocariasis, and this disease can develop as an important series of clinical manifestations that can be classified as follows: visceral larvae, ocular larva migrans, eosinophilic meningitis, covert toxocariasis and neurotoxocariasis [6]. For this reason, the objective of the present study was to evaluate the presence of *Toxocara* spp. in domestic cats in the state of Mexico.

MATERIALS AND METHODS

The present study was based on 229 domestic cats in the state of Mexico, comprising 109 males and 120 females of various ages, which were classified as under six months old, six months to one year old and over one year old. All of these cats had an owner, and fresh feline feces were collected in previously labeled sterile bottles and stored at 4°C until processed. The feces were processed by means of a coproparasitological method for identifying *Toxocara* spp. eggs, using the flotation technique as described by Mizgajska [20], with some modifications to the procedure. Less than 5 grams of feces were taken and put in a beaker with 60 ml of 5% sodium hydroxide (NaOH). This was then mixed and put into a test tube and centrifuged at 800 x *g* for 3 min. The supernatant was discarded, leaving only the sediment, which was then resuspended in added water, for a second round of centrifuging at 800 x *g*. This procedure was repeated three times with water to clean the samples. The water was then removed and sodium nitrate (NaNO3) was added at a density of 1.30. This mixture was then resuspended and centrifuged again at 800 x g for 3 min. Finally, the tube was filled with sodium nitrate, thus forming a meniscus in the tube with a cover slip over it, and was incubated for 20 min. Next, Toxocara spp. eggs were identified under the microscope, in accordance with the morphological descriptions of Bouchet [5].

The data were analyzed by means of Fisher's exact test in order to compare the presence of *Toxocara* eggs according to cat age and sex. The chi-square test was used to determine associations between variables and odds ratios (OR) were calculated to determine the risk factors that presented significance ($P < 0.05$). All the tests were conducted using the JMP® 8.0 software[1].

RESULTS

The presence of Toxocara spp. eggs was identified in 42% (96/229) of the cats, of which 23% were males and 19% females. No significant difference between the sexes was found ($P = 0.55$), although the male cats showed a higher risk factor (OR = 1.57) for the presence of *Toxocara* spp. eggs in feces.

According to the age classification, cats over one year old showed the largest percentage of positives (18%); however, there was no statistically significant difference between the different age groups (Table 1). We did find an association between cats under the age of six months ($P = 0.01$) and the presence of *Toxocara* spp. eggs, and therefore age was determined to be a risk factor (OR = 1.69) for the presence of *Toxocara* spp. eggs in feces (Table 2). Cats over one year old showed a statistically significant association ($P = 0.02$) with the presence of parasite eggs in feces. In comparing age groups within each sex, there was no statistically significant difference with regard to different male age groups ($P = 0.12$); however, a statistically significant difference ($P = 0.03$) was found regarding the female group under six months of age (Table 3). Meanwhile, comparing positive cats of both sexes with age, a statistically significant difference ($P = 0.02$) was found regarding cats over one year old (Table 4).

Table 1. Differences between positive and negative cats of different ages with regard to *Toxocara* spp. eggs in feces.

Age	Positive n = 96 (%)	Negative n = 133 (%)	Total	*P*
< 6 months	39 (17%)	34 (15%)	73	0.08
6 months to 1 year	15 (7%)	21 (9%)	36	0.97
> 1 year	42 (18%)	78 (34%)	120	0.20
Total	96 (42%)	133 (58%)	229	

*Fisher exact test, significance $P < 0.05$; no differences were found between groups.

Table 2. Association between age risk factors and *Toxocara* spp. egg presence in domestic cats in the state of Mexico.

Age	Positive N = 96	Negative N = 133	X^2	*P*	OR	*P*	CI
< 6 months	39	34	5.82	0.01	1.69	0.06	0.973-2.951
> 1 year	42	78	4.96	0.02	0.54	0.02	0.322-0.932

χ^2 = Chi-square: association level, $P < 0.05$ significance; OR = Odds Ratio: risk factor; $P < 0.05$ significance; CI = confidence interval.

Table 3. Comparison of positive and negative cats of the same sex in relation to *Toxocara* spp. egg presence.

Age	Positive males	Negative males	*P*	Positive females	Negative females	*P*
< 6 months	20 (9%)	15 (6%)	0.12	20 (8%)	21 (8%)	0.03
6 months to 1 year	7 (3%)	10 (4%)	0.37	12 (3%)	24 (5%)	0.68
> 1 year	25 (11%)	32 (14%)	0.25	12 (7%)	31 (20%)	0.09

Fisher exact test, significance $P < 0.05$; negative females were different from the other groups.

Table 4. Evaluation of the differences between positive cats of different sexes and *Toxocara* spp. eggs in feces.

Age	Positive males	Negative females	*P*
< 6 months	20 (9%)	20 (8%)	0.31
6 months - 1 year	7 (3%)	12 (3%)	0.07
> 1 year	25 (11%)	12 (7%)	0.02

Fisher exact test, significance $P < 0.05$; group over 1 year was different.

DISCUSSION

In the present study, were identified *Toxocara* spp. eggs in 42% of the feces of domestic cats from the state of Mexico. These results are similar to those reported by Martínez [17] in Mexico City, who found that 42.5% of cats were infected. They also reported that there was a larger number of infected cats under one year of age and that males had higher infection rates.

For both sexes, an age of less than six months was considered to be a risk factor for *Toxocara* infection. Although parasite presence was only found in female cats less than six months old, Shabbir [26] also found a higher likelihood of infection among cats under six months of age, compared with other age groups. This was probably due to the *Toxocara* life cycle, since the infection might start during lactation [16]. Kittens start to excrete eggs from the third week after birth onwards and the rates of excretion increase around the eighth week [4]. During the first months of life, the larvae migrate and finish their cycle, but when the cat has reached its mature stage, the larvae may become entrenched and avoid finishing their life cycle [9].

Male sex was identified as a risk factor for the presence of *Toxocara* spp. These results match the findings reported in the literature regarding sex [24,25].

There are studies that have shown that behavior such as roaming, burial of feces, marking of territory and hunting arguably make males more susceptible to parasites that are present in their prey [1,8].

Toxocara spp. are distributed worldwide. For instance, in Italy, 58.3% of the cats studied were infected with *T. cati* [21]; in Iran, 54.5% [24]; in Nigeria, 48.5% [28], and in Colombia, 43% [11]. These results are comparable to our findings and reflect the climatic adaptability of *Toxocara* spp. Moreover, this is one of the most common nematodes found in felines, and it is zoonotic. Nevertheless, *T. cati* is considered to have lower epidemiological potential than *T. canis*. On the other hand, low prevalence has also been reported; for instance, only 7.8% of the cats were infected with *Toxocara* spp. in a study in Canada [13].

In the present study, the *Toxocara* species was not identified because, morphologically, the eggs are very similar among species; differentiation is complicated and has poor accuracy [30]. In contrast, Cardillo [7] reported finding eggs of different species and sexes. They found *Toxocara cati* in 25% of the cats, *Toxoscara leonina* in 16.6% and both species in 20%. Sommerfelt [27] also found *T. cati* in 61.2% of cat feces as well as *Toxoscara leonina* in 15.1% of fecal samples.

The prevalence of *Toxocara* spp. in domestic cats in the state of Mexico is high, and represents a potential risk of human toxocariasis. Nonetheless, there have been no studies on the seroprevalence of *T. cati* in humans, unlike *T. canis*, for which prevalence of 22% was recently reported in the state of Mexico. This was associated with ownership of pets such as dogs and cats [23].

CONCLUSION

It is important reflect on the role of domestic cats as a source of infection and dissemination of parasites, including *Toxocara* spp., which can affect humans and other animals. Simultaneously, it is vital to generate comprehensive programs to control cat populations and the transmission of their diseases to humans.

MANUFACTURERS

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***Declaration of interest*.** The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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