



Research Article

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Prevalence of *Cystoisospora* spp. in Domestic Cats in Mexico

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Abstract

Cystoisospora spp. is a parasite with high transmission potential. Among populations of the family *Felidae*, *Cystoisospora felis* and *Cystoisospora rivolta* are the species that affect the domestic cat. Cystoisosporosis is characterized by high morbidity and low mortality; immunocompromised patients experience more severe and prolonged signs. The prevalence of *Cystoisospora* varies according to the study region; prevalences from 1.4 to 21.9% have been reported in cats within households and up to 46.3% in stray cats. The objective of this study was to determine the prevalence of *Cystoisospora* in cats with owners from different states of Mexico. Fecal samples (n= 927) from cats attending consultation from June to December 2019 were collected. 429 were positive: 13.59% came from kittens (under 6 months old), 9.49% from juveniles (aged 7 to 12 months), and 27.51% from adults (over 13 months). There was a prevalence of 50.59%; risk factors included an outdoor lifestyle, having been adopted, and lack of grooming. These could be associated with coexistence with other cats having access to the outside, the consumption of infected tissues, or contact with contaminated areas, representing the main forms of transmission of this protozoan.

Keywords: Cystoisosporosis, *Cystoisospora felis*, Cat, Prevalence, Mexico

Introduction

The cat (*Felis catus*) is a domestic species that has been coexisting with humans for millennia [1]. It has maintained its hunting habits, mainly for rodents, reptiles, birds, fish, and amphibians; over the past two decades, ownership of cats as pets has increased, and so has the adoption of stray specimens. Thus, cats have gained a place in homes around the world, becoming part of the family nucleus [2,3].

However, they commonly have access to the outside world, which makes them susceptible to various enteroparasites, such as protozoans. Among these, the genus *Cystoisospora* represents

a high transmission potential, mainly among populations of the family *Felidae*, since it is species-specific. *Cystoisospora felis* and *Cystoisospora rivolta* are the species affecting the domestic cat [4,5]; these coccidias are transmitted efficiently by ingestion of sporulated oocysts present in the environment or by ingestion of contaminated tissues. They multiply intracellularly in the enterocytes, producing different degrees of epithelial damage; the non-spun oocysts are excreted with the feces and begin their infectious stage in the environment. The sporulated oocysts remain infective for years [6-8]. Cystoisosporosis is characterized by high morbidity and low mortality; it is usually asymptomatic,



but immunocompromised patients experience more severe and prolonged signs, making therapeutic management difficult. This is generally true for stray cats and animals in overcrowded conditions and/or with nutritional deficiencies, which can be reservoirs and sources of infection [9]. Prevalence's from 1.4 to 21.9% have been reported in cats within households [10]. The objective of this study was to determine the prevalence of *Cystoisospora* spp. in owned cats in Mexico.

Materials and Methods, Area Descriptions

A cross-sectional study was conducted in 18 of the 32 states of Mexico (Table 1) from June to December 2019. In total, 927 fecal samples of cats were collected for consultation, regardless of breed, age, gender, provenance, or health status; all owners who agreed to participate in the project were asked to sign an informed consent and to complete a survey about epidemiological data and risk factors for *Cystoisospora*.

Sample Collection

The samples were collected from 178 clinics, hospitals, and veterinary offices, with the help of 305 previously trained veterinary doctors (training was provided through workshops, videos, conferences, webinars, and communication via email or WhatsApp) All obtained data were stored in an Excel sheet, and the analyzed samples were verified through electronic photographs evaluated by the researcher.

Analysis Procedures, Cyst Recovery Techniques, and Coproparasitoscopic Analysis

The fecal samples were collected fresh and subsequently processed directly in the veterinary clinics, using direct examination as well as the Faust and Graham techniques. For direct examination, one drop of physiological saline was applied on a slide strip, and at the other end, one drop of Lugol's solution and a small, una pequeña fresh fecal sample (1mg of feces) were placed and mixed homogeneously with each solution. The samples were cover with a cover slip and observed under the microscope [11,12] report a sensitivity of 97.1 % and a specificity of 93.8% of this technique for protozoans. For Graham's method, one sample was obtained with acetate or scotch tape from the anal region of the cat, adhered to the slide sheet, and subsequently observed under the microscope [13]. Beltran *et al.* 2020, report a sensitivity of 71% and a specificity of 100% for this simple, rapid, and economic method; however, it cannot be performed in stressed and aggressive cats and are very

inefficient [14]. Faust's technique was performed by suspending 1 to 1.5 g of feces in distilled water, followed by sieving and centrifugation at 1,500-2,000 rpm for 2 minutes. The supernatant was discarded, and 2 to 3 ml of 33% zinc sulfate solution (specific gravity-1.18) were added; the mixture was stirred until the sediment was completely suspended. It was then centrifuged again at 2,000 rpm for 2 minutes. Using a bacteriological handle, a sample was taken from the tube and placed on a cover slip with a drop of Lugol's solution [15] and a few drops of zinc sulfate; the tube was left in the centrifuge until a meniscus was achieved and subsequently covered for a few minutes. After this, one drop of Lugol's solution was applied to a slide, covered with a cover slip, and observed under the microscope. Previous studies have reported a sensitivity of 100% and a specificity of 83% [16] for this method. It is inexpensive and keeps the sample clean, making it more reliable. However, the procedure is more time-consuming, and there may be greater chances of errors during processing, such as dilution of the zinc sulfate solution and damaging of cysts after prolonged contact with the solution. Inadequate management of the final centrifugal solution makes it difficult to identify species; thus, the possibility of observing co-infections is diminished.

Statistical Analysis

The results for each sample were recorded in an Excel Microsoft Office sheet. The prevalence of isolated parasites was estimated as the number of positive animals divided by the total number of animals examined.

Results

Age was not associated with prevalence, but it was a risk factor (OR 1.47, P. 0.01) for kittens (Table 1). Coexistence with other cats translated into a tendency to be positive to *Cystoisospora*, but there was no association, nor was it a risk factor. Living with other animals and having a hunting habit were not associated with prevalence nor were they a risk factor in these felines (Table 1). Having access to the outside world if you filed association (Chi2.17.89, P-0.0001) with the presence of *Cystoisospora* in feces and in addition to being a risk factor in cats (OR 1.76), as well as the place of origin, the adopted animals had association (Chi2-13.15, P-0.004) and was a risk factor (Chi2-18.68, P. 0.0001) to present *Cystoisospora* in feces (Table 1) Failure to groom was associated (Chi2-16.50, P-0.0009) with the prevalence of *Cystoisospora* and represented a risk factor (OR 1.64, P. 0.0002).

Table 1: Variables associated with the presence of *Cystoisospora* and risk factors in cats.

	Positives No. 469	%	Negative No. 458	%	Chi2	Q	OR	Q	(95% CI)
Age									
Kitten	126	13.59	119	12.84	1.01	0.58	1.47	0.01*	1.09-1.99
Young	88	9.49	76	8.2					
Adult	255	27.51	263	28.37					
Lives with other cats									
Yes	308	33.23	325	35.06	2.99	0.08	0.78	0.08	0.59-1.03
No	161	17.37	133	14.35					
Lives with other animals									
Yes	226	24.41	198	21.38	2.2	0.13	1.21	0.13	0.93-1.57
No	243	26.24	259	27.97					
Hunting habit									
Yes	313	33.8	297	32.07	0.42	0.51	1.09	0.51	0.83-1.43
No	155	16.74	161	17.39					
Access to the outside									
Yes	226	24.38	158	17.04	17.89	0.0001*	1.76	0.0001*	1.35-2.30
No	243	26.21	300	32.36					
Origin									
Adopted	438	47.25	417	44.98	13.15	0.004*	18.68	0.0001*	10.33-33.77
Bought	4	0.43	20	2.16					
Breeder	21	2.27	19	2.05					
It is unknown	6	0.65	2	0.22					
Brushed									
Daily	31	3.34	32	3.45					
Weekly	125	13.48	151	16.29					
Monthly	40	4.31	65	7.01					
Never	273	29.45	210	22.65	16.5	0.0009*	1.64	0.0002*	1.26-2.13

OR, odds ratio, 95% CI, 95% confidence interval, * Significant

Discussion

Cystoisospora felis and *Cystoisospora rivolta* cause diarrhea in domestic felines around the world, often in tropical regions due to warm temperatures (between 20-40°C) and humidity, which provide an adequate environment for the development of all their stages [7,17,18]. In this study, we sampled 18 of the 32 states of the Mexican Republic (56.2%), representing 63.86% of the extent of the national territory. From the sampling sites, 927 stool samples were collected, of which 469 were positive. Estimates show that in Mexico, 82% of households have a pet, of which 29% are cats [18]. Our study revealed a prevalence of 50.59%, which is very high compared to the 1.4% reported by [11] in Japan, to the 5.8% in Canada [19], to the 9.4% in North America, to the 9.5% [20] and 16.4% [21] in Greece, and to the 219% in Germany [22].

It is estimated that stray, shelter, and outdoor cats are more susceptible to parasitic infections due to their predatory habit, as

they consume rodents, birds, reptiles, amphibians, and even food scraps and are also in greater contact with other cats; they are also less likely to access veterinary care. Our analysis shows a tendency for felines to be positive to *Cystoisospora* when living with other congeners; in addition, there was a high prevalence (24.38%) in cats with access to the outdoors, compared to the 2.9% in outdoor cats and the 1.1% in indoor cats reported by [23]. However, the owners do not always know where their cats come from, and many cats have spent time in pet shops, veterinarians, breeders, shelters, or on the street. It is generally assumed that pet shops, veterinary hospitals, and breeders have greater control over parasites. In our study, cats from breeders showed a prevalence of 2.27%, less than the 5% reported by [17] for cats from breeders in Japan. However, shelters house a high number of animals, and the lack of effective antiparasitic treatment and inadequate management of cat groups increase parasite prevalence. Shelters have reported prevalence's of 1.5% to 23% [3]. It is proposed that in Mexico, most cats are

adopted (92.23%) and come from the street; they are therefore more susceptible to any parasites. This could explain the high prevalence (47.25 %), compared to those reported in both shelter and stray cats by Szwabe and Blaszkowska [24] (11.8%) and by [2] (12.9%). Only [22] observed high prevalence's (35 and 46.3%, respectively) in stray cats, but these remain lower than those observed in owned cats in the present study.

On the other hand, grooming by the owner influenced the results obtained in the present work. Most felines (52.10%) have never been groomed, and these represented 29.45% of the population positive to *Cystoisospora*. Lack of grooming might be a major risk factor, since the hair may contain a significant proportion of parasite eggs, which is in agreement with [3]. Considering that most cats are adopted and that the majority of them come from the street, they may have discharged cysts from these protozoans into the environment. Previous studies have revealed that large numbers of infectious eggs from other parasites are detected in the fur [25], suggesting that direct contact with the fur of a contaminated cat could be an additional route of transmission and re-infection among the feline population [26].

Conclusion

The data presented in this analysis show that *Cystoisospora* spp. was present in most of the samples from owned cats. The prevalence rate was 50.59 %, which is high even compared to other studies conducted in stray cats. We also showed that cats with access to the outside or which have been adopted have a higher incidence of these protozoans; in addition, brushing the pet decreases the numbers of these parasites. Although they do not produce zoonoses, our data suggest the need to improve the control measures for these coccidian's to decrease their morbidity, including effective therapeutic management procedures, stress management, feline and environmental hygiene, in addition to paratenic host control.

Conflict of Interest

The authors declare that they have no conflict of interest.

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