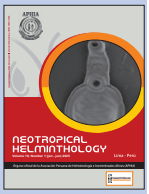
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ORIGINAL ARTICLE / ARTÍCULO ORIGINAL

FECAL EXAMINATIONS OF DOGS AND CATS RESCUED AND ADOPTED FROM THE FLOOD IN PORTO ALEGRE, RIO GRANDE DO SUL, BRAZIL

EXÁMENES FECALES DE PERROS Y GATOS RESCATADOS Y ADOPTADOS DE LA INUNDACIÓN EN PORTO ALEGRE, RIO GRANDE DO SUL, BRASIL

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ABSTRACT

The objective of this work is to report gastrointestinal parasitism in dogs and cats abandoned during the May 2024 flood, rescued and adopted in Porto Alegre, Rio Grande do Sul, Brazil. From June to October 2024, fecal samples from 93 pets (15 dogs and 78 cats) were analyzed using five parasitological techniques. Of the total number of pets (15 dogs and 78 cats), the frequencies of positive samples were 46.6% (7/15) and 43.6% (34/78), respectively, for dogs and cats. The parasites present in dogs were: *Ancylostoma caninum* (Ercolani 1859), *Trichuris vulpis* (Frolich 1789), *Cystoisospora felis* (Wenyon, 1923; Frenkel 1977), and *Toxocara canis* (Werner, 1782); in cats, they were: *T. canis*, *C. felis*, *Giardia* sp., larvae of *Aelurostrongylus abstrusus* (Railliet, 1898) and *Strongyloides* sp., *A. caninum*, *Dipylidium caninum* (Linnaeus, 1758), and *Dioctophyma renale* (Goeze, 1782). These results demonstrate the importance of parasitological diagnosis based on the identification of parasites that can affect not only animal health, but also human health.

Keywords: emerging zoonoses – parasitic zoonoses – pet animal – prevention – helminth

RESUMEN

El objetivo de este trabajo es reportar el parasitismo gastrointestinal en perros y gatos abandonados durante la inundación de mayo de 2024, rescatados y adoptados em Porto Alegre, Rio Grande do Sul, Brasil. De junio a octubre de 2024 se

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analizaron muestras fecales de 93 mascotas (15 perros y 78 gatos) mediante cinco técnicas parasitológicas. Del total de mascotas (15 perros y 78 gatos), las frecuencias de muestras positivas fueron del 46,6% (7/15) y del 43,6% (34/78), respectivamente, para perros y gatos. Los parásitos presentes en los perros fueron: *Ancylostoma caninum* (Ercolani, 1859), *Trichuris vulpis* (Frolich, 1789), *Cystoisospora felis* (Wenyon, 1923; Frenkel, 1977) y *Toxocara canis* (Werner, 1782); en gatos fueron: *T. canis*, *C. felis*, *Giardia* spp., larvas de *Aelurostrongylus abstrusus* (Railliet, 1898) y *Strongyloides* sp., *A. caninum*, *Dipylidium caninum* (Linnaeus, 1758) y *Dioctophyma renale* (Goeze,1782). Estos resultados demuestran la importancia del diagnóstico parasitológico basado en la identificación de parásitos que pueden afectar no sólo la salud animal, sino también la salud humana.

Palavras clave: animal de companhia – helminto – prevención– zoonosis emergentes – zoonosis parasitarias

INTRODUCTION

Gastrointestinal parasites that more frequently occur in dogs in Brazil are nematodes of the genera *Ancylostoma* spp., *Toxocara* spp., *Trichuris* spp. and *Strongyloides* spp., followed by the cestode of the genus *Dipylidium* (Berenger *et al.*, 2021; Lima *et al.*, 2021; Lopes *et al.*, 2021; Souza *et al.*, 2024). All these genera, with the exception of *Trichuris* spp., contain species with zoonotic potential of transmission, especially in the presence of poor hygiene and sanitation conditions (Chomel, 2008) to control active infections in the environment (Henke *et al.*, 2023).

Infections caused by *Toxocara* spp. and *Ancylostoma* spp. can cause the zoonoses Visceral Larva Migrans (VLM) and Cutaneous Larva Migrans (CLM), respectively. Cutaneous Larva Migrans (CLM) is an infectious syndrome caused by several *Ancylostoma* species; it is more commonly transmitted by animal feces depositing eggs in the soil, with larvae entering humans through direct contact with skin (Maxfield & Crane, 2024). Visceral Larva Migrans (VLM) occurs due to the migration of the second stage larvae of nematodes through the human body's viscera. It is an underdiagnosed condition that usually affects the liver with eosinophilic abscesses and that appears as coalescent and conglomerate cavities in imaging exam (Kashyap *et al.*, 2024). They present a rare, but grave risk, to humans (Huynh *et al.*, 2024). Migrans cutaneous larva is unlike the cutaneous manifestation of the infection by *Strongyloides stercoralis* (Bavay, 1876) called *larva currens*, which demonstrates fast movement through the skin (Patil *et al.*, 2024), and the intestinal strongyloidiasis that affects about 100 million people worldwide, being endemic in tropical and subtropical regions (Merman *et al.*, 2016).

Prevalence of parasitic infection in dogs, confirmed through stool samples, in European countries are variable, with *Toxocara* spp. (1.7% – 22.4%) and *Ancylostoma* spp. (2.0% – 8.6%), *Dipylidium caninum* (0.2% – 1.25%), *Cystoisospora felis* (4.6% – 22.3%) and *Giardia* spp. (3.8% – 51.6%) (Barutzki & Schaper, 2003; Riggio *et al.*, 2013; Kostopoulou *et al.*, 2017; Bourgoin *et al.*, 2022), while in Morocco, the general prevalence was of 58%, with *Ancylostoma* spp. (31.9%), *Toxocara canis* (27.1%), *Cystoisospora* spp. (13.4%) and *Giardia* spp. (7.2%) (Idrissi *et al.*, 2022).

In cats, the most frequent helminthiasis in Brazil is caused by *Ancylostoma* spp., with a prevalence greater than 40% (Melo *et al.*, 2021), but *Toxocara* spp. is the most common worldwide parasite in cats, especially in young animals (Marques *et al.*, 2020). Prevalences in cats in Brazil vary: in the Southern region, an occurrence from 21% to 76.9% is reported (Marques *et al.*, 2017; Mósena *et al.*, 2019); in the Southeast, it varies from 18.1% to 50.64% (Ramos *et al.*, 2020) and in the Northeast rates vary from 13.65% to 100% (Silva *et al.*, 2017). *Aelurostrongylus abstrusus* (Railliet, 1898) is the most important nematode that affects the respiratory system of domestic cats, therefore being an important differential diagnosis in respiratory diseases (Crisi *et al.*, 2019; Fagundes-Moreira *et al.*, 2023). The conditions that favor the development of both eggs and larvae (exogenous development stages) in the environment are similar to all helminths that infect dogs and cats in tropical and subtropical regions and, despite biological and transmission particularities of each species, mixed infections occur frequently in these hosts (Silva *et al.*, 2017).

Giardia spp. Is the most frequent protozoosis in dogs and cats and is included among the "Neglected Tropical Diseases" of the World Health Organization (WHO),

due to its connection to poverty and poor sanitation conditions. It is part of a group of diarrheal diseases that cause serious socioeconomic problems in Least Developed Countries (Souza *et al.*, 2024). *Cystoisospora* spp. frequently causes diarrhea, fever, dehydration, and a decline in immunity. The contamination of the environment combined with the lack of basic sanitation becomes an important factor that contributes to the occurrence of this disease. Furthermore, its control is made difficult given how easily the etiologic agent can spread to dogs and cats; prevalence was of 24.73% in household cats that had access to the outdoors in Porto Alegre (Klimpel *et al.*, 2010; Marques *et al.*, 2017). The goal of this investigation was to determine, through stool samples, the parasite infections present in adopted dogs and cats, based on the unknown sanitation history, thus being able to guide treatment and epidemiologic care.

MATERIAL AND METHODS

Stool samples of 15 dogs (4 males, 11 females, 3 puppies and 12 adults) and of 78 cats (68 males, 10 females, 3 kittens and 75 adults), with a total of 93, were analyzed from June to October 2024. These animals were rescued after being abandoned during the flooding that destroyed and damaged many districts of Rio Grande do Sul in May of 2024. Fig. 1 shows some examples of dogs and cats that were rescued.



Figure 1. Examples of cats and dogs being rescued in the 2024 flooding in Porto Alegre, Rio Grande do Sul, Brazil.

Samples were collected in two community shelters in the city of Porto Alegre, Rio Grande do Sul, Brazil. The animals underwent veterinary screening and necessary exams before being put for adoption. Cats and dogs sampled had their stool collected and sent to the Laboratório de Parasitologia da Faculdade de Veterinária da Universidade Federal do Rio Grande do Sul (Laboratory of Parasitology of the Veterinary College of the Federal University of Rio Grande do Sul), in Porto Alegre, where they were kept in a temperature of 39.2 °F and processed in a period no longer than 24 hours with the following techniques: Willis-Mollay, Lutz, Faust, Baermann and direct parasitological examination. The identification of the parasite genre was conducted

based on the morphologic characteristics of the eggs, cysts, oocysts and larvae (Zajac & Conboy, 2012). The microscopy for each sample was observed with the use of a binocular optical microscope Olympus® BX 41 with an amplification of 100 × and, if necessary, 400 × to confirm the protozoan parasites.

Ethic aspects: For this study formal consent is not required.

RESULTS AND DISCUSSION

In the study period, 465 stool sample exams were performed with the previously mentioned techniques. From the total of 93 animals rescued and adopted (15 dogs and 78 cats), the frequency of positive samples for dogs was of 46,6% (7/15) and of 43,6% (34/78) for cats. Table 1 describes the parasites detected in the specific methodologies for visualization and identification of eggs, larvae, cysts and/or oocysts in stool samples.

Table 1. Parasites diagnosed in stool samples of dogs and cats rescued in the flooding (May/2024) in Porto Alegre, Rio Grande do Sul, Brazil.

Species	Identified parasite	N (%)
Canine	*Ancylostoma caninum*	3 (20)
	Ancylostoma caninum + *Trichuris vulpis*	2 (13.3)
	Ancylostoma caninum + *Cystoisospora felis*	1 (6.7)
	Ancylostoma caninum + *Toxocara canis*	1 (6.7)
	Positive Samples	7 (46.7)
	Negative Samples	8 (53.3)
	Total	**15**
Feline	*Toxocara canis*	10 (12.8)
	Cystoisospora felis	6 (7.7)
	Giardia spp.	4 (5.1)
	Aelurostrongylus abstrusus	3 (3.8)
	Strongyloides sp. larvae	2 (2.6)
	Ancylostoma caninum	3 (3.8)
	Giardia spp. + *Cystoisospora felis*	1 (1,3)
	Giardia spp. + *Toxocara canis*	1 (1.3)
	Ancylostoma caninum + *Toxocara canis*	1 (1,3)
	Dipylidium caninum	2 (2.6)
	Dioctophyma renale	1 (1.3)
	Positive samples	34 (43.6)
	Negative samples	44 (56.4)
	Total	**78**
Total		**93**

The presence of endoparasites in dogs and cats involves matters of public health, since some parasite genera have significant zoonotic potential. All seven infected dogs (46.7%) presented eggs of potentially zoonotic agents. In the stool samples of the 78 cats, the frequency of gastrointestinal parasites was of 46.3%, with 22 animals presenting zoonotic parasites. Prevalence rates in the range of 50% in this relevant study impact on how important parasitological diagnosis is both for human and animal health. In some cases, it was not possible to determine the origin of the animals since they were taking shelter wherever they could in order to escape the powerful flooding (over 4ft of water). The catastrophic situation did not allow many of these animal's tutors to stay with them, since many of these people had no home to return to.

Prevalence of gastrointestinal parasites in dogs and cats in Brazil vary, ranging up to 80%. Nevertheless, this report is in accordance with other investigations (Marques *et al.*, 2017; Silva *et al.*, 2017; Mósena *et al.*, 2019; Ramos *et al.*, 2020; Berenger *et al.*, 2021) for more important

zoonotic helminths. The reality of frequencies also applies to the same helminths and prevalence rates, as published in other countries (Barutzki *et al.*, 2003; Riggio *et al.*, 2013; Kostopoulou *et al.*, 2017; Bourgoin *et al.*, 2022; Idrissi *et al.*, 2022).

Aelurostrongylus abstrusus is the most important nematode that affects the respiratory system of domestic cats, thus being an important differential diagnosis in diseases that affect the respiratory tract (Fagundes-Moreira *et al.*, 2023). Diagnosis through the Baermann technique is reliable and low cost.

Strongyloides sp. larvae were present in the stool samples of two cats, which is unusual in the routine of exams of this laboratory. In literature, there are few reports of infection by the currens larva, whose clinical signs are, frequently, unspecific. Patil *et al.* (2024) report that the proper diagnosis and treatment with ivermectin is necessary, especially when the patient is immunocompromised and at higher risk of hyperinfection syndrome and disseminated disease. This recent case justifies giving the due attention to the presence of this parasite in animals in close proximity to humans.

Giardiasis is a routine result in the laboratory as stool samples of dogs and cats are run, and it can manifest with typical signs such as feces with mucus or bloody and smelly diarrhea, with or without vomiting. Prevalence is high in young animals and can reach up to 50%. There are 8 different genotypes (assemblages) (A - H). C and D are the most common ones in dogs and the F assemblage is more frequent in cats. Nonetheless, animals can also be infected by the zoonotically efficient A and B assemblages or have multiple infections. The adoption of specific hygiene habits is necessary and, in case the pet presents with clinical signs, or lives in the same household as high-risk patients, medication is recommended (Kansky *et al.*, 2023). Kurnosova *et al.* (2024) have investigated stool samples of 2761 dogs and 1579 cats in order to determine infection rates by *G. duodenalis,* that resulted in 18.2% (215/1182) in dogs from 1 to 12 months and 3.8% (60/1579) in dogs older than 12 months; for cats the infection rate was of 7.8% (48/615) in cats from 1 to 12 months and 3.35% (33/994) in cats >12 months. The rate of positive animals in this study was of 7.7% (6/78) in cats, and even though our sampling is not big and cannot be compared to that of the previously mentioned study, the zoonotic aspect should be considered. In dogs, prevalences vary uniformly in many studies, and in this report with a sampling of 15 dogs, not one has tested positive for giardiasis in the one stool sample collected. In our routine practice, though, the collection of three stool samples per animal is recommended.

In Rio Grande do Sul, a prevalence of endoparasites of 47.1% has been observed in household and shelter cats, with *T. canis* and *Giardia* spp. being the biggest occurrences (Pivoto *et al.*, 2013). In the city of Porto Alegre-RS, a *T. canis* prevalence of 26,8% in the stool samples of cats has been reported (Marques *et al.*, 2017; Sarmento *et al.*, 2021). High prevalence rates for *Toxocara* spp. have been reported in Andradina-SP, 43.1% (Coelho *et al.*, 2009) and Lages-SC, 49.4% (Quadros *et al.*, 2014).

Henke *et al.* (2023) have described in a comprehensive review that growing evidence suggests a potential association between toxocariasis and chronic diseases such as asthma, cases of cognitive and behavioral disturbance (schizophrenia, neurodegenerative diseases and epilepsy), making the investigation of the physio pathological interactions between host and parasite in the pathogenesis of many systemic disorders a true research challenge. This observation is particularly important when we take into consideration that helminthiases are the etiology of millions of deaths, and take part in the estimate to determine the number of Disability Adjusted Life Years (DALY), that associate these diseases as the cause for a lack in productivity of 6 to 35.3% in those affected. Therefore, feces of infected dogs make parks, squares, playgrounds, litter boxes and beaches the main source of transmission to humans. E Huynh *et al.* (2024) have described a case of hepatic larva migrans in a young person caused by *T. canis.* The lack of specific clinical signs was what stood out in general practice, which leads to the importance of considering toxocariasis as a differential diagnosis in hepatic abscesses, especially in regions of high seroprevalence, highlighting the need of corroborative evidence, including invasive procedures such as hepatic biopsy, for the precise diagnosis of hepatic toxocariasis.

Unlike the treatment dispensed to cats and dogs with parasitic diseases, treatment in humans varies according to clinical symptoms and the location of larvae. Molecular technologies can also help demonstrate the importance of *T. canis* in public health, providing new evidence to support the launching of control programs, by national initiatives, that still need to be developed. Many countries have developed programs of reproductive control in household and stray dogs to reduce the number of young dogs—more prevalent—in the population. The growth in human and canine populations and, more recently, the population of cats in the homes of Brazilians, populational movements as well

as climate changes will help increase the importance of this zoonosis (Macpherson, 2013).

Toxocariasis continues to be an important neglected parasitic disease, as it is one of the most common zoonotic infections caused by the parasite *T. canis* or, less frequently, *T. cati*. The disease's epidemiology is complex due to its transmission route by accidental ingestion of eggs or embryonated larvae of *Toxocara* from domestic or wild paratenic host's tissue. Although the World Health Organization and the Centers of Disease Control have classified toxocariasis among the six main parasitic infections of priority to public health, global epidemiological data on the relationship between seropositivity and toxocariasis is limited.

Infection by cutaneous larva migrans, caused by the helminth of the genus *Ancylostoma* in humans, occurs when the skin gets into contact with fomites contaminated with the feces of dogs or cats. L3 stage has the capacity to penetrate skin tissue through the action of an enzyme known as hyaluronidase or through the hair follicle, sweat glands and skin tears, popularly known as "geographic worm" in Brazil due to its creeping eruptions (Soares *et al.*, 2018; Lima *et al.*, 2021), and it can cause a series of risks both for animal and human health, with severe complications for both species. As a consequence, there is a great need to control this disease in order to interrupt its biological cycle. Many options can be taken to prevent the transmission of this zoonosis and among them we can quote the administration of anthelmintic drugs, that can also be used therapeutically in infected animals. The drug resistance found in *A. caninum* is an emerging and serious problem (Lima *et al.*, 2021). Despite anthelmintic drugs being efficient in deworming, the fast reinfection in endemic areas occurs due to the organism's inability to develop immunological anti-parasite memory, thus requiring treatment in infected hosts to be repetitive and resulting in helminth resistance to the available drugs (Wang *et al.*, 2010). Prevention strategies include educational programs, changes in behavior and hygiene habits, enhancement of the role of the veterinarians, and anthelmintic protocols to control active infections (Marques *et al.*, 2020; Henke *et al.*, 2023).

Gastrointestinal parasitic diseases are one of the main causes of infections in humans (Hall *et al.*, 2008). They usually affect populations that do not have access to basic sanitation, education, and are more socioeconomic challenged, therefore accounting for a public health problem in Brazil (Cirne & Cabrera, 2019). Every year, about 3.5 billion of people are affected by these diseases, and around 65 thousand people die, especially in Least Developed Countries (Zamprogno *et al.*, 2015).

Control and prevention of emerging parasitic zoonoses poses complex challenges that demand an integrated and multidisciplinary approach. Therefore, ecological and environmental modifications need to be implemented in order to reduce not only parasite load, but also the risk of parasite transmission (Felix, 2020). In conclusion, the climate tragedy that took place in part of the state of Rio Grande do Sul, affecting millions of people and animals, has confirmed the importance of One Health actions to prevent and control zoonotic parasitic diseases, promote programs to spay, neuter and deworm pets, public policies and educational programs directed to the more vulnerable communities.

Author contributions: CRediT (Contributor Roles Taxonomy)

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Visualization: SMTM, RGT, ES
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