REVISTA BIO CIENCIAS
http://revistabiociencias.uan.edu.mx
https://doi.org/10.15741/revbio.12.e1753

ISSN 2007-3380

Artículo original/Original Article

Frequency of gastrointestinal parasites in shelter dogs in the municipality of Jamapa, Veracruz.

Frecuencia de parásitos gastrointestinales en perros de un albergue en el municipio de Jamapa, Veracruz.

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Please cite this article as/Como citar este artículo: Reyes-Sandoval, R.M., Romero-Salas, D., Cruz-Romero, A., Alcalá-Canto, Y., Del Río-Araiza, V.H., Salguero-Alonso J.L., Ojeda-Robertos, N.F. (2025). Frequency of gastrointestinal parasites in shelter dogs in the municipality of Jamapa, Veracruz. Revista Bio Ciencias, 13, e1753. https://doi.org/10.15741/revbio.12.e1753

Article Info/Información del artículo
Received/Recibido: August 26th 2024.
Accepted/Aceptado: September 19th 2025.
Available on line/Publicado: October 06th 2025.

ABSTRACT

Parasitosis is a public health concern, with pets acting as reservoirs and sources of both direct and indirect contamination, spreading parasites through their feces into water, soil, and food sources. This study aimed to determine the frequency of gastrointestinal parasites in dog feces from the Jamapa shelter, Veracruz. Fecal samples from 230 dogs were analyzed in a cross-sectional convenience sampling conducted from March to July 2023. The samples were collected directly from the rectum of the animals and analyzed at the Parasitology Laboratory of the Torreón del Molino ranch, FMVZ, at Veracruzana University. The techniques used included McMaster, flotation, and modified Faust methods. Data analysis was performed using the STATA program, revealing a general parasite frequency of 98.7 %. The individual frequencies were as follows: Trichuris spp. (16 %), Giardia spp. (19.5 %), Strongyloides spp. (28.2 %), Uncinaria spp. (34.7 %), Toxocara spp. (57.3 %), and Ancylostoma spp. (81.7 %). The overall frequency was similar for both sexes. Regarding age, all groups showed a frequency greater than 95%. The findings indicate a high prevalence of gastrointestinal parasites in this shelter, which may pose a risk to public health.

KEY WORDS: Animal welfare, Dewormer, Parasite, Transmission, Zoonosis.

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ISSN 2007-3380

RESUMEN

Las parasitosis son un problema en Salud Pública, las mascotas actúan como reservorios y son una fuente de contaminación directa e indirecta, contaminan fuentes de agua, suelo y alimentos a través de sus heces. El objetivo fue determinar la frecuencia de parásitos gastrointestinales en heces de perros del albergue de Jamapa, Veracruz. Se analizaron las heces de 230 perros en un muestreo transversal por conveniencia que duró de marzo a julio del 2023. Las muestras se tomaron del recto de los animales y fueron analizadas en el laboratorio de Parasitología del rancho "Torreón del Molino", FMVZ de la Universidad Veracruzana. Las técnicas empleadas fueron: Mc Máster, Flotación y Faust modificada. En análisis se realizó usando el programa STATA ver 14.0; se determinó una frecuencia general de 98.7 %; de forma independiente las frecuencias fueron: Trichuris spp. 16 %; Giardia spp. 19.5 %; Strongyloides spp. 28.2 %; Uncinaria spp. 34.7 %; Toxocara spp. 57.3 % y Ancylostoma spp. 81.7 %. La frecuencia general fue similar para ambos sexos. Con respecto a la edad, todos los grupos presentaron frecuencia superior al 95 %. Se determinó que existe una alta presencia de parasitosis gastrointestinales en este albergue, lo cual podría significar un riesgo para la Salud Pública.

PALABRAS CLAVE: Bienestar animal, Desparasitante, Parásito, Transmisión, Zoonosis

Introduction

Companion animals, particularly dogs and cats, serve as potential hosts or reservoirs for a wide range of parasitic infections and represent a constant source of direct contamination, especially for children with whom they interact closely. Indirect contamination also occurs through the dissemination of infective stages or eggs present in feces, which can pollute water sources, soil, and food (Sarmiento-Rubiano *et al*., 2018). Dogs and cats admitted to shelters may harbor gastrointestinal parasites that pose significant risks to shelter personnel, visitors, and other animals. Furthermore, such environments provide favorable conditions for the transmission and persistence of infections within the population (Raza et al., 2018). Infections caused by gastrointestinal parasites in dogs and cats occur worldwide and are mainly associated with nonspecific intestinal disorders, presenting with clinical manifestations that may manifest in acute, subacute, or chronic forms (Caraballo *et al*., 2007). These parasitoses represent one of the most frequent health concerns in canines, causing infections of moderate to severe intensity and constituting an important zoonotic

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threat (Quijada *et al*., 2008; Sierra-Cifuentes *et al*., 2014). Numerous studies have documented the presence of diverse gastrointestinal parasites in feces and soil from public areas, where humans may acquire them through accidental ingestion of larval stages, underscoring their impact on public health (Morales *et al*., 2016). Transmission typically follows the fecal–oral route, either through direct or indirect contact with infective stages (e.g., cysts), person-to-person spread, or via the consumption of contaminated food and/or water (Cacció *et al*., 2005). In canines, gastrointestinal parasites are associated with clinical signs such as diarrhea, dehydration, vomiting, and, in certain cases, respiratory symptoms. Frequently reported genera include *Toxocara* spp., *Ancylostoma* spp., *Uncinaria* sp, *Trichuris* sp, *Strongyloides* spp., *Spirocerca* sp, *Giardia* spp, and *Dipylidium* sp., among others (Solarte-Paredes *et al*., 2013; Morales *et al*., 2016; Saari *et al*., 2019). Of particular medical relevance *are Toxocara canis* and *Echinococcus granulosus*, both transmitted by dogs and recognized for their zoonotic epidemiological significance. *T. canis* is a nematode responsible for visceral, cutaneous, or ocular larva migrans, while *E. granulosus* is a cestode that causes hydatidosis in humans (Caraballo *et al*., 2007; Sotiriadou *et al*., 2013; Dantas-Torres & Otranto, 2014; Iannacone *et al*., 2001). Giardiasis, caused by *Giardia* spp., is another parasitic infection with high zoonotic potential. The parasite produces cysts that are excreted in feces and remain viable for extended periods in the environment. Fecal–oral transmission starts with the ingestion of cysts, and as few as ten may induce an experimental infection. The clinical outcome depends on the *Giardia* species involved and host-related factors such as immune status. In most cases, infection results from inadequate food handling, poor hygiene, or environmental persistence of cysts in animal habitats or fur. These factors enhance the risk of transmission in vulnerable groups, particularly children (Cabrera & Molina, 2015; Godínez-Galaz *et al*., 2019; Naupay *et al*., 2019). Climatic conditions typical of tropical and subtropical regions, particularly warm and humid environments, further promote the development and survival of these parasites (Giraldo *et al*., 2005). Consequently, assessing the occurrence of gastrointestinal parasites in dogs living under high-density conditions is essential for guiding preventive and control measures. Such efforts contribute not only to animal health but also to the safeguarding of public health. In light of these considerations, the objective of the present study was to determine the prevalence of gastrointestinal parasites in the feces of dogs housed at the Jamapa shelter, Veracruz, which harbors the largest canine population among shelters in the central region of the state.

Material and methods

Study type and location

A cross-sectional, qualitative epidemiological study was conducted using a convenience sampling strategy at a shelter located in the municipality of Jamapa, Veracruz, Mexico, over five months (March–July 2023). Jamapa is situated in the central region of Veracruz, bordering the municipalities of Medellín, Manlio Fabio Altamirano, and Cotaxtla. The predominant climate is warm and sub-humid, with summer rainfall, and an average annual temperature ranging from 24 to 26 °C (INEGI, 2010).

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Sample size

The sample size was estimated using Win Episcope version 2.0 for calculating proportions in infinite populations. Assuming a maximum expected prevalence of 50 %, a 95 % confidence level, and a 5 % margin of error, the estimated sample size was 385 dogs. However, since the shelter population only consisted of 230 dogs, this number was used as the study population.

Sample collection

Fecal samples were obtained aseptically via direct rectal collection from each animal. Each sample was placed in a hermetically sealed bag labeled with the animal's identification number and/or name. Samples were transported under refrigeration (4 °C) to the Parasitology Laboratory of the "Torreón del Molino" Diagnostic Unit, Faculty of Veterinary Medicine and Zootechnics, Universidad Veracruzana, for processing.

Data collection

A general and individual survey were administered to collect study variables, including age, sex, previous diagnosis of parasitosis, history of anthelmintic treatment, frequency of veterinary consultations, episodes of illness, and hygiene practices.

Diagnostic techniques

Coproparasitological techniques were performed according to the methodology described by Coles *et al*. (1992). The McMaster technique, flotation (sodium chloride solution), and a modified Faust technique with 33 % zinc sulfate were used for the detection of *Giardia* spp. cysts Leventhal & Cheadle (1992).

Differentiation between Uncinaria sp. and Ancylostoma spp. was achieved through morphometric analysis (Uppal et al., 2017; Bowman et al., 2021).

Statistical analysis

Survey data were recorded in Microsoft Excel spreadsheets and analyzed using descriptive statistics in STATA version 14.0 (StataCorp). Prevalence was calculated, and causal associations were assessed using the Chi-square test (χ^2) (Thrusfield, 2005).

Results and Discussion

Table 1 shows that 37 out of 230 dogs tested positive for *Trichuris* spp., yielding a prevalence of 16 % (95 % CI: 11.5–21.4). Regarding sex, prevalence differed between females and males, with 18.1 % (95 % CI: 12.0–25.8) and 13.2 % (95 % CI: 7.2–21.6), respectively. Regarding age,

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the highest prevalence was observed in dogs older than 49 months (26.3 %; 95 % CI: 9.1–51.2), while the lowest prevalence was recorded in the 13–24 month age group (8.0 %; 95 % CI: 2.6–17.8). Purebred dogs exhibited the highest prevalence of *Trichuris* spp. infection (18.3 %; 95 % CI: 12.2–26.0) compared with mixed-breed dogs.

Table 1. Frequency of *Trichuris* spp. in dogs from the Jamapa shelter, Veracruz, in relation to sex, age, and breed, by the Sodium Chloride Flotation technique

Variable	"n"	Positive	Frequency (%)	*CI95 %	X^2	*P*
Sex						
Female	132	24	18.1	12.0-25.8	1.007	0.316
Male	98	13	13.2	7.2-21.6		
Age (months)						
6-12	70	12	17.1	9.1-28.0	5.053	0.282
13-24	62	5	8.0	2.6-17.8		
25-36	65	12	18.4	9.9-30.0		
37-48	14	3	21.4	4.6-50.7		
>49	19	5	26.3	9.1-51.2		
Breed						
Pure	131	24	18.3	12.1-26.0	1.124	0.289
Creole	99	13	13.1	7.1-21.4		
Total	230	37	16.0	11.5-21.4		

*95 %CI (95 % Confidence Interval), X2 (Chi square), *p* (<0.05)

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Table 2 shows that 68 out of 230 dogs tested positive for *Giardia* spp., with a prevalence of 19.5 % (95 % CI: 13.7–25.9). Prevalence varied only slightly by sex, with 28.7 % (95 % CI: 21.2–37.3) in females and 30.6 % (95 % CI: 21.6–40.7) in males. For age, the highest prevalence was observed in dogs aged 6–12 months (60.0 %; 95 % CI: 47.5–71.5), while no positive cases were recorded in the 37–48 months group (0.0 %; 95 % CI: 0–23.1). Regarding breed, mixed-breed dogs showed a higher prevalence of *Giardia* spp. infection (32.3 %; 95 % CI: 23.2–42.4) compared with purebred animals

Table 2. Frequency of *Giardia* spp. in dogs from the Jamapa shelter, Veracruz in relation to sex, age, and breed, using the Faust technique.

Variable	"n"	Positive	Frequency (%)	*CI95 %	X^2	*P*
Sexo						
Female	132	38	28.7	21.2-37.3	0.089	0.764
Male	98	30	30.6	21.6-40.7		
Age (months)						
6-12	70	42	60.0	47.5-71.5	48.89	0
13-24	62	15	24.1	14.2-36.7		
25-36	65	9	13.8	6.5-24.6		
37-48	14	0	0.0	0-23.1		
>49	19	2	10.5	1.3-33.1		
Breed						
Pure	131	36	27.4	20.0-35.9	0.634	0.426
Creole	99	32	32.3	23.2-42.4		
Total	230	68	19.5	13.7-25.9		

*95 % CI (95 % Confidence Interval), X2 (Chi square), *p* (<0.05)

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Table 3 indicates that 65 out of 230 dogs tested positive for *Strongyloides* spp., corresponding to a prevalence of 28.2 % (95 % CI: 22.5–34.5). Prevalence was similar between females and males, showing no notable variation by sex. For age, the highest prevalence was observed in dogs aged 37–48 months (35.7 %; 95% CI: 12.7–64.8). Regarding breed, both mixed-breed and purebred dogs exhibited the same prevalence of infection (28.2 %; 95 % CI: 20.7–36.7).

Table 3. Frequency of *Strongyloides* spp. in dogs from the Jamapa shelter, Veracruz, in relation to sex, age, and breed, by the Sodium Chloride Flotation technique.

Variable	"n"	Positive	Frequency (%)	*CI95 %	X^2	*P*
Sex						
Female	132	37	28.0	20.5-36.5	0.008	0.928
Male	98	28	28.5	19.8-39.5		
Age (months)						
6-12	70	12	17.1	9.1-28.0	6.242	0.182
13-24	62	21	33.8	22.3-47.0		
25-36	65	21	32.3	21.2-45.0		
37-48	14	5	35.7	12.7-64.8		
>49	19	6	31.5	12.5-56.5		
Breed						
Pure	131	37	28.2	20.7-36.7	0	0.995
Creole	99	28	28.2	19.6-38.2		
Total	230	65	28.2	22.5-34.5		

*95 % CI (95 % Confidence Interval), X2 (Chi square), *p* (<0.05)

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Table 4 shows that 80 out of 230 dogs tested positive for *Uncinaria* spp., with an overall prevalence of 34.7 % (95 % CI: 28.3–41.6). Prevalence differed slightly by sex, with 37.1 % (95 % CI: 28.8–45.9) in females and 31.6 % (95 % CI: 22.6–41.8) in males. Regarding age, the highest prevalence was recorded in the 6–12 months group (40.0 %; 95 % CI: 28.4–52.4). Purebred dogs showed a slightly higher prevalence of *Uncinaria* spp. infection (35.1 %; 95 % CI: 26.9–43.9) compared with mixed-breed dogs.

Table 4. Frequency of *Uncinaria* spp. in dogs from the Jamapa shelter, Veracruz, in relation to sex, age, and breed, by the Sodium Chloride Flotation technique

Variable	"n"	Positive	Frequency (%)	*CI95 %	X^2	*P*
Sex						
Female	132	49	37.1	28.8-45.9	0.746	0.387
Male	98	31	31.6	22.6-41.8		
Age (months)						
6-12	70	28	40.0	28.4-52.4	3.424	0.49
13-24	62	24	38.7	26.6-51.9		
25-36	65	20	30.7	19.9-43.4		
37-48	14	3	21.4	4.6-50.7		
>49	19	5	26.3	9.1-51.2		
Breed						
Pure	131	46	35.1	26.9-43.9	0.014	0.903
Creole	99	34	34.3	25.0-44.5		
Total	230	80	34.7	28.3-41.6		

*95 % CI (95 % Confidence Interval), X2 (Chi square), *p* (<0.05)

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Table 5 shows that 132 out of 230 dogs tested positive for *Toxocara* spp., yielding a prevalence of 57.3 % (95 % CI: 50.7–63.8). By sex, prevalence was 55.3 % (95 % CI: 46.4–63.9) in females and 60.2 % (95 % CI: 49.8–69.9) in males. To age, the highest prevalence was recorded in the 37–48 months group (78.5 %; 95 % CI: 49.2–95.3). Regarding breed, mixed-breed dogs showed a higher prevalence of *Toxocara* spp. (58.5 %; 95 % CI: 48.2–68.3) compared with purebred dogs.

Table 5. Frequency of *Toxocara* spp. in dogs from the Jamapa shelter, Veracruz, in relation to sex, age, and breed, by the Sodium Chloride Flotation technique.

Variable	"n"	Positive	Frequency (%)	*CI95 %	X^2	*P*
Sex						
Female	132	73	55.3	46.4-63.9	0.552	0.457
Male	98	59	60.2	49.8-69.9		
Age (months)						
6-12	70	42	60.0	47.5-71.5	4.116	0.391
13-24	62	36	58.0	44.8-70.4		
25-36	65	33	50.7	38.0-63.3		
37-48	14	11	78.5	49.2-95.3		
>49	19	10	52.6	28.8-75.5		
Breed						
Pure	131	74	56.4	47.5-65.1	0.101	0.750
Creole	99	58	58.5	48.2-68.3		
Total	230	132	57.3	50.7-63.8		

*95 % CI (95 % Confidence Interval), X2 (Chi square), *p* (<0.05)

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Table 6 shows that 188 out of 230 dogs tested positive for *Ancylostoma* spp., with a prevalence of 81.7 % (95 % CI: 76.1–86.5). Prevalence was similar between sexes, with 81.8 % (95 % CI: 74.1–87.9) in females and 81.6 % (95 % CI: 72.5–88.7) in males. Regarding age, the highest prevalence was observed in the 6–12 months group (90.0 %; 95 % CI: 80.4–95.8), whereas the lowest prevalence was found in the 25–36 months group (69.2 %; 95 % CI: 56.5–80.0). For breed, mixed-breed dogs exhibited a higher prevalence of *Ancylostoma* spp. infection (87.8 %; 95 % CI: 79.7–93.5) compared with purebred dogs.

Table 6. Frequency of *Ancylostoma* spp. in dogs from the Jamapa shelter, Veracruz in relation to sex, age, and breed, by the Sodium Chloride Flotation technique.

Variable	"n"	Positive	Frequency (%)	*CI95 %	X^2	*P*
Sex						
Female	132	108	81.8	74.1-87.9	0.001	0.971
Male	98	80	81.6	72.5-88.7		
Age (months)						
6-12	70	63	90	80.4-95.8	12.18	0.016
13-24	62	54	87	76.1-94.2		
25-36	65	45	69.2	56.5-80.0		
37-48	14	12	85.7	57.8-98.2		
>49	19	14	73.6	48.7-90.8		
Breed						
Pure	131	101	77	68.9-83.9	4.389	0.036
Creole	99	87	87.8	79.7-93.5		
Total	230	188	81.7	76.1-86.5		

*95 % CI (95 % Confidence Interval), X2 (Chi square), *p* (<0.05)

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Table 7 summarizes the overall occurrence of gastrointestinal parasites, showing that 227 out of 230 dogs tested positive, corresponding to a prevalence of 98.7 % (95 % CI: 97.2–100). By sex, prevalence was 98.4 % (95 % CI: 96.4–100) in females and 98.9 % (95 % CI: 97.0–100) in males. Concerning age, the highest prevalence was recorded in the 6–12 months group (97.1 %; 95 % CI: 93.2–100). Regarding breed, mixed-breed dogs exhibited a prevalence of 98.9 % (95 % CI: 97.2–100).

Table 7. General frequency of positive dogs *Giardia* spp., *Ancylostoma* spp., *Uncinaria* spp., *Trichuris* spp., *Toxocara* spp., and *Strongyloides* spp. from the Jamapa shelter, Veracruz, in relation to sex, age, and breed.

Variable	"n"	Positive	Frequency (%)	*CI95 %	X^2	*P*
Sex						
Female	132	130	98.4	96.40-100	0.008	0.928
Male	98	97	98.98	96.99-100		
Age (months)						
6-12	70	68	97.1	93.2-100	48.027	0
13-24	62	61	98.3	95.2-100		
25-36	65	65	100	100-100		
37-48	14	14	100	100-100		
>49	19	19	100	100-100		
Breed						
Pure	133	131	98.5	96.4-100	1.561	0.211
Creole	97	96	98.9	96.9-100		
Total	230	227	98.7	97.2-100		

*95 % CI (95 % Confidence Interval), X2 (Chi square), *p* (<0.05)

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The prevalence of gastrointestinal parasites reported in this study varies considerably depending on factors such as the region studied, sampled population, socioeconomic conditions, diagnostic techniques employed, and the health status of the animals, among others. The results are discussed below in the order presented in the tables.

A study conducted in Medellín, Veracruz, Mexico, analyzing shelter dogs, identified five species of endoparasites, among which *T. vulpis* showed a prevalence of 18.8 %. Parasitism was associated with age, breed, sex, and contact with cats, with 100 % of dogs in contact with cats testing positive for *T. vulpis* (Alvarado-Esquivel *et al*., 2015). In contrast, a prevalence of 4 % for T. vulpis was reported in both domiciled and stray dogs in Durango, Mexico, with this parasite being the only zoonotic agent detected in pet dogs (Aguillón-Gutiérrez *et al*., 2021). In Armenia, Colombia, *T. vulpis* prevalence was 4.3 % (Giraldo *et al*., 2005). Thus, *T. vulpis* is consistently reported in both stray and domiciled dogs, underscoring its zoonotic significance.

It has been noted that *T. vulpis* may be underdiagnosed due to its biological cycle, as adult worms may be migrating at the time of sampling. Diagnostic technique limitations also contribute, leading some authors to recommend concentration techniques via centrifugation (Traversa, 2011).

Giardiasis is one of the most important gastrointestinal infections affecting global public health, primarily associated with poor hygiene and contact with infected animals. Approximately 200 million people in Latin America, Africa, and Asia suffer from this disease, with around 500,000 new cases reported annually (Godínez-Galaz *et al*., 2019; Tarqui-Terrones *et al*., 2019). Vasilopulos (2007) reported a general Giardia prevalence of 5–15 %, which is lower than the prevalence observed in this study. The higher prevalence here may be explained by overpopulation and the absence of a preventive medicine program at the Jamapa shelter.

A meta-analysis in China reported an overall *Giardia* spp. prevalence of 11 %, with regional and temporal differences, as well as variability depending on diagnostic techniques (Zhao *et al*., 2022). Dogs serve as a significant reservoir for *Giardia* spp., facilitating transmission to other mammals and humans through contaminated water and recreational areas, emphasizing the need for disease control in both humans and animals (Godínez-Galaz *et al*., 2019).

Strongyloides stercoralis is another zoonotic parasite of major concern, affecting 100–370 million people worldwide, with strongyloidiasis considered a neglected disease. Infection is more common in young dogs, with clinical signs dependent on immune status and preexisting conditions. Worldwide prevalence in dogs is approximately 6 %, higher in stray and shelter populations (Eslahi *et al*., 2022). Studies in Colombia reported *Strongyloides* spp. prevalence of 4 % (Giraldo *et al*., 2005), while a study in Italy found 6 positive cases among 272 dogs, mostly shelter animals (Paradies *et al*., 2017). In northern Mexico, *Strongyloides* spp. was not detected (Aguillón-Gutiérrez *et al*., 2021), highlighting that stray and shelter dogs are the primary hosts for this parasite (Eslahi *et al*., 2022).

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A study conducted in Colombia aimed at identifying intestinal helminths found that *Strongyloides* spp. represented 4.0 % of the population (Giraldo *et al*., 2005). More recently, in an Italian province, 272 dog samples were analyzed for *S. stercolaris*, six animals tested positive: one was a domestic animal, and the other five belonged to a shelter. It is evident that the first of these animals had been adopted some time previously from a shelter (Paradies *et al*., 2017). In northern Mexico, the presence of *Strongyloides* spp. was not recently reported in the dogs analyzed (Aguillón-Gutiérrez *et al*., 2021). It is notable that in studies where *Strongyloides* spp. are mentioned, stray dogs or those belonging to shelters are the ones with the highest presence of these parasites.

Similarly, *Uncinaria stenocephala* is a key helminth in shelter dogs. Factors such as high population density, fecal contamination, unpaved areas, and elevated temperature and humidity create an optimal environment for larval development, facilitating rapid spread within the population. *Ancylostoma* spp. share these characteristics and can penetrate host skin (Raza *et al*., 2018). Clinical manifestations of uncinariosis include cutaneous lesions, which can be mistaken for other skin conditions but must be considered depending on geographic location (Chu *et al*., 2013).

Prevalences for *U. stenocephala* are lower in other regions, such as 0.4 % in Canada (Gaunt & Carr, 2011). In Veracruz, Mexico, shelter dogs showed 42.6 % prevalence (Alvarado-Esquivel *et al*., 2015), whereas Aguillón-Gutiérrez *et al*. (2021) did not report any cases.

Toxocara canis prevalence varies widely (0–90 %) depending on host factors (age, sex, breed, immune status) and environmental or sociocultural conditions (Ketzis *et al*., 2020). Studies in Mexico also report high variability, influenced more by animal and environmental factors than by parasite characteristics (Vélez-Hernández *et al*., 2014; Alvarado-Esquivel *et al*., 2015).

Fecal contamination of public areas is common, with egg densities ranging from 1 % to 80 % in different regions (Ketzis *et al*., 2020). In the present study, the prevalence was 60 % in dogs aged 6–12 months, peaking at 78.5 % in animals aged 37–48 months, highlighting the influence of infection type on age-related prevalence (Rodríguez-Vivas *et al*., 2011; Romero-Núñez *et al*., 2013; Raza *et al*., 2018).

In the Caribbean, *Ancylostoma* spp. prevalence has remained stable over time, unaffected by ownership status, likely due to free-roaming dogs and high environmental contamination. Reported prevalences range from 20 % to 90 % (Kim *et al*., 2022). In northern Mexico, prevalence was 12 % in stray dogs (Aguillón-Gutiérrez *et al*., 2021), and in Armenia, Colombia, 13.9 % (Giraldo *et al*., 2005). In this study, prevalence reached 81.7 %, consistent with previous findings in Veracruz 88 %; Alvarado-Esquivel *et al*., (2015). Climatic conditions in the Caribbean and Colombia resemble those of Jamapa, Veracruz, while northern Mexico's arid climate explains the lower prevalence. These findings underscore the need for canine deworming programs to reduce intestinal helminths.

Revista Bio ciencias
ISSN 2007-3380

In Oriente Antioqueño, Colombia, endoparasite prevalence reached 72.1 %, with *U. stenocephala*, *A. caninum*, and *T. vulpis* most prevalent (Sierra-Cifuentes *et al*., 2014). At the Jamapa shelter, prevalence was 98.7 %, with *Ancylostoma* spp. being the most common at 81.7 %.

Fecal contamination by dogs is a significant public health issue due to zoonotic transmission risk. In Mexico City, an estimated five tons of dog feces are dispersed daily in urban environments due to owners' negligence (Aguillón-Gutiérrez *et al*., 2021). Season, environmental characteristics, sample size, animal age, diagnostic techniques, and sociocultural and economic factors influence variations in reported prevalence internationally. Shelters consistently show the highest prevalence due to poor hygiene, resource scarcity, high population density, nutritional deficiencies, and other contributing factors (Rodríguez-Vivas *et al*., 2011; Ruvalcaba, 2012; Alvarado-Esquivel *et al*., 2015; Trasviña-Muñoz *et al*., 2017; García-Hinojosa *et al*., 2018; Ketzis *et al*., 2020; Zhao *et al*., 2022).

Conclusions

This study detected *Ancylostoma* spp., *Toxocara* spp., *Uncinaria* spp., *Strongyloides* spp., *Giardia* spp., and *Trichuris* spp. in fecal samples from dogs housed at the Jamapa shelter, Veracruz, demonstrating a high prevalence of gastrointestinal parasitism in this canine population.

Recommendations

• Develop a tailored parasite control program for each shelter, considering economic, population, and geographic factors to reduce disease transmission.

• Continue epidemiological studies to monitor the health status of domiciled and stray dogs, especially those that may be adopted into households, to ensure public health protection and reduce zoonotic disease risk.

• Implement regulations to improve shelter conditions, including reducing overcrowding, preventing animal abuse, and minimizing animal suffering.

Authors' contributions

"Conceptualization, R.S.R.M., R.S.D., C.R.A.; development of the methodology R.S.R.M., R.S.D., R.A.V.H., S.A.J.L.; software management R.A.V.H., C.R.A.; experimental validation R.S.D.; A.C.Y., R.A.V.H., O.R.N.F.; analysis of results R.S.R.M., R.S.D., C.G.Y.; data management R.S.D., O.R.N.F., S.R.J.L.; writing R.S.R.M., R.S.D.; writing, reviewing and editing R.S.R.M, R.S.D., R.A.V.H., A.C.Y; Project manager R.S.D., C.R.A., A.C.Y.; Funding R.S.D.

"All authors of this manuscript have read and agreed to the published version."

Revista Bio ciencias
ISSN 2007-3380

Financing

"The Parasitology Laboratory funded this research at the Diagnostic Unit of the "Torreón del Molino" ranch of the Faculty of Veterinary Medicine of The Veracruzana University and with its own funds."

Ethical statements

In accordance with NOM-063-ZOO-1999, this study was approved by the Bioethics and Animal Welfare Commission, belonging to the Faculty of Veterinary Medicine of The Veracruzana University.

Acknowledgments

The authors are grateful for the facilities provided by the Jamapa shelter administration to conduct this research, as well as the students who participated in sample collection

Conflict of interest

"The authors declare that they have no conflict of interest".

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