Journal MVZ Cordoba
2022; september-december. 27(3):e2686.
https://doi.org/10.21897/rmvz.2686

Original

Prevalence of digestive parasites of dogs in Central Mexico

Emmanuel Hernandez-Valdivia[1]; Juandedios Martínez-Robles[2]; Arturo Gerardo Valdivia-Flores[1]*; Carlos Cruz-Vazquez[3]; Raúl Ortiz-Martinez[1]; Teódulo Quezada-Tristan[1].

[1]Universidad Autónoma de Aguascalientes, Centro de Ciencias Agropecuarias, Aguascalientes, México.
[2]Centro de Control, Atención y Bienestar Animal del municipio de Aguascalientes. Aguascalientes, México.
3Tecnológico Nacional de México, Instituto Tecnológico El Llano Aguascalientes. Aguascalientes, México.
*Correspondence: avaldiv@correo.uaa.mx

Received: March 2022; Accepted: August 2022; Published: September 2022.

ABSTRACT

Objective. To identify the abundance and prevalence in infection by digestive parasites (DPs) and their seasonal distribution in dogs from Aguascalientes, Mexico. **Materials and Methods**. A statistically representative sample (n=927) systematically selected (first in each 10), of stray or owners-surrendered dogs at a local animal control and welfare center was examined. Immediately after legal euthanasia (pre-anesthetic plus anesthetic overdose), the entire intestine was removed, and intestinal contents were sieved; macroscopically visible helminths were collected; a stool sample was then examined in duplicate by flotation, McMaster, and Lugol's-stained smear. **Results**. The prevalence of DPs was 42.8%. Elevated prevalence values were detected among puppies (60.6%), in dogs with lower body weight (72.7%), also in stray dogs (57.5%) compared with those voluntarily surrendered by their owners (37.5%; p<0.01); additionally, more cases were found during temperate seasons (51.0 vs 33.1%; p<0.01). The DPs prevalence values were determined: *Dipylidium caninum* (26.2%), *Taenia spp.* (4.0%), *Giardia* spp. (13.6%), *Cystoisospora* spp. (7.8%), *Sarcocystis* spp. (5.3%); *Toxocara canis* (14.0%), *Ancylostoma caninum* (12.9%), *Uncinaria stenocephala* (4.2%), *Toxascaris leonina* (0.5%), and *Oncicola canis* (0.1%). The DPs reached a high prevalence with hundreds of adult forms in the intestine and thousands of eggs or oocysts per gram of feces. **Conclusions**. These results indicated a high prevalence of DPs in dogs of central Mexico, especially in the population segment constituted by stray, young and underweight animals, which is relevant in public health due to its recognized zoonotic capacity.

Keywords: Canidae; Host-Parasite Interactions; Parasite Load; Parasitic Diseases; stray dogs (*Fuente: DeCS*).

RESUMEN

Objetivo. Identificar la prevalencia de la infección por parásitos digestivos (PD) y su distribución estacional en perros de Aguascalientes, México. **Materiales y métodos**. Se examinó una muestra estadísticamente representativa (n=927), seleccionada sistemáticamente (primero de cada 10), de

How to cite (Vancouver).
Hernandez-Valdivia E, Martínez-Robles J, Valdivia-Flores AG, Cruz-Vazquez C, Ortiz-Martinez R, Quezada-Tristan T. Prevalence of digestive parasites of dogs in Central Mexico. Rev MVZ Cordoba. 2022; 27(3):e2686. https://doi.org/10.21897/rmvz.2686

perros vagabundos o entregados voluntariamente por sus propietarios al centro local de control y bienestar animal. Inmediatamente después de la eutanasia legal (preanestesia más sobredosis de anestesia) se extrajo el intestino, se tamizó el contenido y se recogieron los helmintos macroscópicos; una muestra de heces por duplicado se examinó mediante flotación, McMaster y frotis teñido con Lugol. **Resultados**. La prevalencia global de los PI fue 42.8%; pero fue más alta entre cachorros (60.6%), perros con mala condición corporal (72.7%) y perros vagabundos (57.5%), en comparación con los entregados (37.5%; p<0.01); además, se encontraron más casos durante las estaciones húmedas (51.0 vs 33.1%; p<0.01). Se estimaron los valores de prevalencia de: *Dipylidium caninum* (26.2%), *Taenia spp.* (4.1%), *Giardia spp*. (13.6%), *Cystoisospora spp.* (7.8%), *Sarcocystis spp*. (5.3%); *Toxocara canis* (14.0%), *Ancylostoma caninum* (12.9%), *Uncinaria stenocephala* (4.2%), *Toxascaris leonina* (0.5%) y *Oncicola canis* (0.1%). La prevalencia de PD alcanzó cientos de formas adultas en el intestino y miles de huevos u ooquistes por gramo de heces. **Conclusiones**. Estos resultados indicaron una alta prevalencia y abundancia de PD en perros del centro de México, especialmente en el segmento poblacional constituido por animales vagabundos, jóvenes y de bajo peso, lo cual es relevante por su reconocida capacidad zoonótica.

Palabras clave: Cánidos; carga parasitaria; enfermedades parasitarias; perros callejeros; interacciones huésped-parásito (*Fuente: DeCS*).

INTRODUCTION

Humans have coexisted with dogs since time immemorial, but this relationship has changed substantially in urban societies, and the dog has come to occupy an important role within the family environment. Interactions between dogs and their owners may involve companionship, home protection, and benefits for physical and emotional health. Coexistence with dogs also favors close physical contact with them and with the surfaces of objects located in the home environment and in streets, parks, and other public areas, facilitating the transmission of diseases from animals to humans (1). Intestinal nematodes, cestodes, and protozoa are organisms disseminated in canine populations, where the main transmission mechanism is contamination of the environment through the deposition of feces with the presence of various stages of parasitic development with infectious capacity; thus, intestinal parasitic diseases in dogs represent a risk not only to their health but also that of humans, because many of the parasites are zoonotic (2).

The frequency and distribution of intestinal parasites (DPs) has been reported in many countries; in addition, their importance on animal and public health is recognized, as well as the need to document their presence and implement prevention measures according to the epidemiological situation of each location (3). In Mexico, the presence of DPs has been documented in dog populations in some localities of the country (4,5,6,7,8,9,10,11); however, there are no reports for the Mexican Highland Plateau.

The objective was to determine the prevalence of IP infection, paying special attention to that of a zoonotic nature, and to assess their seasonal distribution in dogs in Aguascalientes, Mexico.

MATERIALS AND METHODS

Study site. The study was conducted at the Center for Animal Control, Attention and Welfare of the Municipality of Aguascalientes (CCABA), situated in the capital city of Aguascalientes, Mexico. The state of Aguascalientes is in Mexican Highland Plateau, which is considered a single biogeographic province. Aguascalientes is located at 22°27’N, 21°37’S, 101°51’E, 102°53’W, 1,870 masl, with an extreme temperate (winter, spring) semi-dry climate and a mean temperature of 18.5°C, an annual relative humidity of 43.5%, and a mean annual precipitation of 526 mm, with rainy seasons in spring and summer (12). The city of Aguascalientes is administratively divided into five delegations that have similar socioeconomic and geographic characteristics.

Animals and sampling. The CCABA temporarily households unowned dog that are collected from the streets of the urban areas and accepts animals voluntarily surrendered by their proprietors (aggressive, aged, sick, unwanted dogs, etc.); after the period indicated by local legislation, dogs that are not claimed by their owners or adopted are humanely and legally euthanized performed by CCABA personnel, according to procedure of Mexican Official Standard for the Humane Slaughter of Domestic and Wild Animals (NOM-033-SAG/ZOO-2014;

pre-anesthesia plus anesthesia overdose). No dogs were euthanized for this study.

A total of 927 canines between January and December 2019 were included, comprising 240 stray dogs and 687 dogs voluntarily surrendered by their owners. the CCABA was visited on all scheduled dates for the dog slaughter. At each visit, the first of every 10 dogs progressively registered on the corresponding date was systematically selected. Immediately after euthanasia, a complete longitudinal intestinal resection was performed from the pylorus to the rectal ampulla; the intestine was placed in a stainless-steel tray to collect and identify macroscopically visible helminths, as well as to obtain a stool sample for parasitoscopic analysis (2.0 g) in duplicate. Descriptive information was recorded for each dog, such as the reason for admission to CCABA (captured in the street or delivered by their owners), age (determined by a dentition check), sex, weight (using a digital scale), and body condition using the scale of 1–5 proposed by Lund et al (13), as well as the municipal delegation of origin.

Animal housing conditions and general care were in accordance with the approved suggestions of the Federation of Animal Science Societies. The research protocol of the study and the activities derived therefrom were reviewed, approved (Project no. PIP/SA 15-1), and supervised in the Bioethics Commission of the Autonomous University of Aguascalientes.

Parasitological diagnosis. Intestinal contents were sieved with running water through six stainless steel sieves of decreasing caliber (8.0 to 0.18 mm) to obtain the adult stages of the helminths, which were preserved in buffered formalin (10%) for subsequent identification based on their morphological characteristics (14,15). Stool samples were subjected to parasitoscopic flotation examination with saturated sodium chloride solution to morphologically identify DP eggs, cysts, and oocysts under the microscope (15). Positive samples were processed by McMaster's technique to quantify the number of eggs or oocysts per gram of feces; additionally, a Lugol's-stained smear was performed (15). The sample was identified as positive when at minimum one parasite form was identified by any diagnostic technique.

Data analysis. The sample size (n=959) was estimated for a finite population (with no replacement) to estimate the relative frequency of dogs with intestinal parasites (95% confidence interval, 3% precision), considering as total population the average of annual dog culling records in the CCABA in the last five years (N=9420). The parameters for calculating the sample size were selected to achieve the highest possible precision, depending on the available budget and the cost of the series of measurements (16). A systematic sampling fraction (n/N) of 1 in 10 dog was selected. The data of the parasitized dogs were recorded to calculate the overall frequency per week, age, sex, weight, corporal condition, reason for admission to CCABA, and municipal delegation of origin. Prevalence was considered as the proportion of dogs infected with at least one species of parasitic helminths, proglottids, eggs, or oocysts within the total number of dogs considered in each group (16). The data were examined with the Chi-square test ($p<0.05$) to detect statistically significant differences. All analyses were done using statistical software (R, Ver. 3.5.0; Statgraphics, Ver. 16.1.03).

RESULTS

The overall prevalence of DPs was 42.8% (397/927; Table 1), while significant differences were identified between the prevalence of DPs in stray dogs, which was 57.5% (138/240), compared to owner-surrendered dogs, which was 37.7% (259/687). Also, animals younger than 6 months of age had a prevalence of 60.6% (20/33), which was significantly higher than dogs older than 10 years (26.2%; 42/160). Dogs with poor corporal condition had a prevalence of 72.7% (8/11), and those of low corporal condition was 61.7% (29/47). Geographical differences in DP prevalence were also observed because the Morelos municipal district, made up of popular housing developments, showed a higher value (53.8%; 64/119), while the Centro district, with abundant commercial neighborhoods, had the lowest prevalence detected (39.8%; 70/176). Positive dogs were identified throughout the study period; however, the seasonal distribution of prevalence was associated ($p<0.01$) with average ambient relative humidity and rainfall amounts (winter, spring, summer and fall: 31, 56, 57 and 44%; 11.5, 39.3, 114.3 and 20.6

mm/month) (12), so that the highest levels of prevalence were observed during spring and summer, with values of 43.9% and 58.1%, respectively.

As shown (Table 2), the prevalence of adult digestive parasites, proglottids, eggs, or oocysts of two cestodes, three protozoa, four nematodes, and one acanthocephalan were estimated. The most prevalent and abundant genera were the DPs considered zoonotic: *Dipylidium caninum*, *Toxocara canis*, *Ancylostoma caninum*, and *Giardia* spp (26.2, 14.0, 12.9, and 13.6% prevalence, respectively). These DPs reached a high abundance of hundreds of adult forms in the intestine and thousands of eggs or oocysts per gram of feces. Other species detected were *Taenia spp.* (4.1%); *Cystoisospora* spp. (7.8%) and *Sarcocystis* spp. (5.3%); *Uncinaria stenocephala* (4.2%) and *Toxascaris leonina* (0.5%); as well as *Oncicola canis* (0.1%). Of the parasitized dogs, 25.9% had a single infection, 16.3% had a double infection, and 15% had multiple infections.

Table 1. Prevalence of digestive parasites in canines respect to different characteristics of the population and their seasonal distribution (n=927).

Characteristic	Dogs (No)	Positive (No)	Prevalence (%)	X^2 (p-value)
Motive for admission				
Captured on publicstreets	240	138	57.5	< 0.01
Delivered voluntarily	687	259	37.7	
Gender				
Male	421	180	42.8	0.956
Female	506	217	42.9	
Age (years)				
< 0.5	33	20	60.6	<0.01
0.6 - 1.5	79	42	53.1	
1.6 - 5.5	352	174	49.4	
5.6 - 10	303	119	39.2	
> 10	160	42	26.2	
Corporal condition (score (1-5)				
Emaciated	11	8	72.7	0.032
Low weight	47	29	61.7	
Normal	425	184	43.3	
Overweight	392	155	39.5	
Obese	52	22	42.3	
Body weight (group)				
Large (>18 kg)	295	137	46.4	0.3
Medium (13-18 kg)	263	101	38.4	
Small (6-12.9 kg)	151	61	40.4	
Mini (< 6.0 kg)	218	98	45.0	
Municipal delegation				
Centro	176	70	39.8	0.243
Insurgentes	84	35	41.7	
Jesús Terán	213	87	40.8	
Morelos	119	64	53.8	
Pocitos	335	142	42.4	
Season of the year				
Winter	285	125	30.9	< 0.01
Spring	227	132	43.9	
Summer	152	47	58.1	
Fall	263	93	35.3	
Total	**927**	**397**	**42.8**	

Table 2. Digestive parasitic specimens, eggs, cysts, oocysts and proglottids average in feces in dogs (n=927).

Parasite	Dogs		Prevalence Mean (Min -Max)		
	Positive (No)	(%)	Whole specimens	Proglottids (No)	Eggs/cysts (g/f)
Toxocara canis	130	14.0	5.6 (1-170)		115 (1-2515)
Ancylostoma caninum	120	12.9	14.3 (1-124)		213 (1-4276)
Uncinaria stenocephala	39	4.2	5.9 (1-65)		104 (1-1056)
Toxascaris leonina	5	0.5	2.8 (1-8)		1.3 (1-543)
Dipylidium caninum	243	26.2	21.4 (1-290)	76.5 (1-829)	
Taenia spp.	38	4.1	9.2 (1-43)	49.5 (1-827)	
Oncicola canis	1	0.1	1 (1-1)		
Giardia spp.	126	13.6			21.9 (1-420)
Cystoisospora spp.	72	7.8			19.6 (1-55)
Sarcocystis spp.	49	5.3			10.3 (1-75)

DISCUSSION

DP infections in dogs represent a major animal and public health problem around the world (11); DPs are widely distributed in all continents, with wide variations in prevalence depending on the geographic region, the DP species under study, and the attributes of the canine population included in the investigation (17-20). In the present study, an elevated prevalence of digestive parasites was observed, especially in stray, young, and underweight animals; infection was associated with geographic environmental conditions and environmental humidity. Twelve DP species were found, some recognized for their zoonotic power (*Dipylidium caninum*, *Toxocara canis*, *Ancylostoma caninum*, and *Giardia* spp.), also two DPs that had not been previously reported in the biogeographic region of the Mexican Central Mesa (*Sarcocystis* spp. and *Oncicola canis*).

In this study, a general prevalence of DPs was identified (42.8%), which was significantly elevated in unowned dogs (57.5%) compared to observed in dogs voluntarily surrendered by their owners (37.7%). Several studies have shown that feces from stray dogs have a higher prevalence of gastrointestinal parasites, with mixed parasitosis presence by at least two species of parasites with zoonotic potential (21). This fact is important because stray dogs are more mobile and can more easily disseminate the infecting forms to the urban ecosystem, favoring infection among animals, reinfection, and risk of transmission to humans (1). This finding coincides with previous reports in Mexico because there have been lower values (26.5-37.2%) in owned dogs (6,8); meanwhile the prevalence was extremely high (72.8–100%) in stray dogs and public places in several cities of Mexico (4,5,7,11). While similar prevalence values (40.0–77%) are reported in dogs of other countries (17-22).

In the present study, puppies younger than 6 months were identified with the highest prevalence (60.6%) compared to adult animals ($p < 0.01$). These results coincide with those reported in other studies where the prevalence of gastrointestinal parasites was higher (24.0-62.9%) in young animals (22-24) and decreased (3.8-10.5%) as age increased (25,26). This suggests that although DP infection can occur at any age, puppies are especially vulnerable to DPs, probably caused by an immature immune system and there are additional routes of infection such as by the transplacental and lactogenic routes or by increased consumption of water or food contaminated with infective parasitic forms.

In this study, emaciated or underweight dogs had a higher prevalence compared to animals with a healthier body condition ($p < 0.05$); this fact agrees with what was previously reported (7). In this sense, authors have described that dog with lower corporal condition are prone to problems of polyparasitism and other diseases, which are often associated with the socioeconomic and epidemiological situation of the human population (27). This suggests a close association between body condition and parasitosis, both because of the net loss of nutrients and tissues caused by the infection and because of the increased susceptibility to PI infection in animals with poor body condition, so these animals generally present a precarious state of health and lower defenses.

The most frequent IP was *D. caninum* with a prevalence of 26.2 % of included dogs in the study. This is the most frequent cestode worldwide with a variation in prevalence between 8.9 and 72% in countries such as Brazil, China, Serbia, the United States, and Iran (17,19,28-30). In Mexico, previous studies of this zoonotic cestode reported a percentage of infection between 2.3 and 60.0%; the existing differences may be a consequence of different factors such as levels of urbanization, socioeconomic diversity, and uniformity, as well as the presence of barriers that prevent dogs into contact with fleas and lice which, as the intermediate hosts, are fundamental to infection (7). The frequency of this parasite worldwide has been directly associated with the abundance of intermediate hosts, as a larger flea population in the environment increases the percentage of *Dipylidium*-infected dogs (6,31).

In this study, the presence of parasitized dogs was detected in all seasons of the year; however, the prevalence at PI showed a seasonal distribution with higher values in winter and spring. Similarly, the highest prevalence has been identified in spring and summer (24); therefore, these two seasons represented the highest epidemiological risk in Mexican Highland Plateau. This seasonal difference has also been detected in other studies; for example, in Baja California, in the northwest of the country where the climate is desert-like, elevated incidence was identified in spring (9,11). In addition, the highest prevalence

(98 – 100 %) has been reported in Veracruz and Campeche (2,4), both of which have a humid tropical climate. Also, in the United States, it has been found that *T. canis* and *A. caninum* present prevalence peaks in winter (32). These facts suggest that dry environmental conditions limited the development, permanence or spread of the parasite.

The most frequent nematodes in our study were *T. canis* and *A. caninum*, with prevalence values of 14.0% and 12.9%, respectively. Both nematodes are of great importance because of their wide geographic distribution and because they represent an important public and animal health risk (3). Prevalence values for *A. caninum* and *T. canis* vary widely (10.3-46.8%) among different countries (33-35). In Mexico, the prevalence reported for *A. caninum* has reached 88.1%, and the presence of its eggs has been reported in a high percentage of streets and public parks (4), whereas *T. canis* is less frequent (19%). Humans and animals can be infected by these nematodes through contaminated soil or other efficient routes of transmission (1,36).

Our study showed the presence of *Oncicola canis* (acanthocephalus) in the small intestine of a stray dog (prevalence 0.1%); worldwide there are few reports on the presence of this acanthocephalus in dogs; it was reported in Perú and Brazil in 0.2% of dogs in urban and rural areas and 40% in wild animals respectively; this result suggests the existence of transmission mechanisms of *Oncicola canis* from rural to urban areas in presence of intermediate hosts, such as the naked-tailed armadillo (*Cabassous spp.*, Cingulata:Dasypodidae) (37,38).

The protozoa *Giardia* spp. was identified in the present study in 13.6% of the samples, while *Cystoisospora* spp. and *Sarcocystis* spp. have been detected in 7.8% and 5.3% of the animals, respectively in comparative reports (6,9,10). The prevalence of *Giardia* spp. in fecal samples has been documented by several authors, with different results according to the population studied, time of year, diagnostic method, and origin of the dogs (39). The presence of oocysts in feces has been reported in clinically healthy animals and in dogs with digestive disease. In Mexico, it has been reported both in stray populations and in pet dogs; the prevalence has been highly variable, with values between 1 and 51% (4,40); while worldwide the prevalence values vary between 3 y 30 % (18,41,42). In Mexico there are few reports of the presence of *Cystoisospora spp*., with prevalence values ranging from 1.9% in northern areas of the country to 14% in southern areas (8,9,11). The prevalence of this protozoan has been estimated at 10.4% in countries such as Canada (43); but there are no previous communications of the prevalence of *Sarcocystis* spp. in the Mexican Highland Plateu.

In summary, the present study indicated a high abundance and prevalence of intestinal parasites in dogs in the Aguascalientes state, Mexico, especially in the population segment consisting of stray, young, and underweight animals; the infection was associated with environmental conditions in winter and spring. Twelve DP species were found, some recognized for their zoonotic power (*T. canis*, *D. caninum*, *A. caninum*, and *Giardia* spp.), as well as DPs that had not been previously reported in the biogeographic region of Mexico (*Sarcocystis* spp. and *Oncicola canis*). These DPs can influence animal health and constitute an important public health risk. The results obtained in this study provide useful information to establish adequate sanitary measures for prevention, integral control, and treatments that limit contamination of homes, streets, parks, and public spaces.

Conflict of interest

The authors declare no competing interests.

Acknowledgments

The support of the Center for Animal Control, Attention and Welfare of the Municipality of Aguascalientes, Mexico, is gratefully acknowledged. This study was supported by the Aguascalientes Autonomous University de (project: PIP/SA 15.1).

REFERENCES

1. Traversa D, di-Regalbono AF, Di-Cesare A, La-Torre F, Drake J, Pietrobelli M. Environmental contamination by canine geohelminths. Parasit. Vectors. 2014; 7(1):67. http://www.parasitesandvectors.com/content/7/1/67

2. Cortez-Aguirre GR, Jiménez-Coello M, Ortega-Pacheco A, Gutiérrez-Blanco E. Stray dog population in a city of southern Mexico and its impact on the contamination of public areas. Vet Med Int. 2018; 2381583. https://doi.org/10.1155/2018/2381583

3. Traversa D. Pet roundworms and hookworms: a continuing need for global worming. Parasit Vectors. 2012; 5(91):1–19. https://doi.org/10.1186/1756-3305-5-91

4. Alvarado-Esquivel C, Romero-Salas D, Aguilar-Domínguez M, Cruz-Romero A, Ibarra-Priego N, Pérez-de-León AÁ, Epidemiological assessment of intestinal parasitic infections in dogs at animal shelter in Veracruz, Mexico. Asian Pac J Trop Biomed. 2015; 5(1):34–39. https://doi.org/10.1016/S2221-1691(15)30167-2

5. Cantó GJ, García MP, García A, Guerrero MJ, Mosqueda J. The prevalence and abundance of helminth parasites in stray dogs from the city of Queretaro in central Mexico. J Helminthol. 2011; 85(3):263–269. https://doi.org/10.1017/S0022149X10000544

6. Lara-Reyes E, Quijano-Hernández IA, Rodríguez-Vivas RI, Ángel-Caraza D, Martínez-Castañeda JS. Factors associated with endoparasites and ectoparasites in domiciled dogs in the metropolitan area of Toluca, México. Biomédica. 2021; 41(4):756–772. https://doi.org/10.7705/biomedica.6013

7. Rodríguez-Vivas RI, Gutierrez-Ruiz E. Bolio-González ME, Ruiz-Pina H, Ortega-Pacheco A, Reyes-Novelo E, et al. An epidemiological study of intestinal parasites of dogs from Yucatan, Mexico, and their risk to public health. Vector-Borne Zoonotic Dis. 2011; 11(8):1141–1144. https://doi.org/10.1089/vbz.2010.0232

8. Torres-Chablé OM, García-Herrera RA, Hernández-Hernández M, Peralta-Torres JA, Ojeda-Robertos NF, Blitvich BJ, et al. Prevalence of gastrointestinal parasites in domestic dogs in Tabasco, southeastern Mexico. Rev Bras Parasitol Vet. 2015; 24(4):432–437. https://doi.org/10.1590/S1984-29612015077

9. Trasviña-Muñoz E, López-Valencia G, Centeno PÁ, Cueto-González SA, Monge-Navarro FJ, Tinoco-Gracia L, et al. Prevalence and distribution of intestinal parasites in stray dogs in the northwest area of Mexico. Austral J Vet Sci. 2017; 49(2):105–111. https://doi.org/10.4067/S0719-81322017000200105

10. Trasviña-Muñoz E, López-Valencia G, Monge-Navarro FJ, Herrera-Ramírez JC, Haro P, Gómez-Gómez SD, et al. Detection of intestinal parasites in stray dogs from a farming and cattle region of northwestern Mexico. Pathogens. 2020; 9(7):516. https://doi.org/10.3390/pathogens9070516

11. Velez-Hernandez L, Reyes-Barrera KL, Rojas-Almaraz D, Calderón-Oropeza MA, Cruz-Vázquez JK, Arcos-García JL. Potential hazard of zoonotic parasites present in canine feces in Puerto Escondido, Oaxaca. Salud Publica Mex. 2014; 56(8):625–630. https://saludpublica.mx/index.php/spm/article/view/7389/10275

12. INEGI. Instituto Nacional de Estadística y Geografía (INEGI, México). 2017. Instituto Nacional de Estadística y Geografía. Anuario estadístico y geográfico de Aguascalientes. INEGI: Mexico; 2017. https://www.inegi.org.mx/contenidos/productos/prod_serv/contenidos/espanol/bvinegi/productos/nueva_estruc/anuarios_2017/702825092078.pdf

13. Lund EM, Armstrong,PJ, Kirk CA, Klausner JS. Prevalence and risk factors for obesity in adult dogs from private US veterinary practices. Int J Appl Res Vet Med. 2006, 4(2):177-186. https://jarvm.com/articles/Vol4Iss2/Lund.pdf

14. Bowman DD. Georgis' Parasitology for Veterinarians. 10th ed. St. Louis: Elsevier Saunders Health Sciences; 2014.

15. Rodríguez-Vivas RI. Técnicas para el diagnóstico de parásitos con importancia en salud pública y veterinaria. AMPAVE-CONASA; 2015.

16. Thrusfield M. Veterinary epidemiology. John Wiley & Sons; 2018

17. Fang F, Li J, Huang T, Guillot J, Huang W. Zoonotic helminths parasites in the digestive tract of feral dogs and cats in Guangxi, China. BMC Vet Res. 2015; 11(211):1–5. https://doi.org/10.1186/s12917-015-0521-7

18. Gillespie S, Bradbury R. A survey of intestinal parasites of domestic dogs in Central Queensland. Trop Med Infect Dis. 2017; 60(2):1-10 https://doi.org/10.3390/tropicalmed2040060

19. Traub RJ, Zendejas-Heredia PA, Massetti L, Colella V. Zoonotic hookworms of dogs and cats–lessons from the past to inform current knowledge and future directions of research. Int J Parasitol. 2021; 51(13–14):1233–1241. https://doi.org/10.1016/j.ijpara.2021.10.005

20. Adolph C, Barnett S, Beall M, Drake J, Elsemore D, Thomas J, et al. Veterinary parasitology diagnostic strategies to reveal covert infections with intestinal helminths in dogs. Vet Parasitol. 2017; 247:108–112. https://doi.org/10.1016/j.vetpar.2017.10.002

21. Mircean V, Dumitrache MO, Mircean M, Colosi HA, Györke A. Prevalence and risk factors associated with endoparasitic infection in dogs from Transylvania (Romania): A retrospective study. Vet Parasitol. 2017; 243:157–161. https://doi.org/10.1016/j.vetpar.2017.06.028

22. Traub RJ, Pednekar RP, Cuttell L, Porter RB, Abd-Megat-Rani PA, Gatne ML. The prevalence and distribution of gastrointestinal parasites of stray and refuge dogs in four locations in India. Vet Parasitol. 2014; 205(1-2):233–238. https://doi.org/10.1016/j.vetpar.2014.06.037

23. Al-Sabi MNS, Kapel CMO, Johansson A, Espersen MC, Koch J, Willesen JL. A coprological investigation of gastrointestinal and cardiopulmonary parasites in hunting dogs in Denmark. Vet Parasitol. 2013; 196:366–372. https://doi.org/10.1016/j.vetpar.2013.03.027

24. Idika IK, Onuorah EC, Obi CF, Umeakuana PU, Nwosu CO, Onah DN, et al. Prevalence of gastrointestinal helminth infections of dog in Enugu State, Southeastern Nigeria. Parasite Epidemiol Control. 2017; 2(3):97–104. https://doi.org/10.1016/j.parepi.2017.05.004

25. Morandi B, Greenwood SJ, Conboy GA, Galuppi R, Poglayen G, VanLeeuwen JA. Endoparasites in dogs and cats diagnosed at the Veterinary Teaching Hospital (VTH) of the University of Prince Edward Island between 2000 and 2017. A large-scale retrospective study. Prev Vet Med. 2020; 175,104878. https://doi.org/10.1016/j.prevetmed.2019.104878

26. Barutzki D, Schaper R. Age-dependant prevalence of endoparasites in young dogs and cats up to one year of age. Parasitol Res. 2013; 112(1):S119–S131. https://doi.org/10.1007/s00436-013-3286-6

27. Enriquez GF, Macchiaverna NP, Argibay HD, Arias LL, Farber M, Gürtler, et al. Polyparasitism and zoonotic parasites in dogs from a rural area of the Argentine Chaco. Vet Parasitol Reg Stud Reports. 2019; 16(100287):1-8. https://doi.org/10.1016/j.vprsr.2019.100287

28. Ilić T, Nišavić U, Gajić B, Nenadović K, Ristić M, Stanojević D, Dimitrijević S. Prevalence of intestinal parasites in dogs from public shelters in Serbia. Comp Immunol Microbiol Infect Dis. 2021; 76:101653. https://doi.org/10.1016/j.cimid.2021.101653

29. Costa-Santos JL, Magalhães NB, Santos HA dos, Ribeiro RR, Guimarães MP. Parasites of domestic and wild canids in the region of Serra do Cipó National Park, Brazil. Rev Bras Parasitol Vet. 2012; 21(3):270–277. https://doi.org/10.1590/s1984-29612012000300016

30. Adinezadeh A, Kia EB, Mohebali M, Shojaee S, Rokni MB, Zarei Z, Mowlavi G. Endoparasites of stray dogs in Mashhad, Khorasan Razavi Province, northeast Iran with special reference to zoonotic parasites. Iran J Parasitol. 2013; 8(3):459–466. https://ijpa.tums.ac.ir/index.php/ijpa/article/view/469

31. Hernández-Valdivia E, Cruz-Vázquez C, Ortiz-Martínez R, Valdivia-Flores AG, Quintero-Martínez MT. Presence of *Ctenocephalides canis* (Curtis) and *Ctenocephalides felis* (Bouché) infesting dogs in the city of Aguascalientes, México. J Parasitol. 2011; 97(6):1017–1019. https://doi.org/10.1645/GE-2701.1

32. Drake J, Carey T. Seasonality and changing prevalence of common canine gastrointestinal nematodes in the USA. Parasit Vectors. 2019; 12(430):1–7. https://doi.org/10.1186/s13071-019-3701-7

33. Johnson SAM, Gakuya DW, Mbuthia PG, Mande JD, Maingi N. Prevalence of gastrointestinal helminths and management practices for dogs in the Greater Accra region of Ghana. Heliyon. 2015; 1(1):e00023. https://doi.org/10.1016/j.heliyon.2015.e00023

34. Moskvina TV, Zheleznova LV. A survey on endoparasites and ectoparasites in domestic dogs and cats in Vladivostok, Russia 2014. Vet Parasitol Reg Stud Reports. 2015; 1–2:31–34. https://doi.org/10.1016/j.vprsr.2016.02.005

35. Kimura A, Morishima Y, Nagahama S, Horikoshi T, Edagana A, Kawabuchi-Kurata, *et al.* A coprological survey of intestinal helminthes in stray dogs captured in Osaka Prefecture, Japan. J Vet Med Sci. 2013; 75(10):1409–1411. https://doi.org/10.1292/jvms.12-0499

36. Overgaauw PAM, van Knapen F. Veterinary and public health aspects of *Toxocara spp*. Vet Parasitol. 2013; 193(4):398–403. https://doi.org/10.1016/j.vetpar.2012.12.035

37. Tantaleán M, Sánchez L, Gómez L, Huiza A. Acanthocephalan from Peru. Rev Peru Biol. 2005; 12(1):83-92. http://www.scielo.org.pe/pdf/rpb/v12n1/v12n1a06.pdf

38. Benatti D, de Santi M, Werther K, Tebaldi JH, Hoppe EGL. Helminthfauna of road-killed cougars (*Puma concolor*) from the Northeastern Region of São Paulo State, Brazil. Rev Bras Parasitol Vet. 2021; 30(1):e024120. https://doi.org/10.1590/S1984-29612021008

39. Bouzid M, Halai K, Jeffreys D, Hunter PR. The prevalence of *Giardia* infection in dogs and cats, a systematic review and meta-analysis of prevalence studies from stool samples. Vet Parasitol. 2015; 207:181–202. https://doi.org/10.1016/j.vetpar.2014.12.011

40. Romero CMGE, Pineda MA, Nava N, Bautista LG, Heredia R. Prevalence of intestinal parasites with zoonotic potential in canids in Mexico City. Acta Sci Vet. 2015; 43:1307–1313. http://www.ufrgs.br/actavet/43/PUB%201307.pd f

41. Neves D, Lobo L, Simões PB, Cardoso L. Frequency of intestinal parasites in pet dogs from an urban area (Greater Oporto, northern Portugal). Vet Parasitol. 2014; 200(3-4):295–298. https://doi.org/10.1016/j.vetpar.2013.11.005

42. Sommer MF, Rupp P, Pietsch M, Kaspar A, Beelitz P. *Giardia* in a selected population of dogs and cats in Germany – diagnostics, coinfections and assemblages. Vet Parasitol. 2018; 249:49–56. https://doi.org/10.1016/j.vetpar.2017.11.006

43. Villeneuve A, Polley L, Jenkins E, Schurer J, Gilleard J, Kutz S, et al. Parasite prevalence in fecal samples from shelter dogs and cats across the Canadian provinces. Parasites and Vectors 2015; 8(281):16–18. https://doi.org/10.1186/s13071-015-0870-x