Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Biomedicine

journal homepage: www.elsevier.com/locate/apjtb

Document heading doi: 10.1016/S2221-1691(15)30167-2

Epidemiological assessment of intestinal parasitic infections in dogs at animal shelter in Veracruz, Mexico

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ARTICLE INFO

Article history:
Received 6 Oct 2014
Received in revised form 20 Oct, 2nd revised form 28 Oct, 18 Nov 2014
Accepted 19 Nov 2014
Available online 20 Nov 2014

Keywords:
Intestinal parasites
Infection
Prevalence
Shelter
Dogs
Mexico

ABSTRACT

Objective: To determine the prevalence of infection with intestinal parasites in 101 dogs in an animal shelter in Veracruz, Mexico, and investigate whether any general characteristics of the dogs were associated with infections.
Methods: Parasitological examination of fecal samples from the dogs was performed by means of centrifuge-flotation using Sheather's sucrose and zinc sulfate flotation media. In addition, hematocrit was determined in each canine blood sample.
Results: Intestinal parasites were found in 99 (98.0%) of the 101 dogs studied. About five different intestinal parasites were identified: *Ancylostoma caninum* in 89 dogs (88.1%), *Giardia canis* in 46 (45.5%), *Uncinaria stenocephala* in 43 (42.6%), *Trichuris vulpis* in 19 (18.8%) and *Strongyloides canis* in 16 (15.8%). Multivariate analysis showed: 1) *Giardia* infection was associated with young age and mixed breed; 2) *Ancylostoma* was associated with young age and no rabies vaccination; and 3) *Strongyloides* was associated with no rabies vaccination. *Uncinaria* and *Trichuris* infections were not associated with the variables assessed.
Conclusions: A high prevalence of intestinal parasites was found in the dogs studied. This suggests that the environment is highly contaminated with intestinal parasites. Preventive and therapeutic measures should be taken against infection with intestinal parasites in dogs in this region.

1. Introduction

The intestinal parasites, which cause significant morbidity and mortality in dogs, include species of nematodes, cestodes, trematodes and protozoa[1-5]. Coinfection with other pathogens can exacerbate the detrimental effect of intestinal parasites[6]. In addition to direct health benefits, understanding the epidemiology of intestinal parasites in dogs is of public health relevance because several species are zoonotic[7-12]. Some intestinal parasitic zoonoses of dogs can cause considerable burdens in humans[13]. Canine geohelminths infect millions of people around the world[14]. Application of the One Health concept, in which the collaborative work of multiple disciplines aims to help attain optimal health for people, animals and our environment, has been advocated to improve the management of intestinal parasitic infections and minimize the risk of exposure for humans and dogs[15-17].

There are approximately 700 million dogs in the world. It

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Foundation Project: Supported by Universidad Veracruzana and Juárez University of Durango State (Grant No. P4 UV-UJED).

is estimated that 75% of them are strays because they roam freely and are mostly free to reproduce[18,19]. The human-dog relationship remains strong in many societies. Dogs are very popular pets in Mexico, but in many cases they are unconfined[20,21]. Mexico City alone has nearly 1.5 million stray dogs[22]. Infected dogs lacking veterinary care are important reservoirs. They would contaminate the environment with intestinal parasites[23,24].

The epidemiology of intestinal parasites of dogs in Mexico remains to be fully understood. Studies have been conducted to assess the prevalence of intestinal parasites in some parts of the country[22,25,26]. Investigations on the factors associated with infection are limited to certain geographic locations[27]. Epidemiological information on intestinal parasitic infections at the local level can be obtained by surveying dogs in animal shelters[28].

There is a lack of information on the epidemiology of intestinal parasites infecting dogs in the Mexican state of Veracruz. Access to shelters in the state has provided the opportunity to investigate the epidemiology of zoonotic diseases in which dogs are reservoirs of the infectious agent[29]. Thus, we sought to determine the prevalence of intestinal parasitic infection and associated characteristics in dogs at a local animal shelter.

2. Materials and methods

2.1. Canine population and survey

A total of 101 dogs (*Canis familiaris*) at the animal shelter of the municipality of Medellin in the state of Veracruz, Mexico were studied. This municipality belongs to the Sotavento Region (19°03' N 96°09' W), which is located in the central part of Veracruz, and close to the Gulf of Mexico. The municipality is composed of rural communities and its main economic activities are agriculture, cattle raising and fishing. This region has a warm-humid climate and an altitude of 52 m above sea level.

The animal shelter houses stray dogs. Sampling of dogs was performed during the mornings from February to May 2013. Fresh canine fecal samples were collected from the housing floor immediately after deposition and put inside plastic bags. Additionally, a blood sample from each dog was obtained. A questionnaire was used to record the general characteristics of the dogs, including age, sex, breed (pure and mixed), history of vaccination against rabies and contact with cats. Deworming was carried out with mebendazole on December 2012. History of deworming before housing the dogs in the animal shelter was not available. Apart from dogs, the animal shelter houses cats on a temporary basis. No further animal species are housed in the animal shelter. The fecal and blood samples were transported to the Parasitology Laboratory of the School of Veterinary Medicine, Veracruz State University, in Veracruz City, for analysis.

2.2. Laboratory tests

The fecal samples from the dogs were analyzed by means of centrifuge-flotation using Sheather's sucrose and zinc sulfate flotation media (Faust's technique)[30]. Samples were examined using 100× and 400× microscope magnifications and parasites were identified based on morphological features. Hematocrit was determined in each canine blood sample.

2.3. Statistical analysis

Data were analyzed using the Epi Info software, version 7 (Centers for Disease Control and Prevention: http://www.cdc.gov/epiinfo/), and SPSS version 15.0 (SPSS Inc. Chicago, Illinois, USA). Pearson's *Chi*-square test and, when indicated, the Fisher's exact test were used to evaluate significant differences in dichotomous variables between dogs with infections and those without infections. Multivariable analysis with the Enter method was used to assess the association between infection and dog characteristics. Variables with a zero value were not included in the multivariate analysis. This strategy was used to increase the statistical power. Regression model fitness was assessed by means of the Hosmer-Lemeshow goodness-of-fit test. Odd ratios (OR) and 95% confidence intervals (*CI*) were calculated and a two-tailed $P<0.05$ was considered to be statistically significant.

2.4. Ethical aspects

Sampling of dogs was carried out in accordance with the good animal practice regulations of the Bioethics and Animal Welfare Commission of the School of Veterinary Medicine, Veracruz State University. And consent was obtained from the owner of the animal shelter.

3. Results

3.1. Prevalence of infection with intestinal parasites

Intestinal parasites were found in 99 (98.0%) of the 101 dogs studied. About five different intestinal parasites were identified. Numbers of dogs infected with each parasite and specific infection rate (%) were: *Ancylostoma caninum* (*A. caninum*), 89 (88.1%); *Giardia canis* (*G. canis*), 46 (45.5%); *Uncinaria stenocephala* (*U. stenocephala*), 43 (42.6%); *Trichuris vulpis* (*T. vulpis*), 19 (18.8%); and *Strongyloides canis* (*S. canis*), 16 (15.8%). About 26 of the 101 dogs (25.7%) presented monospecific infection, 38 dogs (37.6%) were infected with two parasite species, 29 (28.7%) dogs hosted three parasite species and 6 (5.9%) dogs had infection involving four parasite species.

3.2. Characteristics of dogs associated with intestinal parasitic infection

The general characteristics of the dogs studied and the overall prevalence of infection with intestinal parasites are shown in Table 1. Although most of the dogs had been dewormed (89 dewormed and 12 dogs not dewormed), the prevalence of intestinal parasitic infections was higher (P=0.01) in dogs with a history of deworming (100.0%) than in those without it (83.3%). The overall prevalence of all parasitic infections together did not vary with age, sex, breed, history of vaccination against rabies, contact with cats or hematocrit level.

Table 1

General characteristics of the 101 dogs studied and prevalence of intestinal parasitic infection.

Characteristics		Dogs tested No.	Prevalence No.	%	*P*-value
Age (years)	0.5-1	47	47	100.0	0.41
	1.1-2	26	25	96.2	
	>2	28	27	96.4	
Sex	Male	37	37	100.0	0.53
	Female	64	62	96.9	
Breed	Pure	37	36	97.3	1
	Mixed	64	63	98.4	
Deworming	Yes	89	89	100.0	0.01
	No	12	10	83.3	
Vaccinated against rabies	Yes	33	33	100.0	1
	No	68	66	97.1	
Contact with cats	Yes	12	12	100.0	1
	No	89	87	97.8	
Hematocrit level	Normal	61	60	98.4	1
	Low	40	39	97.5	

Table 2 lists the results from the bivariate analysis for individual infections. The prevalence of *G. canis* infection decreased with increasing age of the dogs and was higher in mixed-breed dogs than in purebred dogs. The prevalence of *A. caninum* infection decreased with increasing age and was higher in dogs that had been dewormed than in those without this treatment. The prevalence of this infection was also higher in dogs unvaccinated against rabies than that of in vaccinated dogs. In contrast, the prevalence of *U. stenocephala* infection was higher in dogs without history of deworming and in the dogs with rabies vaccination. Dogs that had been in contact with cats showed higher prevalence of *T. vulpis* infection than those lacking such contact. The prevalence of *S. canis* infection was lower in dogs with rabies vaccination that in those without it.

The results from the multivariate analysis showed that different dog characteristics were associated with specific infections. Young age (OR=3.71; 95% *CI*: 1.72-8.03; P=0.001) and mixed breed (OR=29.71; 95% *CI*: 6.25-141.05; P<0.001) were associated with *G. canis* infection. The characteristics associated with *A. caninum* infection included young age (OR=7.20; 95% *CI*: 1.83-28.23; P=0.005) and no rabies vaccination (OR=35.11; 95% *CI*: 3.77-326.58; P=0.002). Lack of rabies vaccination was the only variable associated with *S. canis* infection (OR=11.15; 95% *CI*: 1.23-100.83; P=0.03). No association was detected between any of the variables assessed and infection with *U. stenocephala* or *T. vulpis*. The variation in these analyses according to the Hosmer-Lemeshow test ranged from 3.96 to 13.9 (P=0.08-0.86), which indicated that the fit for the regression models used was acceptable.

4. Discussion

This study documented the high prevalence of intestinal parasitic infections in dogs at an animal shelter in the state of Veracruz, Mexico. The zoonotic potential of some of the identified intestinal parasites presents an immediate public health risk of infection for personnel working in the animal shelter[31]. Veterinarians play a critical role in these situations and have the opportunity to promote the One Health approach, because

Table 2

Correlation of the general characteristics of the dogs studied and prevalence of individual parasitic infections.

Characteristics		Dogs tested No.	*G. canis* infection No.	%	*P*-value	*A. caninum* infection No.	%	*P*-value	*U. stenocephala* infection No.	%	*P*-value	*T. vulpis* infection No.	%	*P*-value	*S. canis* infection No.	%	*P*-value
Age (years)	0.5-1	47	33	70.2	<0.01	44	93.6	0.04	23	48.9	0.20	8	17.0	0.25	7	14.9	0.44
	1.1-2	26	9	34.6		24	92.3		12	46.2		3	11.5		6	23.1	
	>2	28	4	14.3		21	75.0		8	28.6		8	28.6		3	10.7	
Sex	Male	37	18	48.6	0.63	34	91.9	0.52	13	35.1	0.25	8	21.6	0.58	5	13.5	0.62
	Female	64	28	43.8		55	85.9		30	46.9		11	17.2		11	17.2	
Breed	Pure	37	3	8.1	<0.01	31	83.8	0.34	17	45.9	0.60	6	16.2	0.61	4	10.8	0.29
	Mixed	64	43	67.2		58	90.6		26	40.6		13	20.3		12	18.8	
Deworming	Yes	89	41	46.1	0.77	89	100.0	<0.01	34	38.2	0.01	17	19.1	1.00	15	16.9	0.68
	No	12	5	41.7		0	0.0		9	75.0		2	16.7		1	8.3	
Vaccinated against rabies	Yes	33	18	54.5	0.20	24	72.7	0.002	33	100.0	<0.01	4	12.1	0.23	1	3.0	0.01
	No	68	28	41.2		65	95.6		10	14.7		15	22.1		15	22.1	
Contact with cats	Yes	12	6	50.0	0.74	10	83.3	0.63	6	50.0	0.57	12	100.0	<0.01	0	0.0	0.20
	No	89	40	44.9		79	88.8		37	41.6		7	7.9		16	18.0	
Hematocrit level	Normal	61	30	49.2	0.36	52	85.2	0.35	28	45.9	0.40	8	13.1	0.07	9	14.8	0.71
	Low	40	16	40.0		37	92.5		15	37.5		11	27.5		7	17.5	

Numbers in individual infections may not add up to 101 because prevalence of individual infections varied among dogs.

controlling the intestinal parasites in dogs can be an effective strategy for minimizing the risk of infection in people[14,15]. The conditions at the shelter could also reflect the epidemiology of intestinal parasites infecting dogs in the study area, where the canine population appears to be as high as in other parts of Mexico[20,29,32].

Approximately 74% of the infected dogs hosted more than one parasite species. *A. caninum* was the most prevalent enteric parasite (88.1%) among the dogs tested. This is a common endoparasite of dogs in Mexico. Infection with *A. caninum* has been reported in Mexico City, Queretaro and in rural areas of the state of Yucatán, but at lower or similar prevalence rates (23.0%-73.8%) compared to those reported here for dogs in Veracruz[25-27,33]. The infection rates in dogs in Mexico contrast with the relatively low prevalence (1.9%-2.0%) for *A. caninum* in stray dogs in Japan and Italy[34,35]. Studies on dogs in Brazil and Iran have reported prevalences of 19.4% and 46.0% of *A. caninum* infection, respectively[9,36]. Infection with *A. caninum* in Veracruz was associated with dogs of young age and those that had not been vaccinated against rabies. This finding is consistent with results from a previous study in the USA, in which researchers found an association between *A. caninum* infection and dogs aged 12 months[37]. However, the association between *A. caninum* infection and young age found in our study differs from the results from a Cuban study, in which *A. caninum* infection was more prevalent in older dogs (1 year old)[7]. Different environmental conditions might explain the discrepancy in the age associated with prevalence of *A. caninum* infection that can be seen between these studies. Urban stray dogs were studied in Cuba, while rural stray dogs made up most of the shelter population studied here. The association between *A. caninum* infection and lack of rabies vaccination in the present study stresses that there is a need to implement and practice health programs at animal shelters. The health status of stray and unwanted dogs arriving at shelters in Veracruz is generally unknown[29]. Stray dogs tend to be infected with multiple species of intestinal parasites, as documented in this and other studies[31,38].

Concerning *G. canis*, nearly half (45.5%) of the dogs studied were infected. The prevalence recorded in this study is close to that reported (51%) for *Giardia intestinalis* infection in dogs in Mexico City[25]. The infection rate for dogs in Mexico contrasts with relatively low seroprevalence of *G. canis* infection reported in other countries. A study in Portugal reported prevalence of 7.4% in apparently healthy dogs and 15.5% in dogs with gastrointestinal disease[5], while seroprevalence of 3.8% in owned dogs was reported in a study in Italy[35]. Here, we reported that *G. canis* infection was associated with young age and mixed breed. Young age was also found to be associated with infection in Germany, where 52.5% of the dogs aged 12 weeks were positive for *Giardia*[39]. Our results showed that young dogs (0.5-1.0 year old) had high prevalence (70.2%) of *G. canis* infection. The association of *G. canis* infection with mixed breed is probably due to differences in healthcare received, in comparison with pure breeds. Stray dogs tend to be mixed breed, whereas purebred dogs are generally owned and thus generally receive better care, including deworming and access to clean food and water[20,40]. Thus, stray mixed-breed dogs are more likely to eat contaminated garbage and drink dirty water on the streets[23]. This condition might also have contributed to acquire other infections.

Infection with *U. stenocephala* in dogs in Veracruz was also common (42.6%). This prevalence was higher than the 7.3% prevalence of *U. stenocephala* which was reported among hunting dogs in Denmark and the 14.29% prevalence among rural dogs in Buenos Aires, Argentina[4,41]. Differences in prevalences among the countries might due to differences in environment contamination. Cutaneous larva migrans occurs in Veracruz[42]. In addition to *Ancylostoma braziliense* and *A. caninum*, the differential diagnosis of cutaneous larva migrans in humans needs to include consideration of *U. stenocephala* as a possible cause[43].

It has been suggested that *T. vulpis* may be zoonotic[34]. Human infection in a child with rhinitis has been described, and *T. vulpis* was found in 3.5% of dogs studied in Mexico City[32]. We found higher prevalence (18.8%) among the dogs at the shelter in Veracruz.

The prevalence of *S. canis* (15.8%) was lower than other infections in this study. *S. canis* infection was associated with no history of rabies vaccination. It is possible that the causes for an association similar to that described above for *A. caninum* infection apply here too.

The high prevalence of infection reported in this study may reflect favorable conditions for environmental contamination and transmission of enteric parasites through the fecal-oral route at the shelter in Veracruz. No disinfectants are used on the soil of the shelter, and cages are cleaned with water and soap. Dogs at shelters tend to have higher prevalence of endoparasites than their pet counterparts living at home with their owners[31,38]. Parasite control needs to become a part of healthcare program to manage infectious diseases at animal shelters[28]. In addition to use of parasiticides, a thorough evaluation of the facilities and management practices is required in order to protect dogs from intestinal parasites infection and enhance their welfare at shelters[28]. Further research to improve the deworming efficacy is also needed.

A high prevalence of intestinal parasites was detected in the dogs at an animal shelter in the state of Veracruz, Mexico. The enteric parasites with zoonotic potential were identified by means of fecal analysis included *A. caninum* and *U. stenocephala*, and possibly *T. vulpis*. It can be hypothesized that the conditions at the shelter reflect the epidemiology of intestinal parasites infecting dogs in the study area. Establishing a healthcare program that includes parasite control protocols will improve the management of enteric parasitic infections and minimize the risk of exposure for humans and dogs.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgements

We are grateful to the dedicated personnel at the animal shelter for their support and collaboration. USDA is an equal opportunity provider and employer. Universidad Veracruzana and Juárez University of Durango State financially supported this study (Grant No. P4 UV-UJED).

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