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Article

Prevalence and diversity of zoonotic intestinal parasites in household dogs in urban areas of the Colombian Caribbean

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Abstract:

Dogs offer multiple benefits in their relationship with humans, but they can also be carriers of zoonotic parasites that affect human and animal health. Zoonoses account for about 58% of all human infectious diseases. The objective of this study was to assess intestinal parasitism in dogs with owners in the City of Barranquilla in the years 2016 to 2018. A retrospective descriptive study was carried out that included 3,279 reports of parasitological evaluation of feces from a clinical laboratory that serves a network of veterinary services in the city of Barranquilla. 49.2 % of the dogs had some type of intestinal parasite. The most frequent were helminths: *Strongyloides* sp. 9.6 %, *Toxocara canis* 7.7 % and *Ancylostoma* *caninum* 6.2 %; and the protozoa: *Entamoeba* spp. 10.0 %, *Isospora* spp. 6.9 % and *Giardia* spp. 5.7 %. The Principal Component Analysis of the parasite profiles by year showed significant differences. The presence of zoonotically transmitted intestinal parasites in dogs evidenced the need to establish corrective and preventive measures in the field of public health that allow their control, since they constitute a significant risk of disease in the community.

Keywords: Intestinal parasites, Giardia, Blastocystis, Helminths, Zoonoses, Protozoa.

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Introduction

Companion animals such as dogs offer multiple benefits in their relationship with humans, but in this close and millennial association of collaboration and affection between species, there are also zoonotic transmission parasites that can represent a potential risk to human and animal health. Zoonoses account for about 58 % of human infectious diseases, and of the 177 pathogens considered by the WHO to be reemerging, 73 % are related to human contact with an animal source[1,2]. The transmission of zoonotic parasites between humans and pets, such as dogs, is linked to the inadequate handling of excreta. The presence of dog feces in parks, streets, and public spaces where pets walk with their owners is an important source of contamination for humans and animals. The physical contact of children and adults during the game with their pets allows the exchange of parasites present in the hair and paws of the animals. In the feces of dogs that live with humans in both rural and urban environments, it is possible to find, in addition to canine intestinal parasites such as *Toxocara canis*, *Ancylostoma caninum*, *Echinococcus* sp., and *Dipylidium caninum*, among others, parasites typical of humans such as *Ascaris lumbricoides* or *Strongyloides stercolaris* as occasional findings[3].

Protozoa such as *Giardia* sp., *Entamoeba histolytica*/dispar, *Cyclospora*, and *Cryptosporidium* sp., commonly found in the world human population as the cause of gastrointestinal disorders and diarrhea in both healthy and immunologically compromised people, are considered parasites of zoonotic transmission[4,5]. Intestinal parasites are a global public health problem that has social, economic, and cultural effects associated with poverty[6]. In Colombia, the national parasitism surveys of the years 1965, 1980, and 2014 coincide in reporting intestinal parasitism in more than 80 % of the population[7].

The impact of zoonoses on human health makes it pertinent and opportune to conduct studies that help to understand and define the possible risks of transmission of these pathologies, even more so when they involve animals that live as closely with our families as dogs. In Colombia, according to data from the National Administrative Department of Statistics (DANE), pet ownership increased significantly in the last few years. Actuality 57 % of households live with at least one pet (4.4 million families); dogs are the preferred pet in 71 % of these households[8]. The climatic and environmental conditions of the Colombian Caribbean, where the city of Barranquilla is located, are appropriate for the transmission of intestinal parasites. The objective of this work was to determine the frequency of intestinal parasites in dogs with owners, including 3279 results of coprological analyses performed on pets during the years 2016 to 2018 in the city of Barranquilla, Colombia.

Material and methods

Description of the study area

Barranquilla, located in the northeastern vertex of the department (province) of Atlántico, Colombia. This urban center borders the Caribbean Sea to the north, the Magdalena River to the east, and other municipalities to the southwest. It has a dry tropical climate; the average temperature ranges between 24 °C and 28 °C, and humidity ranges between 65 % and 85 %[9]. There are no exacting data on the dog population in Barranquilla in 2016 – 2018 period, but it is calculated that in 2016 there were 82,386 dogs[10], and if it is considered that the estimated human population was 1’223,616 people in Barranquilla for the same year according to the National Department of Statistics[11], it can be inferred that there is a dog for every 15 inhabitants, approximately.

Sample collection and evaluation

A retrospective descriptive study in which were linked 3,279 reports of feces parasitological analysis of dogs with owner from a clinical laboratory that attends a network of veterinarian services in the city of Barranquilla. The fecal samples were provided by the dog owners as a routine control examination of their pets and the parasitological diagnosis was carried by an expert bacteriologist through direct microscopic examination of the fecal samples with saline and lugol solution to for the identification of parasitic forms.

Statistical analysis

For the analysis of the results, the dogs were classified into two categories: mongrels, as those animals of unknown ancestry with characteristics of two or more types of breeds, and purebred animals, according to the classification of the International Cynological Federation

(FCI) of the Organization Canine World (Table 1). An exploratory descriptive analysis of the results was carried out to establish the absolute and relative frequency of the parasites present in the samples and to compare, using the Chi-square test for categorical variables, the results between purebred and mixed-breed dogs and between the years evaluated. (It is considered significant if the value of P<0.05) Using a Principal Component Analysis (PCA), the parasite profiles by breed and by year were compared (XLSTAT program for Excel Addinsoft Inc., Paris, France).

Table 1: Classification of the dog population according to the breed groups established by the International Cynological Federation (FCI)

Animals (n)	Sections by group (n)
Total dogs (3,279) Mixed-breed dogs (861) Purebred dogs (2,418)	
GROUP I. Sheepdogs and Cattledogs (74)	Sheepdogs (74)
GROUP II. Pinscher and Schnauzer (574)	Molosoides (150) Pinschers and Schnauzers (424)
GROUP III. Terriers (344)	Companion Terriers (258) Bull Terriers (86)
GROUP IV. Dachshunds (6)	dachshunds (6)
GROUP V. Spitz and Primitive(192)	Alaskan Malamute (6) Nordic sled dogs (95) Asian Spitz and similar (16) European Spitz (72) Primitive Type - Hunting Dogs (3)
GROUP VI. Hound and trail (115)	Hound type dogs (115)
GROUP VII. Scent hounds and related breeds (16)	Continental samples (13) Sample English and Irish (3)
GROUP VIII. Retrievers - Flushing dogs (289)	Hunting Retrievers (200) Hunting lifting dogs (89)
GROUP IX. Companion and toy dogs (808)	Bichons and similar breeds (42) Poodle (404) Chihuahua (43) Small Molossian type Dogs (157) Tibetan breeds (162)

The table shows the number of animals for each group and section in the FCI classification.

Results

Of the 3,279 fecal samples analyzed, 73.7 % came from dogs of breeds identified and classified by the FCI (n= 2,418) and 26.3% (n= 861) were mixed-breed dogs. 49.2 % of the animals had intestinal parasites, without significant differences between purebred and mixed-breed dogs, only in the *Toxocara canis* helminth was a significantly higher prevalence observed in mixed-breed dogs in relation to purebred dogs (P=0.010 Chi square) (Table 2). Table 3 shows the parasite profiles for the total population studied, purebred and mixed-breed dogs, and by year.

Table 2: Prevalence of parasitism in dogs by race and year of evaluation

Parasitism	Total % (n 3,279)	Purebred (n 2,418)	Mixed-breed (n 861)	2016 (n 997)	2017 (n 1,428)	2018 (n 854)
Positive	49.2 (1,614)	49.0 (1,184)	49.9 (430)	51.2 (510)	47.8 (683)	49.3 (421)
1 parasite	41.8 (1,371)	41.4 (1,002)	42.9 (369)	43.2 (431)	41.0 (586)	41.5 (354)
2 parasite	6.6 (215)	6.9 (167)	5.6 (48)	7.7 (77)	5.7 (82)	6.6 (56)
3 ≥ parasites	0.9 (28)	0.6 (15)	1.5 (13)	0.2 (2)	1.1 (15)	1.3 (11)
Helmintes	28.2 (925)	27.4 (662)	30.5 (263)	23.1^{a} (230)	31.5^{b} (450)	28.7^{b} (245)
1 helminte	25.5 (836)	25.0 (604)	26.9 (232)	20.6 (205)	27.6 (394)	27.8 (237)
2 helmintes	2.3 (77)	2.2 (52)	2.9 (25)	2.5 (25)	3.3 (47)	0.6 (5)
3 helmintes	0.4 (12)	0.2 (6)	0.7 (6)	0.0 (0)	0.6 (9)	0.4 (3)
Protozoa	24.2 (794)	24.9 (602)	22.3 (192)	31.3^{a} (312)	18.6^{b} (265)	25.4^{c} (217)
1 protozoa	22.3 (731)	22.8 (551)	20.9 (180)	29.0 (289)	17.5 (250)	22.5 (192)
2 protozoa	1.8 (60)	2.0 (49)	1.3 (11)	2.2 (22)	1.0 (14)	2.8 (24)
3 ≥ protozoa	0.1 (3)	0.1 (2)	0.1 (1)	0.1 (1)	0.1 (1)	0.1 (1)

^{abc} Frequencies (%) in the same row that do not share the superscript letter are different (P< 0.05).

Table 3. Prevalence of parasitism by groups of breeds and by year

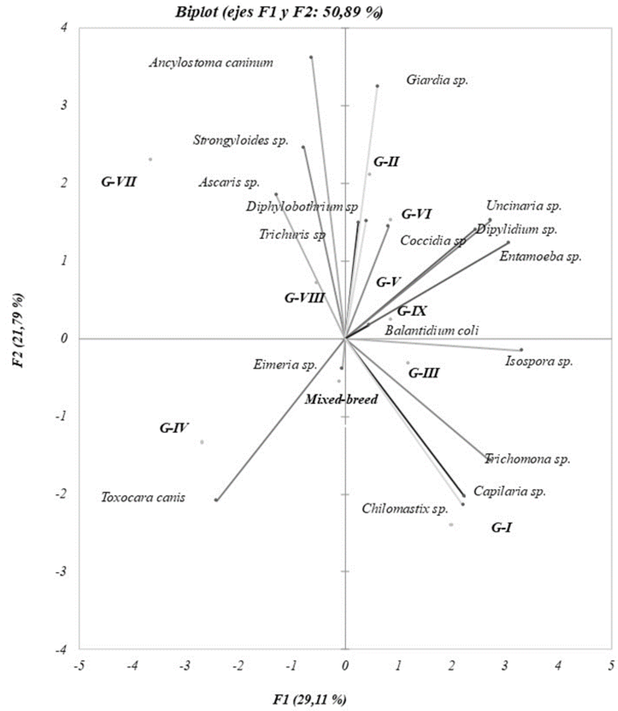
Parasite	Total n (3,279)	Purebred n (2,418)	Mixed-breed n (861)	2016 n (997)	2017 n (1,428)	2018 n (854)
Nematodes						
Toxocara canis	7.7 (254)	7.0^{a} (170)	9.8^{b} (84)	9.2^{a} (92)	8.2^{b} (117)	5.3^{c} (45)
Trichuris spp.	0.1(3)	0.1(3)	0.0 (0)	0.0 (0)	0.2 (3)	0.0 (0)
Ancylostoma caninum	6.2 (200)	6.0 (140)	6.2 (54)	3.1^{a} (31)	7.8^{b} (112)	6.7^{c} (57)
Diphylobothrium spp	0.0 (1)	0.0 (1)	0.0 (0)	0.0 (0)	0.0 (0)	0.1 (1)
Capillaria spp.	0.3 (11)	0.3 (7)	0.5 (4)	0.4 (4)	0.4 (6)	0.1 (1)
Strongylus spp	9.6 (314)	9.0 (218)	11.1 (96)	6.9^{a} (69)	12.8^{b} (183)	7.3^{a} (62)
Uncinaria spp.	6.1 (200)	6.0 (144)	6.5 (56)	5.7 (57)	6.4 (91)	6.1 (52)
Ascaris spp.	1.1 (35)	1.2 (28)	0.8 (7)	0.0 (0)	0.1 (1)	4.0 (34)
Cestodes						
Dipylidium caninum	0.3 (9)	0.4 (9)	0.0 (0)	0.2 (2)	0.2 (3)	0.5 (4)
Protozoa						
Entamoeba spp	10.0 (329)	10.5 (253)	8.8 (76)	13.3^{a} (133)	7.1 (102)	11.0^{a} (94)
Giardia spp.	5.7 (188)	6.0 (144)	5.1 (44)	7.4^{a} (74)	3.6^{b} (52)	7.3^{a} (62)
Isospora canis.	6.9 (225)	6.7 (163)	7.2 (62)	7.6 (76)	7.1 (101)	5.6 (48)
Coccidia sp*	3.0 (99)	3.3 (81)	2.1 (18)	4.4^{a} (44)	1.3^{b} (19)	4.2^{a} (36)
Balantidium coli	0.0 (1)	0.0 (1)	0.0 (0)	0.1 (1)	0.0 (0)	0.0 (0)
Eimeria spp.	0.0 (1)	0.0 (0)	0.1 (1)	0.1 (1)	0.0 (0)	0.0 (0)
Thichomonas spp.	0.3 (11)	0.4 (9)	0.2 (2)	0.3 (3)	0.5 (7)	0.1 (1)
Chilomastix spp.	0.2 (4)	1.4 (1)	0.2 (2)	0.4 (4)	0.0 (0)	0.2 (2)

* Different species of *Coccidia* infect dogs: *Isospora burrowsi*, *I. canis*, *I. neorivolta*, and *I. ohioensis*, only *I. canis* can be identified by the oocyst structure; the others were classified as *Coccidia* sp.

abc Frequencies (%) in the same row that do not share the superscript letter are different (*P*<0.05).

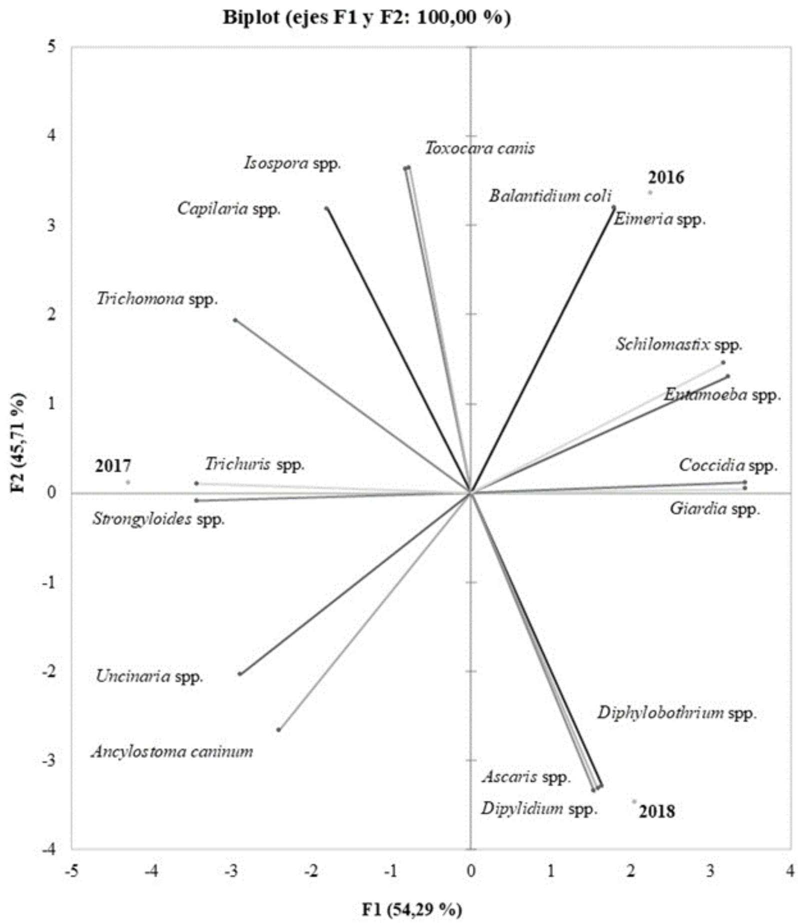
Principal component analysis (PCA) allows to summarize and to visualize the relationship between the parasite profiles and dog breeds according to FCI and mixed-breed dogs using the Pearson correlation coefficient. Figure 1, is the graphical representation of factors 1 and 2 with an accumulated variance of 50.89 %; the main components of factor 1 (variance 29.11 %) are *Isospora* sp. (17.9 %), *Entamoeba* (15.5 %), *Coccidia* sp. (12.2 %), and *Trichomonas* (12.1 %); the main components of factor 2 (Variance 21.79 %) were *Ancylostoma* sp. (21.3 %), and *Giardia* (17.2 %); the addition of factor 3 results in an accumulated variance of 68.1 % for the components *Ascaris* sp. (20.0 %) and *Strongyloides* sp. (17 %). It is not observed that there are relationships between the parasitic profiles of the dog groups of breeds.

Figure 1. PCA analysis relates parasite profiles between the groups of dogs studied



When parasitism by year was compared, it was observed that there are no significant differences in the number of animals with intestinal parasites per year; however, contamination by helminths and by trophozoans shows significant differences (P<0.05 Chi-square test). 2017 is the year with the highest prevalence of helminthiasis, and 2016 is the year with the highest contamination with protozoa (Table 2). The main helminths that establish the difference between years are *Toxocara canis*, *Ancylostoma caninum*, and *Strongyloides* sp.; the protozoa *Entamoeba* spp., *Giardia* spp., and *Coccidia* sp. show significant differences between the years evaluated (P<0.05) (Table 3). The PCA analysis of the parasitary profiles by year (Figure 2), shows that 100 % of the variance is reached with factors 1 and 2, being the main variables of factor 1 (variance 59.3 %), *Giardia* sp. 10.8 %, *Strongyloides* sp. 10.8 %, *Trichuris* sp. 10.8 %, and *Coccidia* sp. 10.8 %; and for factor 2 (variance 45.7 %), *Isospora* sp. 12.2 %, *Toxocara canis* 12.1 %, *Dipylidium* 10.3 %, and *Ascaris* sp. 10.1 %. It is observed that the parasite profiles per year are different.

Figure 2: PCA analysis of the parasite profiles by year



Discussion

Recently, a large number of studies have been carried out in many parts of the world to determine the presence of intestinal parasites in companion animals that live with human families. The results of these studies have been heterogeneous and largely dependent on environmental and climatic factors that facilitate the transmission of parasites. Furthermore, the socioeconomic conditions of poverty and poor hygiene facilitate the transmission of zoonotic parasites. La Torre *et al*[12] found in urban areas such as the city of Rome a prevalence of parasitism of 9.7 % when evaluating 493 dogs with owners, with *Trichuris vulpis* (5.5 %) and *Toxocara canis* (4.3 %) being the most frequent parasites[12]. In the city of Villahermosa in Tabasco, Mexico, it was observed that 26.5 % of the 302 evaluated feces of domestic dogs contained gastrointestinal parasites, with *Ancylostoma caninum* being the most common parasite[13]. And in Argentina, the evaluation of 1,944 samples of dog feces collected in rural and urban areas showed the presence of parasites in 37.86 % of the samples, with rural areas having 40.06 % and urban areas having 33.44 %, with significant differences between the parasite profiles of both areas[14].

In Barranquilla city, was found 49.2 % of parasitism prevalence in dogs with owners; the most frequent parasites were the helminths *Strongylus* sp., *Toxocara canis*, and *Ancylostoma caninum*, and the protozoa *Entamoeba* spp., *Isospora* spp., and *Giardia* spp. One previous study in Barranquilla in the year 2015 found parasitism in 73.3 % of 925 dogs analyzed; the most prevalent parasites were *Entamoeba* sp. 34.1 %, *Isospora* sp. 21.1 %, *Giardia* 18.1 %, and *Toxocara canis* 12.3 %, showing a reduction in the number of parasitized animals in comparison with the actual study but maintaining a similar parasite profile[15]. The public health importance of the protozoa found in this study is evidenced by their zoonotic potential and their significant pathogenicity in both humans and animals. *Isospora canis* and *Isospora ohioensis* are the most common species of coccidia that affect dogs. *I. canis* in the canine gastrointestinal tract results in enteritis and mucosal damage causing hemorrhagic diarrhea, vomiting, tenesmus, inappetance, and respiratory and neurologic signs. Human infection is associated with ingesting fecally contaminated food with dog feces[16].

The prevalence of Giardia in people and dogs as asymptomatic carriers and as a cause of pathology represents a constant risk to the health of both species; continuous treatment and reinfection can cause resistance to antiparasitic that make it increasingly difficult to eliminate the parasite[17]. Giardiasis is the cause of diarrhea and malnutrition in children and has a global distribution, with more than 200 million cases annually. Giardia has been included in the "*neglected diseases initiative*" by the World Health Organization[18]. A systematic review reporting what the prevalence of Giardia in Colombian, analyzed by microscopy is between 0.9 and 48.1 %[19]. In the metropolitan área of Barranquilla, the prevalence of giardiasis in 2015 was 15.2 % in children under 10 yr of age[20]. *Entamoeba* is the third most common parasitic disease responsible for mortality worldwide; it is the cause of human amoebiasis and invasive liver abscesses. About 90 % of human amoebiasis cases are asymptomatic, leading to continuous transmission of the parasite. *Entamoeba* is a zoonotic protozoan that colonizes the digestive tract of humans and animals and is considered a worldwide public health problem[21]. The prevalence of *Entamoeba* spp. in the Barranquilla human population in 2015 was 6.1 %[20]. *Toxocara* infection in humans may cause visceral larva migrans and, together with *Ancylostoma* spp., is associated with cutaneous larva migrans in poor communities[22]. The dogs are susceptible to experimental infection with *S. stercoralis* of human origin, although infection from dogs to humans has not been fully demonstrated[23].

Balantidium coli is considered a neglected zoonotic disease in tropical areas. This protozoan infects the intestinal tract, causing severe diarrhea and other gastrointestinal abnormalities in domestic animals. *B. coli* is considered a finding of zoonotic significance[24]. In this study, one of the animals had *Balantidium*, which represents a risk to the health of the pet and its owners. Other infrequent findings in this study include *Eimeria* sp., which was found in one of the animals, this species of coccidia parasite, which causes diarrhea and gastrointestinal disorders mainly in immunosuppressed people, was also found in domestic dogs in Peru with a prevalence of 10.68 %[25]. *Trichomonas* that are occasionally observed in the feces of dogs with diarrhea, although considered opportunistic, were found in eleven of the samples analyzed in this study even though the feces were not diarrheal. Using molecular and sequencing techniques, Gookin *et al*[26], demonstrated that *Trichomonas fetus* and *Pentatrichomonas hominis* are present in canine samples and that this protozoan causes human gastrointestinal infections.

The PCA analysis of the parasite profiles for each year evaluated showed significant differences, which could be attributed to slight variations in climatic conditions from one year to another in the same geographical area. This has been previously observed in the same geographic area, but when comparing human parasite profiles in areas with very similar environmental and cultural characteristics[20]. Cultural factors could also cause variations and favor or inhibit the possibility of infection at each moment of the complex life cycle of each parasite. The proper disposal of human and animal excrement is essential. Diverse studies have demonstrated in urban and rural areas of different countries that the presence of infective parasitic forms in the soil from the feces of humans and parasitized animals is a key factor in the infection of pets. In Chile, in 48.3 % of 83 parks in the city of Temuco, parasite eggs were found with *Toxocara* sp. (12.4 %) were the most frequent[27]. In the Tunja city, Colombia, 60.7 % of canine fecal samples collected in city parks and 100 % of soil samples had parasite eggs and larvae, mainly *Toxocara* sp., *Ancylostoma* spp., *Trichuris* sp., and *Strongyloides* sp.[28]. The viability of *Toxocara* sp. in the soil depends on factors such as temperature, pH, humidity, among others. However, it is known that they are very resistant to climatic conditions and that, depending on the condition, they could be infective for 6 to 12 mo or even up to several years at low temperatures[29].

Conclusions and implications

This study found that 49.2 % of the animals had intestinal parasites. It is not observed that there are relationships between the parasitic profiles of the dog groups for breeds, but it is observed that the parasite profiles per year are statistically different. The presence of intestinal parasites with zoonotic potential found in owned dogs observed in this work demonstrates the need for new studies to define the factors associated with this public health problem, and implement corrective and preventive measures to control them.

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