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Canine zoonotic enteroparasites with the "One Health" approach in Mar del Plata city, Buenos Aires, Argentina

Enteroparásitos zoonóticos caninos con el enfoque de "Una Salud" en la ciudad de Mar del Plata, Buenos Aires, Argentina

Enteroparasitas zoonóticos caninos com a abordagem "Uma Saúde" nacidade de Mar del Plata, Buenos Aires, Argentina

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ABSTRACT

Canine zoonotic parasites have been recognized as a significant public health problem especially in developing countries with vulnerable socio-environmental conditions. In the context of "One

Health" the aim of this work was to assess the animal domain by the evaluation of canine zoonotic enteroparasites associated to a Parasite Vulnerability Index (PVI) in peripheral (PC) and urban communities (UC) from Mar del Plata city. The PVI was elaborated in a previous work as a vulnerability indicator of parasite diseases, in relation to socio-environmental conditions surveyed in the communities about the next dimensions: house, sanitation, hygiene, education and work. A coproparasitological study was performed to establish the presence and the richness of canine parasites in the environment in both communities. The PC evidenced homes with a higher mean number of canine fecal samples (CFS) with parasites than the UC, showing also the highest parasite specific richness with helminths and protozoan. Frequencies of Ancylostomids, Capillariids and *Toxocara canis* were higher in the PC, but *Trichuris vulpis* frequencies and the positive coproantigen test to detect *Echinococcus granulosus*, were similar between communities. The PC evidenced association to variables related to dogs' ownership (absence of veterinary attention and not adequate deworming), with the presence of CFS with parasites and the positive coproantigen test. Families with medium and high PVI from the PC evidenced a strong association with the presence of CFS with parasites and also with high parasitic richness, while families from the UC with low PVI evidenced CFS without parasites. These results revealed a vulnerable scenario for the permanence and the transmission of canine zoonotic parasites in most families from the PC, highlighting the value of the socio-environmental features as predictors of parasitoses.

Keywords: Canine enteroparasitoses, Socio-environmental conditions, Parasite Vulnerability Index, Peripheral and Urban Communities, One Health

RESUMEN

Los parásitos zoonóticos caninos han sido reconocidos como un importante problema de salud pública, especialmente en países en desarrollo con condiciones socioambientales vulnerables. En el contexto de "Una Salud" el objetivo de este trabajo fue evaluar el dominio animal mediante la evaluación de enteroparásitos zoonóticos caninos asociados a un Índice de Vulnerabilidad Parasitaria (IVP) en comunidades periféricas (CP) y urbanas (CU)

de la ciudad de Mar del Plata. El IPV fue elaborado en un trabajo anterior como un indicador de vulnerabilidad de enfermedades parasitarias, en relación a las condiciones socioambientales relevadas en las comunidades sobre las siguientes dimensiones: vivienda, saneamiento, higiene, educación y trabajo. Se realizó un estudio coproparasitológico para establecer la presencia y la riqueza de parásitos caninos en el ambiente de ambas comunidades. La CP evidenció hogares con mayor número medio de muestras fecales caninas (MFC) con parásitos que la CU, mostrando también la mayor riqueza específica parasitaria con helmintos y protozoos. Las frecuencias de Ancylostomids, Capillariids y Toxocara canis fueron mayores en la CP, pero las frecuencias de Trichuris vulpis y la prueba de coproantígeno positivo para detectar Echinococcus granulosus, fueron similares entre comunidades. La CP evidenció asociación de variables relacionadas con la tenencia de perros (ausencia de atención veterinaria y desparasitación no adecuada), con la presencia de MFC con parásitos y la prueba de coproantígeno positiva. Las familias con IVP medio y alto de la CP evidenciaron una fuerte asociación con la presencia de MFC con parásitos y también con alta riqueza parasitaria, mientras que las familias de la CU con IVP bajo evidenciaron MFC sin parásitos. Estos resultados revelaron un escenario vulnerable para la permanencia y la transmisión de parásitos zoonóticos caninos en la mayoría de las familias de la CP, destacando el valor de las características socio ambientales como predictores de parasitosis.

Palabras clave: Enteroparasitosis caninas, Condiciones socio ambientales, Índice de Vulnerabilidad de Parásitos, Comunidades Periféricas y Urbanas, Una Salud

RESUMO

Parasitos zoonóticos caninos têm sido reconhecidos como um importante problema de saúde pública, especialmente em países em desenvolvimento com condições socioambientais vulneráveis. No contexto de “One Health” o objetivo deste trabalho foi avaliar o domínio animal pela avaliação de enteroparasitas zoonóticos caninos associados a um Índice de Vulnerabilidade Parasitária (PVI) em comunidades periféricas (PC) e urbanas (UC) de Mar del Plata cidade. O PVI foi elaborado em trabalho anterior como indicador de vulnerabilidade a doenças parasitárias, em relação às

condições socioambientais levantadas nas comunidades nas seguintes dimensões: moradia, saneamento, higiene, educação e trabalho. Um estudo coproparasitológico foi realizado para estabelecer a presença e a riqueza de parasitas caninos no ambiente em ambas as comunidades. O PC evidenciou domicílios com maior número médio de amostras fecais caninas (CFS) com parasitas do que o UC, apresentando também a maior riqueza específica parasitária com helmintos e protozoários. As frequências de Ancilostomídeos, Capillariids e Toxocara canis foram maiores no PC, mas as frequências de Trichuris vulpis e o teste de coproantígeno positivo para detectar Echinococcus granulosus, foram semelhantes entre as comunidades. O CP evidenciou associação com variáveis relacionadas à posse de cães (ausência de atendimento veterinário e não vermifugação adequada), com a presença de SFC com parasitas e o teste de coproantígeno positivo. Famílias com PVI médio e alto do PC evidenciaram forte associação com a presença de SFC com parasitos e também com alta riqueza parasitária, enquanto famílias da UC com baixo PVI evidenciaram SFC sem parasitos. Esses resultados revelaram um cenário vulnerável para a permanência e transmissão de parasitoses zoonóticas caninas na maioria das famílias do PC, destacando o valor das características socioambientais como preditores de parasitoses.

Palavras-Chave: Enteroparasitoses caninas, Condições socioambientais, Índice de Vulnerabilidade Parasitária, Comunidades Periféricas e Urbanas, Uma Saúde

Introduction

Of some 1400 species of infectious pathogens of humans, nearly 60% are derived from animal sources, hence the importance of recognizing the role of livestock, companion animals and wildlife in the interactions between animals and humans. In that way the concept of “One Health” (OH) is currently used to describe the interconnections between people, animals, plants and their shared environment, and it advocates for increased collaboration among diverse scientific disciplines in order to mitigate many of the wicked problems that impact health[1, 2]. An important goal would be

to identify available information, such as human and animal morbidity rates from zoonotic diseases, which could serve to provide decision-makers with a more concrete concept of One Health's added value and benefit[3].

Zoonotic parasites continue to cause significant morbidity and mortality mainly to poor and marginalized populations that lack access to health services and are readily ignored[4]. Dog feces harboring infective parasitic forms (larvae, eggs, cysts of helminths and oocysts of protozoan) are potential sources of environmental contamination and represent a high risk of infection for the people, especially in developing countries and communities living with vulnerable socio-environmental conditions[5, 6].

Destabilizing factors consist in those conditions which produce imbalance in the parasite–host relationship and generate parasite disease[7, 8]. These conditions could be explained by the resilience of some life stages in surviving adverse environmental conditions, or by the complexity of parasite life cycles some of which involve people, animals, vectors, and/or transmission through the environment[9]. Parasitic infections cannot be solved by eliminating the parasites, it is also necessary to take control of different aspects like the improvement of sanitation conditions[10]. That's for socio-environmental features are also considered with a huge importance in the transmission of parasite zoonoses and they make sense in the construction of ''One Health''.

Mar del Plata city (Buenos Aires province, Argentina) has experienced a sub-urbanization beyond the boundaries of the main city, reflecting the fast population growth and the high migration from rural areas to the cities which characterized Latin America and Argentina[11]. The expansion on peri-urban areas has been in a disorderly manner and without planning, with deep regional contrasts, a negative impact on the environment and a deteriorating people' s life quality as consequences[12,13]. This generates an epidemiological framework that is characterized by poor socio-environmental conditions which make peripheral populations vulnerable to get parasitoses[14-16]. In that sense, a Parasite Vulnerability Index (PVI) was built in a previous study, taking socio-environmental variables such as: overcrowding, floor type, drinking water source, wastewater disposal, solid waste disposal, presence of animals and schooling level. Associations

between high PVI and human parasitoses were seen mainly in the peripheral community compared with the urban community[15].

The previous study included the association between the human and the environmental domains, being necessary to approach the animal domain through the infection status of zoonotic enteroparasites and its relation with disease risk factors in the community[17]. The aims of the present study were: i) to research the presence of canine zoonotic enteroparasites in the same urban communities from Mar del Plata city studied before, and ii) to analyze associations between canine parasitic infections and the PVI previously built in both communities.

Methodology

STUDY AREA AND DESIGN

The study was conducted in two communities from Mar del Plata city, General Pueyrredon district, located on the southeast coast of Buenos Aires Province, Argentina (38°S; 57°33'W). The peripheral community (PC) belonged to the neighborhood of ''Santa Rosa del Mar'', located 14 km southwest from downtown. The estimated population was 500 inhabitants, and it was characterized by precarious housing with limited access to public services. The urban community (UC) was constituted by families whose children attend an urban kindergarten, and by other families who wanted to join the study. They lived in neighborhoods located in the urban area, and most of them counted with all the public services. These communities were participants of the previous study of zoonoses parasites affecting children in relation with socio-environmental variables, assessing the human and the environmental domains of the ''One Health'' approach.

A descriptive and cross-sectional epidemiological study was carried out in both communities. Epidemiological surveys were designed to measure housing variables through information regarding structural qualities, amenities, and family features. A total of 108 families from the PC agreed to participate in the study, while the population from the UC was formed by 43 families.

SOCIO-ENVIRONMENTAL DATA

A Parasite Vulnerability Index (PVI) previously elaborated was used as a vulnerability indicator to parasite diseases, in relation to the socio-environmental conditions surveyed about the next dimensions: house, sanitation, hygiene, education and work. PVI was classified as low (1–1.6), medium (1.7–2.2) and high (2.3–2.7) (15).

Thematic maps of punctual implantation were made from the primary data referencing each sampling unit (homes surveyed) and overlapping thematic layers such as PVI, canine fecal samples with parasites and specific richness. The different shades of grey indicate the condition of vulnerability with respect to the PVI. The thematic maps obtained were elaborated with the geographical information system QGIS version 2.14.

CANINE PARASITOLOGICAL DATA

Coproparasitological research

A coproparasitological study was performed to establish the existence of canine parasites in the environment. Three hundred and six (306) fresh canine fecal samples (CFS) from the PC and 46 from the UC were collected in the houses surveyed, processed through the modified Sheather's flotation technique, and microscopically examined[18]. Parasitic loads were estimated by means of the number of eggs (helminths) or cysts (protozoan) in fields of 100x and 400x, respectively, because stool samples were taken and kept with formaldehyde 10% (v/v). In case of helminths, worm burdens were estimated 2 per field (light), 3–6 (moderate) and higher than 7 (heavy). A burden of more than five cysts per field was considered high for protozoan[19].

Coproantigen research

Coproantigen test was performed for detection of the definite host of *E. granulosus*. Following a methodology of coproantigen determination for *E. granulosus*, 109 CFS from the PC and 27 from the UC were processed[20]. The samples were sent to the Laboratory of Parasitology (Cathedra of Microbiology and Parasitology, Medicine School, Comahue National University).

STATISTICAL ANALYSIS

Data analysis was performed using Info Stat and MedCalc version 4.6b[21,22]. The use of epidemiological files generated a lot of categorical variables; some of them were analyzed through the Multiple Correspondence Analysis (MCA), which operates on the Chi-square deviations matrix. This method measures the combination of modalities that have more inertia, contributing most to reject the hypothesis of independence between two variables. Comparisons of proportions were used to establish differences between frequencies of canine parasites, and between the communities (significance level of 95–99%). The species richness (number of parasite species/families) in each community, and the Sørensen similarity coefficient (degree of enteroparasites similarity in percentage terms) were also calculated[23].

DEVOLUTION

With the collaboration of veterinarians from the Municipal Centre of Zoonoses, several talks were performed with the PC, giving advice about good practices in raising farm animals and pets, then parasitized dogs were deworming. Families from the UC with parasitized dogs were suggested to visit a veterinarian.

Results

CANINE PARASITOLOGICAL RESEARCH

The overall frequencies of CFS with parasites were 83.3% (n= 255/306) in the PC and 45.6% (n= 21/46) in the UC. In relation to houses surveyed the 91.1% (n= 82/90) from the PC presented canine parasites, while in the UC was the 40.7% (n= 11/27). The mean number of CFS with parasites per home was statistically significantly higher in the PC than the UC (PC: 2.83 ± 2.12 vs. UC: 0.8 ± 1.12; t= 6.32; $P < 0.0000$; CI= 1.38 – 2.62). Sørensen similarity coefficient was 53.3%, and the specific richness was 11 in the PC and 4 in the UC. Helminths were identified in CFS from both communities and protozoan only in the PC; their respective frequency and dominance were assessed (Table 1). Among the parasites found the highest frequencies belonged to Ancylostomids and *T. vulpis*. The frequencies of Ancylostomids and Capillariids were statistically significantly higher in the PC and *T. vulpis*

frequencies were similar in both communities. Due the complex morphological characteristics among the eggs of the Capillariidae family, some CFS were further analyzed in other study, taking account morphological and molecular features, arriving to the identification of eggs assigned to *Eucoleus aerophilus*, *E. boehmi* and *Calodium hepaticum*[24].

Table 1. Parasites found in canine fecal samples from peripheral and urban communities.

Parasites	N° of positive samples		Frequency (%)[a]		Dominance (%)[b]	
	PC	UC	PC	UC	PC	UC
Helminths						
Ancylostomids	247	9	80.7*	19.6	96.8	42.8
Trichuris vulpis	126	18	41.2	39.1	49.4	85.7
Capillariids	68	3	22.2**	6.5	26.7	14.3
Toxocara canis	41	4	13.4	8.7	16.1	19
Ascaris sp.	8	-	2.6	-	3.1	-
Dipylidium caninum	7	-	2.3	-	2.7	-
Heterakis sp.	6	-	2	-	2.3	-
Strongyloides sp.	4	-	1.3	-	1.6	-
Taenia sp.	2	-	0.6	-	0.8	-
Protozoan						
Isospora sp.	28	-	9.1	-	11	-
Sarcocystis sp.	11	-	3.6	-	4.3	-

PC peripheral community, UC urban community.
a Frequency was estimated in relation to the total number of CFS analyzed.
b Dominance was estimated in relation to the total number of CFS with parasites.
* significant difference (X2= 72.2; p<0.01)
** significant difference (X2= 5.2; p<0.05)

The coproantigen test for *E. granulosus*, did not show significative difference between frequencies of positive samples in the PC and the UC (16.5%, n= 18/109; 22.2%, n= 6/27). Parasitic loads of helminths were mainly light in both communities (PC 91.7%,

n=253; UC 90.5, n=21) and parasitic loads of protozoan were light in the PC (100%, n=36). Frequencies of CFS with the parasitic loads for each parasite were shown in Table 2.

Table 2. Frequencies of canine fecal samples with light and moderate parasitic loads in peripheral and urban communities.

Parasites	PC (Frequency %)		UC (Frequency %)	
	Light	**Moderate**	**Light**	**Moderate**
Helminths				
Ancylostomids	78.1	2.6	19.6	-
Trichuris vulpis	39.2	1.9	30.4	8.7
Capillariids	21.2	1	4.3	2.2
Toxocara canis	13.1	0.3	6.5	2.2
Ascaris sp.	2.6	-	-	-
Dipylidium caninum	2.3	-	-	-
Heterakis sp.	2	-	-	-
Strongyloides sp.	1.3	-	-	-
Taenia sp.	0.3	0.3	-	-
Protozoan				
Isospora sp.	8.8	0.3		
Sarcocystis sp.	3.6	-		

Association between canine parasites and dogs' ownership features

The MCA evidenced association between variables related to dogs' ownership, the existence of CFS with parasites and the coproantigen test. In Figure 1, the left quadrant showed that families from the PC evidenced association to: CFS with parasites (CFSP), the habit of leaving canine feces into the environment (E), the absence of veterinary attention (NVA), not adequate deworming treatment (NAT) or the absence of it (NT), and positive coproantigen test (CP+). In the right quadrant families from the UC showed association to: CFS without parasites (CFSWP), the habit of disposing the canine feces with solid waste (SW), veterinary attention (VA), adequate deworming treatment (AT) and negative coproantigen test (CP-). Statistically significant association were

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Vol. 25, Nº 1 (2023) Pp. 38-63

seen between: CFSP/NAT when they were stratified by communities (v2 Cochran–Mantel–Haenszel = 7.48, P< 0.05); CFSP/NVA (X^2 MV-G2= 8.91, P< 0.01; OR = 0.24, 0.09–0.6) and CFSP/E (X^2 MV-G2= 28.68, P< 0.01).

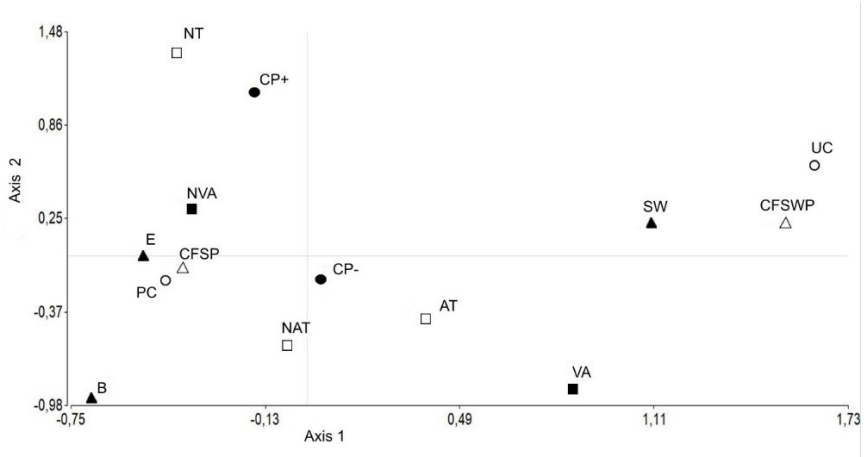

Figure 1. Multiple Correspondence Analysis (MCA) of variables related to dogs' ownership, CFS with parasites and coproantigen test in families from peripheral and urban communities.

PC: peripheral community; UC: urban community
CFSP: canine fecal samples with parasites; CFSWP: canine fecal samples without parasites
VA: veterinary attention; NVA: not veterinary attention
E: canine feces into the environment; SW: canine feces with the solid waste
AT: adequate deworming treatment; NAT: not adequate deworming treatment; NT: not deworming treatment
CP+: positive coproantigen test; CP-: negative coproantigen test

ASSOCIATION BETWEEN CANINE PARASITES AND PVI

The PVI previously developed for PC and UC, had shown statistically significant differences between frequencies of families with high, medium and low PVI (high PVI: 38.9% PC vs. 2.3% UC, X^2 = 18.5, P < 0.01; medium PVI: 55.5% PC vs. 4.6% UC, X^2 = 30.9, P < 0.01; low PIV: 5.6% PC vs. 93% UC, X^2 = 106.8, P < 0.01)[15].

Figure 2(a) evidenced most families with low PVI without canine parasites from UC, while figure 2(b) revealed association mainly between families with medium and high PVI and the presence of 1-

5 fecal samples with parasites in the PC. Furthermore, some of them reported 6-11 fecal samples with parasites. Figure 3(a) evidenced mainly families from the UC with low PVI and without canine parasites or with a parasitic richness of 1-4 species, while in figure 3(b) was observed an important association between high or medium PVI and a parasitic richness of 1-4 and 5-9 species in families from the PC. In that sense the analysis between PVI and parasitic richness evidenced also similar associations than those that occurred between PVI and fecal samples with parasites.

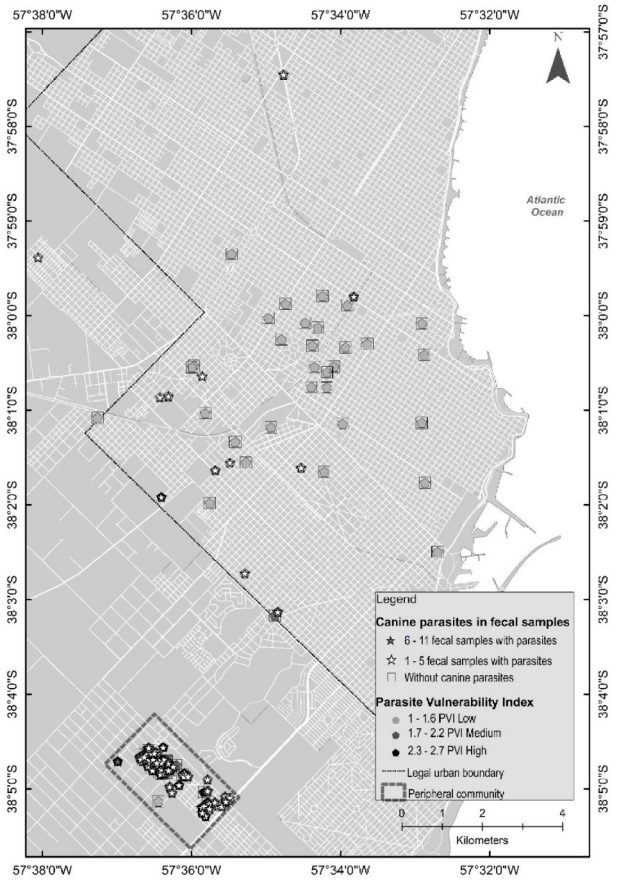

Figure 2. Geographic ubication of Parasitic Vulnerability Index (PVI) and Canine samples with parasites in families surveyed from the PC and the UC.
a) Map of the whole city including the urban and the peripheral areas studied.

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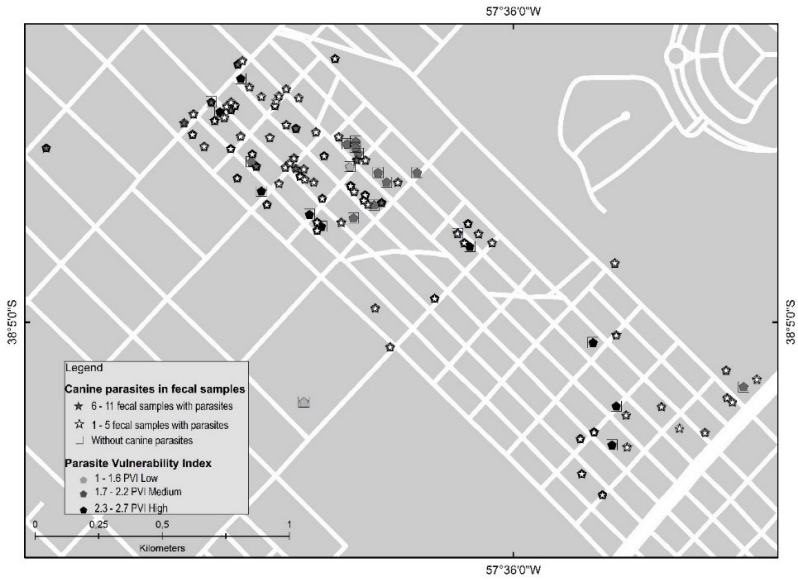
Vol. 25, Nº 1 (2023) Pp. 38-63



b) Detail of the peripheral neighbourhood Santa Rosa del Mar.

Source: cartography developed by the Remote Sensing Subprogram (National Institute for Fisheries Research and Development) based on own data.

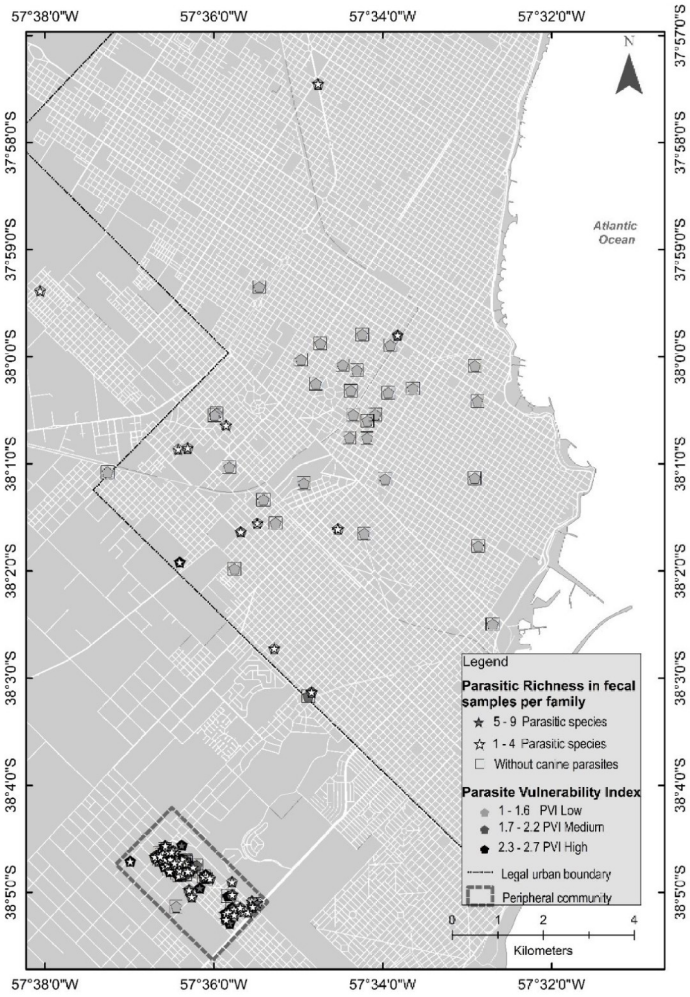


Figure 3. Geographic ubication of Parasitic Vulnerability Index (PVI) and Parasitic Richness in canine fecal samples in families surveyed from the PC and the UC.

a) Map of the whole city including the urban and the peripheral areas studied.

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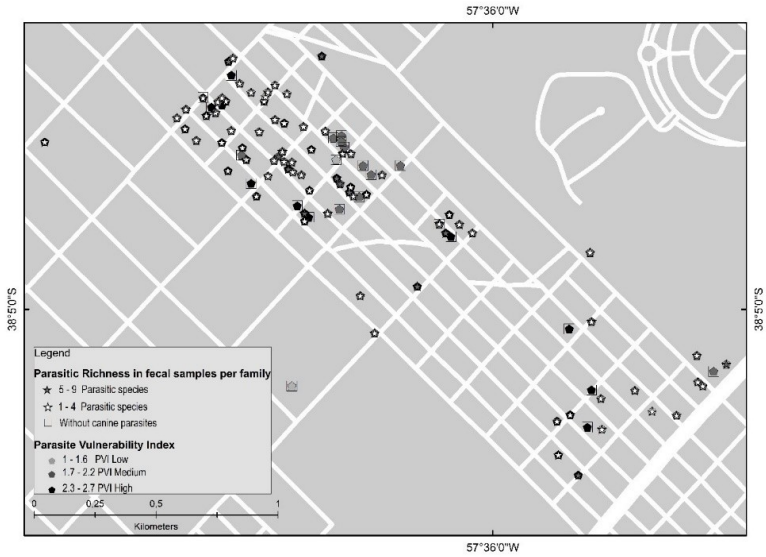
Vol. 25, Nº 1 (2023) Pp. 38-63



b. Detail of the peripheral neighborhood Santa Rosa del Mar.

Source: cartography developed by the Remote Sensing Subprogram (National Institute for Fisheries Research and Development) based on own data.

Discussion

The three OH domains should be evaluated to approach zoonotic canine enteroparasites, because they significantly affect humans and domestic animals' health, and the infective structures are transmitted through the ecosystem.

The previous study developed in the same communities from Mar del Plata city, have been focused on the human and environmental domains, integrating several socio-environmental features to address the con-causal factors of toxocarosis and enteroparasitoses affecting children[15]. This study evidenced that deficient socio-environmental conditions made children more vulnerable to get enteroparasitoses and toxocarosis in the PC than in the UC, where the PVI was higher. After the analysis of these domains, the present study attempted to approach the animal domain through the study of canine parasites in association with the same PVI.

More than sixty parasite species are related to canines and among them several enteroparasites can occasionally infect humans causing zoonotic parasitoses[5]. The two communities involved in this study, evidenced CFS with parasites, but the overall frequency was highest in the PC. The high mean number of CFS with parasites per home in the PC revealed an important source of environmental contamination with parasitic forms of zoonotic potential, also reinforced for the major specific richness of parasites. The maps of punctual implantations exposed medium and high PVI in most of these families, which lead to the idea that people from the PC was more vulnerable to be infected with a wide range of canine parasites than the UC. These results were concomitant with the existence of not appropriated habits of dogs' ownership in the families of the PC, like the habit of leaving canine feces into the environment, the absence of veterinary attention and deworming. On the other hand, a strong association was seen between the absence of canine parasites and appropriated habits of dogs' ownership in the UC where low PVI was prevalent. In contrast with these results, a study performed in Bahía Blanca (Buenos Aires province), developed an assay to evaluate the occurrence of canine parasites in relation to a Quality Life Index (QLI), finding no differences in the overall parasite frequencies between the areas studied with very high, high and low QLI[25]. The present work revealed a possible context for the transmission of canine zoonotic parasites in both communities, requiring more attention in the PC where the poor habitational quality, the socio-economic situation, the lack of education and hygiene and the habits of raising pets and poultry, become into the con-causal factors which allow the establishment, the permanence, and the dissemination of zoonotic parasites [7].

The assessment of canine enteroparasites in many countries has been very heterogeneous, with frequencies from 12% to 96%. The higher frequencies (66% to 96%) belonged to countries with deficient socio-economic conditions added to cultural habits that propend to the parasite transmission[26,27]. Other countries with better economic incomings and sanitary conditions showed the lowest frequencies (12,5% to 40%)[28-30]. Several studies developed in Argentina have evidenced environmental contamination with canine intestinal parasites with heterogeneous results: Ushuaia (32,5%), Neuquén (37,9%), Chubut (46,6%), Buenos Aires (52,4%), Salta (77,4%), and Bahía Blanca (87%) among others[6,31,32].

The occurrence of canine intestinal parasites in the PC and the UC, was similar to the countries with disadvantaged and advantaged socio-economic conditions respectively. The result from the PC was between the highest frequencies found in Argentina and also higher than those reported in peri-urban populations with similar socio-environmental features in the cities of La Plata (Buenos Aires province) and Santa Rosa (La Pampa province)[33].

In the present study both communities showed CFS with helminths but only in the PC were observed protozoan. About helminths the dominant parasites were Ancylostomids in the PC while in the UC was *T. vulpis*. The PC showed higher frequencies of Ancylostomids and Capillariids than the UC, and also evidenced helminths like *Ascaris* sp., *D. caninum*, *Heterakis* sp., *Strogyloides* sp. and *Taenia* sp. which were absent in the UC. The finding of *E. granulosus* was similar in the communities. These results agreed with the low parasites similarity between the communities and the high specific richness in the PC. International studies have reported ancylostomids and *T. canis* between the most common geohelminths, followed by *Giardia* sp. as the usual protozoan, and *Sarcocystis* sp. and *Isospora* sp. also reported in the PC [26, 27-30, 32]. Similar studies from Argentina have shown a lower specific richness, agreeing with the same protozoan and the geohelminths *A. caninum*, *T. vulpis* and *T. canis,* as the most frequently found parasites.

The dominance of these parasites could be related to the huge resistance of the eggs to extreme environmental conditions being a continuous source of re-infections, and to their ability to evade the host immune response[34]. Furthermore, the transmission of ancylostomids through the per-cutaneous via is more likely in an environment with high areas of soil and grass as occurred in the PC, where the development of the filariform larvae can take place. This situation, reinforced by the presence of feces with moderate parasitic loads in the area, could increase the transmission of ancylostomids and the occurrence of the cutaneous larva migrans syndrome in humans. Regarding *T. vulpis*, cases of visceral larva migrans and intestinal infections in humans have been reported[35,36]. Both communities were exposed to this parasite, however the parasitic load was more relevant within the UC, lightening the importance of a correct dog's deworming and feces' disposal.

T. canis produces toxocarosis, a usual helminth neglected disease in industrialized countries, which affects several organs in its presentation as visceral larva migrans, and also could cause ocular and brain toxocarosis[37]. A review based on the meta-analysis of 250 eligible studies of seroprevalence conducted worldwide, pointed out a toxocarosis seroprevalence rate of 22.8% (19.7–26.0%) in the American region[38]. Potential risk factors associated with seropositivity included male gender; living in a rural area; young age; close contact with infected dogs, cats or soil; consumption of raw meat; drinking and/or irrigating with untreated water[37,38]. Eggs of *T. canis* have been found in studies performed in urban and peripheral areas from Mar del Plata city[39,40]. The previous study conducted in these communities, showed a statistically significant higher proportion of seropositive children to *Toxocara* from the PC (55%), in comparison with the UC (8.5%). In addition, associations were observed between seropositivity and variables such as contact with infected dogs, not adequate hand washing, and moderate and hypereosinophilia in children from the PC. Most of these children belonged to families with medium and high PVI[15]. The existence of *T. canis* IgG could indicate past infestations, enhanced for the high frequency of CFS with this parasite mainly in the PC. Even though the presence of *T. canis* was more relevant in the PC, the moderate load observed in the UC stablished the risk to develop some of the toxocarosis presentations also in this community.

Within the Capillaridae family, eggs of *E. aerophilus*, *E. bohemi* and *C. hepaticum* were diagnosed in the CFS analysed. Reports of *Eucoleus* sp. are scarce in Argentina. This could be related to the misdiagnosis due to confusion with morphologically similar trichuroid eggs, and the lack of knowledge about the species of *Eucoleus* in this geographical area. Epidemiological studies developed on the beach and in peripheral neighbourhoods at local level, showed low frequencies of CFS with eggs assigned to this genus[6,40]. The finding of *E. boehmi* in the PC is interesting because this parasite is a neglected and underestimated cause of upper respiratory disease in dogs[41]. Furthermore, a unique case of respiratory capillariosis attributable to *E. bohemi* has been reported in the country[42]. On the other hand, *E. aerophilus* has been deeply described as parasitizing the lower respiratory tract of dogs, and also could cause zoonotic disease in humans[43]. This situation took importance in both communities due the presence

of the parasite, nevertheless, the transmission risk increased in the PC where the frequency was higher. Regarding *C. hepaticum*, it could cause spurious infections through the ingestion of the definitive host, principally rodents and the release of eggs in the feces[44].

Heterakis sp. is a genus that parasitized mainly birds and occasionally rodents[45]. The existence of *Heterakis* sp. in the CFS from the PC, evidenced the real possibility of parasite-host new associations when the context is appropriated[7]. Raising poultry such as geese and chickens without adequate veterinary assistance, added to the presence of rodents due to the open dumps in the PC, would generate this context.

Taenia sp./*Echinococcus* sp., indistinguishable between them by coprological examination, has been reported in the Patagonia region of Argentina with frequencies between 0.31% - 12.6% which was related to the endemism of the cystic echinococcosis in the region[6,31]. A previous sampling performed in Gral. Pueyrredon district also evidenced this kind of eggs[46]. In the present study the frequency of samples with *Taenia* sp. was low, which could be associated with the poor sensitivity of the flotation technique to recover tenids' eggs. The presence of these eggs evidenced that dogs were fed with raw meat, and the low and moderate loads would indicate an important liberation of eggs to the environment, increasing the infection risk and the possible development of cystic echinococcosis. The existence of tenids' eggs in two families from the PC which used to race pigs, added to the cystic echinococcosis case reported in a child from one of them, and the positive coproantigen test found in the community, pointed out the importance of the con-causal factors to the establishment of this zoonoses[47].

Isospora sp. and *Sarcocystis* sp. found in the PC, could mean a source of infection for humans since they can persist in the environment for long periods of time depending on the climate conditions, contaminating sources of water and vegetables. These coccids affect mainly children and immunocompromised people with diarrhea, nausea, anorexia, among other symptoms[48].

Strongyloides stercoralis is a common soil-transmitted helminth that infects humans, primates, cats and also canids, therefore

presents both environmental and zoonotic sources of transmission to humans[49]. Molecular studies performed on *S. stercolaris* from humans and dogs, revealed that both hosts could share the parasite populations[50]. Taking account that it has been diagnosed in canids' feces in the country and in the region under study and eggs assigned to *Strongyloides* sp. were observed in canine feces from the PC, dogs could be a possible reservoir for zoonotic infection in this community[40, 51].

Regards *Ascaris* sp. the presence of eggs in the feces would indicate a coprophagic behavior of dogs, in case the structures would have belonged to *A. lumbricoides*[52].

The WHO (2012) argues that most infectious diseases, parasitic zoonoses included, affect mainly poor and marginalized populations which have no access to health services. Studies carried out in Argentina gave account of the epidemiological scenario to the development of canine zoonotic parasitoses, built up on the vulnerable socio-environmental conditions and deficient hygiene practices of the populations[52]. The results of the present study revealed a vulnerable scenario for the permanence and the transmission of canine zoonotic parasites in most families from the PC, highlighting the value of the socio-environmental features as predictors of parasitoses, as the human cystic echinococcosis, and other new parasitic associations[16]. The animal domain addressed in this work, added to the human and environmental domains deeply studied in the previous work, offered valuable information into the "One Health" approach to generate a global synergism for all aspects of health care for humans, animals and the environment. These tools will alert the authorities about the epidemiological context for taking decisions to mitigate the effect of canine intestinal parasitoses on public health.

Conclusion

In the context of ''One Health'' the results of this work evidenced a higher vulnerability in the peripheral community to be exposed to several canine zoonotic parasites. This context added to the previously results about enteroparasitoses and toxocarosis in children, pointed out that the Parasite Vulnerability Index was a useful tool to identify families with deficient socio-environmental conditions, and reinforced the knowledge of the environmental

domain which is essential to understand the transmission of human and animal parasite diseases.

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