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Original Contribution

Enteroparasitoses and Toxocarosis Affecting Children from Mar del Plata City, Argentina

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Abstract: This study evaluated the existence of enteroparasitoses and toxocarosis in children of peripheral (PC) and urban communities (UC) from Mar del Plata city (Argentina) and their associations with socio-environmental conditions. A Parasite Vulnerability Index (PVI) was elaborated using variables such as over-crowding, floor type, drinking water source, wastewater disposal, solid waste disposal, presence of animals and schooling level. The PC evidenced statistically significant higher frequencies of families with high (38.9%) and medium (55.5%) PVI, while in the UC low PVI (93%) was the most frequent. A statistically significant higher frequency of PC children was parasitized (30.2 vs. 14.5%; χ^2 Pearson = 5.21; $P < 0.05$), presented higher parasite frequencies, specific richness, parasitic loads, and they also evidenced polyparasitism. The Multiple Correspondence Analysis (MCA) showed associations between PC-parasitized children, overcrowding and contact with pets and farm animals. The ELISA test to the specified determination of *Toxocara canis* IgG was reactive in a statistically significant higher proportion of PC children than the UC (55 vs. 8.5%; $\chi^2 = 30.5$; $P < 0.01$). The MCA associated PC reactive children, not adequate hand washing, moderate and hypereosinophilia and contact with pets and farm animals. Deficient socio-environmental conditions became children more vulnerable to get enteroparasitoses and toxocarosis in the PC than in the UC.

Keywords: Enteroparasitoses, Toxocarosis, Children, Socio-environmental conditions, Peripheral and urban communities

Introduction

The relationship between poverty and lack of basic amenities such as potable water and environmental sani-

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tation is a characteristic of the dynamic urbanization in Latin America and Argentina, reflecting the fast population growth and the high migration from rural areas to the cities (WHO 1998); Arriagada 2000; Dávila 2009). The families inhabiting the peri-urban neighborhoods generated by this situation live with denied basic needs and limited access to health services. This circumstance produces an epidemiological framework that is characterized by a high prevalence of infectious diseases, including parasitoses (Thompson 2001; Gamboa et al. 2011). The population growth in Mar del Plata city (Buenos Aires province, Argentina) has produced a sub-urbanization beyond the boundaries of the main city. The expansion on peri-urban areas has been in a disorderly manner and without planning. The consequences of this process were deep regional contrasts, a negative impact on the environment and a deteriorating people's life quality (Lucero 2004; Zulaica and Celemín 2008). Considering factors such as access to public services, education, health, dwelling and social security, a socio-environmental Vulnerability Index (SVI) was established in the city. The SVI was very low in the downtown and very high in the peripheral zone, meaning a poor socio-environmental condition to the peripheral inhabitants (Aveni 2008).

Populations living with vulnerable socio-environmental conditions became vulnerable to the development of enteroparasitoses and parasite zoonoses. Con-causal or destabilizing factors consist in those conditions which produce imbalance in the parasite–host relationship and generate parasite disease (Denegri 2008; Yannarella 2014). Protozoan and helminth parasites have been responsible for numerous diseases and losses of human lives, being actually a serious public health problem worldwide mainly in developing countries (Manning 2006). School children are the most affected having consequences at physical development and learning (Nematian et al. 2004). Infections caused by protozoan are an indicator of the sanitary and ecological conditions of the host environment (Gamboa et al. 2003). They are related to defecation practices, the contamination of the soil and the water, the hygiene habits and the overcrowded conditions, which are usual characteristics within the poorest sectors (Gamboa et al. 1998; Navone et al. 2006).

One of the most widespread and public health zoonoses shared with dogs, cats and several wild definitive hosts is the toxocarosis (Glickman and Schantz 1981). It is primarily caused by infection with larvae of the ascaroid nematode *Toxocara canis* (Werner 1782) and to a lesser extent by *Toxocara cati* (Schrank 1788). Human toxocarosis includes several syndromes; however, most infections are clinically asymptomatic (Despommier 2003; Schantz 1989; Smith et al. 2009). In its generalized form causes visceral larva migrans (VLM) and covert toxocarosis (CT), and in its compartmentalized form causes ocular toxocarosis (OT) and neurological toxocarosis (NT) (De la Fe Rodríguez et al. 2006; Fillaux and Magnaval 2013). Latin American countries such as Brasil, Chile, Colombia, Cuba and Argentina showed prevalence rates higher than 30% in humans, definitive hosts and soil samples (Delgado and Rodríguez-Morales 2009). Transmission and risk factors vary considerably in different parts of the world. Poverty, lack of education and problems with uncontrolled and untreated definitive host populations may lead to heavily contaminated environments. Under warm climatic conditions, these places may provide ideal transmission opportunities particularly if coupled with poor hygiene and geophagia or pica (Overgaauw and Nederland 1997; Won et al. 2008; Lee et al. 2010). Children are more exposed due to their close contact with dogs, their behavior of eating soil, putting objects in their mouths, eating earthworms and/or their poor hygiene (Macpherson 2013). Available tools to confirm the clinic suspicion of these parasitoses are: eosinophils blood cell count, abdominal ultrasonography and chest X-ray, ophthalmological examination and serology with excretory–secretory products of in-vitro second-stage larvae (TES-ELISA) (De Savigny et al. 1979; Minvielle et al. 1999; Pawlowski 2001; Altcheh et al. 2003; Despommier 2003; Smith et al. 2009; Roldán et al. 2010).

The aims of this study were to evaluate the existence of enteroparasitoses and toxocarosis in children from peripheral and urban communities and to stablish associations with the socio-environmental conditions.

Methods

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 "Santa Rosa del Mar," located 14 km southwest of the urban center of the city. Its settlement was spread out, and it was conformed of 120 houses distributed

in about 30 blocks. The estimated population was 500 inhabitants, and it was characterized by precarious housing with limited access to public services. The neighborhood counted with electricity, potable water through 12 communal tanks distributed in the blocks, public transport limited at the school schedule, waste collection service three times per week and it lacked of sewage systems. The urban community (UC) was formed by families whose children attend to an urban kindergarten and by another families who wanted to participate. They lived in neighborhoods distributed in the urban area, and most of them counted with all the public services.

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 characteristics. The family members were personally interviewed and questions of three types were used: closed, open and multiple-choice fan type.

In the neighborhood "Santa Rosa del Mar," a census was done with all the families. From the total of 120 families, 108 agreed to participate in the study. A total of 120 families belonging to the kindergarten were invited to participate, but only 40 agreed to be part of the study. Finally, the population from the UC was formed by 43 families. The population under study comprised children aged 0–14 years of the participant families. They participated in the study following written informed consent by their parents. Research protocols followed the principles regarding the privacy of personal data outlined in the Universal Declaration of Human Rights (1948), in the ethical standards instituted by the Nuremberg Code (1947), and in the Helsinki Declaration and successive modifications as well as those under Argentine National Law (No. 25.326).

Socio-environmental Data

The data recorded were obtained from the epidemiological files completed at each home. With the aim of establishing a vulnerability indicator to parasite diseases in relation to the socio-environmental conditions surveyed, a Parasite Vulnerability Index (PVI) was elaborated by operationalizing the qualitative variables obtained. Ten indicators grouped in four dimensions were used to summarize the socio-environmental characteristics of the families living at both communities (Table 1). Each indicator was represented by two or more variables obtained in the epidemiological files. The variables received a weighing value between 1 (the better condition) and 5 (the worst condition). These values were summed and averaged by the number of total variables obtaining an index to each home. PVI was classified as low (1–1.6), medium (1.7–2.2) and high (2.3–2.7). The index construction was done following the methodology used in social studies in which most variables are qualitative (Miguel and Sevilla Guzmán 1973; Lucero and Celemín 2008; Merlotto et al. 2008; Zulaica and Celemín 2008).

Thematic maps of punctual implantation were made from the primary data referencing each sampling units (homes surveyed) and overlapping thematic layers such as PVI, enteroparasitoses and ELISA test results. The different shades of gray indicate the condition of vulnerability with respect to the PVI. Regarding the conditions of enteroparasitoses and ELISA test, nominal conditions were considered indicating with or without possession of parasitoses and reactive or non-reactive to ELISA test. The thematic maps obtained were elaborated with the geographical information system QGIS version 2.14.

Coproparasitological research was performed to establish the existence of *T. canis* in the environment. Three hundred and six dog fresh fecal samples from the PC and 46 from the UC were collected in the houses surveyed, conserved with 10% (v/v) formaldehyde and analyzed through the Sheather flotation technique (Méndez 1998). With each sample, two slides were made and microscopically examined at 100×, 400× and 1000× amplifications. Identification of parasites was performed by morphological characteristics. A sample was recorded as positive if at least one parasitic form was observed.

Children Parasitological Data

For screening intestinal parasites, the total of interviewed children (171 from the PC and 81 from the UC) was invited to participate in the coproparasitological research. Hundred and six children fecal samples from 54 families of the PC and 62 from 32 families of the UC were recovered and analyzed. The collection was performed for three successive days in wide-mouthed screw-capped jars containing 10% (v/v) formal saline solution. The coproparasitological analysis was done through the modified sedimentation technique of Ritchie (Méndez 1998). With each sample, two slides were stained with Lugol solution and microscopically examined at 100×, 400× and 1000× amplifica-

Table 1. Parasite Vulnerability Index.

Dimension	Indicator	Variables	Frequency (%)		Weighing
			PC	UC	
House	Overcrowding[a]	No	82	97	1
		Yes	18**	3	2
	Floor type	Ceramic	31.5	93*	1
		Concrete	60.2*	7	2
		Wood	2.8	0	3
		Soil	5.5	0	4
	Bathroom inside the house	Yes	88.9	95.3	1
		No	11.1	4.7	3
Sanitation	Drinking water source	Potable tap water	0	100*	1
		Communal tank and protected well	58*	0	2
		Protected well	42*	0	3
	Wastewater disposal	Sewage system	0	91*	1
		Septic tank	99.1*	9	2
		Into the environment	0.9	0	4
	Solid waste disposal	Daily waste collection	0	97.7*	1
		Waste collection 3 times per week	56*	0	2
		Burn and/or leave into the environment	44*	2.3	4
Hygiene	Hand washing	≥50% of family members with adequate hand washing	56	65	1
		>50% of family members with not adequate hand washing	44	35	3
	Presence of animals at home	No animals	6	19**	1
		Pets	44	76*	2
		Pets and/or farm animals	50*	5	5
Education and work	Prevalent schooling level (family members older than 14 years old)	Higher than full high school	2.8	44.2*	1
		Equal or lower than full high school	56.5	55.8	2
		Equal or lower than full elementary	40.7*	0	3
	Prevalent type of work (family members older than 18 years old)	Prevalence of stable work	26.9	41.9	1
		At least one member has stable work	38.9	44.2	2
		Only tempory work	22.2	9.3	3
		Prevalence of members unemployed	12	4.6	4

Source own elaboration based on data from the epidemiological files

[a]Overcrowding index: no of persons living in a house/no of rooms per house. Without overcrowding: <2.4; moderate overcrowding: 2.5–4.9; critical overcrowding: >5.

* Significantly different $P < 0.01$. ** Significantly different $P < 0.05$.

tions. Identification of parasites was performed by morphological characteristics using specified literature (Ash and Orihel 2011). Parasitic loads were estimated by means of the number of eggs (helminths) or cysts (protozoan) in fields of 100× and 400×, respectively, because stool samples were obtained only in formal saline 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 (Ertug et al. 2007; Zonta et al. 2010).

Professionals from the Center of Outpatient Medical Specialties (General Pueyrredon district) performed the following screening studies to diagnose toxocarosis: abdominal ultrasonography (US), chest X-ray, ophthalmological examination and eosinophils blood cell count. The Ridascreen ELISA test was developed in the bio-

chemical laboratory of the center to the specified determination of *T. canis* IgG in the children blood serum. The participants were 95 children of 44 families from the PC and 56 children of 23 families from the UC.

Statistical Analysis

Data analysis was performed using Info Stat (Di Rienzo et al. 2014) and MedCalc version 4.6b (Schoonjans 1993). The use of epidemiological files generated a lot of categorical variables; some of them were analyzed through the Multiple Correspondence Analysis (MCA). This is an exploratory technique that allows graph rows and columns of a contingency table as points in a low-dimensional Euclidean space (usually two dimensional). The MCA 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 (Greenacre 1988). In that way, the MCA established the most frequent associations between parasitized children and socio-environmental conditions observed at each community. These associations between variables were also analyzed through contingency tables using the Chi-square (χ^2) Pearson, statistically significant when $P < 0.05$, and the odds ratio (OR) determined with 95% confidence intervals (CI = 95%). The χ^2 Cochran–Mantel–Haenszel was used for the association between a response Y variable and other explanatory X variable in cases that there are one or more control variables (Z) defining strata (Agresti 1990). Comparisons of proportions were utilized to establish differences between frequencies of parasitized children, parasite species and also between variables analyzed in the communities (significance level of 95–99%) (Schoonjans 1993). The species richness (number of parasite species) and the Sørensen similarity coefficient (degree of enteroparasites similarity in percentage terms) were also calculated in each community (Morales and Pino 1987; Bush et al. 1997).

Devolution

Several informative talks were performed with both communities with the aim to give information about parasitoses and the results of the coproparasitological and the screening studies. With the assistance of a doctor, parasitized children from the PC were given deworming treatment and those from the UC were referred to their family doctor with the parasitic diagnose. Children, who were reactive to the ELISA test, were referred to the infectology service from the Center of Outpatient Medical Specialties for medical follow-up.

Results

Socio-environmental Data

The comparison of socio-environmental variables between communities is detailed in Table 1. The house dimension showed that the PC presented a significantly higher frequency of families living in overcrowded conditions than the UC ($\chi^2 = 4.6$; $P < 0.05$). The UC showed significantly higher frequency of houses with ceramic floor ($\chi^2 = 44.1$; $P < 0.01$), while in the PC the concrete floor was the most frequent ($\chi^2 = 33.1$; $P < 0.01$). About the sanitation dimension, potable tap water was only present in the UC ($\chi^2 = 146.1$; $P < 0.01$), while the PC consumed water from communal tanks and protected wells. The 91% of UC houses counted with sewage systems, while in the PC the 99.1% counted with septic tank. Daily waste collection service occurred in the 97.7% of the houses from the UC, while the 56% of the PC families received this service three times per week. The analysis of hygiene dimension showed statistically significant differences in the presence of animals at home. In the UC was more frequent the presence of pets ($\chi^2 = 11.4$; $P < 0.01$), while in the PC was the presence of pets and farm animals ($\chi^2 = 24.8$; $P < 0.01$). Related to the education dimension, the schooling level higher than full high school was significantly more frequent in the UC ($\chi^2 = 39$; $P < 0.01$), while in the PC was more frequent the level equal or lower than full elementary ($\chi^2 = 22.7$; $P < 0.01$). The PVI showed differences statistically significant between the families from the communities (high PVI 38.9% PC vs. 2.3% UC, $\chi^2 = 18.5$, $P < 0.01$; medium PVI 55.5% PC vs. 4.6% UC, $\chi^2 = 30.9$, $P < 0.01$; low PIV 5.6% PC vs. 93% UC, $\chi^2 = 106.8$, $P < 0.01$) (Figures 1, 2).

Enteroparasitoses

A statistically significant higher frequency of parasitized children was observed in the PC than in the UC (30.2 vs. 14.5%; χ^2 Pearson = 5.2; $P < 0.05$; OR = 0.39; 0.18–0.88). There was no statistically significant difference between age groups of parasitized children from both communities (Figure 3). Sørensen similarity coefficient was 66.7%, and the specific richness was four parasite species in the PC and

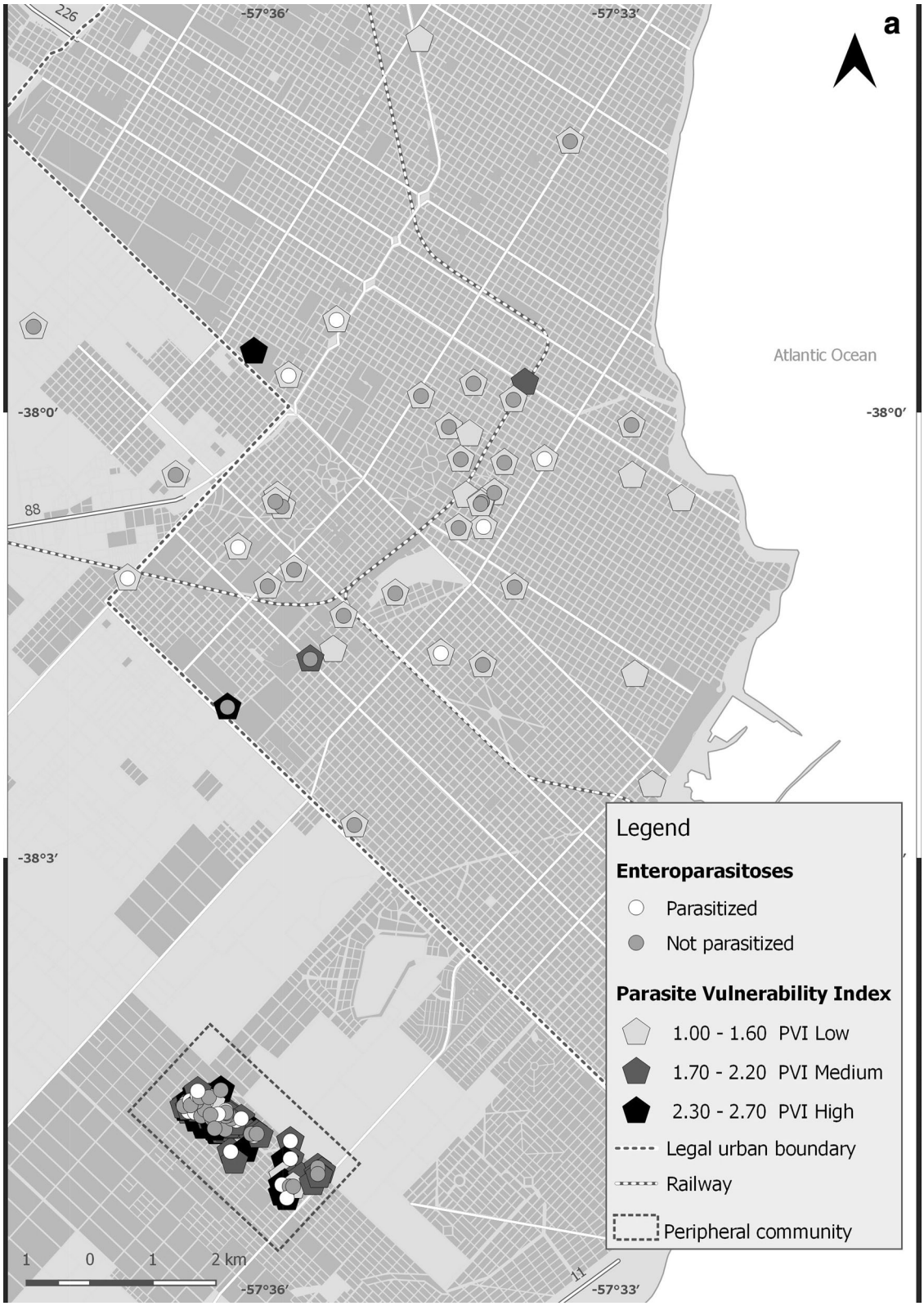


Figure 1. Geographic location of Parasite Vulnerability Index and children enteroparasitoses in families surveyed from the PC and the UC. **a** Map of the whole city including the urban and the peripheral areas studied. **b** Detail of the peripheral neighborhood Santa Rosa del Mar. *Source* cartography developed by the Geography Department (School of Humanities, National University of Mar del Plata) based on own data.

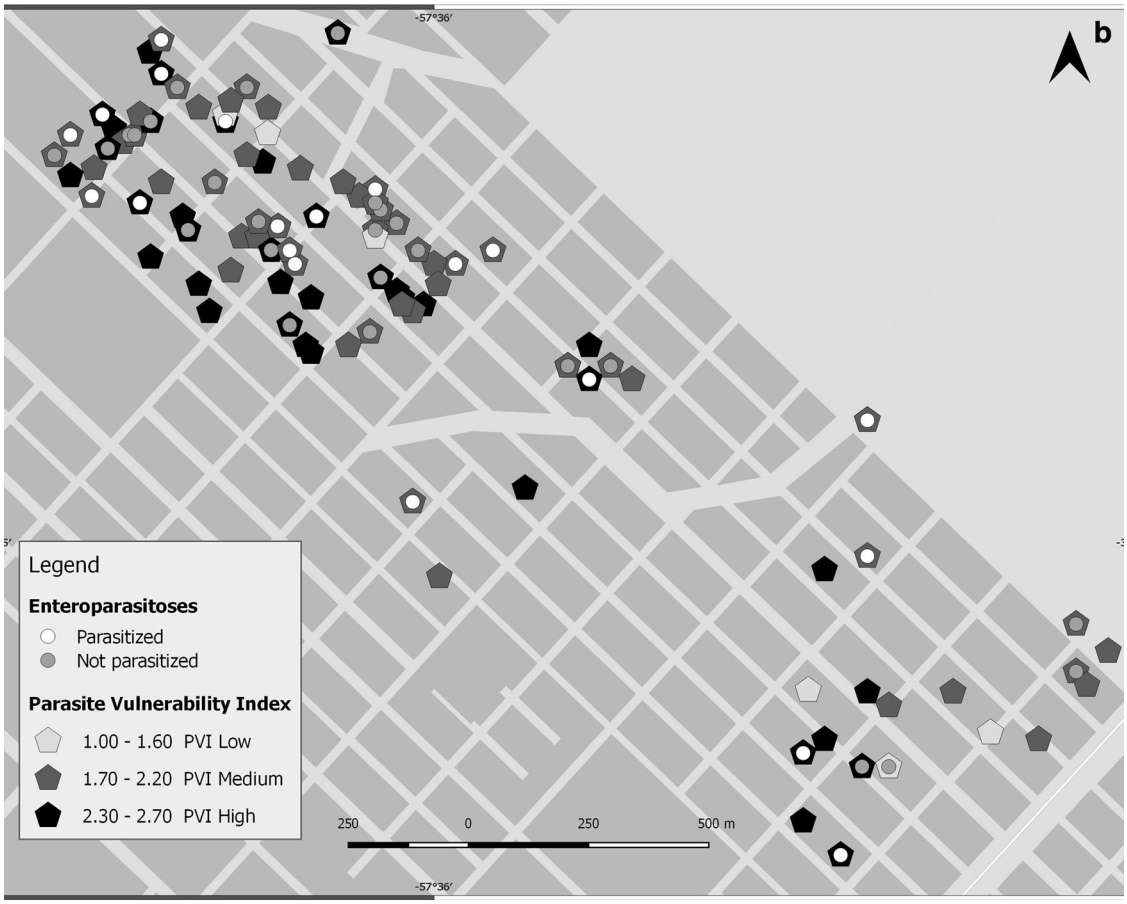


Figure 1. continued

two in the UC. Children from both communities revealed the presence of *Blastocystis* sp. and *Giardia* sp., but the PC children also evidenced *Entamoeba coli* and *Enterobius vermicularis*. The highest frequencies belonged to *Blastocystis* sp. (PC 13%, UC 8%) and *Giardia* sp. (PC 11.3%, UC 6.4%) (Table 2). Parasitic loads were light for all the parasites found, while high loads for *Giardia* sp. were found in the 4.7% of children from the PC and in the 3% from the UC. The 15.6% of children from the PC evidenced parasitic associations between *Blastocystis* sp./*Giardia* sp. (9.4%) and *Giardia* sp./*E. coli* (6.2%).

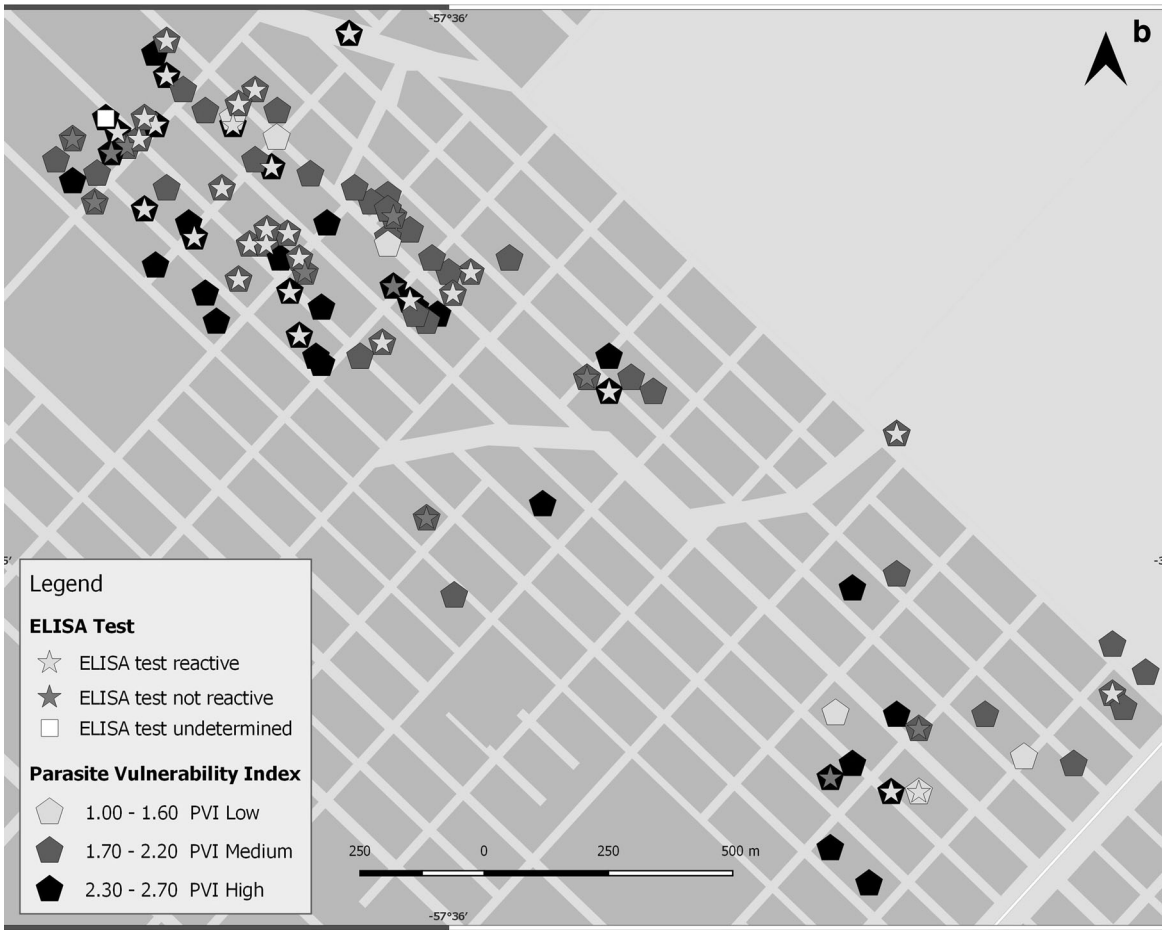
In Figure 1(a) was evidenced important association between absence of enteroparasitoses and low PVI in the UC, while in Figure 1(b) were observed similar associations between parasitized and not parasitized children with high and medium PVI in the PC.

The MCA evidenced association between some socio-environmental variables and the existence of enteroparasitoses in children. In Figure 4, the left quadrant showed that parasitized children belonged to the PC lived in overcrowded conditions and had contact with pets and farm animals. In the same quadrant variables about children without animal's contact, not adequate hand washing and deworming were associated. In the right quadrant, it could be observed that children from the UC were not parasitized, lived without overcrowding, had pet's contact, did adequate hand washing and lacked deworming. There was significant association between community/overcrowding (χ^2 Cochran–Mantel–Haenszel = 20.9; $P < 0.01$; OR = 0.06; 0.02–0.22) and community/animal's contact (χ^2 Cochran–Mantel–Haenszel = 8.6; $P < 0.05$) when they were stratified by parasitized children in the PC.

Toxocarosis

Not radiological or ultrasound images related to toxocarosis were evidenced in the children from both communities who participated in these studies. The ELISA test to the specified determination of *T. canis* IgG was reactive in a statistically significant higher proportion of children serum samples from the PC (55%) in comparison with the UC (8.5%) ($\chi^2 = 30.5$; $P < 0.01$). In the PC, the remaining

Figure 2. Geographic location of Parasite Vulnerability Index and Children ELISA test in families surveyed from the PC and the UC. **a** Map of the whole city including the urban and the peripheral areas studied. **b** Detail of the peripheral neighborhood Santa Rosa del Mar. *Source* cartography developed by the Geography Department (School of Humanities, National University of Mar del Plata) based on own data.



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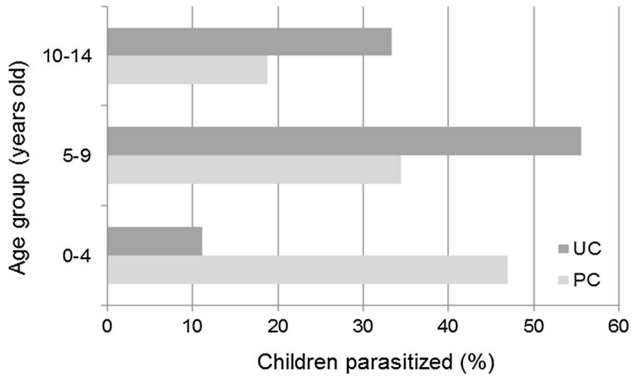


Figure 3. Frequency of parasitized children from peripheral and urban communities according to age groups.

samples resulted in 2% undetermined and 43% not reactive, while in the UC were 4% and 87.5%, respectively.

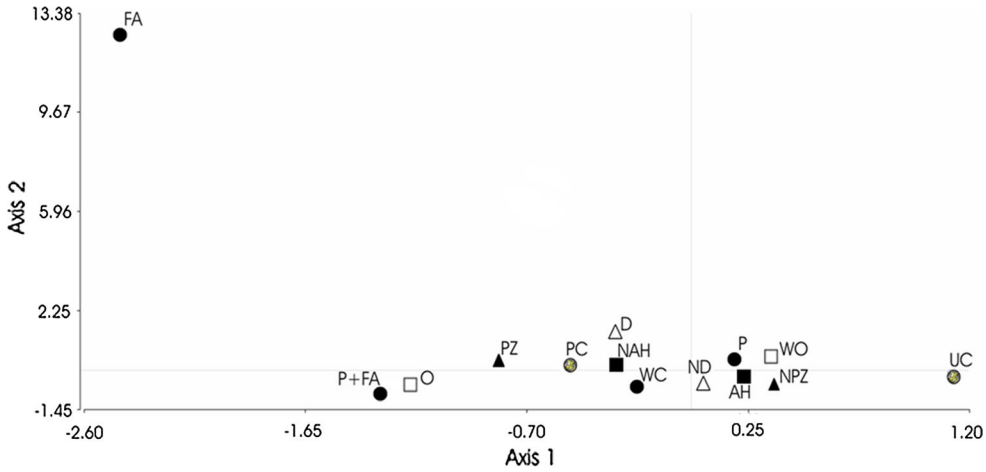
In Figure 2(a) was shown association mainly between families with low PVI and children with non-reactive ELISA test, while in Figure 2(b) was evidenced important association between families with medium PVI and children with reactive ELISA test.

The frequencies of eosinophilia detected in the blood counts were 37.6% in the PC and 36.8% in the UC. The frequencies of associations between the presence of *T. canis* IgG and the existence of different levels of eosinophilia (light, moderate and hypereosinophilia) were shown in Figure 5. Statistically significant difference was observed between the 60.5% of children from the PC and the 11.6% from the UC who presented animal's contact and who were reactive to the ELISA test (χ^2 Pearson = 24.8, $P < 0.01$). The variable not adequate hand washing generated a significant stratum effect over this association in the PC ($\chi^2 = 6.7$; $P < 0.05$). The variables analyzed in relation to the ELISA test are shown in the MCA (Figure 6). In the left quadrant, children from PC were associated with not adequate hand washing, reactive ELISA test, moderate and hypereosinophilia and contact with pets and farm animals. In the right quadrant, children from the UC were associated with not reactive and undetermined ELISA test, adequate hand washing, light eosinophilia, pet's contact and not animal contact.

Table 2. Enteroparasites Found in Children from Peripheral and Urban Communities

Parasites	Number of positive samples		Frequency (%)[a]		Dominance (%)[b]	
	PC (n = 32)	UC (n = 9)	PC (n = 106)	UC (n = 62)	PC (n = 32)	UC (n = 9)
Protozoan						
Blastocystis sp.	14	5	13	8	43.7	55.5
Giardia sp.	12	4	11.3	6.4	37.5	44.4
Entamoeba coli	10	0	9.4	0	31.2	0
Helminths						
Enterobius vermicularis	2	0	1.9	0	6.2	0

PC peripheral community, *UC* urban community.
[a]Frequency was estimated in relation to the total number of children samples analyzed.
[b]Dominance was estimated in relation to the total number of parasitized children.



Contribution to the Chi Square					
	Autovalue	Inertia	Chi Square	(%)	Accumulative %
1	0.52	0.27	409.11	18.06	18.06
2	0.48	0.23	353.70	15.62	33.68

FA (farm animals); P (pets); WC (without contact)
PZ (parasitized); NPZ (not parasitized)
PC (peripheral community); UC (urban community)
D (deworming); ND (not deworming)
NAH (not adequate hand washing); AH (adequate hand washing)
O (overcrowding); WO (without overcrowding)

Figure 4. Multiple Correspondence Analysis of socio-environmental variables and enteroparasitoses in children from peripheral and urban communities.

Toxocara canis was found in the 13.4% of canine fecal samples from the PC and in the 8.7% from the UC. The 55.6% of children from the PC whose dogs were infested with *T. canis* showed a reactive ELISA test, while in the UC this association was seen in one of the two cases of infested dogs with this parasite.

During the ophthalmological examination, 93 children from the PC and 59 from the UC were evaluated. The 3.2% from the PC were diagnosed with retinal inflammatory lesions in both eyes, being two of them reactive to the ELISA test and one undetermined. These two boys also presented one myopia and the other astigmatism. None of them presented eosinophilia.

Discussion

Poverty is one of the most critical and determining factors that impact on populationś health increasing their vulnerability to diseases, which is aggravated by the difficulty to access quality health care, good housing and safe food, among others (Gamboa et al. 2010).

Socio-environmental variables, such as overcrowding, floor type, drinking water source, wastewater disposal, solid waste disposal, presence of animals and schooling level, were more deficient in the PC than in the UC. A high proportion of PC families lived with housing problems, limited access to potable water, without proper sanitation and with poor environmental and personal hygiene. Added to this situation, they had high frequencies of low schooling levels and lack of stable work. In the UC, only one family lived overcrowded, in very precarious habitational and sanitary conditions. In that way, a statistically significant higher frequency of families from the PC showed high and medium PVI compared with the UC where most families had low PVI, which evidenced a worse life's quality in the PC.

A statistically significant higher frequency of children from the PC was parasitized, presented higher parasite frequencies, specific richness, parasitic loads, and they also evidenced polyparasitism in comparison with children from the UC. The absence of enteroparasitoses was mainly associated with low PVI and was higher in the UC. Variables such as overcrowding and contact with pets and farm animals were specially related to parasitized children from the PC. A not adequate hand washing was also seen, meaning an important vulnerability factor to the enteroparasitoses transmission (Lacoste et al. 2012). This situation was aggravated in the PC because the existence of potable water in communal tanks was not guaranteed. Several studies developed in Argentina have linked precarious habitational characteristics, overcrowding and lack of sanitation and potable water to the infection and maintenance of oro-fecal transmission parasites in children (Soriano et al. 2005; Milano et al. 2007; Gamboa et al. 2009, 2011; Zonta et al. 2010).

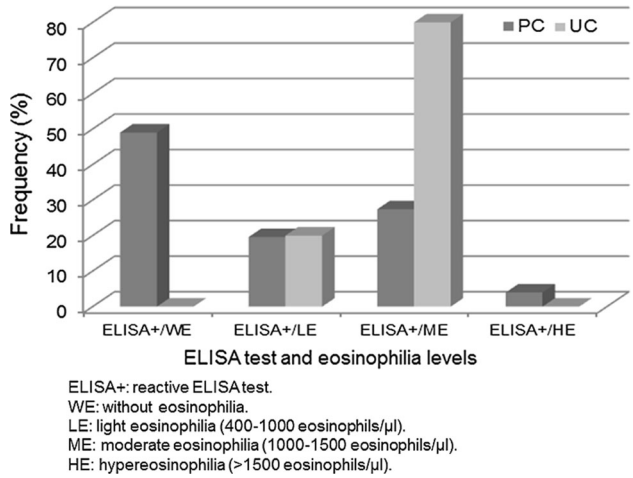
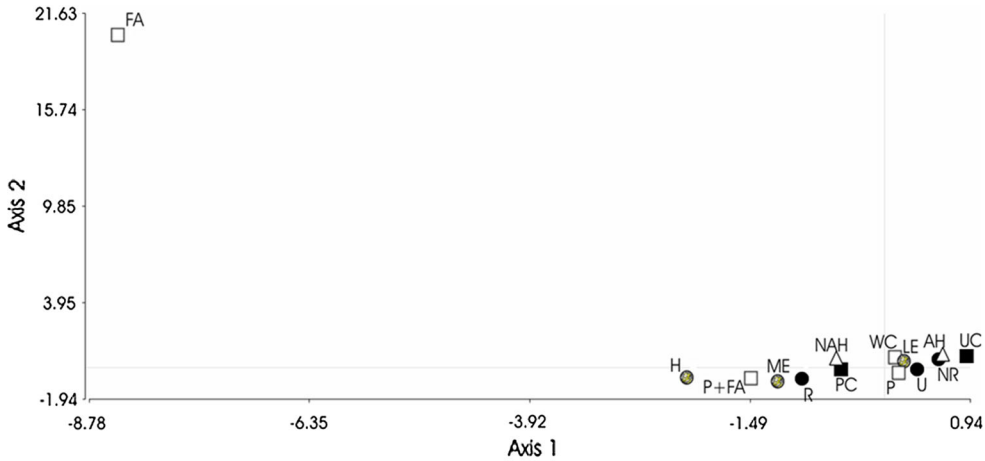


Figure 5. Reactive ELISA test according to eosinophilia levels in children.



Contribution to the Chi Square					
	Autovalue	Inertia	Chi Square	(%)	Accumulative%
1	0.61	0.37	436.09	15.63	15.63
2	0.58	0.33	388.89	13.93	29.56

H (hypereosinophilia); ME (moderate eosinophilia); LE (light eosinophilia)
FA (farm animals); P (pets); WC (without contact)
R (reactive ELISA test); NR (not reactive); U (undetermined)
PC (peripheral community); UC (urban community)
NAH (not adequate hand washing); AH (adequate hand washing)

Figure 6. Multiple Correspondence Analysis of socio-environmental variables and ELISA test in children from peripheral and urban communities.

Blastocystis sp. was the most frequent parasite in both communities. The pathogenicity of this parasite is controversial, although it is one of the most common parasites found in human fecal samples. Several intestinal pathologies have been reported in relation to its presence, and it was associated with low anthropometric rates (Qadri et al. 1989; Doyle et al. 1990; Ertug et al. 2007). Soriano et al. (2005), Milano et al. (2007), Gamboa et al. (2009, 2010) and Zonta et al. (2010) have found *Blastocystis* sp. the most frequent parasite in children not only from communities with deficient socio-environmental conditions, but also from communities with better life's quality. In that way, this parasite would be not related with poverty (Raso et al. 2005).

High loads of *Giardia* sp. were found in both communities mainly in the PC. This protozoan has been reported the most frequent cause of morbidity at world level mainly in developing countries, causing from asymptomatic infections to acute or chronic disease with diarrhea and malabsorption of nutrients (Villalobos et al. 2001; Girard de Kaminsky 2003; Giraldo et al. 2005). Its transmission has been related to feces-polluted water, lack of personal hygiene and poor hygiene in food handling (Borda et al. 1996; Lasta et al. 2005; Soriano et al. 2005; Milano et al. 2007; Zonta et al. 2010; Gamboa et al. 2011). The polyparasitism produced by *Blastocystis* sp. and *Giardia* sp. and the high frequencies of this parasites in the PC would be related to the lack of proper sanitation and the limited access to potable water to drink and to develop hygiene habits.

Entamoeba coli was found only in the PC even associated with *Giardia* sp., meaning fecal pollution of the environment (Bolaños et al. 1997). Most families counted with septic tank and one did the wastewater disposal into the environment. Added to this, several families obtained water from protected wells without proper equipment. These situations would contribute to the persistence and dissemination of these parasites in the PC.

Enterobius vermicularis was the only nematode found in children from the PC. The frequency found was low because the recovery was performed using the Ritchie sedimentation technique. The Graham test would be the most appropriate technique because the oviposition occur in the peri-anal area (Ash and Orihel 2011). The existence of this enteroparasitoses reaffirms that the lack of potable water, proper sanitation and adequate hygiene generated vulnerability in children from the PC to the infestation and dissemination of these parasites.

Protozoan has been more frequently reported than helminths in several studies developed in Buenos Aires Province and in Mar del Plata city. Frequencies between 3.5% and 11.8% of *Ascaris lumbricoides* have been found in peripheral communities from Mar del Plata with disadvantaged socio-environmental conditions (Lasta et al. 2005; Gamboa et al. 2009, 2011, 2014; Lupi et al. 2009; Setti 2014). The low frequency of recovered fecal samples (62% in the PC and 76.5% in the UC) and the use of the sedimentation technique only could have underestimated the presence of helminths such as *A. lumbricoides* in the children, because of its low frequency in the region of study.

Even radiological, ultrasound and ophthalmological screening did not clinically diagnose VLM or OT, the existence of *T. canis* IgG in children serum from both communities could indicate a past infestation, because the antibodies disappear after a long period of time (Roldán et al. 2010). This situation was more serious in the PC where the frequency was significantly higher and reactive children belonged to families with medium and high PVI. The PC seroprevalence was similar to those reported in rural areas from European countries (35–42%) and in tropical countries (50–80%), while the UC seroprevalence coincided with those reported in urban areas from European countries (2–5%) (Magnaval et al. 2001). In Argentina, a seroprevalence of 38% was reported in children from Resistencia, Chaco (Alonso et al. 2000). In Mar del Plata, a previous study done by Setti et al. (2012) in a peripheral neighborhood evidenced a similar seroprevalence (58.7%) in children, which reaffirm that *T. canis* continue being a problem to the public health of the city.

Children from both communities showed light and moderate eosinophilia, but only in the PC was evidenced hypereosinophilia. Moderate and hypereosinophilia could suggest the existence of covert toxocarosis (Glickman and Shofer 1987). For that reason, all these children were referred back to continue with medical follow-up. Radman et al. (2000) reported in La Plata, Argentina, 47% of seroprevalence also in association with light, moderate and hypereosinophilia. More than 40% of reactive children from the PC did not evidenced eosinophilia, which is a characteristic particularly seen in patients with chronic skin allergy symptoms (Gavignet et al. 2008).

The high relation between animal's contact and reactive ELISA test added to the not adequate hand washing evidenced that these habits could increase the vulnerability to get toxocarosis in children from the PC, even more due the high frequency of dogs infested with *T. canis* and the

contact between them and children. This parasite has been reported in several studies developed in urban and peripheral areas from Mar del Plata city, which evidenced that its dissemination and permanence in the environment become a risk to the development of toxocarosis (Andresiuk et al. 2004; Madrid et al. 2005; Riva et al. 2006; Lavallén et al. 2011).

Children from the PC who presented retinal inflammatory lesions and who was reactive to the ELISA test could have gone through an OT (Smith et al. 2009). They also evidenced loss of vision which consists in one of the signs of the disease added to the lack of eosinophilia because the lesion is usually caused by a single larva (Glickman and Schantz 1981; Gillespie et al. 1993; Fillaux and Magnaval 2013).

Several indexes, such as the socio-environmental Vulnerability Index and the Habitability Index, have been developed in the city to analyze socio-environmental characteristics in different populations (Lucero 2004; Aveni 2008; Zulaica and Celemín 2008). The Parasite Vulnerability Index was the first developed in the region of study and evidenced that socio-environmental conditions made the children from the PC more vulnerable to get enteroparasitoses and toxocarosis than those from the UC. In agreement with this, Gamboa et al. (2014) calculated levels of precariousness and vulnerability (Iv rate) and compared them to parasitological results in children and adults from La Plata city, Argentina. The analysis indicated that the most vulnerable were those located in areas with less access to urban infrastructure services and the Iv was strongly associated with the overall prevalence of enteroparasitoses. In this respect, the study of con-causal and/or destabilizing factors should be taken into account when controlling these parasites of importance in public health (Denegri 2008; Yannarella 2014).

The knowledge about the sanitary situation in both communities generated important tools to work with the people about the parasitic zoonoses and the enteroparasitoses. This information was also useful to alert the district authorities about the diseases that affect public health if the socio-environmental conditions are not changed in vulnerable populations.

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Compliance with Ethical Standards

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

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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