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ORIGINAL ARTICLE

PRESENCE OF ENTEROPARASITES IN THE ENVIRONMENT AND THE RESIDENT POPULATION IN A RURAL COMMUNITY IN SANTO ANTONIO DE JESUS IN THE RECONCAVO DA BAHIA, BRAZIL

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ABSTRACT

Studies show environmental contamination as a decisive factor for the perpetuation of the epidemiological triad of infection by parasites, posing a risk to human health. This work identified parasitic contamination in peridomestic soils, enteroparasite infection in humans and domestic animals in the Riacho Dantas and Rio do Onha, rural communities of Santo Antônio de Jesus (Bahia, Brazil). Analyses were performed in 53 homes, with soil samples collected in four points as well as collection of human and domestic animals feces from July to October 2015. Soil samples as well as human and domestic animal feces were analyzed. For the analysis of human fecal samples, four methods were used, including spontaneous sedimentation, Baermann-Moraes, Kato-Katz and Graham. For animal fecal samples three methods were used: spontaneous sedimentation, Willis and Rugai. For soil samples, two methods were used: spontaneous sedimentation and Rugai. Of the 636 samples of soil analyzed, 68.7% were positive for some parasitic form, especially non-ciliated protozoa, ciliate protozoa; adults and larvae of the nematodes and hookworms. Of the 144 samples of human feces, 75% were positive, especially for: *Endolimax nana, Entamoeba coli,* hookworms, *Giardia duodenalis, Entamoeba histolytica/E. dispar* and *Enterobius vermicularis*. Of the 21 animal feces samples, 85.7% were positive, especially for the genera *Ancylostoma, Toxocara, Trichuris* and *Giardia*. The studied soil samples presented biological contaminants (for example, *Toxocara* and *Ancylostoma*) some of which pathogenic for humans and domestic animals. The lack of information regarding the care of domestic soil and direct contact with contaminated soil enabled the detection of parasites with hosts in this environment.

KEY WORDS: Environment; soil; contamination.

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INTRODUCTION

Diseases caused by infection due to parasites that inhabit the gastrointestinal tract are considered serious health problems in the world, mainly because of their wide geographical distribution and scale. In Brazil, these diseases suggest that the country has deficient health system, indicating insuficient human and socioeconomic development (Oliveira Filho et al., 2012).

Three elements are necessary for infection, namely host, parasite and environmental conditions, which make up the classic epidemiological triad of parasitic diseases (Frei et al., 2008; Busato et al., 2014). Differences in education, culture, and eating habits may increase exposure to infection and predisposition to reinfection in endemic areas (De Carli et al., 2006).

It is well known that in Brazil, the occupation of city outskirst or rural areas, where sanitary conditions are deficient, together with lack of information on the part of the population, lead to the transmission of intestinal parasites. In these locations, the proliferation of parasites presenting life cycles dependent mainly on soil and water are highlighted (Dias et al., 2013).

Geohelminths are helminths that pass through soil, as an intermediate stage in their development from the egg stage (or larva) to adult worm. The development cycle of all species of geohelminths is quite similar, since a part of the cycle occurs in the soil (Barbosa et al., 2012).

In addition to the geohelminths that affect only humans, there are some zoonotic potentials, such as *Toxocara* and hookworms (*Ancylostoma caninum* and *Ancylostoma braziliensis*), which can cause larva migrans in humans (visceral and cutaneous, respectively) (Mendonça et al., 2013; Santarém et al., 2004).

Geohelminths are found worldwide, especially in tropical and subtropical countries. Infections caused by these are among the most frequent diseases in the world, with more than one billion cases and deaths each year. Morbidity related to parasites is frequently associated with deficient health and severe malnutrition that increase the aggravations and consequences in affected individuals (Pedraza et al., 2014).

The most common intestinal protozoan parasites are: *Giardia duodenalis* and *Entamoeba histolytica* (Haque, 2007). The diseases caused by these protozoans are known as giardiasis and amoebiasis, respectively. *G. duodenalis* is the most prevalent parasitic cause of diarrhea in the developed world, and this infection is also very common in developing countries. Amoebiasis is the third leading cause of death from parasitic diseases worldwide, with its greatest impact on the people of developing countries (Petri et al., 2000). Non-pathogenic amoebae (*Entamoeba coli, Entamoeba hartmanni, Endolimax nana* and *Iodamoeba butschlii*) usually inhabit the large intestine of the human host and are commonly found in fecal samples. Although

most of the hosts parasitized by these amoebae do not present symptoms, there are still secondary factors that influence the understanding of these parasites. The presence of one or more of these in feces may be an indicator of fecal contamination of a food or water source, as a result of the poor quality of water, which does not exclude the possibility of encountering other pathogenic parasites (Okhuysen & White, 1999).

Public health policies have aimed at the prophylactic treatment of helminths in Brazil, instead of investing in sanitation and expanding the coverage of water treatment for human consumption. Issues caused by waterborne protozoa still remain relevant public health problems, despite the technological advances of water treatment processes in recent years (Fregonesi et al., 2012).

In this context, the present study aimed to investigate the prevalence of enteroparasites in a population living in the rural area of Santo Antônio de Jesus, Bahia, Brazil, and to draw an epidemiological profile of parasite contaminants present in the peridomiciliary environment.

MATERIALS AND METHODS

Area and population

This study covered the communities of Riacho Dantas and Rio do Onha, conveniently chosen because they are part of the rural area of Santo Antônio de Jesus - Bahia and there is previous knowledge of parasitosis in this area. Samples were collected and processed from July to October 2015 (randomly chosen).

In order to collect samples of human and animal feces and the soil from each residence, the residents signed an Informed Consent Form which was presented to each adult participant. In the case of minors, a consent form was signed by a parent/guardian. All individuals who participated in the survey could drop out at any time at will. All the residences of the researched locality, their residents, soil and domestic animals (dogs and/or cats) were evaluated. The present study was approved by the Research Ethics Committee of UFRB.

After the terms were duly signed, a questionnaire was applied, collection flasks for the feces samples were identified and distributed along with instructions for the collection of material from the perianal region destined for research of *Enterobius vermicularis* eggs.

Soil samples were collected once at each address according to Pedrosa et al. (2014). From each house, 12 soil samples were collected at 4 peridomiciliary points (front, back, left and right) and at 3 depths (surface, 10 cm and 20 cm), each sample weighing approximately 100 grams. The samples were stored in plastic bags and identified.

Global Positioning System (GPS) technology was used to characterize the location of the residences surveyed.

Pet (dog and/or cat) owners were advised to collect their most recent feces and avoid those in contact with the soil to avoid cross contamination in these samples. The samples were collected in specific flasks without preservatives, identified and sent to the laboratory. Diarrheal samples from the animals were excluded.

All samples were sent to the Laboratory of Parasitology at the Health Sciences Center of the Federal University of Recôncavo da Bahia for processing and analysis.

Reports with the parasitological results of feces and soil tests were given to residents with guidelines on treatment and control of environmental contamination. The parasitized individuals were instructed to seek the local Basic Health Unit for medical consultation and treatment. A veterinarian doctor participating in the study defined the guidelines on the use of a broad-spectrum vermifuge indicated for the control of helminths in dogs and cats. A health fair was held in the locality of the research, as an extension activity providing clarifications regarding the findings in this study.

Laboratory analysis

For analysis of human fecal samples (a sample for each individual, human or animal), four methods were used, including spontaneous sedimentation (Hoffman et al., 1934), Baermann-Moraes (Moraes, 1948), Kato-Katz (Katz et al., 1972) and Graham (Graham, 1941). For the analysis of fecal samples from animals, three methods were used: spontaneous sedimentation (Hoffman et al., 1934), Willis (Willis, 1921) and modified Rugai (Rugai et al., 1954). For the analysis of the soil samples, two methods were used, modified for this type of research: spontaneous sedimentation and Rugai (Pedrosa et al., 2014). It was not the purpose of this research to compare the results obtained by the different parasitological methods used, but to use them in order to avoid finding false negative results. The use of Kato Katz did not show infection with a high parasite load in the individuals surveyed.

Statistical analysis

After the application of the questionnaires and analysis of all samples, data were tabulated using the IBM Statistical Package for the Social Sciences (SPSS) version 20, a statistical program for further analysis of possible associations.

RESULTS

Of the 154 participants who answered the questionnaire, 144 presented a fecal sample for analysis, as inclusion criterion. This corresponds to 93.5% of adherence to the survey; 53.5% were women, who presented a higher positivity for parasites (75.3%). The over 20 age group presented a higher frequency of positive samples (Table 1).

Table 1. General characterization of individuals and place of residence - Rural area of the municipality of Santo Antônio de Jesus, Bahia, Brazil, 2015.

Variables	Total		Parasitological of feces				p-value*
			Positive	Negative			
	n	%	n	%	n	%	
Sex / gender							923
Male	67	46.5	50	74.6	17	25.4	
Female	77	53.5	58	75.3	19	24.7	
Age group (years)							364
0 ¬ 10 years	32	22.2	24	75	8	25	
10 ¬ 20 years	18	12.5	17	94.4	1	5.6	
Over 20 years	93	64.6	61	65.6	32	34.4	
Did not inform	1	0.7	----	----	----	-----	
Structure of the residence							806
Wall of bricks	137	95.1	103	75.2	34	24.8	
Adobe wall	5	3.5	4	80	1	20	
Do not know	2	1.4	----	----	----	-----	
Number of rooms in the house							359
One to two	1	0.7	1	100	----	----	
Three to four	36	25	27	75	9	25	
Five to six	68	47.2	55	80.9	13	19.1	
Above seven	35	24.3	23	65.7	12	34.3	
Do not know	4	2.8	----	----	----	----	
Number of residents							52
One to two	29	20.1	25	86.2	4	13.8	
Three to four	51	35.5	37	75.5	14	24.5	
Five to six	44	30.6	36	81.8	8	18.2	
Above seven	17	11.8	9	52.9	8	47.1	
Do not know	3	2.1	----	----	----	----	
There are or have been domestic animals in the household							771
Yes	118	81.9	89	83.2	29	16.8	
No	23	16	18	78.3	5	21.7	
Do not know	3	2.1	----	-----	-----	-----	
Where the animal(s) lived							438
Inside the home	44	30.5	36	81.8	8	18.2	
In the courtyard / outside the home	74	51.4	53	71.6	21	28.4	
Do not know	26	18.1	----	----	----	-----	
Presence of the animal during the preparation of food in the kitchen							824
Yes	32	22.2	23	71.9	9	28.1	
No	86	59.7	66	76.7	20	23.3	
Do not know	26	18.1	----	----	----	-----	
The animal was treated with anti-helminths							703
Yes	30	20.8	22	73.3	8	16.7	
No	88	61.1	67	76.1	21	15.9	
Do not know	26	18.1	----	----	----	-----	

Some environmental factors related to higher prevalence of positive samples were: residence structure (brick wall or adobe); the number of rooms in the house; the number of residents in the home and the presence of pets. The frequency of positive samples proved to be higher in families in adobe houses; with five to six rooms per house; one or two siblings and animals in the home, and if these stayed inside or outside the house, in the kitchen during food preparation, and whether the animal was treated with antiparasitic drugs (against helminths) or not. Despite presenting interesting frequencies and a tendentious epidemiological picture of the perpetuation of parasitic infections, none of the associations were statistically significant ($p>0.05$), since the confidence level stipulated was 95% (data in Table 1).

Regarding the sanitary aspects of the homes analyzed, the criterion of adequate disposal of trash was not prevalent for a lower occurrence of positivity in the analyzed fecal samples (Table 2).

There was no difference between parasite infection among individuals who habitually defecate in toilets or bury their feces. However, this variable presents four categories, so there was statistical significance in relation to the prevalence of infection and place of defecation ($p=0,009$; $p\leq0,05$). The unspecified form of defecating site with high prevalence in the positivity for enteroparasites is highlighted when compared to the negative results for this research. 99.3% of the individuals did not have a sewage network connected to their houses, and even for those who had septic tanks at the place of residence, the prevalence for enteroparasites was high (Table 2).

Regarding the origin of drinking water, a lower prevalence of positive results for enteroparasites was observed in the samples of the individuals that used water from the tank in relation to the negative samples for this analyzed category. For those individuals who used some type of sanitation in the water, there was a lower prevalence in the positivity for enteroparasites (Table 2).

The copro parasitological analysis shows a high frequency of hookworms in human feces (Figure 1A) and in feces from dogs and cats (Figure 1B). There was a high frequency of commensal enteroparasites in human feces (Figure 1A). Ascarididae nematodes, *Ascaris lumbricoides* in humans and *Toxocara* spp. in animals, also presented high prevalence in the population studied.

Table 2. General sanitary aspect of the living quarters of individuals in the rural area of the municipality of Santo Antônio de Jesus, Bahia, Brazil, 2015.

Variables	Total		Parasitological of feces				p-value*
			Positive	Negative			
	n	%	n	%	n	%	
Trash disposal							929
Plastic bag, can or bucket with lid	72	50	54	75	18	25	
Box, crate or bucket without cover	22	15.3	16	72.3	6	27.3	
Without packaging	47	32.6	36	76.6	11	23.4	
Other	1	0.7	1	100	----	-----	
Do not know	2	1.4	---	----	----	-----	
Place of defecation*							9
Bathroom / Toilet	78	54.2	59	67.9	19	32.1	
Backyard (Burying)	34	23.6	22	64.7	12	35.3	
Diaper	4	2.8	1	25	3	75	
Other	27	18.8	25	92.6	2	7.4	
Sewage system on site							------
Yes	----	----	---	----	----	-----	
No	143	99.3	107	74.8	36	25.2	
Do not know	1	0.7	---	----	----	-----	
Septic tank on site							897
Yes	103	71.5	77	74.8	28	27.2	
No	38	26.4	28	73.7	10	26.3	
Do not know	3	2.1	----	----	----	-----	
Origin of water for ingestion							227
Tank	9	6.3	4	44.4	5	55.6	
Semi-artesian well	113	78.5	88	77.9	25	22.1	
Dam / River	6	4.2	5	83.3	1	16.7	
Cistern with rainwater	9	6.3	6	66.7	3	33.3	
Piped water	3	2.1	2	66.7	1	33.3	
Other	4	2.8	----	----	----	-----	
Water treatment*							17
Yes	30	20.8	18	60	12	40	
No	110	76.4	89	80.1	21	19.9	
Do not know	4	2.8	----	----	----	-----	
Any river water usage							87
Yes	134	94.4	103	76.9	31	23.1	
No	8	5.6	4	50	4	50	
Do not know	2	1.4	----	----	----	-----	

* $p \leq 0.05$. Source: Authors' data.

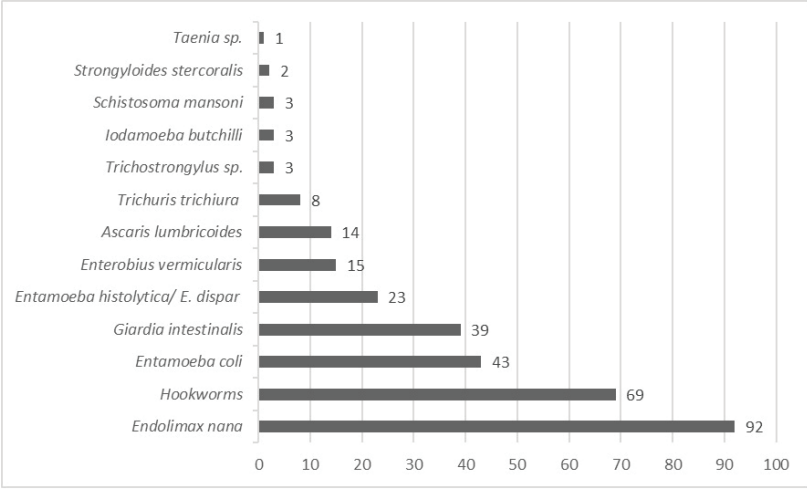

Figure 1A. Main parasites found in humans (n=108) - Rural area of Santo Antônio de Jesus, Bahia, Brazil, 2015.

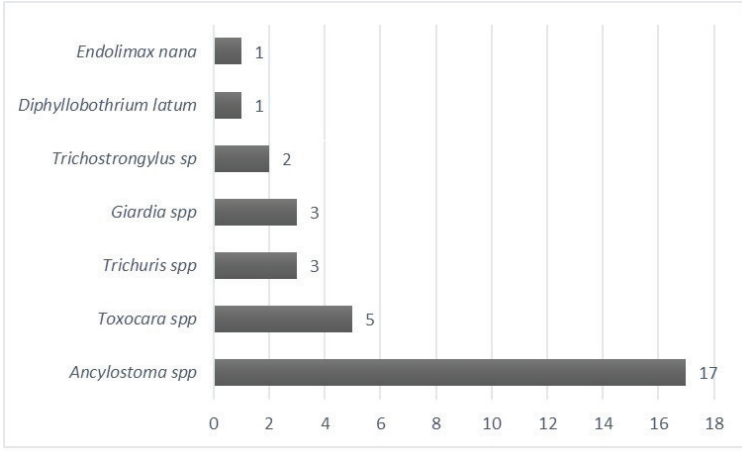

Figure 1B. Main parasites found in animals (dogs and cats) (n=18) - Rural area of Santo Antônio de Jesus, Bahia, Brazil, 2015.

The results of the tests for parasite contamination in the soils of the residences surveyed in the Onha and Riacho Dantas communities are described in Figure 2. The surface area of the soils surveyed presented greater contamination in relation to those 10 and 20 cm deep. Nematode larvae and various protozoa were the parasites most frequently found in the soil where larvae and adult hookworms were noted. Besides the hookworms and the parasites *Ascaris lumbricoides* and *Toxocara* spp. these results suggest that unidentified parasite forms constitute the local soil biota.

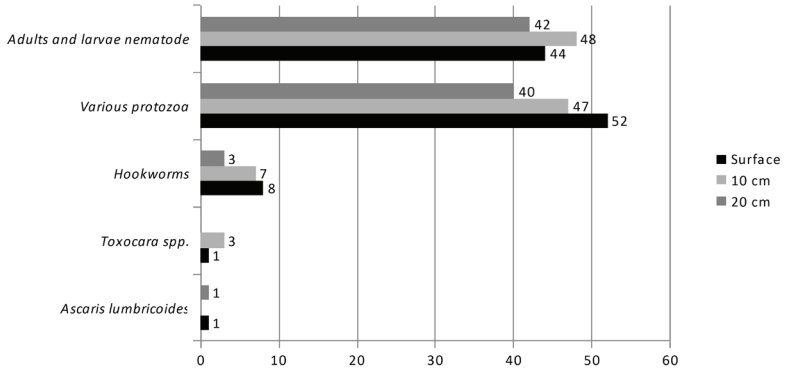

Figure 2. Main parasites found in peridomiciliary soils (n=52) - Rural area of Santo Antônio de Jesus–Bahia-Brazil, 2015.

Figures 3 and 4 present the results obtained from the analyzed materials in the rural community surveyed: soil samples, human feces and feces from domiciled animals. These represent the researched residences and data on environmental contamination and parasitic infection in humans and animals, showing areas with interesting occurrences of soil contaminated with hookworms, as well as human and animal infection by this parasite, evidencing that the Riacho Dantas region presents higher occurrences of this parasite. Only one residence did not present parasitic forms in any category analyzed, house C39.

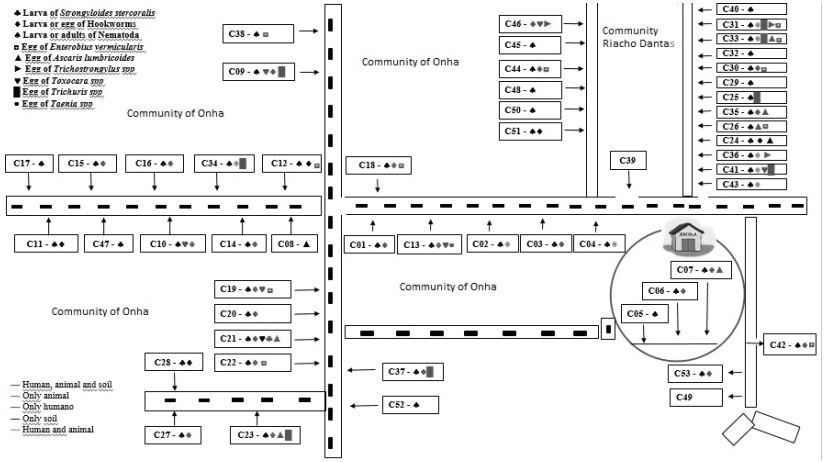

Figure 3. Contamination in the researched residences: data from the overlapping of geohelminths in humans, soils and animals.

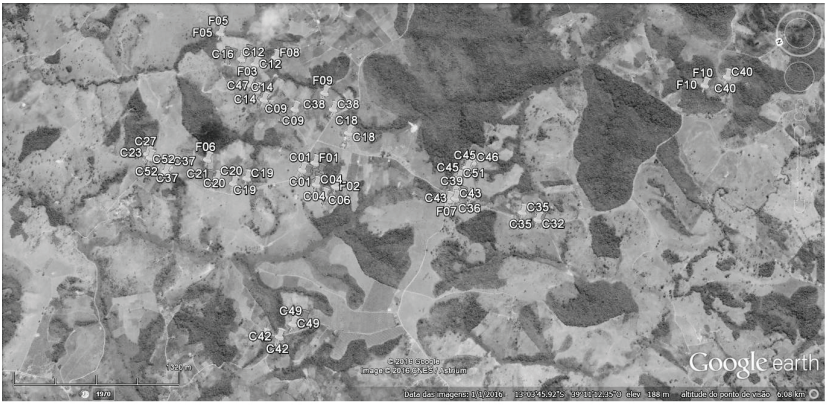

Figure 4. Global Positioning System mapping of the residences surveyed.

DISCUSSION

Considering that enteroparasitoses are considered one of the public health problems in Brazil, it is fundamental that research on the prevalence of enteroparasites cover other perspectives besides human copro parasitology. Essentially because they are diseases whose etiological agents affect humans and animals, and their dissemination is even greater due to socioeconomic conditions, mainly as a result of the low level of education and lack of information regarding sanitation (Oliveira & Amor, 2012).

To better discuss the epidemiological factors related to the distribution of parasitic diseases, it is interesting to perform copro parasitological research in humans and to investigate the environmental and health aspects of the place where the individuals live.

Other rural communities in the municipality of Santo Antônio de Jesus suffer from deficiencies related to the basic sanitation system and treated water supply (Carvalho et al., 2016). The great majority, as well as those individuals studied live in favorable conditions for the proliferation of parasites, where only a small part of the population has access to tap water or some form of water treatment for consumption.

In this study, the human feces samples analyzed presented a high prevalence of parasites, corroborating the studies in Brazilian communities with conditions similar to those in this study (Andrade et al., 2011; Carvalho et al., 2016). The cause being precarious sanitary conditions and hygiene habits in the analyzed localities.

Helminths of the hookworm group stood out among the geohelminths, being prevalent in the analyzed materials, surpassing some studies with lower prevalence in other Brazilian cities (Andrade et al., 2011; Mati et al., 2011). This result is probably due to the sum of several factors that contribute to the dissemination of this group of parasites, such as the presence of animals, inadequate places to defecate and precarious sanitary sewage. All these factors contribute to the penetration of hookworm larvae, very likely due to excellent soil conditions for the proliferation of these, increasing the probability of human contact with the parasite, reflecting the profile of the community surveyed (Amor & Oliveira, 2017).

In contrast to the high prevalence of hookworms, the other helminths were less evident (*Enterobius, Ascaris* and *Trichuris*) in humans. The helminth transmission mode which is related more closely to soil contamination, may explain this result (Belo et al., 2012), since for these, the most common infection mechanism is the ingestion of egg contaminated food (Brasil, 2010).

The indiscriminate use of anthelmintic medication may have contributed to such results. This is due to the control strategy usually adopted by the public authorities in different municipalities (Frei et al., 2008) with the distribution of the drug albendazole, and by the routine purchase of this drug in pharmacies (Belo et al., 2012). These facts mask the real sanitary and socioeconomic conditions of the population, since the prevalence of helminthoses by Ascarididae nematodes is reduced without improving living conditions. However, the prevalence of hookworms still persists due to the continuation of the parasitic cycle in a favorable environment, where subjects are susceptible to reinfection.

Endolimax nana presented the highest overall prevalence in humans among the commensal protozoans and *Giardia duodenalis* and *Entamoeba histolytica* among the pathogens. The prevalence of these protozoa is believed

to be intrinsically associated with non-treatment of drinking water, since these are water transported parasites (Mati et al., 2011).

The copro parasitological analysis of the domestic animals showed that they were all parasitized. Pereira et al. (2016) presented significant results for hookworm found in domestic animals, however, our results were higher, demonstrating that there is a serious risk of infection for the animals in the rural area surveyed and may result in zoonosis. The larger occurrence of canine hookworms shows that individuals living with animals are exposed and there is the possibility of cutaneous larva migrans infection, since the majority of this population claimed that they had never treated their animals for parasites.

It was further noted that *Toxocara* can also present a risk for humans with regard to visceral larva migrans (Mendonça et al., 2013). Since this parasite was detected in animal feces (27.8%), in the future it is important to investigate seropositivity for these parasites in humans.

The presence of the protozoan *Giardia* has proved to be an important agent in domiciled animals, leading to the belief that transmission between different species is possible (Esch & Petersen, 2013).

Therefore, the results of animal coprological analysis demonstrated the potential for transmission of zoonotic parasites from the animals to their owners, which also puts at risk the population that frequents the same area as these animals. Eggs are often carried by wind and insects, which can contaminate food. This result shows the importance of frequent copro parasitological examinations in domestic animals, to guarantee the appropriate treatment for the animal avoiding the dissemination of these parasites (Baneth et al., 2016).

Surprisingly, a dog was diagnosed with *Diphyllobothrium*. As a river is part of the local environment, it is interesting to continue the parasitic investigation in the area to avoid this parasitic cycle, since animals and humans become infected by ingesting insufficiently cooked infected fish (Kuchta et al., 2013).

In the soil sample analysis, an important positivity was noted, which is that 98.1% of the houses had at least one species of parasite, with a higher prevalence for hookworms. In this rural environment, in most of the houses that presented positive soil for hookworms, at least one animal and/or resident human were infected by this parasite, demonstrating that there is a parasitic cycle conducive to cases of infection and reinfection.

Soil contamination of other public areas, such as parks, squares and beaches, recorded in other studies, is an important means of parasitic zoonoses transmission (Ribeiro et al., 2013; Silva et al., 2017). The analysis of the parasitic contamination of the peridomiciliar soils is still a new topic for research, important for controlling infection cycles and parasitic reinfection

The data in this study indicate that soil has great potential for harboring biological contaminants, some being pathogenic for humans and for domestic animals, constituting an important transmission route for parasitic zoonoses.

The data show the presence of the parasitic cycle of human and animal hookworms in the rural area studied, revealing the importance of adopting prophylactic measures to ensure the health of each individual, based on soil care. The proximity of the houses and their contaminated environment help to spread parasitic evolutionary forms and reinforce the epidemiological triad of the infection.

This study suggests that the lack of basic sanitation, the difficulty in adopting prophylactic measures and the nonexistence or inefficiency of education and health activities regarding this topic contribute to the persistence of this contamination in the peridomicile.

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