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One Health strategies for the prevention and control of infections by parasites with zoonotic potential in canines and felines from *Quilombola* communities in the northeast region of Brazil

Estratégias de Saúde Única para prevenção e controle de infecções por parasitos com potencial zoonótico em caninos e felinos de comunidades *Quilombolas* da região Nordeste do Brasil

Estrategias de Una Salud para prevención y control de infecciones por parásitos con potencial zoonótico en caninos y felinos de comunidades *Quilombolas* de la region nordeste de Brasil

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Abstract

The objective of this study was to propose One Health strategies for the prevention and control of gastrointestinal parasites (GIP) of canines and felines in six *Quilombola* communities in the northeast region of Brazil. For this purpose, a field study of a quantitative and qualitative nature was carried out. In canines and felines of both sexes, ages and breeds, fecal samples were collected, and clinical evaluation was carried out. Of the 95 animals, in 54.74% parasites with zoonotic potential were detected: *Ancylostoma* spp. (96.15%), *Strongyloides stercoralis* (5.77%), *Toxocara canis* (3.85%) and *Trichuris vulpis* (1.92%). Most parasitized animals (61.54%) did not show clinical signs, with a statistical difference in relation to those parasitized with symptoms (p=0.03098). As an unexpected result, 13 individuals with hoarding disorder were identified: 84.61% hoarded animals and 15.38% hoarded animals and objects. Overall, 49.47% were canines from these individuals, in which *Ancylostoma* spp. (92%) and *S. stercoralis* (8.0%) were found. The risk of infection was higher for semi-domiciled animals/free access to the street (OR 9.3). This is the first study on GIP in canines and felines from *Quilombola* communities from Northeastern Brazil, where socioeconomic, health and environmental vulnerability contributes to the risk of parasitism in animals and humans. In the context of One Health approach, a proposal was formulated for the prevention and control of these parasites in canines and felines from these

communities, with multi-professional, transdisciplinary and intersectoral actions, respecting the knowledge and culture of *Quilombola*.
Keywords: Hoarding disorder; Nematodes; Traditional communities; Zoonoses.

Resumo

O objetivo deste estudo foi propor estratégias de Saúde Única para prevenção e controle de parasitos gastrointestinais (PGI) de caninos e felinos em seis comunidades quilombolas da região Nordeste do Brasil. Para isso, foi realizado um estudo de campo de natureza quantitativa e qualitativa. Em caninos e felinos de ambos os sexos, idades e raças, foram coletadas amostras fecais e realizada avaliação clínica. Dos 95 animais, em 54,74% foram detectados parasitos com potencial zoonótico: *Ancylostoma* spp. (96,15%), *Strongyloides stercoralis* (5,77%), *Toxocara canis* (3,85%) e *Trichuris vulpis* (1,92%). A maioria dos animais parasitados (61,54%) não apresentou sinais clínicos, com diferença estatística em relação aos parasitados com sintomas (p=0,03098). Como resultado inesperado, foram identificados 13 indivíduos com transtorno de acumulação: 84,61% acumulavam animais e 15,38% acumulavam animais e objetos. No total, 49,47% eram caninos desses indivíduos, nos quais foram encontrados *Ancylostoma* spp. (92%) e *S. stercoralis* (8,0%). O risco de infecção foi maior para animais semidomiciliados/livre acesso à rua (OR 9,3). Este é o primeiro estudo sobre PGI em caninos e felinos de comunidades quilombolas do Nordeste do Brasil, onde a vulnerabilidade socioeconômica, sanitária e ambiental contribui para o risco de parasitismo em animais e humanos. No contexto da abordagem One Health, foi formulada uma proposta para a prevenção e controle dessas parasitoses em caninos e felinos dessas comunidades, com ações multiprofissionais, transdisciplinares e intersetoriais, respeitando o conhecimento e a cultura quilombola.
Palavras-chave: Comunidades tradicionais; Nematoides; Transtorno de acumulação; Zoonoses.

Resumen

El objetivo de este estudio fue proponer estrategias de Una Salud para la prevención y control de parásitos gastrointestinales (PGI) de caninos y felinos en seis comunidades quilombolas de la región Nordeste de Brasil. Para tal fin se realizó un estudio de campo cuantitativo y cualitativo. En caninos y felinos de ambos los sexos, edades y razas, se recolectaron muestras fecales y se realizó evaluación clínica. De los 95 animales, en 54,74% se detectaron parásitos con potencial zoonótico: *Ancylostoma* spp. (96,15%), *Strongyloides stercoralis* (5,77%), *Toxocara canis* (3,85%) y *Trichuris vulpis* (1,92%). La mayoría de los animales parasitados (61,54%) no presentaron signos clínicos, con diferencia estadística con relación a los parasitados con síntomas (p=0,03098). Como resultado inesperado se identificaron 13 individuos con trastorno de acaparamiento: 84,61% animales acaparados y 15,38% animales y objetos acaparados. En total, 49,47% eran caninos de estos individuos, en los que se encontró *Ancylostoma* spp. (92%) y *S. stercoralis* (8,0%). El riesgo de infección fue mayor para los animales semidomiciliados/libre acceso a la calle (OR 9,3). Este es el primer estudio sobre PGI en caninos y felinos de comunidades quilombolas del Nordeste de Brasil, donde la vulnerabilidad socioeconómica, sanitaria y ambiental contribuye al riesgo de parasitismo en animales y humanos. En el contexto del enfoque Una Salud, se formuló una propuesta para la prevención y control de estos parásitos en caninos y felinos de estas comunidades, con acciones multiprofesionales, transdisciplinarias e intersectoriales, respetando el conocimiento y la cultura quilombolas.
Palabras clave: Comunidades tradicionales; Nematodos; Trastorno de acaparamiento; Zoonosis.

1. Introduction

One Health is a strategy for promoting well-being and health that recognizes that human, animal, environmental and plant health are interconnected and interdependent, and must be addressed with multi-professional, transdisciplinary, transcultural and intersectoral actions and public policies (OHHLEP et al., 2022). According to Overgaauw et al. (2020), there are few publications about One Health focused on canines and felines, although these animals are present in most homes around the world. These pets are hosts to a wide variety of parasites that affect animal and human health, such as *Ancylostoma* spp., *Toxocara* spp., *Strongyloides stercoralis*, *Trichuris vulpis*, *Giardia* spp., *Cryptosporidium* spp. and *Toxoplasma gondii* (Calderón et al., 2008; Castro et al., 2009; Oliveira, 2015; Ribeiro et al., 2015; Berenguer et al., 2021).

Socioeconomic and environmental factors, in addition to the lack of sanitary management of pets, favor the sharing of parasites (Overgaauw et al., 2020; Bergamo et al., 2022; Santarém et al., 2023b), especially in traditional *Quilombola* communities, where basic health problems associated with precarious living, housing and basic sanitation conditions contribute to the occurrence of diseases in animals and humans (Coutinho et al., 2020; Cherol et al., 2021; Santarém et al., 2023b). In this scenario, psychosocial factors can contribute to the development of hoarding disorder, which affects approximately 2% to 6%

of the world population (American Psychiatric Association [APA], 2014) and is characterized by the need to collect and accumulate, intentionally and obsessively objects and/or animals. Hoarders live with dozens or hundreds of objects and/or animals, without basic health and well-being care, which favors the transmission of enzootic and zoonotic pathogens (Patroneck, 1999; Patroneck et al., 2006; Polak et al., 2014, 2014; Felix, 2023).

The remaining *Quilombola* communities are a representation of the resistance of black Brazilians and correspond to 1.32 million people or 0.65% of the total population of Brazil (Instituto Brasileiro de Geografia e Estatística [IBGE], 2022). In these communities, canines and felines perform functions of protection, companionship and cooperation (Costa, 2023). Although the socioeconomic, health and environmental vulnerability of *Quilombola* communities and their pets increases the transmission of enzootic and zoonotic parasites, which may also favor the development of hoarding disorder, studies about parasite infections in canines and felines in these populations are still lacking in Brazil (Cunha et al., 2020; Macedo et al., 2022; Felix, 2023; Santarém et al., 2023b). This gap must be filled to provide subsidies for the formulation of actions and public policies to promote animal, human and environmental well-being and health, from the One Health perspective (Overgaauw et al., 2020; OHHLEP et al., 2022), meeting the precepts of axis 2 of the Brasil Quilombola Program, with regard to infrastructure and quality of life (Brasil, 2007).

Therefore, the objective of this study is to propose One Health strategies for the prevention and control of canine and feline parasite infections in *Quilombola* communities and people with hoarding disorder.

2. Methodology

This study was approved by the Animal Use Ethics Committee of the Federal Rural University of Pernambuco (CEUA/UFRPE #4226250822) and by the Ethics Committee on Research with Human Beings (CEP/UFRPE #5.693.493).

For this study, field research of a quantitative and qualitative nature was carried out. In quantitative studies, the results are expressed in numerical terms and are treated in statistics, where the quantification of a given disease allows the evaluation of its occurrence, magnitude, among other factors (Toassi & Petry, 2021). Qualitative research is characterized by having responses that cannot be translated into numbers and assesses people's subjective understanding of their daily lives (Bosi, 2012; Toassi & Petry, 2021).

2.1 Study area

The municipality of Garanhuns (08°53′25" S, 36°29′34" W) is located in the Agreste of Pernambuco, 896 m above sea level, with a population of approximately 142,506 inhabitants (IBGE, 2022). The municipality has a high-altitude forest and humid mesothermal climate, with an average annual temperature of 20ºC and an average annual precipitation of 908.6mm (Chaves et al., 2017).

It is estimated that there are around 822 members of *Quilombola* communities in the municipality, distributed across six communities (Almeida et al., 2021). The selection of communities was carried out with the assistance of the municipality's Environmental Surveillance professionals, being located in Territories 3 (Miracica 1, Miracica 3 and Iratama) and 4 (Castainho, Estivas and Tigre).

2.2 Actions of Continuing Health Education and characterization of *Quilombola* communities

Continuing Health Education actions were carried out with Community Health Agents (Agentes Comunitários de Saúde - ACS) and Endemic Disease Combat Agents (Agentes de Combate a Endemias - ACE), which work in Basic Care and Health Surveillance, in urban and rural areas of the municipality of Garanhuns.

In these actions, aspects related to infections by gastrointestinal parasites (GIP) of canines and felines, the risk of infection in humans by GIP with zoonotic potential, as well as the main prevention and control measures from the perspective of One Health approach were addressed. The characteristics for identifying people with hoarding disorder in the territory where health professionals work were also addressed, based on the "Guide for animals in a hoarding situation: a One Health strategy for caring for cases" (Brasil, 2023).

After carrying out these actions, we did home visits with the support of agents from the respective study territories.

2.3 Clinical evaluation of animals, collection and processing of fecal samples and analysis of risk factors

During home visits, after completing the Free and Informed Consent Form (Termo de Consentimento Livre e Esclarecido - TLC) by the owners, clinical evaluation and collection of fecal samples were carried out, in addition to collecting data to evaluate the risk factors associated with GIP infection, using a questionnaire adapted from Rossa et al. (2019).

Animals of both sexes, with varying ages and breeds, were evaluated for the presentation of clinical signs, through evaluation of body score and general clinical evaluation, in addition to information obtained in the anamnesis.

Fecal samples were collected, preferably, directly from the animals' rectal ampulla. When this procedure was not possible, fresh fecal samples were collected (discarding both the upper and lower parts of the samples). The samples were transported in an isothermal box with ice to the laboratory, where they were processed and analyzed by the modified Sheather flotation method (with hypersaturated sucrose solution 1.3d) (Berenguer et al., 2021) and the zinc sulfate flotation (1.18d) (Zajac & Conboy, 2012).

2.4 Data analysis

A survey of the number of animals was carried out to calculate the sample size, but during the home visits, it was only possible to collect samples from 40.77% of the animals. This occurred due to the dynamics of raising dogs and cats, which although several visits were made, the animals were not present in the homes for feces collection.

The prevalence of GIP infection was calculated according to Bush et al. (1997): number of parasitized animals/number of animals evaluated x 100. The data were analyzed using descriptive statistics.

The Statistical Test for Proportion, Chi Square Test (χ^2) and Fisher at 5% significance level was used to evaluate statistical differences between the analyzed variables. To evaluate risk factors, odd ratios (OR) were calculated at the 95% significance level. The OR calculation requires the arrangement of data in a 2x2 table and the data must be formatted categorically (Rodrigues, 2015).

3. Results

Overall, 289 professionals participated in Continuing Health Education actions: 223 CHA and 66 EDCA, which work in urban and rural areas of the municipality of Garanhuns.

In total, 95 animals were evaluated in the six communities (Table 1).

Table 1 - Canines and felines from *Quilombola* communities in the northeast region of Brazil.

Study areas				Species				Sex			
Territory 3	**n**	**Territory 4**	**n**	**Canine**		**Feline**		**Males**		**Females**	
Miracica 1	5	Castainho	24	n	%	n	%	n	%	n	%
Miracica 3	15	Estivas	10	94	98.95	1	1.05	56	58.95	39	41.05
Iratama	18	Tigre	23								
Total	38		57								

Age range									
Until 6 months		**6-12 months**		**1-5 years**		**6-10 years**		**Over 10 years**	
n	%	n	%	n	%	n	%	n	%
1	1.05	16	16.84	54	56.84	21	22.11	3	3.16

(n) number of animals; (%) prevalence. Source: Authors.

Of the 95 animals studied, GIP were detected in 54.74% (52/95): 59.61% (31/52) from Territory 4 and 40.38% (21/52) from Territory 3. All parasitized animals were canines. The lower prevalence of GIP in Territory 3 animals may have been influenced by the smaller number of animals. However, there was not statistically significant difference between the two territories (p=0.9329).

The majority of parasitized animals (48/52; 92.31%) were infected by a single species of nematode: *Ancylostoma* spp. (50/52; 96.15%), *Strongyloides stercoralis* (3/52; 5.77%), *Toxocara canis* (2/52; 3.85%) and *Trichuris vulpis* (1/52; 1.92%). The coinfections identified were *Ancylostoma* spp. + *T. canis* (2/52; 3.85%), *Ancylostoma* spp. + *S. stercoralis* (1/52; 1.92%) and *Ancylostoma* spp. + *T. vulpis* (1/52; 1.92%). The age group of 1-5 years presented the highest prevalence of infection, especially by *Ancylostoma* spp. (33/52; 63.46%). The majority of GIP was detected in the two coproparasitological techniques used.

Forty-four owners indicated they had 160 canines and 73 felines. This total, 40.77% (95/233) animals were part of this study. Of the 44 tutors, eight chose not to respond to the questionnaire. The information obtained from the 36 tutors is presented in Table 2.

Table 2 - Data from environmental analysis, sanitary analysis and predictive risk factors for infection by gastrointestinal parasites in canines and felines from six *Quilombola* communities in the Northeast region of Brazil.

Categories	Yes % (n)	No % (n)	OR (95%CI)	Chi square test (p-value)	Fisher test (p-value)
Way of raising animals					
Domiciled	38.89 (14/36)	61.11 (22/36)	-	0.009084	0.008596
Semi-domiciled	72.22 (26/36)	27.78 (10/36)	9.3461 (3.542154 - 26.73135)	0.009084	0.008596
Free access to the street	69.44 (25/36)	30.55 (11/36)	9.3461 (3.542154 - 26.73135)	1.542e-06	6.502e-07
Supervised access to the street with a guide	2.78 (1/36)	97.22 (35/36)	-	-	-
Access to vacant land	11.11 (4/36)	88.89 (32/36)	-	1.542e-06	6.502e-07
Access to the residence's vegetable garden	-	100 (36/36)	-		
Access to forest areas	77.78 (28/36)	22.22 (8/36)	6.243197 (2.565287 - 16.75501)	0.0001541	0.0001186

Contact with other animals	30.55 (11/36)	69.44 (25/36)	6.243197 (2.565287 - 16.75501)	0.0001541	0.0001186
Type of residence construction					
Masonry	100 (36/36)	-	-	-	-
Wood	-	-	-	-	-
Mixed	-	-	-	-	-
Fenced	30.55 (11/36)	69.44 (25/36)	-	-	-
Vertical/horizontal condominium	-	-	-	-	-
Irregular occupation area	-	-	-	-	-
Yard Conditions					
Paved	2.78 (1/36)	97.22 (35/36)	-	-	-
Earth/sand	100 (36/36)	-	-	-	-
Mixed	2.78 (1/36)	97.22 (35/36)	-	4.3e-07	7.138e-08
Presence of organic matter	61.11 (22/36)	38.89 (14/36)	6.482446 (2.70318 - 16.48569)	0.2972	0.2415
Clean vegetation	63.89 (23/36)	36.11 (13/36)	6.482446 (2.70318 - 16.48569)	0.0003362	0.0002674
Accumulation of associated objects	19.44 (7/36)	80.56 (29/36)	2.795177 (1.286762 - 6.270172)	0.0003362	0.0002674
Surroundings of the residence					
Paved public road	-	100 (36/36)	-	0.03301	0.02493
Floodable area	16.67 (6/36)	83.33 (30/36)	-	0.03301	0.02493
Wasteland	11.11 (4/36)	88.89 (32/36)	4.872312 (2.036708 - 12.8442)	1.293e-08	1.293e-08
Open sewer	77.78 (28/36)	22.22 (8/36)	4.872312 (2.036708 - 12.8442)	0.2972	0.2415
Rivers, streams, water collections	16.67 (6/36)	83.33 (30/36)	-	4.14e-12	2.371e-14
Accumulation of sand/sand boxes with free access	52.78 (19/36)	47.22 (17/36)	-	0.0001242	7.391e-05
Forest areas	100 (36/36)	-	-	4.14e-12	2.371e-14
Presence of community/semi-domiciled dogs on the streets	8.33 (3/36)	91.67 (33/36)	-	0.0001242	7.391e-05
Food growing areas	-	100 (36/36)	-	-	-
Presence of industries	-	100 (36/36)	-	-	-
Health management				-	-
Species-specific vaccination	27.78 (10/36)	72.22 (26/36)	-	0.01731	0.01666
Rabies vaccination	69.44 (25/36)	30.55 (11/36)	-	-	-
Regular control of endoparasites	58.33 (21/36)	41.67 (15/36)	3.209804 (1.472401 - 7.248835)	0.01731	0.01666
Ectoparasite control	38.89 (14/36)	61.11 (22/36)	-	0.0005	0.0002
Veterinary assistance	2.78 (1/36)	97.22 (35/36)	-	-	-
Public service	-	100 (36/36)	-	1,00	1,00
Private service	2.78 (1/36)	97.22 (35/36)	-	1,00	1,00
Self-prescription of medicines for animals	97.22 (35/36)	2.78 (1/36)	-	-	-
Separation of sick animals and animals undergoing treatment from others	8.33 (3/36)	91.67 (33/36)	-	-	-
Water supply					
Rivers/lakes/pond	58.33 (21/36)		2.795177 (1.286762 - 6.270172)	-	-
Water tap	36.11 (13/36)		-	-	-
Filtered water	5.56 (2/36)		-	-	-
Share a source of drinking water with the animals in the house	97.22 (35/36)	2.78 (1/36)	-	-	-
How consider animals under guardianship					
Security dog	94.44 (34/36)	5.56 (2/36)	-	-	-
Family member	94.44 (34/36)	5.56 (2/36)	-	-	-

Source: Authors.

In the analysis of risk factors were identified as predictors for GIP infection: semi-domiciled animals or animals that have free access to the street (OR 9.3); presence of organic matter or vegetation in the yard (OR 6.4); access to forest/forest areas or contact with other animals (OR 6.2); access to vacant land or open sewers (OR 4.8); lack of regular control of endoparasites (OR 3.2), and accumulation of objects or ingestion of river/lake/pond water (OR 2.8) (Table 2). The other variables analyzed did not present statistically significant OR values.

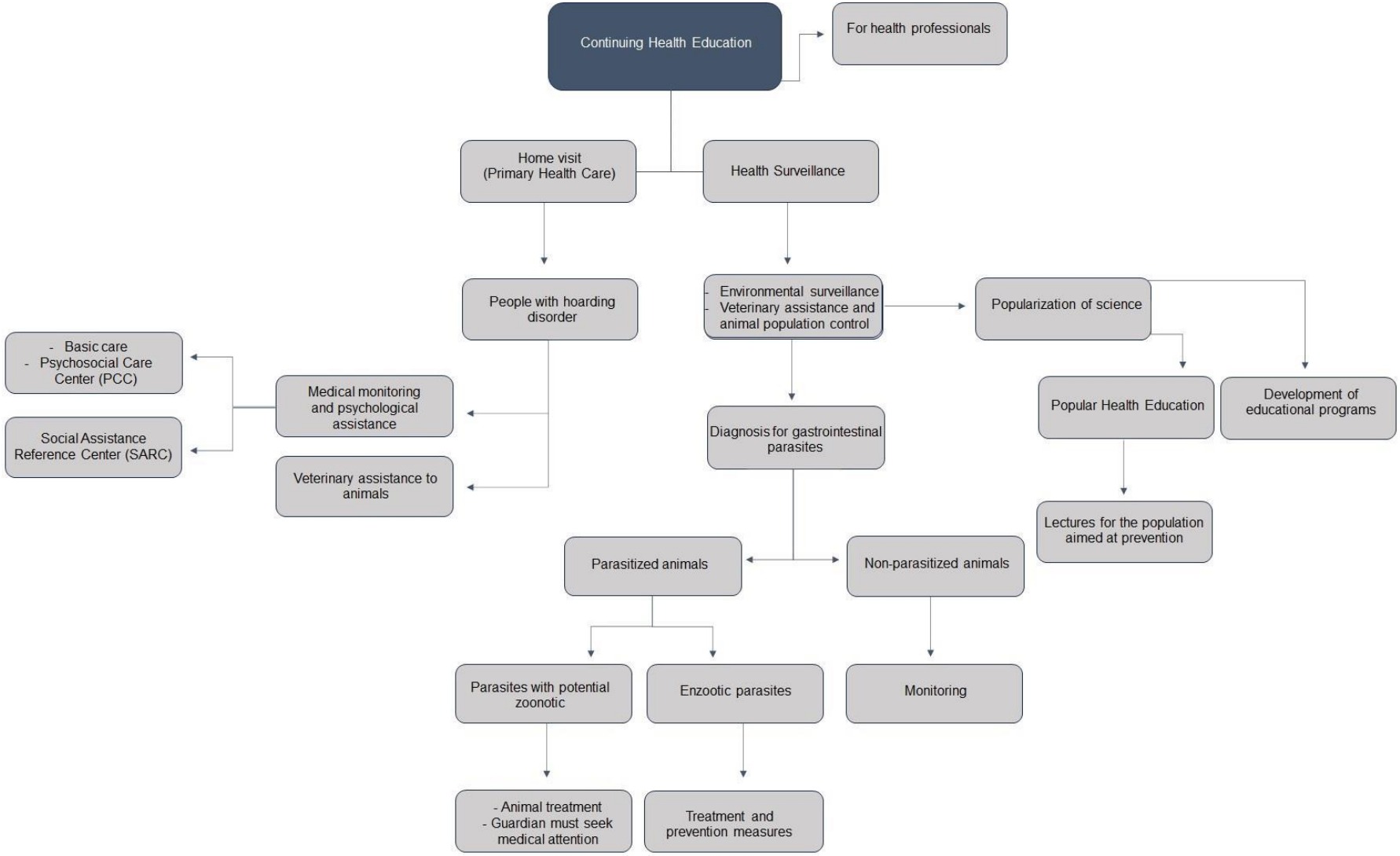
The Chi Square e Fisher tests showed that only when we compare "presence of organic matter and open sewer", as well as "public service and private service" there is no statistically significant association between these variables. This means that there is not enough statistical evidence from the statistical tests performed to reject the null hypothesis of independence between "presence of organic matter" and "open sewage". Similarly, we verified independence between the variables "public service" and "private service". For the other comparisons, the tests revealed a statistically significant association between the variables at the 5% significance level.

The majority of parasitized animals (32/52; 61.54%) did not show associated clinical signs, with a statistically significant difference in relation to the presentation of clinical signs in parasitized animals (p=0.03098). In parasitized animals, the clinical signs were: weight loss (17/52; 32.70%), decreased appetite (11/52; 21.15%), diarrhea (10/52; 19.23%), cachexia (9/52; 17.31%), hypocolored mucous membranes (5/52; 9.61%), apathy (3/52; 5.77%), vomit (3/52; 5.77%), weakness (2/52; 3.85%) and presence of parasites in feces (1/52; 1.92%).

Of the 44 owners who participated in the study, 13 (29.54%) were identified with hoarding disorder, with 11 (84.61%) animal hoarders and two (15.38%) animal and object hoarders. Of the 95 animals evaluated in the six communities 47 (49.47%) were from hoarders, of which 53.19% (25/47) were parasitized by *Ancylostoma* spp. (23/25; 92%) and *S. stercoralis* (2/25; 8%), and 68% (17/25) presented associated clinical signs, with a statistically significant difference in relation to those infected who did not present clinical signs (p=0.02365). The clinical signs were: weight loss (16/25; 64%), apathy (10/25; 40%), diarrhea (8/25; 32%), decreased appetite (6/25; 24%), cachexia (1/25; 4%), vomit (1/25; 4%) and hypocolored mucous membranes (1/25; 4%).

Given the results obtained, a flowchart is suggested for the implementation of One Health strategies and, consequently, the establishment of measures to prevent and control parasite infections in canines and felines in *Quilombola* communities, to promote the well-being and health of animals, humans and the shared environment (Figure 1).

Figure 1 - Flowchart of One Health strategies for the prevention and control of parasite infections in canines and felines in *Quilombola* communities and people in hoarding disorders.



Source: Authors.

4. Discussion

The success of One Health strategies depends on multi-professional and intersectoral action, such as those in the health, environment, education sectors, among others, integrated with the needs of the target population (Overgaauw et al., 2020; OHHLEP et al., 2022). The involvement of the municipality's Health Department and the participation of the Community Health Agents (CHA) and Endemic Disease Combat Agents (EDCA) were fundamental premises for carrying out this study, as these agents act as mediators between the community, surveillance and primary health care. These professionals know the needs and cultivate a bond with the population assisted.

The prevalence of GIP recorded in the present study may be associated with the precarious socioeconomic, educational, sanitary and environmental conditions that, historically, affect *Quilombola* communities, and which are also reflected in pets. These conditions are associated with the high prevalence of parasitic infections in both humans and pets (Rosine et al., 2018; Coutinho et al., 2020; Cherol et al., 2021; Silva et al., 2021; Santarém et al., 2023b).

All parasites diagnosed in the present study have zoonotic potential. *Ancylostoma* spp. is the etiological agent of Cutaneous Larva Migrans (CLM) (Lopes et al., 2021; Stufano et al., 2022), while toxocariasis or Visceral Larva Migrans (VLM) results from the migration of larvae of *Toxocara* spp. in various human tissues (Santarém et al., 2023a, 2023b). These zoonoses are neglected worldwide (Sharma et al., 2015; Rostami et al., 2019; Stufano et al., 2022), despite their high prevalence, especially in communities with low socioeconomic, educational and health levels (Sharma et al., 2015; Stufano et al., 2022; Santarém et al., 2023a, 2023b). Santarém et al. (2023b) attributed the high seroprevalence of anti-*Toxocara* spp. antibodies (82.7%) in *Quilombola* communities in the southeast region of Brazil to the presence of parasitized canines (5.2%) and soil contamination with eggs of *Toxocara* spp. (30%). This is the highest seroprevalence of anti-*Toxocara* spp. antibodies in humans already registered in the country (Santarém et al., 2023b).

Strongyloidiasis is also a common parasitic disease in developing countries (Bergamo et al., 2022), where young, elderly and immunocompromised animals and people are the most susceptible to manifesting the chronic disease (Neumann et al., 2012). Although some cases of *T. vulpis* infection in humans have already been recorded, mainly in children (Márquez-Navarro et al., 2012; Boeva-Bangyozova et al., 2018), information on genetic sequencing to confirm infection by this nematode is limited (Elsemore & Ketzis, 2021).

The increase in the population of canines and felines and the consequent environmental contamination by feces from parasitized animals have been blamed for the increase in the prevalence of zoonoses caused by GIP in these animals (Castro et al., 2009; Sharma, 2015; Snak et al., 2019; Bergamo et al., 2022; Stufano et al., 2022; Santarém et al., 2023a, 2023b), which can be transmitted through contact with soil or ingestion of contaminated water and foods of plant origin (Oliveira, 2015; Stufano et al., 2022; Santarém et al., 2023a, 2023b). Parasitized canines and felines are sentinels of environmental contamination by nematodes with zoonotic potential, acting as indicators of infection risks for humans (Oliveira, 2015; Sharma et al., 2015).

As recorded in the present study, simple infection by *Ancylostoma* spp. and *Ancylostoma* spp. + *T. canis* coinfection are the most prevalent in domiciled and semi-domiciled canines in urban and rural areas (Katagiri & Oliveira-Sequeira, 2007; Snak et al., 2019; Berenguer et al., 2021; Lopes et al., 2021). This is mainly due to the various forms of infection in susceptible animals (oral, cutaneous, transmammary and congenital) (Urquhart et al., 1998; Calderón et al., 2008; Oliveira, 2015; Berenguer et al., 2021; Santarém et al., 2023b), in addition to the biotic potential of these nematodes, due to the high fecundity of females and resistance of *T. canis* and *T. vulpis* eggs in the environment (Urquhart et al., 1998; Calderón et al., 2008; Castro et al., 2009; Santarém et al., 2023a, 2023b). In the present study, the majority of animals were between 1-5 years old, which may have influenced the prevalence of *Ancylostoma* spp., a parasite considered more prevalent in canines over one year of age (Eguía-Aguilar et al., 2005; Funada et al., 2007).

The majority of parasitized animals in the present study were asymptomatic, which is also highlighted in the literature (Urquhart et al., 1998; Eguía-Aguilar et al., 2005; Calderón et al., 2008; Oliveira, 2015; Berenguer et al., 2021). This result reinforces the importance of parasitological diagnosis (Katagiri & Oliveira-Sequeira, 2007; Calderón et al., 2008; Oliveira, 2015; Berenguer et al., 2021). Young animals are more susceptible to presenting symptoms associated with GIP infection, which can negatively interfere with the development of animals, due to the spoliative action of nutrients and blood, in addition to the irritative and obstructive action on the intestine (Urquhart et al., 1998; Calderón et al., 2008; Oliveira, 2015).

The techniques used to process fecal samples are easy to perform, low cost and, mainly, effective for diagnosing eggs of the nematodes identified in this study, as well as protozoan cysts/oocysts (Zajac & Conboy, 2012; Soares et al. al., 2020; Pena et al., 2022). The zinc sulfate flotation method was used mainly to detect *Giardia* spp. cysts, which were not detected in the animals in the present study. This may have occurred because fecal samples collected on alternate days (three) were not used. This procedure is recommend to increase the chances of detecting the cysts of this protozoan, which are excreted intermittently (Oliveira, 2015; Coutinho et al., 2020; Berenguer et al., 2021). *Giardia duodenalis* was one of the most prevalent parasites in children from *Quilombola* communities in the cities of Garanhuns (Coutinho et al., 2020) and Caetés (Silva et al., 2021) in Pernambuco, as well as in Pau D'Arco in Bahia (Rosine et al., 2018), by spontaneous sedimentation and Kato-Katz techniques.

Perhaps because they live in a rural area *Quilombola* owners tend to raise their dogs and felines in a semi-domiciled way, which was observed in most of the homes visited. Therefore, most of the animals in the communities studied were not in their homes, making it impossible to collect feces, especially from felines. Most owners said that their animals had free access to the street and forest areas, where they usually defecate and spend most of the day. Living freely can bring benefits to animals, such as relieving stress and energy expenditure. However, depending on the environment and habits, this exposure may result in the risk of infection by pathogens (Pereira et al., 2018). Furthermore, contact with wild animals in forest areas can also facilitate the cross-transmission of pathogens (Müller et al., 2009). As verified in this study, semi-domiciled animals, which have free access to the street and forested areas or which have contact with other animals are more likely to be infected with PGI.

The *Quilombola* population maintains a close relationship with canines and felines, which includes protection, companionship and cooperation, in addition to cultural practices such as hunting (Costa, 2023). For most interviewees, canines and felines are considered family members, in addition to being used for home security, in the case of guard dogs.

Most owners stated that they use well water for their own consumption and that the animals have access to water from a river, lake or reservoir. In the *Quilombola* community of Jaraguari, Mato Grosso do Sul, only 34.28% of the population had access to piped water and the remaining inhabitants used well water (Borges et al., 2020). These data are worrying, since the quality of the water used by the population is an important factor in promoting health. Several parasitic infections can be transmitted through water, both to humans and animals (Ferraz et al., 2019; Santarém et al., 2023a). In *Quilombola* communities in southern of Brazil, Santarém et al. (2023b) pointed out that the seroprevalence of anti-*Toxocara* spp. antibodies in humans it was associated with the consumption of untreated water (OR 2.0). In the present study, ingestion of water from rivers, lakes or reservoirs was shown to be a factor that increases the risk of GIP infection in animals.

Despite the prevalence found in this study, the majority of owners stated that they regularly control endo and ectoparasites in your animals, different from what was recorded by Santarém et al. (2023b) in *Quilombola* communities in the southeast region, where the animals were not dewormed or vaccinated. The lack of endoparasite control proved to be a risk factor for GIP infection in the present study and the majority of owners indicated that their animals do not receive veterinary assistance, which was also verified by Costa (2023) in the Pedro Cubas *Quilombo*, in Vale do Ribeira, São Paulo.

Perhaps the lack of veterinary assistance is the reason why the majority of owners interviewed self-prescribe antiparasitics for their animals, based on suspicion of parasitism in the face of clinical signs such as diarrhea, weight loss and

apathy. However, as verified in the present study, the majority of parasitized animals were asymptomatic. The habit of self-prescribing antiparasitics point a warning about the risk of the chosen antiparasitics not being efficient in controlling parasites, due to the incorrect calculation of the dose/weight ratio of the animal and the use of inappropriate antiparasitics to treat the parasites in question, factors that also represent a risk for the development of resistance (Stull et al., 2007; Oliveira, 2015). These factors are very common when deworming is carried out without guidance from a veterinarian and without support from a parasitological diagnosis (Stull et al., 2007; Oliveira, 2015).

As *Quilombola* communities are located in rural areas, geographic isolation contributes to the persistence of social inequality and lack of assistance to this population by public authorities (Batista & Rocha, 2020). In the present study, there was difficulty in moving the team to the communities, due to difficult access, as they are far from the urban area and have precarious dirt roads. This was also a limitation noted by Costa (2023) and Santarém et al. (2023b) to access *Quilombola* communities in the southeast region of Brazil. This may be one of the factors that also contribute to the lack of veterinary assistance reported by owners in the present study.

Quilombola communities have specific ethnic characteristics, maintained over time, such as the practice of family-based agriculture, of which the traditional production system predominates (Araújo et al., 2017). Agriculture is a symbol of cultural identification for the *Quilombola* people (Costa, 2023). Under these circumstances, farmers may be exposed to contact with soil contaminated by parasites with zoonotic potential, such as the canine and feline hookworms detected in this study, which can infect humans through the skin. The CLM is considered an occupational disease (Stufano et al., 2022).

The lack of infrastructure and basic sanitation is also a reflection of the lack of assistance in *Quilombola* communities and deserves attention, since as found in this study, the presence of organic matter and open sewage increases the chances of GIP infection in animals. Inadequate sanitation was detected in 94.8% of *Quilombola* communities in several Brazilian regions (Cherol et al., 2021), which favors parasitic infections.

In this context, it is important to highlight environmental racism, which manifests when low-income communities or certain ethnic groups, such as the *Quilombola*, are disproportionately affected by problems such as climate change and environmental degradation (Santinelli, 2024). This also affects animals, since in vulnerable communities there is no access to veterinary services, which results in an increase in the canine and feline population and poor health conditions (Santinelli, 2024). Thus, in these populations, factors like the environmental racism, precarious living conditions and the lack of basic sanitation can facilitate the occurrence of health problems, such as the occurrence of zoonoses, or even contribute to the development of hoarding disorder.

In this research, hoarders of animals and/or objects were identified, based on characteristics already described in studies and guides (Patroneck et al., 2006; APA, 2014; Grisham & Baldwin, 2015; Mendes et al., 2022; Brasil, 2023), such as: (i) lack of minimum standards of animal care, (ii) obsession with accumulating more and more animals/objects, (iii) denial of the problem and (iv) inability to recognize the negative effects of accumulation for animals, people and the environment.

Factors like relationship difficulties and traumatic events (Mills, 2013), history of losses and suffering (Mendes et al., 2022) are predisposing to hoarding disorder. Furthermore, geographic isolation, socioeconomic vulnerability and lack of medical and psychological assistance can influence the development of this disorder in *Quilombolas*, since psychosocial stress and loneliness are also predisposing factors for this psychopathology (Henriques et al., 2019).

The accumulation of materials and waste by hoarders directly affects the risks of vector-borne diseases, including zoonotic diseases (Henriques et al., 2019; Macedo et al., 2022). Furthermore, close contact with companion animals, combined with behaviors and habits related to poor hygiene, facilitate the transmission of zoonotic pathogens, especially in less favored

populations (Souza & Costa, 2014). The prevalence of GIP in hoarder animals in the present study is higher than that recorded by Felix (2023) in an urban area of the city of Recife, Pernambuco (40.7%).

Studies about GIP infections in canine and feline hoarders are still scarce (Patroneck, 1999; Patroneck et al., 2006; Polak et al., 2014), mainly in Brazil (Cunha et al., 2020; Macedo et al., 2022; Felix, 2023). The present study is pioneering with regard to GIP infections in canines and felines from *Quilombola* communities in the Northeast region of Brazil and also in animal hoarders in these communities.

All owners received the results of the coproparasitological analysis of their animals and were instructed to seek veterinary assistance for the animals at the zoonosis control center, to be treated according to the identified GIP. Owners were also advised to seek medical assistance at the Basic Health Unit in the territory where they live, as the GIP found have zoonotic potential. Environmental Surveillance professionals also received the test results so that they could monitor the population studied, especially in relation to parasitized animals and cases of hoarding disorder.

According to Overgaauw et al. (2020), the health of canines and felines is underestimated in publications about One Health approach, despite the increase in the population of these animals and the increasingly close contact with their owners, factors that favor the sharing of pathogens with zoonotic potential. Furthermore, the fact that these animals act as sentinels of environmental contamination by pathogens (Day, 2010; Overgaauw et al., 2020; Macedo et al., 2022) should be more than enough reason for One Health strategies to be implemented, aiming to attention to the health of these animals, especially those whose owners live in vulnerable conditions, such as *Quilombolas* and hoarders. In most developing countries, disease surveillance sectors are separate and independent from each other, without integration between different teams and health professionals (Leandro et al., 2021; Sekabira et al., 2023). Therefore, to meet the principles of multi-professionality and intersectorality of One Health (OHHLEP et al., 2022; Sekabira et al., 2023), in the present study, a strategic flowchart for health assistance for both animals and their owners (*Quilombolas* and hoarders) was suggested to the Municipal Health Department of Garanhuns.

For the actions proposed in this study to be successful, it is necessary to take into account the knowledge and traditions of the *Quilombola*, as each culture is unique and has symbolic characteristics that form the identity of each individual (Schek et al., 2020; Sekabira et al., 2023). According to Schek et al. (2020), exchanging knowledge and understanding traditional practices is a major challenge for health professionals who work in these communities. The transculturality is one of the principles of One Health approach (OHHLEP et al., 2022), although it is recognized as a major challenge for implementing actions in traditional communities (Sekabira et al., 2023), since culture influences perception, understanding and response to diseases (Pimentel, 2023).

Finally, it is important that health authorities form multi-professional and intersectoral Technical Groups (TG) for the development of Unique Therapeutic Projects (UTP) for the target territory of the actions.

5. Conclusion

The presence of animals parasitized by GIP with zoonotic potential is an alert to the risk of transmission to owners, which can be increased by the socioeconomic, health and environmental vulnerability of the communities studied. Therefore, we hope that the One Health strategies proposed in this study with multi-professional and intersectoral actions contribute together with other government actions, to improving health conditions (physical, mental and social), education, infrastructure and environmental sanitation, respecting the *Quilombola* knowledge and traditions, contributing to strengthening the principles of the Aquilomba Brasil Program (Decree nº 11.447/2023). Furthermore, we hope that such strategies can be implemented in other states and that they inspire new research on animal health and the One Health approach in vulnerable communities.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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