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Intestinal parasitic infections in a population of a Brazilian Amazonian city: an approach to intestinal helminths

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ABSTRACT

Introduction: Humans can be infected with different intestinal parasites that can cause diarrhea, dysentery, and even death. These parasitic diseases are more common in individuals living in vulnerable situations, such as those often found in small towns in northern Brazil. **Objective:** To analyze the frequency of intestinal parasites and the risk factors inherent to infections with an emphasis on helminths in patients attended at the Municipal Laboratory of Oriximiná, a city located in the state of Pará. **Methods:** In 2019, 294 fecal samples from patients addressed in this laboratory were retrieved, as were socioeconomic and environmental information through a form. The fecal samples were subjected to direct examination and the techniques of thermohydrotropism, centrifugal-sedimentation, spontaneous sedimentation, and centrifugal-flotation. **Results:** The positivity rate for intestinal parasites was 25.5%. Among the helminths, the most frequently detected were hookworms (10.7%), *Ascaris lumbricoides* (8%), and *Strongyloides stercoralis* (2.7%). The parasitological profile of the samples revealed a greater frequency of monoparasitism (78.6%) than of polyparasitism (21.3%). Patients who had close contact with soil were approximately 1.8 times more likely to be parasitized than those who did not directly manipulate the soil, and this association was statistically significant (p=0.017). Furthermore, forms of *Urbanorum* spp. that were not counted as intestinal parasites were also detected in the patients' fecal material. **Conclusion:** The information obtained in this study highlights the need for improvements in basic sanitation in the city and the implementation of health education activities to disseminate information about parasites.

Keywords: Helminths; Parasites; Parasitology; Diagnostic techniques and procedures; Intestinal Diseases, Parasitic.

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INTRODUCTION

Intestinal parasitic infections remain a major public health problem, particularly in low- and middle-income countries where poor sanitation, limited access to clean water, and tropical climates favor transmission[1]. Socioeconomic inequalities and favorable microclimates sustain the persistence of both protozoa and helminths[2]. Globally, over 3.5

billion people are infected and about 450 million develop clinical disease, mostly children[2]. In Latin America, around 20% of the population is affected[3], leading to malnutrition, anemia, growth retardation, cognitive deficits, and chronic gastrointestinal disorders[4]. In the Brazilian Amazon, co-infections with malaria and intestinal parasites are frequent, reflecting overlapping environmental and social risk factors[5].

Although intestinal parasites are recognized as significant health issues in Brazil, official national data remain scarce and are often aggregated under Neglected Tropical Diseases (NTDs), hindering precise epidemiological assessment. The study[6] identified the North region as a priority area for NTD control, reporting the country's highest rates and emphasizing the need for more studies.

Aligned with the United Nations 2030 Agenda, intestinal parasitic infections are included among the NTDs targeted by the Sustainable Development Goals (SDGs), particularly Goal 3—Ensure healthy lives and promote well-being for all ages. Target 3.3 calls for ending epidemics of AIDS, tuberculosis, malaria, and NTDs by 2030, recognizing their strong link to poverty and poor sanitation. The agenda also connects health improvement to Goals 6 (Clean Water and Sanitation) and 10 (Reduced Inequalities), both essential for parasite control[7].

In Brazil, national actions against NTDs are guided by the National Plan to Combat Neglected Tropical Diseases 2021-2030, which promotes preventive chemotherapy (mass deworming), improved water, sanitation, and hygiene (WASH), health education, and strengthened surveillance—particularly in the North and Northeast[8].

Despite these initiatives, epidemiological data remain scarce in several Amazonian municipalities, limiting targeted interventions and risk-factor mapping[5]. Therefore, this study aimed to determine the frequency of intestinal parasites and identify associated risk factors—with emphasis on helminths—among patients attending the municipal laboratory of Oriximiná, Pará, in 2019. These findings are expected to fill a critical knowledge gap and support local public health planning in northern Brazil.

METHODS

Study location

Biological samples were collected at the municipal laboratory of Oriximiná, a municipality located in the inland region of the state of Pará. Oriximiná is a Brazilian municipality in the Amazonian state of Pará, which is part of the Lower Amazon region. It is the second largest municipality in the state of Pará and is bordered by two Brazilian states (Roraima and Amazonas) and two other countries (Guyana and Suriname). The city has large and flowing watercourses, the main ones being the Trombetas and Amazon rivers[9]. The municipality extends over 107,603.2 km^2 and has approximately 73,000 inhabitants. Given the characteristics of the region, which is segmented by large rivers and has very few highways, river transport is the most common method used for the movement of people and cargo[10].

Temperatures in the city during summer range between 35°C and 37°C. In the period from December to July, the rainy season or winter, the temperature is approximately 32 °C. Ethnically, the city's population is of indigenous, African, and European origin. The banks of the Trombetas River include quilombola communities and indigenous populations, in addition to the urban population that lives in the district[11]. Oriximiná has two public hospitals, totaling 60 beds, and five basic health units, of which only one participates in the Family Health Strategy. The municipality also has a private hospital and a municipal laboratory that serves the entire population, where blood counts and biochemical, immunological, and coproparasitological tests are performed.

Forms and sampling

In February 2019, fecal samples were collected from 294 individuals attending the Municipal Laboratory of Clinical Analysis of Oriximiná, Pará. Thus, convenience sampling was used. People who were in the waiting room of the laboratory were invited and encouraged to participate in the study. The individuals who agreed to participate signed the free and informed consent form and/or the free and informed assent form and were thus subjected to the collection of information through a semi-structured form.

This study included people of all age groups who were interested in participating. The data obtained for children and/or adolescents were answered by the parents and/or legal guardians via the forms. Exclusion criteria included indigenous users of the laboratory services, as communication barriers prevented the administration of the questionnaire. Their exclusion did not compromise access to care.

Ethical Approval

This study evaluated the frequency of intestinal parasites in fecal samples collected at the municipal laboratory of Oriximiná, Pará, and was initiated only after approval by the Research Ethics Committee (CEP) of UFF CAE03218818.8.0000.5243.

Biological sample collection and parasitological analyses

A portion of each patient's fecal samples was donated to the study; thus, the participants did not need to perform a new fecal collection. As the fecal samples were already delivered without chemical preservative as normal, the technique of Rugai et al.[12] was performed to investigate nematode larvae, and a direct examination. All the samples were subsequently identified and placed in plastic bags, which were subsequently stored under refrigeration (4 °C) until they were sent to the Parasitology Laboratories

of the Biomedical Institute of the Fluminense Federal University, Niterói, Rio de Janeiro.

At the Laboratory of Parasitology of the Biomedical Institute of UFF/RJ, a portion of the fecal sample was subjected to the coproparasitological centrifuge-sedimentation technique of Ritchie[13] modified by Young et al.[14] and the centrifuge-flotation method of Faust et al.[15], and a portion of the filtrate was allowed to settle in sedimentation cups for 24 hours before performing the Lutz technique[16].

The slides obtained from each technique and the photomicrographs were examined with an Olympus® BX 41 binocular optical microscope, initially at 100x magnification and, for confirmation, if necessary, at 400x magnification, coupled to a Samsung® SDC415 digital camera with Honestech® TVR capture system software. For morphometry of the evolutionary forms of the parasite, a single-ocular optical microscope Olympus® CH30 with an Olympus® SWH micrometric eyepiece was used at 400x magnification.

Epidemiological survey and statistical analysis of data

Data were collected from patients attended at the municipal laboratory of Oriximiná, and the following variables were included in the form: age, sex, neighborhood, number of residents in the household, family income, type of water in the residence, water treatment, type of water, type of cesspool (sewer), consumption and hygiene of vegetables and greens, whether the patient worked, played, or handled the soil, performance of the stool exam, administration of antiparasitic medication, presence of abdominal pain, presence of diarrheal episodes, and observation of fragments of helminths or blood in the stool.

To verify the relationship between the diagnosis of intestinal parasites and the possible risk factors associated with infection, Fisher's exact or chi-square statistical tests were performed using $p \leq 0.2$. The statistically significant risk factors in the univariate analysis were transferred to a multivariate model and expressed as *odds ratios* (ORs) with a 95% confidence interval and a 5% significance level. All the statistical tests were performed via SPSS software version 25.

RESULTS

In the fecal samples of patients included in the study and attended at the municipal laboratory of Oriximiná, Pará, an overall positivity frequency of 75/294 (25.5%) for intestinal parasites was observed when combining the results obtained by all the coproparasitological techniques. Of these, 17/75 (22.7%) were positive for intestinal helminths. Among the helminths, the most diagnosed were hookworms (10.7%), followed by *Ascaris lumbricoides* (8%) and *Strongyloides stercoralis* (2.7%). *Hymenolepis nana* and *Trichuris trichiura* eggs were detected in one fecal sample each (1.3%) (Table 1). In addition to these, typical unicellular eukaryotic forms of *Entamoeba* sp., *Giardia duodenalis*, and *Blastocystis* sp. were also detected (Table 1).

In addition to the intestinal parasites, evolutionary forms compatible with *Urbanorum* spp. were also unexpectedly detected in 38 fecal samples. Although they were detected via microscopy, these forms were not counted as intestinal parasites. The morphotype of *Urbanorum* spp. detected was the rounded type with a thick wall, with coloration ranging from hyaline to light yellow. In the wall of this morphotype, a small opening was observed, like a pore, from which leakage of the filamentous content sometimes occurred.

The parasitological profile of the samples revealed a greater frequency of monoparasitism, at 59/75 (78.6%), than of polyparasitism, at 16/75 (21.3%). In general, most patients who participated in the study were adults, followed by children, elderly individuals, and adolescents. The youngest participant was 7 months, and the oldest was 90 years, with a mean age of 33.07 years (±21.9). Participants of both sexes joined the study, with a preponderance of female participants. According to the information retrieved from the forms, most participants lived in houses with more than three residents. These residences were in different areas of the city, including the urban area locally called the downtown and the interior neighborhoods locally referred to as the periphery. Most of the population had a monthly income of approximately R$ 954.00, the minimum wage at the time, and consumed water from a well or municipal supply that was a 1% sodium hypochlorite solution (Table 2).

In terms of the general frequency of participants who were positive for intestinal parasites according to the variables in Table 2, the majority were female adults, lived in peripheral neighborhoods in households with more than three residents, received up

Table 1: Frequency of parasites detected in fecal samples from patients attended at the municipal laboratory of Oriximiná, Pará, Brazil, 2019.

Parasites	Number of positive samples	%
Protozoa	62	82.7
Entamoeba coli	57	76
Entamoeba complex	14	18.7
Blastocystis sp.	1	1.3
Giardia duodenalis	5	6.7
Helminths	17	22.7
Ascaris lumbricoides	6	8
Trichuris trichiura	1	1.3
Hookworms	8	10.7
Strongyloides stercoralis	2	2.7
Hymenolepis nana	1	1.3
General frequency (n=294)	75	25.5

to the minimum wage as income, consumed water from wells and the municipal supply, and treated the water with 1% sodium hypochlorite. In the screening of variables associated with infection by intestinal parasites, the univariate analysis revealed that only age and the habits of working with, playing with, and managing the soil were significantly associated with these infections, i.e., a p-value ≤0.2. However, when the factors were analyzed together in the multivariate model, it was observed that only people who worked with, played with, or handled the soil were approximately 1.8 times more likely to be parasitized than those who did not manipulate the soil directly, which was a statistically significant risk factor (p≤0.05) (Table 2).

Table 2: Risk factors associated with intestinal parasite infection detected in fecal samples from patients attended at the Municipal Laboratory of Oriximiná, Pará, Brazil, 2019.

Information		Samples	Gastrointestinal parasites		Univariate	Multivariate	
			n	%	P value	Odds ratio	P value
Age range	0–18 years	95	19	20	0.154*	1.766 (1.277 - 3.404)	0.065
	> 18 years old	199	56	28			
Sex	Female	171	41	24	0.5		
	Male	123	34	28			
Neighborhood location	Downtown	50	12	24	0.404		
	Periphery	244	63	26			
Number of residents in the household	Up to 3 people	82	17	21	0.297		
	More than 3 people	212	58	27			
Family Income	Up to 1 minimum wage	221	57	26	1,000		
	More than 1 minimum wage	73	18	25			
Type of water in the residence	River, lake, or pond water	26	8	31	0.636		
	Well	134	36	27			
	Municipal water	134	31	23			
Water treatment	No	107	25	23	0.579		
	Yes	187	50	27			
Type of water treatment	1% sodium hypochlorite	168	44	26	0.788		
	Others	126	31	25			
Type of septic tank	Septic	197	50	25	1,000		
	Black	97	25	26			
Consumption and hygiene of consumed leaves and vegetables	Sodium hypochlorite	9	2	22	0.878		
	Manual washing in water and/or others	225	59	26			
	Does not consume	60	14	23			
Consumption of vegetables produced at home	No	200	54	27	0.474		
	Yes	94	21	22			
Work, play, or handle soil	No	145	29	20	0.044*	1.8428 (1.05 – 3.05)	0.017**
	Yes	149	46	31			
Conducting a stool test	No	15	2	13	0.37		
	Yes	279	73	26			
Use of antiparasitic medication	No	40	9	23	0.701		
	Yes	254	66	26			
Stomach pain	No	127	29	23	0.418		
	Yes	167	46	28			
Diarrheal episodes	No	128	35	27	0.59		
	Yes	166	40	24			
Observation of blood in the stool	No	223	53	24	0.274		
	Yes	71	22	31			

*p≤0.20; **p≤0.05

DISCUSSION

When analyzing the fecal material of patients in different age groups attended at the municipal laboratory of Oriximiná, Pará, a frequency of approximately 25% positivity for intestinal parasites was observed. The results greater than those of this study have been reported in other studies also conducted in this state, such as in the riverine population of Igarapé Miri (94.5%), in adult patients attended at the Clinical Analysis Laboratory in Cametá (76.31%) and Santarém (54%), in retrospective studies (49.07%) and coproparasitological surveys (75.3%) conducted with children in Belém and Breves (91.2%), and in schoolchildren in Santarém (67.5%), riverside communities (95.1%) and elderly individuals (54.1%) from Pará[17-25].

Frequencies higher than those observed in patients from Oriximiná, Pará, have also been reported in studies of intestinal parasitic diseases conducted in other states of northern and northeastern Brazil, specifically in the elderly (72.8%), in populations of different age groups (77.9%), and in children and community residents of different age groups (73% to 83%)[26-30]. Higher values were also reported in studies conducted in other states in Brazil, including in schoolchildren in Tocantins (42.9% - 59.7%) and in residents of rural areas of Acre (53.4%) as well as in other South American countries that border the North Region of Brazil, including studies conducted with children in Venezuela (68%), Ecuador (85.7%), Peru (100%), and Bolivia (89%)[31-38].

Positivity for intestinal parasites in the fecal samples of this study was already expected, since the samples were obtained via the medical requirements of patients treated at the only public laboratory in Oriximiná, which is attached to the public hospital in the city. However, the convenience sampling used in this study consisted of obtaining fecal material from participants with different profiles, i.e., from participants of various age groups who lived in different neighborhoods of the city.

In the present study, the smaller sample size of a diverse population may have favored a lower frequency of intestinal parasitic infections, since most of the studies reported above focused on specific and more susceptible communities and sample groups, such as children. Also, some of these studies were conducted many years ago, which may also have influenced the lower positivity for helminths in this current study, considering the improvement in the socioeconomic and sanitary conditions observed in Brazilian urban populations.

Importantly, the results presented here are unprecedented, as a coproparasitological survey has never been proposed at the research level with the local nonindigenous population, which raised the interest of this research group in the epidemiology of these infectious agents in this city. In most of the fecal samples analyzed, only one parasitic taxon was detected, culminating in a predominance of infection by only one parasite. In general, there is a global trend toward a progressive decrease in the incidence and prevalence rates of intestinal parasites, especially nematodes infecting adult populations, the predominant age group in this study, owing to more formal hygienic habits in this age group[26] and associated with improvements in basic sanitation and the expansion of paved areas, a condition that contributes to reducing the risk of geohelminth infection.

Notably, the fecal samples used in this study were obtained from material sent to the Clinical Analysis Laboratory of Oriximiná, which routinely performs analyses of a single fecal sample collected per patient. This single collection per patient may also have led to the lower frequency of intestinal parasites detected in the feces than that reported in the studies. Diagnosis from a single fecal sample is not dependable for detecting parasites, since these parasites, especially unicellular eukaryotes such as protozoa, are intermittently excreted in the fecal material[39]. However, it is important to highlight that several types of parasitological methods were used, expanding the possibility of identifying parasites in the examination of a single fecal sample.

At the end of the analyses, the parasitological results were sent to the professionals responsible for the laboratory to be distributed in a sealed form to each study participant. If the patient had doubts about their results, laboratory and hospital professionals explained the results verbally from the laboratory and hospital. To achieve greater success in the delivery of the results, since there is no public transportation in Oriximiná and most of the population in the periphery lives far from the laboratory, the study team contacted them by telephone. In addition, the date of delivery of the results was announced through the local radio, as well as through a sound vehicle promoted by the study team.

In all, eight parasites of distinct taxonomic categories, particularly protozoa, were identified among the fecal samples analyzed. The higher frequency of protozoa relative to helminths may be associated with the simplicity of the life cycle of these parasites, which do not require an intermediate host; the resistance of their cysts in the environment, including during drinking water treatment; and the fact that the cysts are already infectious when excreted into the environment.

The small size of protozoa and the resistance of the cyst wall make their removal or inactivation in treated water difficult, and even a small number of cysts is sufficient to establish infection. In addition, protozoa have low sensitivity to anthelmintics, favoring the persistence of infection and the release of their cysts into the environment. These characteristics, associated with the precarious conditions of basic sanitation in the city, may have favored the permanence and viability of these parasites in the environment, culminating in reinfections of the study population.

Among the protozoa detected in the fecal material of patients attended at the municipal laboratory of Oriximiná, the Amoebozoa group, e.g., *Entamoeba coli*, stands out. These parasites have recently been investigated by our research team using molecular

tools, in which *E. histolytica* was identified[40]. Furthermore, other protozoa, such as *Giardia duodenalis* and *Blastocystis* sp., were also detected in the feces analyzed in the present study. Among the six samples positive for these parasites, five were from children, with cysts of *G. duodenalis* and a vacuolar form of *Blastocystis* sp. recovered from four of them.

Although *Giardia duodenalis* is already one of the most commonly reported parasites in studies involving coproparasitological tests performed in the North Region of Brazil and *Blastocystis* sp. is one of the most commonly detected parasites in fecal samples from indigenous people in Oriximiná, Pará[23,26,30,32,33,35,37]. In the fecal samples of the patients included in this study, the sample size of these protozoa was small. This fact may be linked to the small number of evolutionary forms in the fecal material analyzed, the diversity of evolutionary forms of *Blastocystis* sp. (which may have hindered microscopic identification), and the analysis of only one fecal sample per patient.

The frequency of helminths detected among the positive samples in the present study was 22.7%. In general, this frequency was lower than that reported in other coproparasitological studies conducted in the North Region of Brazil, such as in Amapá (48.4%), Amazonas (70.4% to 72.6%), and other cities in Pará (34.5% to 57.14%)[17,18,23,26,27,30,35,40]. Positivity values lower than those reported in the present study were reported in the state of Tocantins (7.97%) and in northern Manaus, Amazonas (11%)[29,37]. Among the helminths detected in the feces of patients from Oriximiná, the hookworm and *Ascaris lumbricoides* were most prominent, followed by *Strongyloides stercoralis*, *Trichuris trichiura*, and *Hymenolepis nana*. Notably, the hookworm, *A. lumbricoides,* and *T. trichiura* nematodes were the most reported in the epidemiological surveys conducted in this region. Because they are geohelminths, their transmission is associated with soil contaminated with human waste due to the precarious conditions of basic sanitation still present in the cities of the North Region, as noted in the literature[17,29,30].

The presence of hookworm eggs in the fecal material of patients attended at the Oriximiná Municipal Laboratory was due to their direct exposure to contaminated soil due to the lack of appropriate clothing and footwear. The only fecal sample in which *T. trichiura* eggs were detected also contained *A. lumbricoides* eggs; this sample belonged to an adolescent. Importantly, young people are the most sensitive to infection by these parasites and may present diarrhea and even intestinal obstruction (*A. lumbricoides*) or rectal prolapse (*T. trichiura*), in individuals with high parasitic loads. In general, this parasitic association is commonly detected in fecal samples because the environmental conditions favorable for the development of eggs of both nematodes are similar, i.e., locations with hot and humid climates, which are typical of the North Region of Brazil.

In addition to nematode eggs, *Strongyloides stercoralis* larvae were detected in two samples, diagnosed only through the Rugai technique, as the fecal material had not been preserved. One positive patient was over 60 years old, suggesting that advanced age and socioeconomic vulnerability may favor persistence of infection. *Hymenolepis nana* eggs were identified in only one sample, contrasting with higher frequencies reported in other studies in the North Region[20,26,34]. Its low detection rate may reflect the parasite's fragile eggs and dependence on ingestion of contaminated arthropods; nonetheless, the finding indicates possible risk factors such as rodent presence in peridomiciles and inadequate hand hygiene, highlighting ongoing environmental and behavioral vulnerabilities in the region.

With respect to the risk factors, only the information about managing the soil was associated with infection by intestinal parasites, i.e., patients who reported working with, playing with, or directly managing the soil were more likely to be infected by any of these biological agents. Importantly, a large part of the population of Oriximiná plants vegetables and fruits in their homes, and children play in backyards and streets. These habits, associated with the scarcity of complete sanitation systems in some areas of the city, which still have a cesspool for the disposal of sewage, may favor environmental contamination with parasitic forms and transmission.

Unexpectedly, forms morphologically compatible with those of *Urbanorum* spp. were also detected in the feces of humans. Among the analyzed literature, this is the first study that detected *Urbanorum* spp. in fecal material from humans in the North Region of Brazil. Despite having been diagnosed via microscopic parasitological techniques, *Urbanorum* spp. has not yet been demonstrated to be a parasitic taxon; therefore, in this study, it was not counted among the results for intestinal parasites. However, more studies need to be conducted to verify the possible association of *Urbanorum* spp. with cases of malabsorption syndrome, including those of parasitic origin.

From a socioeconomic perspective, the persistence of intestinal parasites in Oriximiná reflects structural inequalities that go beyond individual habits. Limited access to sanitation services, dependence on cesspools for sewage disposal, and the absence of public transportation to health facilities reinforce the vulnerability of families. In peripheral neighborhoods, where informal housing and precarious urban infrastructure predominate, people are more exposed to contaminated soil and water, increasing the risk of infection. Moreover, low income restricts access to protective resources such as footwear and treated water, perpetuating the cycle of transmission. These findings underline that combating parasitic diseases in Amazonian cities requires not only biomedical interventions but also integrated public policies that reduce poverty, improve living conditions, and promote health equity.

Study limitations include convenience sampling, exclusion of indigenous populations, analysis of a single fecal sample per participant—potentially underestimating prevalence—and

the cross-sectional design, which limits causal inference. Additionally, the biological role of *Urbanorum*-like forms remains uncertain and warrants investigation. Despite these constraints, the study provides the first epidemiological evidence for Oriximiná and supports local public health policies aimed at reducing parasitic infections and improving conditions for vulnerable Amazonian communities.

Conclusion

This coproparasitological survey confirmed intestinal parasitic infections among Oriximiná residents and identified persistent risk factors, notably direct contact with contaminated soil. To reduce transmission, actions should include: (i) expanding sanitation infrastructure; (ii) promoting health education on hygiene, footwear use, and safe soil and food handling; (iii) broadening deworming coverage to adults, following the Practical Guide for the Control of Geohelminthiases; and (iv) incorporating coproparasitological diagnosis into primary healthcare for early detection.

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