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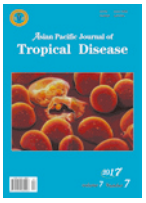

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Intestinal parasitic infections and associated risk factors in preschoolers from different urban settings in Central-Western Brazil

João Gabriel Guimarães Luz[1*], Amanda Gabriela de Carvalho[1], Aline Pereira Marques[1], Alyna Araújo Marcondes[1], José Henrique Francisco Roma[1], Lisie Souza Castro[1], Ludiele Souza Castro[1], João Victor Leite Dias[2], Juliana Helena Chávez Pavoni[1]

[1]*School of Medicine, Institute of Exact and Natural Sciences, Federal University of Mato Grosso, Campus Rondonópolis, Rodovia Rondonópolis-Guiratinga, KM 06, MT 270, 78735-901, Rondonópolis, MT, Brazil*

[2]*School of Medicine, Federal University of the Jequitinhonha and Mucuri, Campus Mucuri, 01 Cruzeiro Street, 39803-371, Teófilo Otoni, MG, Brazil*

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ABSTRACT

Objective: To investigate the prevalence of intestinal parasitic infections and the associated risk factors in children attending preschools located in areas with different socioeconomic and structural features in the city of Rondonópolis, State of Mato Grosso, Brazil.
Methods: A cross-sectional survey was conducted between 2015 and 2016 among four-to-five years old children. Initially, urban neighborhoods with preschools were classified into five risk strata for parasitic infections, which were defined on the basis of socioeconomic and structural variables. Then, one school from each stratum was randomly chosen for data collection. After obtaining the written informed consent from parents or guardians, the children provided stool samples for examination. Interviews were conducted with parents or guardians to determine the associated risk factors.
Results: Coproparasitological tests were performed on 215 (46.5%) preschoolers, and the overall prevalence was 22.8%. The occurrence of such infections increased with the increase in risk stratum of the neighborhood. Protozoa infections, mainly by *Entamoeba coli* (11.2%) and *Giardia duodenalis* (9.8%), were the most frequent. The consumption of tap water (OR = 3.56, P = 0.002), no washing of fruits and vegetables before consumption (OR = 3.44, P = 0.002), and no hand washing before eating (OR = 2.63, P = 0.004) were associated with these infections.
Conclusions: The prevalence of intestinal parasites among Rondonópolis preschoolers is relevant and associated with precarious hygienic–sanitary behavior, especially in areas with poor socioeconomic and structural conditions.

1. Introduction

Human infections with intestinal parasites (helminths and protozoa) represent an important and neglected problem in public health, especially in tropical and subtropical areas in developing and underdeveloped countries, where almost one-third of the population live under precarious socioeconomic conditions and environments favorable for parasites occurrence[1]. Approximately 1.5 billion people are estimated to be currently infected with soil-transmitted helminths[2], 280 million with giardiasis[3], and 35–50 million with amoebiasis[4] worldwide.

Public health interventions which focus on the provision of basic sanitation infrastructure, health education, and target drug administration are essential to prevent and control these parasitic diseases[5]. These measures should be based and adapted to a local context to assure their success and maintenance. In this way, identifying the particularities of an area and the risk factors associated with its population is important[6].

Although people of all ages can be infected with intestinal protozoa and helminths, preschool children are the most vulnerable group because of the immaturity of their immune system, inherent rudimentary hygiene habits, frequent contact with contaminated environments, and high frequency of interpersonal child–child contact[7-9]. Among these individuals, enteroparasites are known to be responsible for high morbidity associated with diarrhea, malnutrition, and several physiological complications, which in turn affect the nutritional, physical, and cognitive development[10].

The prevalence of intestinal parasites among preschoolers in Brazil tends to be high[9]. However, variations are common across the country, so that different rates of occurrence may be found among neighborhoods in the same urban area[1,11,12]. This condition could be attributed to the recent and disorderly occupation of urban space in several Brazilian cities that has created areas with local features and remarkable socioeconomic and structural differences

*Corresponding author: João Gabriel Guimarães Luz, School of Medicine, Institute of Exact and Natural Sciences, Federal University of Mato Grosso, Campus Rondonópolis, Rodovia Rondonópolis-Guiratinga, KM 06, MT 270, 78735-901, Rondonópolis, MT, Brazil.
Tel: +55 66 34104004
E-mail: joaogabrielgl@hotmail.com
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that may favor or hinder the occurrence of diseases[13].

In Rondonópolis, one of the most important cities in Mato Grosso State, a unique reported coproparasitological survey was conducted by Alves *et al.* on children attending a day care center[14]. However, the authors evaluated a single institution and did not consider the differences among the neighborhoods making up the city.

Given that only a few studies conducted this relevant approach, the present study aimed to investigate the prevalence of intestinal parasitic infections and associated risk factors in children of public preschools located in areas with different socioeconomic and structural features in the city of Rondonópolis, State of Mato Grosso. A better understanding of the social context related to the occurrence of such infections can guide future control strategies in their elimination and in the improvement of urban environment and quality of life.

2. Materials and methods

2.1. Study area

The study was conducted in Rondonópolis (16°28'15" S and 54°38'08" W), an agricultural, industrial, and reference center located in the south of the State of Mato Grosso in the central-western region of Brazil (Figure 1). The city has an estimated population of 218 889 and a total area of 4 159.12 km^2, in which 129.2 km^2 is allocated for the urban area. The current 237 urban neighborhoods present remarkable social, economic, and environmental differences[15]. At the time of the present study, 6 081 children aged four-to-five years were enrolled in the 32 urban and 11 rural public preschools of the municipality called Municipal Schools for Children Education (EMEI).

2.2. Study design

An observational cross-sectional survey was conducted to investigate the prevalence and associated risk factors for intestinal protozoa and helminths infection among preschoolers from EMEIs located in areas with different transmission risks.

2.3. Determination of transmission risk strata

In consideration of the hypothesis that differences in the socioeconomic and structural profiles of the neighborhoods in Rondonópolis may expose, a priori, resident populations to high- or low-risk infections with intestinal parasites, an initial classification according to transmission risk was conducted, which was adapted from Souza and Barata[13]. Thus, twenty-six urban neighborhoods that had EMEI and were identified by the Brazilian Institute of Geography and Statistics in the last National Demographic Census were considered[16]. The remaining six urban neighborhoods that had EMEI and emerged after the last census were not included because of the lack of information.

To characterize the socioeconomic status of the selected neighborhoods, 10 variables from the demographic census, including percentage of permanent households (PH) with monthly nominal income per capita up to 1/2 minimum wage, percentage of PH with monthly nominal income per capita greater than five minimum wages, and percentage of literate people aged 10 years or older, were selected. For the structural characterization, the following variables were used: percentage of PH with acceptable solutions (sewage network or septic tank) for sewage drainage; percentage of PH that use ditch or rudimentary cesspit for sewage drainage; percentage of PH that use river, lake, or sea for sewage drainage; percentage of

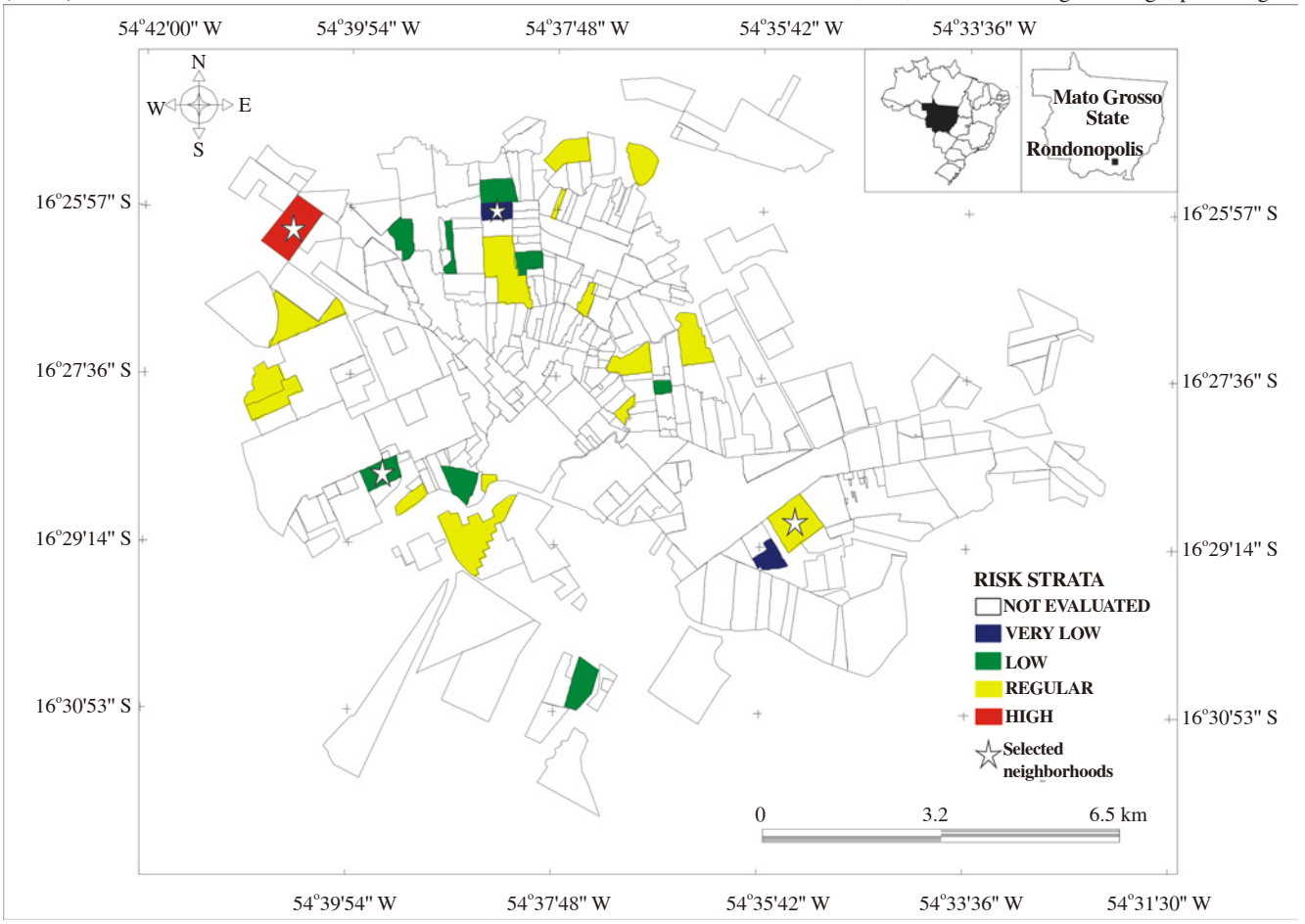

Figure 1. Risk stratification for intestinal parasites among the urban neighborhoods that had public preschools in Rondonópolis city, Mato Grosso State, Central Western Brazil. The four neighborhoods included in the study for data collection are indicated.

PH that use public supply as the main source of water; percentage of PH that use wells or springs as the main source of water; percentage of PH that use river, pond, or lake as the main source of water; and percentage of PH with regular collection of garbage by public services[16].

Subsequently, the 26 neighborhoods were ranked from 0 to 26 for each variable. The neighborhood with a value suggestive of the greatest socioeconomic or structural precariousness and, consequently, the possible highest risk for the transmission of parasitic infections received the maximum value of 26. This criterion was adopted successively until the minimum value of 1 was attributed to the neighborhood with the least socioeconomic or structural precariousness and, consequently, the possible lowest risk for the acquisition of parasitic infections. The same score was assigned to variables with equal values among two or more neighborhoods.

The sum of the points corresponding to the variables generated a parameter denominated by the socioeconomic and structural index (SSI) for each of the evaluated urban neighborhoods. The SSI values ranged from 0 to 260, and five risk strata were established for the transmission of intestinal parasites: very low risk ($0 \geqslant SSI < 60$), low risk ($60 > SSI \leqslant 110$), regular risk ($110 > SSI \leqslant 160$), high risk ($160 > SSI \leqslant 210$), and very high risk ($210 > SSI \leqslant 260$). No neighborhood was classified into the very high risk stratum. The number and geographical location of the neighborhoods are presented in Figure 1. The average value of each variable for the transmission risk strata is summarized in Table 1.

2.4. Study population

Four neighborhoods were randomly selected for the data collection: Núcleo Habitacional São José I (very low risk), Jardim Morumbi (low risk), Parque São Jorge (regular risk), and Vila Rica (high risk). Each neighborhood was located in different risk strata for the transmission of intestinal parasites. The parents or guardians of all children aged four and five years who were enrolled in the corresponding EMEI (n = 462) were invited to participate in the study.

2.5. Data collection and laboratory analysis

Data collection was conducted between 2015 and 2016. The parents or guardians were interviewed using a previously structured questionnaire addressing socioeconomic aspects, structural conditions of the domicile, domestic habits, child hygienic-sanitary behavior, and knowledge about infections with intestinal parasites. Labeled with the child's name and registration number, a proper flask for the collection of a single stool sample was given along with oral and written instructions for collection at home. On a scheduled day, the containers were collected and sent in a thermal box to the Basic Sciences Laboratory of the Federal University of Mato Grosso. The samples were preserved with 10% formaldehyde until analysis.

Each fecal sample was processed using the sedimentation technique[17] and analyzed in triplicate by three different analysts under an optical microscope after coloration with Lugol's iodine solution.

2.6. Data analysis

The obtained data were double checked, organized, and tabulated using EpiData 3.1 software. Statistical analysis was performed using BioEstat 5.3 software to evaluate the association between the presence of infection with intestinal parasites and the studied factors. The *Chi*-square or Fisher exact test was used to compare the groups, and the *Chi*-square trend test was adopted to compare the occurrences of intestinal parasites among the strata. The odds ratios (OR) and confidence intervals (*CI*) were calculated for each variable. The differences were considered statistically significant at a P-value < 0.05.

2.7. Community return

Health education activities based on the risk factors identified in the present study were developed with the children and their respective parents or guardians. The subjects with positive parasitological stool samples underwent specific individual treatments and medical counseling.

2.8. Ethical consideration

The study protocol was performed according to the Helsinki declaration and approved by the Research Ethics Committee of the University Hospital Júlio Müller (CAAE number 39938314.8.0000.5541). Informed written consent was obtained from all the parents or guardians.

3. Results

Among the 462 parents or guardians invited from the four studied neighborhoods, 215 (46.5%) signed the free and informed consent form, answered the questionnaire interview, and provided the stool sample of their respective child. Among the children, 53.5% were

Table 1
Risk stratification for intestinal parasites infections in the urban neighborhoods of Rondonópolis city, Mato Grosso State, Brazil, according to socioeconomic and structural characteristics.

Variables	Risk strata			
	Very low	Low	Regular	High
Number of neighborhoods	2.0	9.0	14.0	1.0
% of permanent households with monthly nominal income per capita up to 1/2 minimum wage[a]	10.0	24.3	26.3	34.6
% of permanent households with monthly nominal income per capita greater than 5 minimum wages[a]	3.5	1.7	0.9	0.5
% of literate people aged 10 years or older	96.8	92.7	90.0	85.3
% of permanent households with sewage network or septic tank	100.0	35.7	26.3	0.4
% of permanent households with ditch or rudimentary cesspit	0.0	63.8	72.2	95.9
% of permanent households that use river, lake or sea for sewage drainage	0.0	0.1	0.9	0.4
% of permanent households that use public supply as the main source of water	100.0	99.1	98.8	99.2
% of permanent households that use wells or springs as the main source of water	0.0	0.8	1.1	0.4
% of permanent households that use river, pond or lake as the main source of water	0.0	0.0	0.1	0.0
% of permanent households with regular garbage collection	100.0	99.9	99.4	99.6

[a]: Brazilian minimum wage (2010) = US$ 157.81 (R$ 510.00).
Source: Demographic Census, 2010[16].

male and 46.5% were female. Majority of the fathers (79.5%) and mothers (92.1%) were literate and had a household income greater than four minimum wages (78.6%).

A total of 49 (22.8%) children were positive for intestinal protozoa or helminths, with 42 (19.5%) presenting monoparasitism and 7 (3.3%) with polyparasitism. Polyparasitism cases were detected with *Endolimax nana* and *Entamoeba coli* ($n = 3$); *Giardia duodenalis* and *E. coli* ($n = 2$); *Blastocystis hominis*, *G. duodenalis,* and *E. coli* ($n = 1$); and *Ascaris lumbricoides* and *E. coli* ($n = 1$).

The analysis of the parasite distribution among the studied EMEIs showed a correspondence between the risk stratification and the prevalence of intestinal parasites ($\chi^2 = 4.78$; $df = 1$; $P = 0.0288$), as the occurrence increased with the increase in risk strata (Table 2).

Table 2

Prevalence of intestinal helminths and protozoa among children from public preschools in the city of Rondonópolis, State of Mato Grosso State, Brazil (2015 and 2016) according to the neighborhood.

Neighborhood	Risk strata	Positive		Negative		Total
		n	%	*n*	%	
Vila Rica	High	20	30.30	46	69.70	66
Parque São Jorge	Regular	14	24.10	44	75.90	58
Vila Rosely	Low	11	18.90	47	81.00	58
Núcleo Habitacional São José I	Very low	4	12.10	29	87.90	33
Total		49	22.79	166	77.21	215

Table 3 shows the distribution and the frequency of the species of intestinal protozoa and helminths among the evaluated EMEIs. Among the six species surveyed, *E. coli* and *G. duodenalis* were more frequent than the others. It is noticeable that the EMEI from the very low risk stratum demonstrated a lower variability of infecting species.

Table 3

Species of intestinal helminths and protozoa detected among children from public preschools located in different risk strata in the city of Rondonópolis, State of Mato Grosso, Brazil (2015 and 2016).

Instestinal protozoa/ helminth	Risk strata								Total	
	High		Regular		Low		Very low			
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Entamoeba coli	13/66	65.0	5/58	8.6	6/58	10.3	-	-	24/215	11.2
Giardia duodenalis	4/66	6.1	8/58	13.8	6/58	10.3	3/33	9.1	21/215	9.8
Endolimax nana	4/66	6.1	-	-	-	-	1/33	3.0	5/215	2.3
Hymenolepis nana	2/66	3.0	2/58	3.5	-	-	-	-	4/215	1.9
Ascaris lumbricoides	2/66	3.0	-	-	-	-	-	-	2/215	0.9
Blastocystis hominis	-	-	-	-	1/58	1.7	-	-	1/215	0.5

The evaluated variables that showed a statistically significant association with the presence of intestinal parasites were related to the hygienic-sanitary habits of the families and children, including consumption of tap water (OR 3.56, 95% *CI* 1.57–8.07), no washing of fruits and vegetables before consumption at home (OR 3.44, 95% *CI* 1.54–7.69), and no hand washing before eating (OR 2.63, 95% *CI* 1.34–5.14) (Table 4).

Table 4

Factors associated with infections by intestinal protozoa and helminth among children from public preschools in the urban area of Rondonópolis city, Mato Grosso State, Brazil (2015 and 2016).

Variables	Total		Positive		OR	95% *CI*	*P*-value
	n	%	*n*	%			
Sex							
Male	115	53.5	26	53.1	0.98	0.52–1.85	0.95
Female	100	46.5	23	46.9	1.00	-	-
Household income (minimum wage)[a]							
< 1	32	14.9	10	20.4	1.64	0.72–3.76	0.24
⩾ 1	180	83.7	39	79.6	1.00	-	-
Not informed	3	1.4	0	0.0	-	-	-
Father's education							
No schooling	37	17.2	11	22.5	4.23	0.48–37.17	0.17[c]
Primary school	67	31.2	22	44.9	4.89	0.59–40.65	0.11[c]
High school	93	43.3	14	28.6	1.77	0.21–14.95	0.59[c]
College	11	5.1	1	2.0	1.00	-	-
Not informed	7	3.2	1	2.0	-	-	-
Mother's education							
No schooling	14	6.5	6	12.3	3.50	0.68–17.97	0.12[c]
Primary school	57	26.5	18	36.7	2.15	0.55–8.46	0.26[c]
High school	124	57.7	22	44.9	1.01	0.27–3.80	0.99[c]
College	17	7.9	3	6.1	1.00	-	-
Not informed	3	1.4	0	0.0	-	-	-
Crowding (people/household)							
< 1	87	40.5	15	30.6	1.00	-	-
1–2	105	48.8	26	53.1	1.58	0.78–3.22	0.21
> 2	10	4.7	3	6.1	2.06	0.48–8.88	0.33[c]
Not informed	13	6.0	5	10.2	-	-	-
Family purchasing power[b]							
B1	7	3.2	2	4.1	1.00	-	-
B2	27	12.6	3	6.1	0.31	0.04–2.38	0.25[c]
C1	86	40.0	19	38.8	0.71	0.13–3.95	0.69[c]
C2	61	28.4	16	32.6	0.89	0.16–5.04	0.89[c]
D or E	34	15.81	9	18.4	1.11	0.18–6.77	0.91[c]
Sewage system							
Yes	209	97.2	46	93.9	1.00	-	-
No	6	2.8	3	6.1	3.54	0.69–18.15	0.11[c]
Public waste collection							
Yes	212	98.6	49	100.0	-	-	0.34[c]
No	3	1.4	0	0.0	-	-	-
Water supply							
Public system	206	95.8	49	100.0	-	-	0.10[c]
Well/stream	9	4.2	0	0.0	-	-	-
Source of drinking water							
Filtered, bottled or boiled	77	35.8	8	16.3	1.00	-	-
Tap	137	63.7	40	81.6	3.56	1.57–8.07	0.002*
Not informed	1	0.5	1	2.1	-	-	-
Vegetable consumption							
Yes	198	92.1	46	93.9	1.41	0.39–5.13	0.60[c]
No	17	7.9	3	6.1	1.00	-	-
Hygiene of vegetables before consumption at the household							
Yes	171	79.5	33	67.3	1.00	-	-
No	31	14.4	14	28.6	3.44	1.54–7.69	0.002*
Not informed	13	6.1	2	4.1	-	-	-
Hand washing before feeding							
Yes	106	49.3	33	67.4	1.00	-	-
No	109	50.7	16	32.6	2.63	1.34–5.14	0.004*
Place used for defecation							
Bathroom	211	98.1	48	98.0	1.00	-	-
Yard	3	1.4	1	2.0	1.68	0.15–19.13	0.66[c]
Not informed	1	0.5	0	0.0	-	-	-
Hand washing after defecation							
Yes	150	69.7	36	73.5	1.00	-	-
No	64	29.8	13	26.5	0.81	0.39–1.65	0.56
Not informed	1	0.5	0	0.0	-	-	-
Previous stool examination in child							
Yes	141	65.6	29	59.2	1.00	-	-
No	71	33.0	19	38.8	1.41	0.72–2.74	0.31
Not informed	3	1.4	1	2.0	-	-	-
Parents' knowledge about the prevention of intestinal parasites							
Yes	119	55.3	23	46.9	1.00	-	-
No	90	41.9	25	51.0	1.61	0.84–3.07	0.15
Not informed	6	2.8	1	2.1	-	-	-

[a]: Brazilian minimum wage (2016) = US$ 276.7 (R$ 880.0); [b]: According to the criteria of the Brazilian Association of Market Research Companies; [c]: Calculated for Fisher's exact test.

4. Discussion

Infections by intestinal parasites remain a major challenge in public health in developing countries, especially among preschoolers[8,9]. Nevertheless, the current information on the occurrence of these infections in some Brazilian regions is still scarce. In the present study, the prevalence of helminths and protozoa in preschoolers from Rondonópolis and the associated risk factors were determined.

The overall prevalence of intestinal parasites detected in the children was 22.8%, which was lower than those reported for preschoolers by Carvalho *et al*. (53.4%)[18] and Santos *et al*. (63.7%)[19] in Brazil, and by Cañete *et al*. (71.1%)[20] and Al-Mekhlafi *et*

al. (54.8%)[21] abroad. These differences may be attributed to the variations in socioeconomic and structural levels of the evaluated populations[18]. In addition, according to Casavechia *et al*., the tendency of authors to analyze specific populations or areas with a high probability of occurrence of these parasites could bias the results to obtain a higher prevalence[22].

To avoid this bias, this study surveyed children from preschools located in neighborhoods with different living condition indicators established previously by an adapted index (SSI)[13]. The risk stratification of the neighborhoods demonstrated wide variations of living conditions throughout the city, consistent with the distribution of intestinal parasitic diseases, once that the prevalence of intestinal parasites increased with the increase in the risk of transmission. Teixeira *et al*. demonstrated a similar relationship between living conditions in different urban spaces in the city of Salvador, Brazil, and mortality due to infectious and parasitic diseases[23].

The municipality of Rondonópolis was emancipated in 1953, and it suffered an accelerated and disorderly process of urbanization and population growth that persists until today. As in other Brazilian municipalities, this condition created neighborhoods with remarkable differences, such as high prevalence of poverty, low educational level, overcrowding, and precarious sanitary conditions; this outcome corroborates the high occurrence of intestinal parasites in these areas[1,11,24].

Although the current study detected a representative prevalence of intestinal protozoa and helminths among several neighborhoods characterized by the proposed SSI, a previous study conducted in a single day care center from the city demonstrated a similar result, that is, a positivity rate of 27.3%[14]. However, as demonstrated in the current study, the occurrence was extremely heterogeneous among the epidemiological scenarios. Therefore, this type of stratification is useful in identifying critical areas and in improving the targeting of control programs for intestinal parasitic diseases and other infectious and parasitic diseases[13,23].

Regarding the species herein detected, the notably higher prevalence of protozoa than helminths is corroborated by the conclusions of Gonçalves *et al*. and Casavechia *et al*., who conducted cross-sectional surveys in Uberlândia City[7] and Marialva City[22] both in Brazil, respectively. This fact may be related to the mass preventive chemotherapy annually conducted with a single dose of broad-spectrum anthelmintic at local public schools and routinely prescribed in basic health units[22,25].

Among the species, the protozoan *E. coli* was the most frequently found, supporting the data of Menezes *et al*.[1] and Santos *et al*.[19]. Despite being nonpathogenic, its cysts have the same transmission pathway of pathogenic species, which is a risk due to the possible fecal contamination of water and/or food consumed by children[22,26]. The same finding is valid for the protozoan *E. nana* and *I. butschlii*.

As detected in the current study, high rates of infections by *G. duodenalis* have been highlighted by recent studies conducted elsewhere on preschoolers[27]. Although *G. duodenalis* is primarily a waterborne pathogen, the transmission of its cysts may occur accidentally during recreational activities through interpersonal contact because of non-hygienic behavior and precarious sanitary conditions[6]. Aside from low immunity to reinfection, these factors consider giardiasis as one of the most common intestinal parasite among preschool children[9,28].

To our knowledge, the present study is the first to identify the behavioral risk factors associated with infections with intestinal parasites among children in Mato Grosso State, Brazil. In this context, the practice of drinking tap water was significantly associated with a high occurrence of infections, thus corroborating the evaluations of Komagome *et al*.[29] and Belloto *et al*.[30]. Given that 95.8% of the evaluated families reported the use of water from the public system, the local water treatment may be inferred to be insufficient to eliminate such parasites. It is known that protozoan cysts used to be resistant to this procedure, as observed in samples of tap water from the city of Ribeirão Preto, Brazil[31].

The practice of not washing vegetables before consuming them was also significantly associated with the infections. Vegetables marketed in Brazil are usually contaminated with helminth and protozoa, thus representing a potential source of infection when not properly sanitized prior to consumption[26,31]. Additionally, not washing hands before eating was also a significant associated factor. Hands can carry parasites that lead to infection and/or reinfection mainly in children who tend to present rudimentary hygienic–sanitary habits[7,18,32]. Thus, regular hand washing is a well-defined protective factor for intestinal parasitic infections[33].

Given the identified associated factors, the infection in the studied population may be strongly related to the adoption of poor hygienic habits at home, as also detected in the Federal District of Brazil[19]. Accordingly, implementing sanitary education programs that address the aspects related to the adoption of correct habits for children and their parents is essential[7]. These programs should emphasize the consumption of filtered or boiled water, the complete washing of fruits and vegetables before consumption, and the correct and frequent hand hygiene.

The current study has some limitations. First, a single stool sample per child was examined because of the difficulty in obtaining these specimens from the population. Thus, the prevalence of intestinal protozoa might have been underestimated. Second, laboratory techniques for the detection of some intestinal parasites with higher sensibility, such as *Strongyloides stercoralis*, *Taenia* spp., and *Enterobius vermicularis*, were not employed. These limitations could be overcome by using multiple stool sampling and different diagnostic techniques[34].

Despite these limitations, the present investigation highlights one health problem of Rondonópolis City. The findings prove that living condition is extremely variable in this population and that it seems to be related to the differences in the occurrence of intestinal parasitic infections. This scenario requires specific and integrated strategies that include the monitoring of health conditions, enhancement of basic sanitation, improved income distribution, and health education programs[1,29,35]. These measures may contribute to the improvement of children's health by reducing public and individual medical care costs and the burden of these infections, thus directly enhancing the quality of life.

In conclusion, this study revealed a relevant prevalence of intestinal parasitic infections, with the predominance of protozoa, among preschoolers in the city of Rondonópolis, especially in neighborhoods with poor socioeconomic and structural conditions. These infections are associated with the precarious hygienic–sanitary behavior of children and their families.

Conflict of interest statement

We declare that we have no conflict of interest.

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