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Downward trend in prevalence of intestinal parasites in children over two decades, southern Brazil

Tendência decrescente na prevalência de enteroparasitoses em crianças atendidas durante duas décadas no sul do Brasil

Tendencia decreciente en la prevalencia de parásitos intestinales en niños atendidos durante dos décadas en el sur de Brasil

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Abstract
About one-quarter of the world's population is infected by geohelminths. The aim of this research was investigated the prevalence and predictors associated with intestinal parasites in children on over two decades. A retrospective study was conducted with children (0-18 years old) attended in the period of 1997-2016 by a public institution in southern Brazil. Data analysis was carried out using Stata® 9.1. A total of 7,292 records were analyzed; the overall prevalence was 25.5%. Most records showed infection by protozoa (69.4%). The most prevalent intestinal parasites were *Entamoeba coli* (9.4%) and *Giardia duodenalis* (8.9%). Statistically significant (p<0.05) associations were found between intestinal parasites and predictor variables of sex and age. The highest infection rates were detected in subjects from 0-4 years old (y/o) by *G. duodenalis* (OR 7.2, p<0.001). The lowest infection rates were in the 10-14 y/o group (OR 1.7, p<0.001). In all age groups, *G. duodenalis* caused the most infections and was more common in males (OR 1.3; p<0.001). Our findings show consistent prevalence with important predictors. We also detected a downward trend in intestinal parasite prevalence in the 20 years of observance.
Keywords: Primary Health Care; Parasitic diseases; Risk factors; Helminthiasis; Prevalence.

Resumo
Cerca de um quarto da população mundial está infectada por geohelmintos. O objetivo deste trabalho foi investigar a prevalência e os preditores associados às enteroparasitoses em crianças atendidas durante duas décadas. Um estudo retrospectivo foi realizado com crianças (0-18 anos) atendidas no período de 1997 a 2016 por uma instituição pública do Sul do Brasil. A análise dos dados foi realizada utilizando-se o Stata® 9.1. Foram analisados 7.292 registros; a prevalência global foi de 25,5%. A maioria dos registros apresentou infecção por protozoário (69,4%). Os parasitas

intestinais mais prevalentes foram *Entamoeba coli* (9,4%) e *Giardia duodenalis* (8,9%). Associações estatisticamente significativas (p<0,05) foram encontradas entre parasitas intestinais e variáveis preditoras de sexo e idade. As maiores taxas de infecção foram detectadas em indivíduos de 0 a 4 anos por *G. duodenalis* (OR 7,2, p<0,001). As menores taxas de infecção foram no grupo 10-14 (OR 1,7, p<0,001). Em todas as faixas etárias, *G. duodenalis* causou mais infecções e foi mais comum no sexo masculino (OR 1,3; p<0,001).
Palavras-chave: Atenção Primária à Saúde; Doenças parasitárias; Fatores de risco; Helmintíase; Prevalência.

Resumen
Alrededor de una cuarta parte de la población mundial está infectada con geohelmintos. El objetivo de este trabajo fue investigar la prevalencia y los predictores asociados con los parásitos intestinales en niños atendidos durante dos décadas. Se realizó un estudio retrospectivo con niños (0-18 años) atendidos de 1997 a 2016 por una institución pública en el sur de Brasil. El análisis de los datos se realizó con Stata® 9.1. Se analizaron un total de 7.292 registros; la prevalencia global fue del 25,5%. La mayoría de los registros presentaron infección por protozoos (69,4%). Los parásitos intestinales más prevalentes fueron *Entamoeba coli* (9,4%) y *Giardia duodenalis* (8,9%). Se encontraron asociaciones estadísticamente significativas (p<0,05) entre parásitos intestinales y variables predictoras de sexo y edad. Las mayores tasas de infección se detectaron en individuos de 0 a 4 años por *G. duodenalis* (OR 7,2, p<0,001). Las tasas de infección más bajas fueron en el grupo 10-14 (OR 1,7, p<0,001). En todos los grupos de edad, *G. duodenalis* causó más infecciones y fue más común en hombres (OR 1,3; p<0,001). Nuestros hallazgos muestran una prevalencia consistente con predictores importantes. También detectamos una tendencia a la baja en la prevalencia de parásitos intestinales en los 20 años de observancia.
Palabras clave: Atención Primaria de Salud; Enfermedades parasitarias; Factores de riesgo; Helmintiasis; Prevalencia.

1. Introduction

Intestinal parasitic infections (IPIs) can be caused by protozoa or nematodes and are considered neglected tropical diseases (World Health Organization, 2022a). Approximately one-quarter of the world's population is infected by soil-transmitted helminths (STHs) (World Health Organization, 2022b). Several studies point to *Giardia duodenalis* as one of the most common protozoans causing chronic diarrhea worldwide (Dunn & Juergens, 2022).

The understanding of the prevalence and transmission of intestinal parasites has a fundamental role in the implementation of therapeutic, preventative, and control strategies by public health systems (Gil, et al., 2013) to reduce suffering in the affected population (World Health Organization, 2017). Different prevalence rates of IPIs have been reported around the world, with percentages ranging from 5% to 80%. These prevalence rates may vary according to socio-economic status, age, and the geography of the studied country (Cabada, et al., 2016; Korzeniewski, et al., 2016). In Brazil, STH prevalence in municipalities with low human development indexes varies from 2 to 36%, and 70% of cases occur in school-age children (Ministério da Saúde, 2013). These indicators are most prominent in the 0-5 y/o group; this is likely due to a lack of hygiene habits and susceptibility to re-infection due to low immunity (both factors are inherent with 0-5 y/o group) (Uchôa, et al., 2001).

The vast majority of the studies conducted on IPIs prevalence are performed with specific populations, spatially constrained, and in distinct time intervals. Such factors complicate the investigation of the course of these diseases. More studies need to address municipal or state databases to enable data analysis and the understanding of IPIs scenarios in the population (Casavechia, et al., 2016). To the best of our knowledge, this is one of the first epidemiological investigations to use an extensive amount of IPI-related data (two decades of records) in school-age children and adolescents. Our study showed high infection risk from the protozoa *G. duodenalis* (approximately 250%) in the 0-10 y/o group. We also performed a temporal series study with data over the two decades to observe the prevalence and predictor variable associations in children with IPIs.

2. Methodology

2.1 Location and type of study

We carried out a cross-sectional epidemiological study (Gordis, 2019, Huley, et al 2015) with retrospective data from 1997 to 2016, in 0-18 y/o subjects at the Laboratory of Teaching and Research in Clinical Analyses (LEPAC) of the State University of Maringá (UEM). This research of a quantitative nature was approved by the Research Ethics Committee of the State University of Maringá (nº 1,664,114). LEPAC assists patients treated by the Brazilian Health System (SUS) at the university community of Maringá and 29 other municipalities (estimated total population of 816,771) of the 15th Regional Health Authority of the State of Paraná (Figure 1) (Ministério da Saúde, 2018).

Figure 1. Geographic scope of the 15th Regional Health Authority of the state of Paraná, Brazil.

Municipalities belonging to 15th Regional Health Authority of the state of Paraná. We highlight the location of the city of Maringá, where the State University of Maringá is located. Source: Authors.

2.2 Laboratory procedures

Analysis results were transcribed to internal quality control books of the laboratory. Routine exam results were used for diagnostics of IPIs by the methods of centrifugal flotation with zinc sulfate (Faust, et al., 1939), concentration by spontaneous sedimentation (Hoffman, et al., 1934), and identification of live larvae (Rugai, et al., 1954).

2.3 Data collection and statistical analysis

Statistical analysis was performed by Stata® software version 9.1 (Stata Corp., College Station, TX, USA). To avoid mistyping, data was organized and tabulated using EpiData® software (version 3.1) with the following variables: age, sex, result, species, and groups of parasites. Descriptive and analytical statistical analyzes were performed using mean and standard deviation. The chi-square test was used for bivariate analysis, with statistical significance of p values <0.05. The measure of effect used was odds ratio (OR) and a 95% confidence interval were used to estimate the risk between variables. Logistic regression models were developed to identify associations between the predictor variables and the outcome. All variables with results of p <0.20 were included in the final logistic model. After adjusting of the variable with the respective parasites (*E. coli*, *G. duodenalis*, *A. lumbricoides*, Hookworms, *E. vermiculari*, *E. nana*, *S. stercoralis*, *T. trichiura*, *H. nana*), significant associations with p values <0.05 were considered significant.

3. Results

A total of 7,292 records were analyzed from a total of 32,580 database records in the studied period. The average age was 8.3 ± 5.2 years old; 55.5% (4,045/7,292) were male and 44.5% (3,244/7,292) were female. General positivity was 25.5% (1,862/7,292) (Table 1); 69.4% (1,293/1,862) tested positive exclusively for protozoa; 17.6% (328/1,862) exclusively for helminths; and 12.3% (229/1,862) for both groups. The variables of age group and positivity demonstrated an increasing gradient of estimated risk between three age groups (0-4, 5-9, 10-14 y/o), respectively (OR 1.37, p<0.01; OR 1.56, p<0.001; OR 1.72, p<0.001).

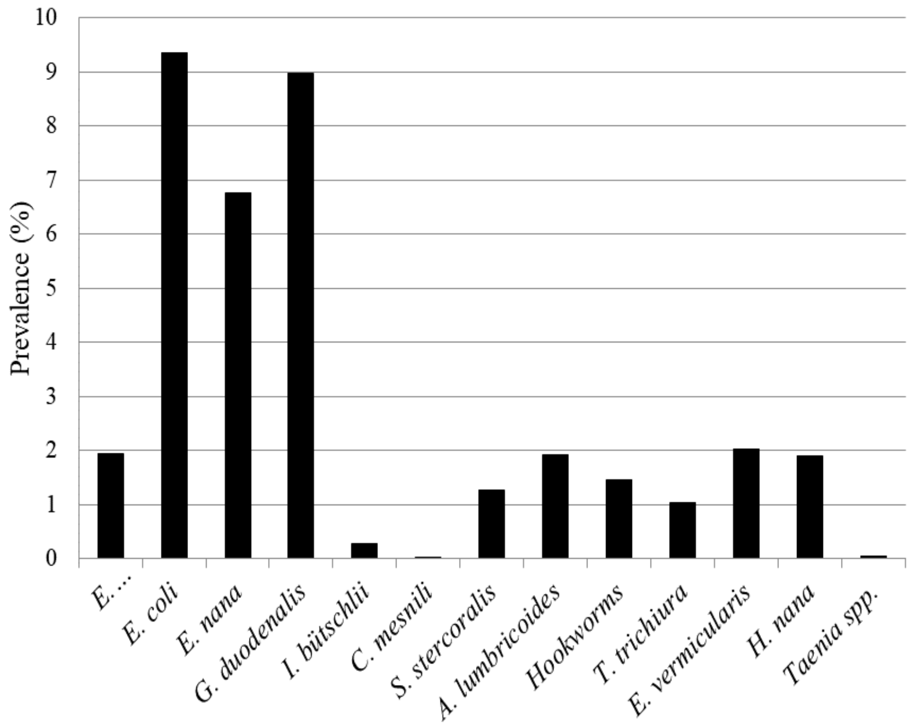
Table 1. Frequency distribution of demographic variables in the studied population, Maringá, state of Paraná, Brazil 1997-2016.

Demographic variables	Total	Positives	OR (95% CI)	p-value*
	n (%)	n (%)		
Sex				
Male	4,045 (55.5)	1,023 (25.3)	0.97 (0.9 – 1,1)	0.593
Female	3,247 (44.5)	839 (25.8)	1.00	-
Age group (years)				
0 to 4	2,086 (28.6)	517 (24.8)	1.37 (1.2 – 1.6)	<0.010*
5 to 9	2,390 (32.8)	654 (27.4)	1.56 (1.3 – 1.8)	<0.001*
10 to 14	1,459 (20.0)	428 (29.3)	1.72 (1.4 – 2.1)	<0.001*
15 to 18	1,357 (18.6)	263 (19.4)	1.00	-
Total	7,292 (100)	1,862 (100)		

Statistical significance was considered for p<0.05*. The table highlights the age group variable with the respective association for positive parasitological test results. Source: Authors.

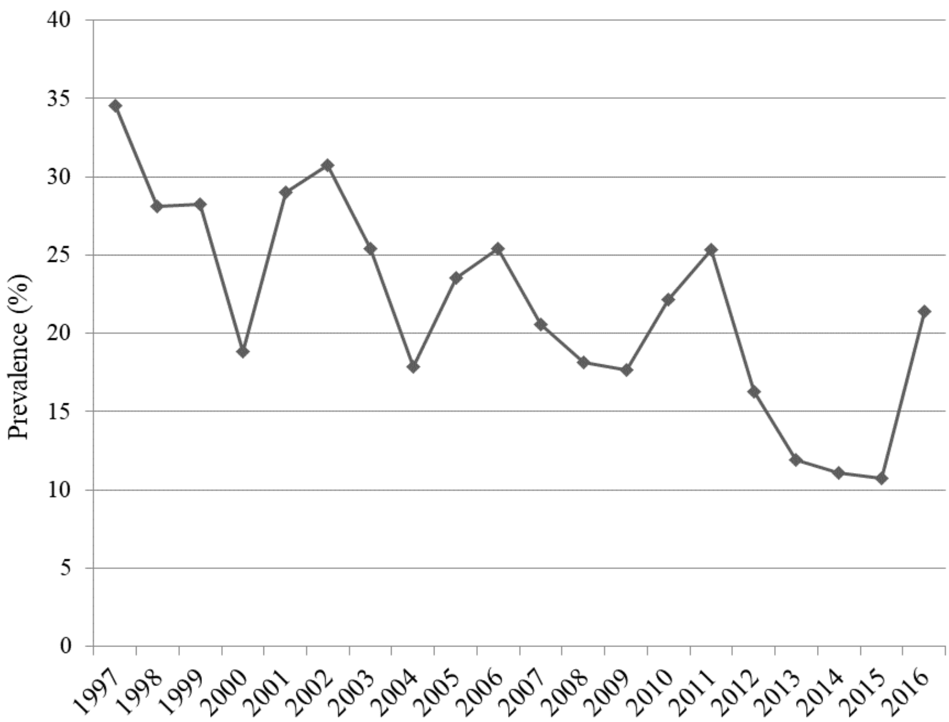
Records presented 13 different species of intestinal parasites (Figure 2). *Entamoeba coli* was the most prevalent protozoa (682/7292: 9.3%) in general and the most prevalent in females (337/7,292: 4.6%). *G. duodenalis* was the most prevalent in males (401/7,292: 5.4%) and the 0-4 y/o group (335/7,292: 4.6%). Among helminths, *Enterobius vermicularis* was the most prevalent (148/7,292: 2.0%) in both sexes and the 5-9 y/o group (64/7,292 0.9%). Polyparasitism was detected in 31% of positive results (586/1,862). Infection prevalence for each year showed a downward trend (34.5% in 1997, 21.4% in 2016) (Figure 3).

Figure 2. Species distribution of intestinal parasites in the studied population, Maringá, state of Paraná, Brazil, 1997-2016.



The highest prevalence rates were for *Entamoeba coli*, *Endolimax nana* and *Giardia duodenalis*. Source: Authors.

Figure 3. Temporal trend of the frequency of intestinal parasites in the studied population, Maringá, state of Paraná, Brazil, 1997-2016.



The figure reports a cyclical variation in prevalence, with a downward trend. Source: Source: Authors.

We observed statistically significant associations between males and *G. duodenalis* protozoan (p<0.001) and *E. coli* and females (p<0.01) (Table 2). We recorded positive associations with age groups for the following species: *Endolimax nana*, *G. duodenalis*, *Strongyloides stercoralis*, hookworms, and *Hymenolepis nana* (p<0.05). OR values ranged from 1.4 to 3.5 for these species. In the 0-10 y/o group, we observed positive associations with the following species: *E. nana*, *G. duodenalis*, and *H. nana*. OR values ranged from 1.4 to 3.5 for these species. In the 0-10 y/o group, we recorded positive associations with *S. stercoralis* and hookworms (OR values of 2.1 and 2.9, respectively). The protozoan *G. duodenalis* presented the highest OR in this study (Table 3).

Table 2. Association between intestinal parasites and sex in patients attended by LEPAC/UEM, Maringá, state of Paraná, Brazil, 1997-2016.

Parasites	Sex		Unadjusted OR (95% CI)	p-value*	Adjusted OR (95% CI)	p-value*
	Male	Female				
	n (%)	n (%)				
Protozoa						
Entamoeba histolytica/dispar	78 (1.93)	63 (1.94)	1.0 (0.7 - 1,4)	0.971	-	-
Entamoeba coli	345 (8.53)	337 (10.38)	1.2 (1.1 – 1.5)	<0.01*	1.2 (1.1 - 1.5)	<0.01*
Endolimax nana	275 (6.80)	218 (6.71)	1.0 (0.8 – 1.2)	0.886	-	-
Giardia duodenalis	401 (9.91)	253 (7.79)	1.3 (1.1 – 1.5)	<0.01*	1.3 (1.1 - 1.6)	<0.01*
Iodamoeba bütschlii	13 (0.32)	7 (0.22)	1.5 (0.6 – 3.7)	0.394	-	-
Chilomastix mesnili	2 (0.05)	0 (0)	-	-	-	-
Helminths						
Strongyloides stercoralis	52 (1.29)	40 (1.23)	1.0 (0.7 – 1.6)	0.838	-	-
Ascaris lumbricoides	70 (1.73)	70 (2.16)	1.3 (0.9 – 1.7)	0.180	1.2 (0.9 - 1.7)	0.212
Hookworms	68 (1.68)	38 (1.17)	1.4 (1.0 – 2.2)	0.072	1.5 (1.0 - 2.2)	0.049*
Trichuris trichiura	43 (1.06)	32 (0.99)	1.1 (0.7 – 1.7)	0.744	-	-
Enterobius vermicularis	71 (1.76)	77 (2.37)	1.4 (1.0 – 1.9)	0.065	1.3 (0.94 - 1.8)	0.105
Hymenolepis nana	71 (1.76)	68 (2.09)	1.2 (0.9 – 1.7)	0.293	-	-
Taenia spp.	1 (0.02)	2 (0.06)	2.4 (0.2 – 27.5)	0.456	-	-

The value of p < 0.05* was established for statistically significant parasites with the outcome variable (Sex), adjusted by *E. coli*, *G. duodenalis*, *A. lumbricoides*, Hookworms, *E. vermicularis*. Source: Authors.

Table 3. Association between intestinal parasites and age group in patients attended by LEPAC/UEM, Maringá, state of Paraná, Brazil, 1997-2016.

Parasites	Age group (years)		Unadjusted OR (95% CI)	p-value*	Adjusted OR (95% CI)	p-value*
	≤10	>10				
	n (%)	n (%)				
Protozoa						
Entamoeba histolytica/dispar	90 (1.84)	51 (2.12)	1.2 (0.8–1.6)	0.412	-	-
Entamoeba coli	467 (9.55)	215 (8.95)	1.1 (0.9-1.3)	0.404	-	-
Endolimax nana	301 (6.16)	192 (7.99)	1.3 (1.1–1.6)	<0.01*	1.4 (1.2 - 1.7)	<0.001*
Giardia duodenalis	566 (11.58)	88 (3.66)	3.4 (2.7–4.3)	<0.001*	3.5 (2.8 - 4.5)	<0.001*
Iodamoeba bütschlii	13 (0.27)	7 (0.29)	1.1 (0.4 –2.8)	0.845	-	-
Chilosmastix mesnili	0 (0)	2 (0.08)	-	-	-	-
Helminths						
Strongyloides stercoralis	45 (0.92)	47 (1.96)	2.1 (1.4–3.2)	<0.001*	2.1 (1.4 - 3.3)	<0.01*
Ascaris lumbricoides	102 (2.09)	38 (1.58)	1.3 (0.9 –1.9)	0.141	1.2 (0.8 - 1.9)	0.285
Hookworms	43 (0.88)	63 (2.62)	3.0 (2.1–4.5)	<0.001*	2.9 (1.9 - 4.4)	<0.001*
Trichuris trichiura	56 (1.15)	19 (0.79)	1.5 (0.9–2.5)	0.161	1.4 (0.8 - 2.5)	0.223
Enterobius vermicularis	97 (1.98)	51 (2.12)	1.1 (0.8–1.5)	0.694	-	-
Hymenolepis nana	108 (2.21)	31 (1.29)	1.7 (1.2–2.6)	<0.01*	1.7 (1.1 - 2.6)	0.012*
Taenia spp.	2 (0.04)	1 (0.04)	1	-	-	-

The value of $p < 0.05$* was established for statistically significant parasites with the outcome variable (age group), adjusted by by *E. nana*, *G. duodenalis, S. stercoralis, A. lumbricoides,* Hookworms, *T. trichiura, H. nana.* Source: Authors.

4. Discussion

IPIs primarily affect impoverished populations, which are often exposed to various infection vectors and poor sanitation conditions (World Health Organization, 2022a). The overall prevalence of IPIs (range of 23 to 61%) in our study was consistent with other studies conducted in the state of Paraná, despite the fact that the other studies used different populations (Lopes-Mori, et al., 2016; Martinichen-Herrero & Lenartovicz, 2013; Pittner, et al., 2007). The prevalence demonstrated in our study is lower than the prevalence reported in the Brazilian states of Pernambuco and Minas Gerais (Aguiar-Santos, et al., 2013; Gil, et al., 2013) and other countries (Korzeniewski, et al., 2016; Palmieri, et al., 2014; Sah, et al., 2013). Although our data were from patients who sought medical care from the public health system, research projects conducted in daycare centers, and low-income communities in the region of Maringá, the results indicate high development in health and sanitation in the studied region (Instituto Paranaense de Desenvolvimento Econômico e Social, 2018). The results also demonstrate the achievement of goals established by the 49th Directing Council to reduce the prevalence of STHs in children in high-risk areas to <20% by using preventive drug therapy. However, the Maringá region is not considered endemic for STHs (Pan American Health Organization & World Health Organization, 2009).

The highest prevalence found in our study was for G. duodenalis in the 0-10 y/o group, with the risk of approximately 250%. This was followed by *E. coli* and *E. nana* in the same age group, with risk of 30% for *E. nana*. High prevalence rates for non-pathogenic protozoa (*E. coli* and *E. nana*) and pathogenic protozoa (*E. histolytica*, *G. duodenalis*, etc.) may indicate water contamination (dos Santos & Merlini, 2010). The higher prevalence of *G. duodenalis* in the 10-18 y/o group is consistent with other research (Huang & White, 2006). A study conducted on the primary health units in the municipality of Marialva, state of Paraná, also showed statistical significance between the ≤10 y/o group and *G. duodenalis* (Al-Mekhlafi, et al., 2016). The detected prevalence and high risk of *G. duodenalis* infection can be due to direct interpersonal transmission of the protozoan and inappropriate hygiene habits that are typical of the age group (0-10 y/o) (Casavechia, et al., 2016). *Enterobius vermicularis* was the most prevalent helminth observed in our study, followed by *Ascaris lumbricoides* and *H. nana*, the latter with risk of 70%. Similar to protozoa transmission, the agglomeration of children in daycare centers and the cycle of autoinfection may explain the high prevalence of helminths *E. vermicularis*, *A. lumbricoides*, and *H. nana* in younger age groups (Neves, et al., 2016). The geohelminths *S. stercoralis* and hookworms presented the approximate risks of 100% and 200% in the 0-10 y/o group, respectively. A study reported that hookworms were the most prevalent IPI in Thailand and the most common in the 0-10 y/o group. More than half of the studied population in Thailand reported that they walked barefoot outside and played on the ground; this may explain the statistical significance found between these geohelminths and this age group (Punsawad, et al., 2018). A study in Campos dos Goytacazes, state of Rio de Janeiro, Brazil, showed a higher prevalence of IPIs in the 0-9 y/o group (de Moraes Neto, et al., 2010), while another study in Bolivia showed a higher prevalence of IPIs in the 0<10 (y/o) group (Macchioni, et al., 2016). The Bolivian study showed statistical significance in both age groups (0-10 y/o, 10-18 y/o) for more than one species of protozoa. However, some studies have not shown this significance (Abossie & Seid, 2014; Gonçalves, et al., 2011; Matthys, et al., 2011), which may be because studies commonly assess different populations and sanitary conditions.

In our study, males showed an increased risk of infection by *G. duodenalis* and hookworms; females showed a higher risk of infection by *E. coli*. However, no association was found between the positivity for IPIs and sex. In a study by Fonseca et al. (2010) on children in northern and northeastern Brazil, a single positive association was found between males and hookworms. Other studies have shown no statistical significance between parasite species and sex (Aguiar-Santos, et al., 2013; Osman, et al., 2016; Zaiden, et al., 2008).

Helminthiasis occurrence in our study was lower than protozoa occurrence. Also, our study showed lower helminthiasis prevalence than in other studies on children in other tropical regions (Abossie & Seid, 2014; Basso, et al., 2008; da Silva, et al., 2009). Our results possibly reflect the wide availability of anthelmintic drugs in primary health units and the preventive prescription of these drugs (Casavechia, et al., 2016). These factors may also justify the overall downward trend of IPI prevalence during the studied period. In addition, our study only used tests with techniques of routine analysis and did not include specific methods for detection of helminths or protozoa. We also did not use immunological methods, PCR, among others. *A. lumbricoides* was the most prevalent helminth in our study. This result was similar to studies conducted in the municipal education system in the municipality of Cascavel, state of Paraná (4.2%) (Martinichen-Herrero & Lenartovicz, 2013), and a daycare center in the city of Tubarão, state of Santa Catarina (1.3%) (Batista, et al., 2009). Other studies in the northeastern region of Brazil have reported *T. trichiura* as the most prevalent helminth (12% and 51.5%) (da Silva, et al., 2016; Lander, et al., 2012). These high rates of prevalence may be due to the common fecal-oral cycle of both helminths.

The percentage of polyparasitism in our study showed similar frequencies (6.7%) to the study of Gonçalves et al. (2011), which was carried out in pre-school children in the municipality of Uberlândia, state of Minas Gerais, and also to the study conducted by Nobre et al. (2013) in pre-school children in the city of Diamantina, in the state of Minas Gerais. In other studies, polyparasitism rates exceeded 50% of the positive samples for IPIs (Bhat, et al., 2013; Monteiro, et al., 2009; Silva & da Silva, 2010). Low socioeconomic populations often have a higher tendency to contract polyparasitism-related infections, as they are exposed to environments contaminated by multiple parasites. Such environments may contain infected animals and precarious sanitation and hygiene levels.

5. Conclusion

E. coli and *G. duodenalis* had the highest prevalence rates in our study, which corroborates with the consistent national levels of IPI prevalence. Also, over the two decades studied, a downward trend was detected each year. We also found predictors associated with sex and age in the population; the 10-14 y/o group was the most affected by IPIs. It is worth noting the importance of hygiene and basic sanitation to combat the transmission of these intestinal parasites in children and teenagers. More studies multicenters with representative samples should be carried out seeking a better understanding of the prevalence and risk factors associated with these parasites. In this way, helping health managers to plan the necessary actions to control these infections.

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References

Abossie, A., & Seid, M. (2014). Assessment of the prevalence of intestinal parasitosis and associated risk factors among primary school children in Chencha town, Southern Ethiopia. *BMC Public Health*, *14*(1), 1–8. https://doi.org/10.1186/1471-2458-14-166

Aguiar-Santos, A. M., Medeiros, Z., Bonfim, C., Rocha, A. C., Brandão, E., Miranda, T., Oliveira, P., & Sarinho, E. S. C. (2013). Epidemiological assessment of neglected diseases in children: Lymphatic filariasis and soil-transmitted helminthiasis. *Jornal de Pediatria*, *89*(3), 250–255. https://doi.org/10.1016/j.jped.2012.11.003

Al-Mekhlafi, A. M., Abdul-Ghani, R., Al-Eryani, S. M., Saif-Ali, R., & Mahdy, M. A. K. (2016). School-based prevalence of intestinal parasitic infections and associated risk factors in rural communities of Sana'a, Yemen. *Acta Tropica*, *163*, 135–141. https://doi.org/10.1016/j.actatropica.2016.08.009

Basso, R. M. C., Silva-Ribeiro, T., Soligo, D. S., Ribacki, S. I., Callegari-Jacques, S. M., & Zoppas, B. C. D. A. (2008). Evolution of the prevalence of intestinal parasitosis among schoolchildren in Caxias do Sul, RS. *Rev Soc Bras Med Trop*, *41*(3), 263–268. https://doi.org/S0037-86822008000300008

Batista, T., Trevisol, F. S., & Trevisol, D. J. (2009). Parasitoses intestinais em pré-escolares matriculados em creche filantrópica no sul de Santa Catarina. *Arquivos Catarinenses de Medicina*, *38*(3), 39–45. Retrieved from http://www.acm.org.br/revista/pdf/artigos/753.pdf

Bhat, V., Vasaikar, S., Nxasana, N., & Baba, K. (2013). Prevalence of intestinal parasites in primary school children of mthatha, Eastern Cape Province, South Africa. *Annals of Medical and Health Sciences Research*, *3*(4), 511. https://doi.org/10.4103/2141-9248.122064

Cabada, M. M., Morales, M. L., Lopez, M., Reynolds, S. T., Vilchez, E. C., Lescano, A. G., Gotuzzo, E., Garcia, H. H., & White, C. A. (2016). *Hymenolepis nana* impact among children in the highlands of Cusco, Peru: An emerging neglected parasite infection. *The American Journal of Tropical Medicine and Hygiene*, *95*(5), 1031–1036. https://doi.org/10.4269/ajtmh.16-0237

Casavechia, M. T. G., Lonardoni, M. V. C., Venazzi, E. A. S., Campanerut-Sá, P. A. Z., da Costa Benalia, H. R., Mattiello, M. F., Menechini, P. V. L., dos Santos, C. A., & Teixeira, J. J. V. (2016). Prevalence and predictors associated with intestinal infections by protozoa and helminths in southern Brazil. *Parasitology Research*, *115*(6), 2321–2329. https://doi.org/10.1007/s00436-016-4980-y

da Silva, E. F., da Silva, E. B., Almeida, K. de S., de Sousa, J. J. N., & Freitas, F. L. da C. (2009). Enteroparasitoses em crianças de áreas rurais do município de Coari, Amazonas, Brasil. *Revista de Patologia Tropical*, *38*(1), 35–43. https://doi.org/10.5216/rpt.v38i1.6219

da Silva, J. V. L., Fontes, G., dos Santos, C. D., dos Santos, R. V., & da Rocha, E. M. M. (2016). Factors Associated with Gastrointestinal Parasitic Infections among Young Population in Northeast Brazil. *Canadian Journal of Infectious Diseases & Medical Microbiology*, *2016*, 1–6. https://doi.org/http://dx.doi.org/10.1155/2016/6239434

de Moraes Neto, A. H. A., Pereira, A. P. M. F., Alencar, M. D. F. L., Souza-Júnior, P. R. B., Dias, R. C., Fonseca, J. G., Santos, C. P., & Almeida, J. C. A. (2010). Prevalence of intestinal parasites versus knowledge, attitudes, and practices of inhabitants of low-income communities of Campos dos Goytacazes, Rio de Janeiro State, Brazil. *Parasitology Research*, *107*(2), 295–307. https://doi.org/10.1007/s00436-010-1861-7

dos Santos, S. A., & Merlini, L. S. (2010). Prevalência de enteroparasitoses na população do município de Maria Helena, Paraná. *Ciência & Saúde Coletiva*, *15*(3), 899–905. https://doi.org/10.1590/S1413-81232010000300033

Dunn N & Juergens A. L. (2022). *Giardiasis*. Treasure Island: StatPearls Publishing. Available from: https://www.ncbi.nlm.nih.gov/books/NBK513239/

Faust, E. C., Sawitz, W., Tobie, J., Odom, V., Peres, C., & Lincicome, D. R. (1939). Comparative Efficiency of Various Technics for the Diagnosis of Protozoa and Helminths in Feces. *The Journal of Parasitology*, *25*(3), 241–262. https://doi.org/http://dx.doi.org/10.2307/3272508

Fonseca, E. O. L., Teixeira, M. G., Barreto, M. L., Carmo, E. H., & Costa, M. D. C. N. (2010). Prevalência e fatores associados às geo-helmintíases em crianças residentes em municípios com baixo IDH no Norte e Nordeste brasileiros. *Cadernos de Saúde Pública*, *26*(1), 143–152. https://doi.org/10.1590/S0102-311X2010000100015

Gil, F. F., Busatti, H. G. N. O., Cruz, V. L., Santos, J. F. G., & Gomes, M. A. (2013). High prevalence of enteroparasitosis in urban slums of Belo Horizonte-Brazil. Presence of enteroparasites as a risk factor in the family group. *Pathogens and Global Health*, *107*(6), 320–324. https://doi.org/10.1179/2047773213Y.0000000107

Gonçalves, A. L. R., Belizário, T. L., Pimentel, J. de B., Penatti, M. P. A., & Pedroso, R. dos S. (2011). Prevalência de parasitoses intestinais em crianças institucionalizadas na região de Uberlândia, Estado de Minas Gerais. *Revista Da Sociedade Brasileira de Medicina Tropical*, *44*(2), 191–193. https://doi.org/10.1590/S0037-86822011005000022

Gordis L. *Epidemiología*. 6ª ed. Madrid: Elsevier España, 2019.

Hoffman, W., Pons, J., & Janer, J. (1934). The sedimentation concentration method in schistosomiasis mansoni. *Puerto Rico J Publ Health Trop Med*, *9*, 283–298.

Huang, D. B., & White, A. C. (2006). An Updated Review on Cryptosporidium and Giardia. *Gastroenterology Clinics of North America*, *35*(2), 291–314. https://doi.org/10.1016/j.gtc.2006.03.006

Huley S. B., Cummings S. R., Browner, W. S., Grady, D. G. & Newman, T. B. (2015). *Delineando Pesquisa Clínica. Uma Abordagem Epidemiológica*. Porto Alegre: Artmed.

Instituto Paranaense de Desenvolvimento Econômico e Social. (2018). *Caderno Estatístico - Município de Maringá*. Retrieved from http://www.ipardes.gov.br/cadernos/MontaCadPdf1.php?Municipio=87000

Korzeniewski, K., Smoleń, A., Augustynowicz, A., & Lass, A. (2016). Diagnostics of intestinal parasites in light microscopy among the population of children in eastern Afghanistan. *Annals of Agricultural and Environmental Medicine*, *23*(4), 666–670. https://doi.org/10.5604/12321966.1226864

Lander, R. L., Lander, A. G., Houghton, L., Williams, S. M., Costa-Ribeiro, H., Barreto, D. L., Mattos, A. P., & Gibson, R. S. (2012). Factors influencing growth and intestinal parasitic infections in preschoolers attending philanthropic daycare centers in Salvador, Northeast Region of Brazil. *Cadernos de Saúde Pública*, *28*(11), 2177–2188. https://doi.org/10.1590/S0102-311X2012001100017

Lopes-Mori, F. M. R., Mitsuka-Breganó, R., Oliveira, F. J. de A., Dutra, M. C. de M. N., Sarzi, M. de B. L., Aidar, M. R., & Conchon-Costa, I. (2016). Fatores associados a enteroparasitoses em escolares da rede municipal de ensino de Cambé. *Semina: Ciências Biológicas e Da Saúde*, *37*(1), 15–24. https://doi.org/10.5433/1679-0367.2016v37n1p15

Macchioni, F., Segundo, H., Totino, V., Gabrielli, S., Rojas, P., Roselli, M., Paredes, G. A., Masana, M., Bartoloni, A., & Cancrini, G. (2016). Intestinal parasitic infections and associated epidemiological drivers in two rural communities of the Bolivian Chaco. *Journal of Infection in Developing Countries*, *10*(9), 1012–1019. https://doi.org/10.3855/jidc.7657

Martinichen-Herrero, J. C., & Lenartovicz, V. (2013). Frequência de comensais e parasitas intestinais em escolares da Rede Pública Municipal de Cascavel, PR. *Revista Brasileira de Análises Clínicas*, *45*(1–4), 49–52.

Matthys, B., Bobieva, M., Karimova, G., Mengliboeva, Z., Jean-Richard, V., Hoimnazarova, M., Kurbonova, M., Lohourignon, L. K., Utzinger, J., & Wyss, K. (2011). Prevalence and risk factors of helminths and intestinal protozoa infections among children from primary schools in western Tajikistan. *Parasites & Vectors*, *Conference*, 318. https://doi.org/http://dx.doi.org/10.1111/tmi.12574

Ministério da Saúde. (2018). POPULAÇÃO RESIDENTE - ESTIMATIVAS PARA O TCU - PARANÁ. DATASUS. Retrieved August 10, 2018, from http://tabnet.datasus.gov.br/cgi/tabcgi.exe?ibge/cnv/poptpr.def

Ministério da Saúde. (2013). *Plano integrado de ações estratégicas de eliminação da hanseníase, filariose, esquistossomose e oncocercose como problema de saúde pública, tracoma como causa de cegueira e controle das geohelmintíases: plano de ação 2011-2015*. Brasília: Ministério da Saúde.

Monteiro, A. M. D. C., Silva, E. F., Almeida, K. D. S., de Sousa, J. J. N., Mathias, L. A., Baptista, F., & Freitas, F. L. da C. (2009). Parasitoses intestinais em crianças de creches públicas localizadas em bairros periféricos do munícipio de Coari, Amazonas, Brasil. *Revista de Patologia Tropical*, *38*(4), 284–290. https://doi.org/10.5216/rpt.v38i4.8592

Neves, D. P., de Melo, A. L., Linardi, P. M., & Vitor, R. W. A. (2016). *Parasitologia Humana*. São Paulo: Atheneu.

Nobre, L. N., Silva, R. V, Macedo, M. S., Teixeira, R. a, Lamounier, J. a, & Franceschini, S. C. C. (2013). Risk factors for intestinal parasitic infections in preschoolers in a low socio-economic area, Diamantina, Brazil. *Pathogens and Global Health*, *107*(2), 103–106. https://doi.org/10.1179/2047773213Y.0000000075

Osman, M., El Safadi, D., Cian, A., Benamrouz, S., Nourrisson, C., Poirier, P., Pereira, B., Razakandrainibe, R., Pinon, A., Lambert, C., Wawrzyniak, I., Dabboussi, F., Delbac, F., Favennec, L., Hamze, M., Viscogliosi, E., & Certad, G. (2016). Prevalence and Risk Factors for Intestinal Protozoan Infections with Cryptosporidium, Giardia, Blastocystis and Dientamoeba among Schoolchildren in Tripoli, Lebanon. *PLoS Neglected Tropical Diseases*, *10*(3), 1–17. https://doi.org/10.1371/journal.pntd.0004496

Palmieri, J., Anne Geers Childers, K., Sampson, M., & Brunet, D. (2014). Prevalence of gastrointestinal parasites in children from Verón, a rural city of the Dominican Republic. *Research and Reports in Tropical Medicine*, *5*, 45. https://doi.org/10.2147/rrtm.s64948

Pan American Health Organization, & World Health Organization. (2009). *Elimination of Neglected Diseases and Other Poverty-Related Infections*. Retrieved from https://iris.paho.org/bitstream/handle/10665.2/33933/CD49-09-e.pdf?sequence=1&isAllowed=y.

Pittner, E., Moraes, I. de F., Sanches, H. F., Trincaus, M. R., Raimondo, M. L., & Monteiro, M. C. (2007). COMUNIDADE ESCOLAR NA CIDADE DE GUARAPUAVA, PR. *Revista Salus*, *1*(1), 97–100.

Punsawad, C., Phasuk, N., Bunratsami, S., Thongtup, K., Viriyavejakul, P., Palipoch, S., Koomhin, P., & Nongnaul, S. (2018). Prevalence of intestinal parasitic infections and associated risk factors for hookworm infections among primary schoolchildren in rural areas of Nakhon Si Thammarat, southern Thailand. *BMC Public Health*, *18*(1), 3–9. https://doi.org/10.1186/s12889-018-6023-3

Rugai, E., Mattos, T., & Brisola, A. (1954). Nova técnica para isolar larvas de nematóides das fezes: modificação do método de Baermann. *Revista Do Instituto Adolfo Lutz*, *14*(1), 1–8.

Sah, R. B., Pokharel, P. K., Paudel, I. S., Acharya, A., Jha, N., & Bhattarai, S. (2013). A study of prevalence of intestinal parasites and associated risk factors among the school children of Dharan, Eastern Region of Nepal. *Indian Journal of Public Health Research and Development*, *5*(4), 294–299. https://doi.org/10.5958/0976-5506.2014.00061.8

Silva, L. P., & da Silva, R. M. G. (2010). Ocorrência de enteroparasitos em centros de educação infantil no município de Patos de Minas, MG, Brasil. *Bioscience Journal*, *26*(1), 147–151. Retrieved from https://seer.ufu.br/index.php/biosciencejournal/article/view/7038/4665

Uchôa, C. M. A., Lobo, A. G. B., Bastos, O. M. P., & Matos, A. D. (2001). Parasitoses intestinais: prevalência em creches comunitárias da cidade de Niterói, Rio de Janeiro - Brasil. *Revista do Instituto Adolfo Lutz*, *60*(2), 97–101. Retrieved from https://periodicos.saude.sp.gov.br/RIAL/article/view/35525

World Health Organization. (2022a). *Neglected tropical diseases*. Retrieved October 02, 2022, from https://www.who.int/health-topics/neglected-tropical-diseases#tab=tab_1

World Health Organization. (2022b). *Soil-transmitted helminth infections*. Retrieved March 12, 2018, from https://www.who.int/en/news-room/fact-sheets/detail/soil-transmitted-helminth-infections

World Health Organization. (2017). Schistosomiasis and soil-transmitted helminthiases: number of people treated in 2016. In *Weekly Epidemiological Record* (Vol. 92, Issue 49). https://doi.org/10.1016/j.actatropica.2012.04.013.

Zaiden, M. F., Santos, B. M. D. O., Cano, M. A. T., & Nascif, I. A. (2008). Epidemiologia das parasitoses intestinais em crianças de creches de Rio Verde-GO. *Medicina (Ribeirão Preto)*, *41*(2), 182–187. https://doi.org/10.11606/issn.2176-7262.v41i2p182-187