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Occurrence and spatial distribution of intestinal parasites in an agricultural center in Paraná State, Brazil

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ABSTRACT. We determined the occurrence of human cases of intestinal parasites and their spatial distribution in an agricultural center of the state of Paraná in southern Brazil. Results from 5,219 stool examinations carried out in 2003 and 2004 in public and private clinical-pathology laboratories were analyzed. The overall occurrence of intestinal parasites was 19.8%. *Entamoeba coli* (7.2%) and *Giardia duodenalis* (5.2%) were the most frequent species. *E. coli* was present in 36.4%, *G. duodenalis* in 26.2% and *E. nana* in 13.6% of positive cases. According to spatial distribution, the highest occurrence of intestinal parasites was observed in the Piquiri/Guarujá area ($p < 0.05$), and the lowest in the CSU, Urupês and Paulista areas. In Piquiri/Guarujá, the most common species were *G. duodenalis* (22.2%) and *E. coli* (7.4%). Significant differences in the occurrence of enteroparasites were observed for females ($p < 0.05$) and children 0 to 10 years of age ($p < 0.05$). The occurrence of intestinal parasites in the municipality was mostly related to children, females, and residence in rural areas and the peripheries of urban centers, where the risk of infection is greater. This information will allow the development of appropriate measures for disease prevention and optimization of resources.

Key words: occurrence, intestinal parasites, spatial distribution, southern Brazil.

RESUMO. Ocorrência e distribuição espacial de parasitos intestinais em polo agrícola, Estado do Paraná, Brasil. O objetivo deste trabalho foi determinar a ocorrência de casos humanos e a distribuição espacial de parasitos intestinais em município agroindustrial do Estado do Paraná, Sul do Brasil. Foram investigados resultados de 5.219 exames coproparasitológicos realizados em 2003 e 2004, em laboratórios de Análises Clínicas da rede pública e privada. A ocorrência de parasitos intestinais foi de 19,8%, sendo *Entamoeba coli* (7,2%) e *Giardia duodenalis* (5,2%) as espécies mais encontradas. Entre os resultados positivos *E. coli* estava presente em 36,4%, *G. duodenalis* em 26,2% e *E. nana* em 13,6%. A mais alta ocorrência de parasitos intestinais foi observada na área do Piquiri/Guarujá ($p < 0,05$) e a mais baixa no CSU, Urupês e Paulista. No Piquiri/Guarujá, as espécies mais frequentes foram *G. duodenalis* (22,2%) e *E. coli* (7,4%). Diferenças significativas na ocorrência de enteroparasitos foram observadas para o gênero feminino ($p < 0,05$) e para a faixa etária de zero a dez anos ($p < 0,05$). A ocorrência de parasitos intestinais no município está mais relacionada às crianças, ao gênero feminino e à área que apresenta características rurais e de periferia de centros urbanos onde o risco de infecção é maior. Esta informação irá permitir o desenvolvimento de medidas apropriadas para prevenir doenças e otimizar recursos.

Palavras-chave: ocorrência, parasitos intestinais, distribuição espacial, Sul do Brasil.

Introduction

Brazil is entering the 21st Century with important social problems that directly impact public health. These problems contribute to an increased incidence of infectious and parasitic diseases, especially in populations without access to adequate sanitation, revealing the degree of environmental contamination by potential human pathogens (BRASIL, 2004).

Parasitic infections caused by intestinal protozoa and helminthes are considered indicators of the degree of socio-economic development of a country (WHO, 2006). These infections take on greater importance because of the frequency with which they produce an organic deficit, with a delay in physical and intellectual development, particularly in younger age groups (FERREIRA et al., 2003; UCHÔA et al., 2001). Factors that influence the development of these infections include poor

sanitary conditions, unsafe water, malnutrition, limited host resistance, frequency of exposure, inadequate vector control, infection of reservoirs, increased migration, and globalization (MARQUES et al., 2005; MORRONE et al., 2004).

The state of Paraná, although it is located in southern Brazil and therefore is considered a prosperous region of the country, still has innumerable communities with high prevalence of intestinal parasites (GUILHERME et al., 2004; PITTNER et al., 2007; PUPULIN et al., 2004; QUEIROZ et al., 2006; SEGANTIN; DELARIVA, 2005). In the northeast part of the state are several municipalities, including the Municipality of Campo Mourão, that are agricultural centers, with mechanized farming of soy bean, corn, sugar cane and manioc, and cattle ranching. Campo Mourão does not monitor the occurrence of intestinal parasites, but often patients are treated with anti-parasitic medicines without confirmation by laboratory diagnosis. Data obtained from the Municipal Department of Health in 2004 show that large amounts of anti-parasitic medicines were dispensed by Health Centers, i.e., 86,042 tablets and 7,458 bottles of suspensions of metronidazole and mebendazole. In this context, this study aimed to determine the occurrence and spatial distribution of intestinal parasites in Campo Mourão, an agricultural center of the state of Paraná in southern Brazil.

Material and methods

Study site and living conditions of the population

The local climate is humid-mesothermal subtropical. The mean annual temperature is 21°C; the mean temperatures in the warmest months are above 22°C, and in the coolest months are below 18°C. Mean annual precipitation averages 1,400 to 1,500 mm, with more rainfall in summer. The predominant soil is red-clay latossol.

This municipality has a population of 80,296, of whom 21,106 (26.4%) live in dwellings with sewage systems and 73,283 (91.6%) have access to treated water (BRASIL, 2005). Its Human Development Index (HDI-M) is 0.7431, which is below the state index of 0.82738 and below the poverty line. To identify the possible causes of the occurrence of intestinal parasites and proposed plan of prevention and quality of life, the study area was geographically distributed according to the area of coverage of 10 Health Service Centers (HSC) of the city of Campo Mourão: Alvorada, Centro Social Urbano (CSU), Conjunto Habitacional Milton Luiz Pereira (Cohapar), Damferi, Lar Paraná (LAR PR), Modelo, Paulista, Piquirí/Guarujá, Tropical and Urupês (Figure 1). The examination results were analyzed by spatial distribution, using the residential addresses on the reports. The public services offered, education level and population coverage of the Family Health Program (Programa de Saúde da Família, PSF) in the area served by each HSC are listed in Table 1. The Alvorada HSC serves a rural settlement area. The area served by the Cohapar HSC includes a slum and a housing development for families in a slum-clearance program. The Modelo HSC area includes a developing slum. The Piquiri/Guarujá HSC area comprises a rural area and a neighborhood that is relatively far from the main urban area and developed around an open trash dump.

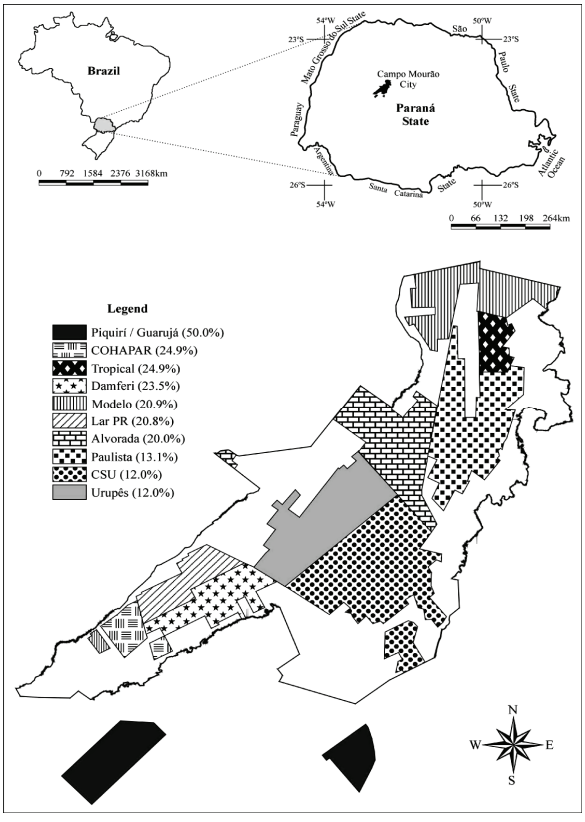

Figure 1. Spatial distribution of cases of intestinal parasites by Health Service Center (HSC) coverage area in Campo Mourão Municipality in the state of Paraná, Brazil. The occurrence per HSC is shown in brackets. Cohapar – Conjunto Habitacional Milton Luiz Pereira; CSU – Centro Social Urbano; LAR PR – Lar Paraná.

Table 1. Access (%) to public goods and services in the area served by each Health Center in Campo Mourão, state of Paraná, Brazil.

Public goods and services	Alvorada*	CSU**	Cohapar*	Damferi*	LAR PR*	Modelo*	Paulista*	Piquiri/Guarujá*	Tropical *	Urupês**
Water supply										
Public	99.05	96.71	98.21	99.18	99.91	97.97	99.57	57.50	99.86	91.38
Well or spring	0.91*	3.23**	1.67	0.82*	0.09*	2.03*	0.28*	42.50*	0.14*	8.56**
other	0.04*	0.06**	0.11*	0.00*	0.00*	0.00*	0.14*	0.00*	0.00*	0.06**
Waste disposal										
Public collection	99.78*	99.33**	97.80*	99.00*	99.91*	98.05*	99.53*	54.02*	99.88*	99.20**
Burning/burial	0.21*	0.67**	2.08*	0.55*	0.09*	1.53*	0.32*	44.54*	0.12*	0.78**
Open field	0.00*	0.00*	0.83*	0.45*	0.00*	0.42*	0.14*	1.44*	0.00*	0.02**
Fecal and urine disposal										
Sewage system	9.48*	37.00**	28.56*	12.50*	54.07*	2.37*	37.93*	0.36*	1.52*	34.60**
Septic or simple tank	90.28*	62.10**	69.06*	87.32*	45.93*	95.34*	61.85*	97.24*	98.14*	64.98**
Open field	0.24*	0.90**	2.37*	0.18*	0.00*	2.29*	0.22*	2.40*	0.33*	0.42**
Education level										
7 to 14 years of schooling	72.56*	97.30**	79.71*	92.72*	86.53*	73.63*	76.73*	81.11*	91.45*	96.36**
≥ 15 years of schooling	92.82*	95.31**	92.57*	94.09*	94.08*	87.98*	92.71*	89.14*	94.51*	94.19**
PSF coverage (%)	100.0*	0.00*	100.0*	100.0*	100.0*	100.0*	100.0*	100.0*	100.0*	0.00*

Sources: *Sistema de Informação de Atenção Básica (SIAB), Campo Mourão, state of Paraná, Brazil, 2004; **IBGE - Instituto Brasileiro de Geografia e Estatística, 2000. PSF: Programa de Saúde da Família (Family Health Program); Cohapar = Conjunto Habitacional Milton Luiz Pereira; CSU = Centro Social Urbano; LAR PR = Lar Paraná.

Study population

A transverse study was conducted using data from 5,219 stool examination results obtained in public and private clinical-analysis laboratories, carried out in 2003 and 2004. In addition to the stool-examination reports, information regarding age, gender, address, whether the test was requested by a physician, number of samples requested and collected, results (positive or negative), species found, laboratory methods used and health-care provider was obtained by means of a specific form. The population was composed of 58.7% females and 41.3% males, and the predominant age group was 0 to 10 years (52.9%). The study was approved by the ethics committee of the Faculdade Integrado de Campo Mourão, state of Paraná, Brazil.

Statistical analysis

The data were examined by exploratory data analysis with the aid of SAS (1999-2000) version 8.2. The variables were compared statistically with the Chi-square and Binomial tests (CAMPOS, 1983). The Chi-square test was used to determine the association between the occurrence of intestinal parasites and geographic region of the municipality, and the binomial test was used to verify the most frequent species and location it occurs in the municipality and the frequency of parasite infections with regard to sex and age. The significance level was 5%.

Results

All the examinations were performed using more than one method. In 68.5% the Faust et al. (1938) and Lutz (1919) methods were used, of which 29.3% gave positive results. In 31.5% the Baermann-Moraes method was included, with a positivity of 17.5%.

The overall occurrence of intestinal parasites was 19.8%, with a predominance of protozoans (Table 2). *Entamoeba coli* (7.2%), *Giardia duodenalis* (5.2%) and *Endolimax nana* (2.7%) were the most prevalent species. Among parasitized individuals, the protozoa more frequent were *E. coli* (36.4%), *G. duodenalis* (26.2%) and *E. nana* (13.6%), and helminthes were *E. vermicularis* (5.0%), *S. stercoralis* (5.0%) and *A. lumbricoides* (4.1) (Table 2).

Table 2. Occurrence of cases (%) of intestinal parasites in 5,219 stool examinations in Campo Mourão, state of Paraná, Brazil, 2003-2004.

Species found	N	Overall occurrence (%)	Occurrence (%) in parasitized individuals
Protozoa			
Entamoeba coli	376	7.2	36.4
Giardia duodenalis	272	5.2	26.2
Endolimax nana	141	2.7	13.6
Iodamoeba butschlli	10	0.2	1.0
Helminthes			
Enterobius vermicularis	52	1.0	5.0
Strongyloides stercoralis	52	1.0	5.0
Ascaris lumbricoides	42	0.8	4.1
Hymenolepis nana	31	0.6	3.0
Trichuris trichiuria	26	0.5	2.5
Ancylostoma duodenale	21	0.4	2.0
Taenia sp.	10	0.2	1.0
All infections	1,033	19.8	
No infection	4,186	80.2	

According to spatial distribution, the highest occurrence of intestinal parasites was observed in the Piquiri/Guarujá area ($p < 0.05$), followed by COHAPAR and Tropical and Damferi. The lowest occurrence was found in the CSU and Urupês and Paulista areas (Figure 1 and Table 3).

Of the species observed, *G. duodenalis* was the most frequent ($p < 0.05$) in Piquiri/Guarujá, followed by *Endolimax nana* (12.2%) in Alvorada and *E. coli* (10.1%) in COHAPAR (Table 3). Helminthes, although less frequently found, were more observed in Piquiri/Guarujá, and *A. lumbricoides* (5.6%), *H. nana* (5.6%) and *S. stercoralis* (3.7%) were the predominant species.

Table 3. Cases (%) of intestinal parasites in children according to district of residence in Campo Mourão, south of Brazil, 2004-2005.

Species	Alvorada	Cohapar	CSU	Damferi	LAR PR	Modelo	Paulista	Piquiri/ Guarujá	Tropical	Urupês
Protozoa										
Entamoeba coli	2.3	10.1	4.4	8.6	8.5	7.4	4.6	7.4	9.6	5.1
Giardia duodenalis	2.7	6.2	2.6	6.2	7.0	5.6	4.1	22.2[b]	5.4	2.5
Endolimax nana	12.2	2.1	1.5	6.2	0.4	2.2	1.0	3.7	4.6	1.5
Iodamoeba butschlii	0.4	0.3	0.9	0.0	0.0	0.3	0.0	0.0	0.2	0.2
Helminthes										
Enterobius vermicularis	0.4	1.7	0.5	0.0	1.7	1.0	0.8	0.0	1.3	0.6
Strongyloides stercoralis	0.4	0.8	0.4	2.5	0.8	0.3	1.2	3.7	1.5	1.1
Ascaris lumbricoides	0.0	1.1	0.4	0.0	0.6	2.3	0.3	5.6	0.7	0.0
Hymenolepis nana	0.0	0.8	0.0	0.0	0.6	0.3	0.3	5.6	0.4	0.4
Trichuris trichiura	0.0	0.6	0.9	0.0	0.9	0.7	0.2	1.8	0.5	0.0
Ancylostoma duodenale	1.4	0.7	0.4	0.0	0.2	0.3	0.1	0.0	0.4	0.2
Taenia sp.	0.0	0.4	0.0	0.0	0.0	0.2	0.2	0.0	0.3	0.2
Total occurrence	20.0	24.9	12.0	23.5	20.8	20.9	13.1	50.0[a]	24.9	12.0
Negative results	80.0	75.1	88.0	76.5	79.2	79.1	86.9	50.0	75.1	88.0

Cohapar = Conjunto Habitacional Milton Luiz Pereira; CSU = Centro Social Urbano; LAR PR = Lar Paraná. [a]$p < 0,0000$; [b]$p < 0,0001$.

Females were significantly more often infected (56.4%) with intestinal parasites than were males (43.6%) ($p < 0.05$). Comparing the areas served, the occurrence of intestinal parasites in females was significantly higher ($p < 0.05$) only in the COHAPAR area.

The occurrence of intestinal parasites by number of species found in the exam was 16.2% for one species and 3.6% for more than one species. Of those exams in which more than one species was present, 52.9% were in the 0 to 10-year age group, with *G. duodenalis* (31.7%), *E. coli* (30.0%), *A. lumbricoides* (9.1%) and *E. vermicularis* (6.5%) the species that occurred most in these cases. The occurrence of intestinal parasites in children aged 0 to 10 years (56.4%) was significantly different ($p < 0.05$) when compared to the total number of examinations.

Discussion

The occurrence of intestinal parasites in Campo Mourão is proportional to the developmental characteristics of the municipality, which is an agricultural center, with a high degree of agricultural mechanization and industrialization, although it has an HDI below the norm for Paraná. However, the rate of positivity found in this study is within the range of values of 14.3 to 46.9% observed in studies in other municipalities of the state (GUILHERME et al., 2004; PUPULIN et al., 2004; SEGANTIN; DELARIVA, 2005) that have HDIs from 0.767 to 0.773. Still in the state of Paraná, there is a municipality with an HDI of 0.810, presenting a higher positivity of enteroparasites (SEGANTIN; DELARIVA, 2005).

The majority of parasitological stool exams were carried out with only one sample. Therefore, the occurrence of intestinal parasites in this study might have been much higher if all the tests had been carried out with three samples on alternate days, because the eggs or cysts of many intestinal parasites are eliminated in intermittent cycles (FERREIRA; ANDRADE, 2005). Other investigators have observed that examinations carried out with more than one sample increase the sensitivity of the method (GARCIA et al., 2006; TELES et al., 2003).

The occurrence of intestinal parasites in the present study varied according to spatial distribution, suggesting that there are differences in infection risk in different parts of the municipality. The occurrence of intestinal parasites was highest in Piquiri/Guarujá, and the lowest occurrences were in CSU, Paulista and Urupês. Piquiri is located in a rural region of Campo Mourão, and Guarujá, which is located some distance from the urban area, developed around an open trash dump. This health service center area has less access to the public water supply, trash collection and sewage network. The rural environment and the periphery of cities have the highest prevalence of parasitosis, due to the lack of sewage, contaminated soil, water quality, poorer socio-economic status and poor hygiene conditions, all factors that affect the dissemination and incidence of parasitosis (GUILHERME et al., 2004; LUDWIG et al., 1999; QUEIROZ et al., 2006; RS VIRTUAL, 2005; SEGANTIN; DELARIVA, 2005). The CSU, Paulista and Urupês areas, located in the central part of the municipality, had the lowest occurrence of parasites. This result may be related to the better infrastructure, with an economically active and better-informed population and with the better socio-economic situation normally found in the central parts of municipalities, because access to goods and services does not differ much from the other health service centers. Souza et al. (2007) also observed differences in prevalence of intestinal parasites in rural area of Acrelândia, Acre State, in the western Brazilian Amazon when comparing households within a spatial cluster and those outside a cluster. These authors related that households

within the large cluster of intestinal parasitic infections were less likely to have access to filtered drinking water, latrines, lower wealth indexes, heads of households had significantly fewer years of formal schooling as compared to those outside the cluster.

E. coli, *G. duodenalis* and *E. nana* were the most frequent species, as observed in other cities in the south and southeast parts of the country (FERREIRA; ANDRADE, 2005; GUILHERME et al., 2004; PUPULIN et al., 2004; TASHIMA; SIMÕES, 2004; SOUZA et al., 2007). Although *E. coli* and *E. nana* are not pathogenic to humans, the presence of these species in feces is a good indicator of local socio-sanitary conditions, and is related to limited education and low social level (RS VIRTUAL, 2005). *G. duodenalis* was the second most frequently found species, especially in children. Its occurrence was significantly higher in Piquiri/Guarujá. This can be explained by the local water quality, because this area has the lowest percentage of treated-water supplies. Water is considered the principal source of contamination by *G. duodenalis*, because chlorination does not fully destroy cysts of this parasite (ALARCON et al., 2005; LUDWIG et al., 1999; NISHI et al., 2009). This parasitosis is spread throughout the world, particularly in children between the ages of 8 months and 12 years (MACHADO et al., 1999; PUPULIN et al., 2004) and can lead to chronic diarrhea with steatorrhea, weight loss, and problems associated with poor food absorption (FERREIRA et al., 2002; MOTTA; SIVA, 2002).

The low occurrence of helminthes in relation to protozoans observed in the present study, as also found by other investigators (NOLLA; CANTOS, 2005; SOUZA et al., 2007; BASSO et al., 2008; TAKIZAWA et al., 2009) may indicate changes in the profile of intestinal parasites. This difference may be related to the use of self-medication for helminthes, which may fail to eliminate protozoans and according to Basso et al. (2008) to improvements in public health, sanitation, housing, and education. In Piquiri/Guarujá, which is the area with the least access to public goods and services, helminthes were more frequent than in other health service center areas. It is known that inadequate sanitation conditions favor the transmission of helminthes (JOMBO et al., 2007; LUDWIG et al., 1999; WANI et al., 2007).

A higher occurrence of intestinal parasites in females was observed both in the municipality as a whole and in the COHAPAR service center in particular. This may be because females seek health services more often, or because most of the samples tested were from females. Other investigators (ALVES et al., 2003; MORRONE et al., 2004) have also reported a high occurrence of parasitosis in females.

Monoparasitism was the most frequent finding, except in children where two or more species were prevalent. Because of their poor hygiene habits, children are normally more frequently infected by enteroparasites. This result agrees with those of other investigators (GURGEL et al., 2005; TASHIMA; SIMÕES, 2004; UCHÔA et al., 2001), who found a higher prevalence of intestinal parasites in younger persons. Guilherme et al. (2004) also observed higher prevalence of intestinal parasites in children under 14 from rural villages in three municipalities in northwestern Paraná, with high rates of infection by two or more intestinal parasites, of which *G. duodenalis*, *E. coli*, and *E. vermicularis* are among the most frequent species in these cases, as observed in this work. The same was found in the study by Falavigna et al. (2008), in Ubiratã, a city in the region of Campo Mourão, where *G. duodenalis* and *A. lumbricoides* were the species most commonly seen. Others have reported that polyparasitism may be associated with poor sanitation and/or poor knowledge of hygiene (GIATTI et al., 2004; MENEGOLLA et al., 2006).

Conclusion

The occurrence of cases of intestinal parasites in Campo Mourão is most related to children and females. Spatial distribution identified areas with rural characteristics and on the periphery of urban centers as higher-risk areas for infection. These results indicate that a more detailed study to identify the real factors of vulnerability responsible for prevalence of intestinal parasites in areas of greatest risk is necessary, and also opens the possibility for the redirection of health policies and actions aimed at the prevention of disease. A multidisciplinary approach could be proposed with intersector activities covering education, housing, public works and community groups, based around the concept of increasing the level of knowledge within a community, in order to ensure sustainable development and a consequent improvement in quality of life.

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