Factors associated with intestinal parasitosis in a population of children and adolescents

Fatores associados à ocorrência de parasitoses intestinais em uma população de crianças e adolescentes

Factores asociados a la ocurrencia de parasitosis intestinales en una población de niños y adolescentes

Vinícius Silva Belo[1], Robson Bruniera de Oliveira[2], Priscila Correia Fernandes[3], Bruno Warlley L. Nascimento[4], Fábio Vitorino Fernandes[5], Cássia Luana F. Castro[6], Wanderson Bassoli dos Santos[7], Eduardo Sérgio da Silva[8]

ABSTRACT

Objectives: To analyze the prevalence and the factors associated with intestinal parasites infections in children and adolescents enrolled in elementary schools from São João del-Rei, Southeast Brazil.

Methods: In this sectional study, coproscopic examinations were performed by spontaneous sedimentation and Kato-Katz techniques in 1,172 schoolchildren. Multivariate logistic regression models were adjusted for the study of factors associated with infections in general and separately for helminthes and protozoon.

Results: The prevalence of infection was 29%, ranging from 7 to 83% between schools of lower and higher occurrence respectively. The presence of toilets in the home was associated with a lower prevalence of helminths; the increasing age of the students was associated with a higher rates of protozoon and parasites in general, while the presence of water filter and living in urban area were associated with a lower prevalence of the three outcomes. In all regions, the consumption of preventive medication against helminths was recorded.

Conclusions: Inequalities in living conditions have changed the prevalence of parasitosis differently among the study regions. The study underscores the need to promote the use of water filters in endemic areas houses and to evaluate the preventive use of anti-helminthic drugs in the dynamic of individual health. Control measures that take into account the factors described should be a priority.

Key-words: protozoan infections; helminths; /epidemiology; risk factors; health inequalities.

RESUMO

Objetivos: Analisar a prevalência de infecções por parasitos intestinais em crianças e adolescentes matriculados em escolas de ensino fundamental no município de São João del-Rei, Minas Gerais, e os fatores associados à infecção.

Métodos: Estudo epidemiológico seccional, realizado entre março/2008 e julho/2009. Foram realizados exames coproscópicos por sedimentação espontânea e Kato-Katz em 1.172 escolares. Foram ajustados modelos de regressão logística

Instituição: Universidade Federal de São João del-Rei (UFSJ), São João del-Rei, MG, Brasil

[1]Doutorando em Epidemiologia em Saúde Pública pela Escola Nacional de Saúde Pública da Fundação Oswaldo Cruz (Fiocruz), Rio de Janeiro, RJ, Brasil

[3]Doutora em Biologia Molecular e Funcional pela Universidade Estadual de Campinas (Unicamp); Professora Adjunta do Departamento de Ciências Naturais da UFSJ, São João del-Rei, MG, Brasil

[4]Mestrando em Ciências da Saúde do Centro de Pesquisas Renê Rachou da Fiocruz, Belo Horizonte, MG, Brasil

[5]Biólogo pela UFSJ, São João del-Rei, MG, Brasil

[6]Mestranda em Bioengenharia Celular e Tecidual do Departamento de Engenharia Biomédica da UFSJ, São João del-Rei, MG, Brasil

[7]Farmacêutico-bioquímico pela Universidade Federal de Juiz de Fora (UFJF); Coordenador do Laboratório de Epidemiologia da Prefeitura Municipal de São João del-Rei, São João del-Rei, MG, Brasil

[8]Pós-doutor em Parasitologia pela Universidade Federal de Minas Gerais (UFMG); Professor Adjunto e Diretor do Campus Centro-Oeste Dona Lindu da UFSJ, Divinópolis, MG, Brasil

Endereço para correspondência:
Vinícius Silva Belo
Rua Leopoldo Bulhões, 1.480 – Manguinhos
CEP 21041-210 – Rio de Janeiro/RJ
E-mail: vinicius.belo@terra.com.br; viniciusbelo4@hotmail.com

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múltipla para o estudo dos fatores associados às infecções em geral e, separadamente, por helmintos e por protozoários.

Resultados: A prevalência de infecções foi de 29%, havendo uma variação de 7 a 83%, respectivamente, entre as escolas de menor e maior ocorrência. A presença de instalação sanitária no domicílio foi associada a uma ocorrência menor de helmintos; o aumento na idade dos escolares associou-se a uma maior ocorrência de protozoários e de parasitos em geral; enquanto a presença de filtro de água e a localização do domicílio em área urbana mostraram-se associadas a uma ocorrência menor dos três desfechos analisados. Em todas as regiões, foi registrado o consumo de medicação preventiva contra helmintos.

Conclusões: Desigualdades nas condições de vida tornaram as prevalências diferenciadas entre as regiões do estudo. O estudo ressalta a necessidade de promover o uso de filtros de água nas residências de áreas endêmicas e de avaliar o consumo preventivo de medicamentos anti-helmínticos na dinâmica e na saúde dos indivíduos. Medidas de controle que levem em conta os fatores descritos devem ser prioritárias em nível de Saúde Pública.

Palavras-chave: infecções por protozoários; helmintos; /epidemiologia; fatores de risco; desigualdades em saúde.

RESUMEN

Objetivos: Analizar la prevalencia de infecciones por parasitas intestinales en niños y adolescentes matriculados en escuelas de enseñanza primaria en el municipio de São João del-Rei, Minas Gerais (Brasil), y los factores asociados a la infección.

Métodos: Estudio epidemiológico seccional, realizado entre marzo/2008 y julio/2009. Se realizaron exámenes coproscópicos por sedimentación espontánea y Kato-Katz en 1.172 escolares. Se ajustaron modelos de regresión logística múltiple para el estudio de los factores asociados a las infecciones en general y, separadamente, por helmintos y protozoos.

Resultados: La prevalencia de infecciones fue de 29%, habiendo una variación de 7 a 83%, respectivamente, entre las escuelas de menor y mayor ocurrencia. La presencia de instalación sanitaria en el domicilio fue asociada a una ocurrencia menor de helmintos; el aumento en la edad de los escolares se asoció a una mayor ocurrencia de protozoos y de parasitas en general; mientras que la presencia de filtro de agua y la ubicación del domicilio en área urbana se mostraron asociadas a una ocurrencia menor de los tres desenlaces analizados. En todas las regiones, se registró el consumo de medicación preventiva contra helmintos.

Conclusiones: Desigualdades en las condiciones de vida convirtieron las prevalencias diferenciadas entre las regiones del estudio. El estudio subraya la necesidad de promover el uso de filtros de agua en las residencias de áreas epidémicas y de evaluar el consumo preventivo de medicamentos anti-helmínticos en la dinámica de las infecciones y en la salud de los individuos. Medidas de control que tengan en cuenta los factores descritos deben ser prioritarias en nivel de Salud Pública.

Palabras clave: infecciones por protozoos; helmintos; epidemiología; factores de riesgo; desigualdades en salud.

Introduction

Intestinal infections by helminths and protozoans are estimated to affect 3.5 billion people and to cause diseases in 450 million, most of them children, around the world[1]. Malnutrition, anemia, growth restrictions, cognitive delays, irritability, increased susceptibility to other infections and acute complications are some of the consequent morbidities[2].

The prevalence of intestinal parasitic infections is one of the most accurate indicators of socioeconomic conditions of a population[3] and may be associated with several determinant factors, such as adequate sanitation, fecal pollution of water and foods, sociocultural factors, contact with animals, lack of basic sanitation, as well as host age and type of infecting parasite[4].

Although Brazil has undergone changes that improved the quality of life of its population in the last decades, intestinal parasitoses are still endemic in several areas of the country and are an important public health problem. Currently, the prevalence in the region of the city of São João del-Rei is underestimated, which prevents the implementation of specific control measures clearly directed to the most susceptible populations.

This study described and analyzed socioeconomic, demographic and environmental factors associated with the occurrence of intestinal parasitoses among schoolchildren in the rural and urban areas of the city of São João del-Rei.

Methods

São João del-Rei, a city in the interior of the state of Minas Gerais in the southeastern region of Brazil, has a total of 84,469 inhabitants[5]. As a historic landmark in the area of the Estrada Real, a road built in the 17th Century

for the transportation of gold to the coastal towns and that today is part of an official project to promote tourism, São João del-Rei receives thousands of visitors during the year. Moreover, it has a human development index of 0.816[6], which is classified as high.

This study was conducted from March 2008 to July 2009 in 21 municipal elementary schools. Initially, the study project included tests in all municipal schools, but one refused to participate and was not included. Of about 1,600 eligible individuals, 1,172 accepted to participate in the study by filling out a questionnaire and providing material for tests; 711 (61%) in six urban schools and 461 (39%) in fifteen schools in rural areas; 597 girls (51%) and 575 (49%) boys. The study population was divided into two groups according to age, 5–10 and 11 years or older, ages that correspond to the two stages of elementary education in Brazil. Participant profile and number of losses were not different in rural and urban schools, and they could, therefore, be classified as random.

In this cross-sectional study, participants received a labeled container and were asked to collect only one stool sample. Samples were collected in the morning of the next day and sent to analysis in the municipal laboratory of the city of São João del-Rei. If a sample was not provided, new visits were made and other dates were scheduled.

The participants' parents or guardians answered a semi-structured questionnaire to investigate factors associated with the occurrence of intestinal parasitosis in schoolchildren. The questions selected for analysis in this study referred to age, sex, presence or absence of toilet in the house, water filter, refrigerator, origin of water supply (public provider or other), place of residence (rural or urban area), wastewater and waste matter disposal (municipal sewage system or open sewers).

This study was approved by the Ethics in Research Committee of Universidade do Estado de Minas Gerais. The study was conducted as part of a program to fight parasitosis, which included educational initiatives and the administration of adequate treatment to infected schoolchildren.

Stool samples were analyzed using the spontaneous sedimentation technique, also known as Hoffmann, Pons and Janer (HPJ), described by Rocha and Melo[7] and the Kato-Katz method[8]. For each technique, two slides were prepared and read under light microscopy by two independent examiners. The presence of parasites was confirmed when helminth eggs or protozoan cysts were detected using at least one of the methods. The following parasites were investigated: *Entamoeba histolytica/dispar, E. coli*, *Giardia lamblia, Endolimax nana, Cryptosporidium parvum, Isospora Belli*, which can be detected using the HPJ technique - and *Ancilostoma spp*, *Ascaris lumbricoides*, *Enterobius vermicularis, Trichuris trichiura*, *Schistossoma mansoni*, which can be detected using both techniques[7].

To record and analyze data statistically, the Epi-Info 3.4.2 and R 2.11.1 software packages were used. The point prevalence of infection was calculated and stratified for urban and rural areas. A chi-square or the Fischer exact test was used to test the differences in number of infections and distribution of the study variables according to regions. Multiple logistic regression models were also adjusted for three possible outcomes: infection by any type of parasite; infection by helminths only; and infection by protozoans only. The Wald test was used for univariate analysis, followed by nonautomated selection of variables for the final model. Interaction terms were added to the model and excluded from the final equation if not statistically significant. After modeling, odds ratio was calculated using the selected variables and their confidence intervals. The level of significance was set at $p<0.05$ for all tests.

Results

The general prevalence of intestinal parasitosis in the study was 29%, that is, 335 schoolchildren were infected by at least one parasite; of these, 75 (22%) were infected by two or more parasites. The tests identified three protozoans (*E. histolytica/dispar* [14.3%], *E. coli* [9.5%] and *G. lamblia* [5.5%]) and four helminth species (*Ancilostoma* spp. [2.1%], *A. lumbricoides* [1.9%], *E. vermicularis* [1.5%] and *T. trichiura* [1.1%]). There was a statistically significant difference between prevalence's in the rural and urban areas, both in general prevalence (36.4 and 23.5%) and in the prevalence of protozoans (29.9 and 20.4%) and helminths (10.2 and 3.5%) (Table 1).

Of the schools under analysis, prevalence ranged from 7.1 to 83.3% considering the lowest and highest values in the rural areas and 13.2 to 31.0% in the urban areas. The number of factors usually associated with increases in the occurrence of intestinal parasitosis was higher among students in the rural area. The socioeconomic conditions of families in the rural area, assessed according to whether

Table 1 - Prevalence of intestinal parasitosis among schoolchildren in urban (n=711) and rural (n=461) areas of the city of São João del-Rei in the state of Minas Gerais, Brazil

Infection	Rural area n (%)	Urban area n (%)	*p*-value	Total (%)
Entamoeba histolytica/dispar	84 (18.2)	84 (11.8)	0.002	168 (14.3)
Entamoeba coli	60 (13.0)	51 (7.2)	0.001	111 (9.5)
Giardia lamblia	29 (6.3)	36 (5.1)	0.370	65 (5.5)
Ancilostoma sp.	22 (4.8)	3 (0.4)	<0.0001	25 (2.1)
Ascaris lumbricoides	14 (3.0)	8 (1.1)	0.018	22 (1.9)
Enterobius vermicularis	8 (1.7)	10 (1.4)	0.655	18 (1.5)
Trichuris trichiura	6 (1.3)	7 (1.0)	0.613	13 (1.1)
Infection by protozoans	138 (29.9)	146 (20.4)	<0.0001	283 (24.1)
Infection by helminths	47 (10.2)	25 (3.5)	<0.0001	72 (6.1)
Infection by one species	123 (26.7)	137 (19.2)	0.07	260 (22.2)
Infection by two species	38 (8.2)	28 (3.9)	0.002	66 (5.6)
Infection by three or more species	7 (1.5)	2 (0.3)	0.020	9 (0.8)
Total infected children	168 (36.4)	167 (23.5)	<0.001	335 (28.6)

Table 2 - Distribution of study variables between urban (n=711) and rural (n=461) areas of the city of São João del–Rei in the state of Minas Gerais, Brazil

	Category	Rural area n (%)	Urban area n (%)	*p*-value
Age (years)	5 to 10	329 (71.4)	411 (57.8)	<0.001
	11 or older	132 (28.6)	299 (42.1)	
Sex	Female	231 (50.1)	366 (51.5)	0.21
	Male	230 (49.9)	345 (48.5)	
Toilet	No	35 (7.6)	12 (1.7)	<0.001
	Yes	426 (92.4)	699 (98.3)	
Refrigerator	Yes	363 (78.7)	670 (94.2)	<0.001
	No	98 (21.3)	41 (5.8)	
Wastewater disposal	Other	414 (89.8)	105 (14.8)	<0.001
	Public sewage system	47 (10.2)	606 (85.2)	
Wastewater disposal	Open sewer	300 (65.1)	672 (94.5)	<0.001
	Public sewage system	161 (34.9)	39 (5.5)	
Origin of potable water	Other	355 (77.0)	63 (8.9)	<0.001
	Public service	106 (23.0)	648 (91.1)	
Water filter	Yes	389 (84.4)	657 (92.4)	<0.001
	No	72 (15.6)	54 (7.6)	

there was a refrigerator in the house, were also poorer than those of families in the urban area (Table 2).

Table 3 shows the results of univariate analyses using the Wald test. In multiple analyses, age of schoolchildren (older than 11 years) was associated with a greater occurrence of parasitic infection in general and infection by protozoans. The existence of a toilet in the house was associated with a lower occurrence of helminthic infection, whereas water filter in the house and house in the urban area were associated with a lower prevalence of helminthic, protozoan and parasitic infection in general (Table 4). There were no significant interactions between the study variables.

Discussion

The prevalence of intestinal parasitoses among schoolchildren in the city of São João del Rei was 29%. Despite the

Table 3 - Univariate analysis of risk factor under study and their impact on the occurrence of three study outcomes in the population of children and adolescents in the city of São João del–Rei in the state of Minas Gerais, Brazil

	Parasites in general	Protozoans	Helminths
Age (older than 11 years)	1.18 (0.9–1.54)	1.34 (1.02–1.76)	0.74 (0.44–1.25)
Male sex	1.01 (0.85–1.41)	1.14 (0.87–1.49)	1.17 (0.73–1.89)
Water from public service	0.67 (0.52–0.87)	0.80 (0.61–1.06)	0.44 (0.28–0.72)
Running water in house	0.52 (0.31–0.85)	0.55 (0.33–0.92)	0.65 (0.27–1.55)
Open sewer	1.67 (1.27–2.18)	1.52 (1.14–2.02)	2.48 (1.53–4.01)
Urban area	0.53 (0.41–0.69)	0.60 (0.46–0.79)	0.32 (0.19–0.53)
Wastewater disposal public sewage system	0.72 (0.56–0.92)	0.80 (0.61–1.05)	0.45 (0.28–0.74)
Water filter in the house	0.36 (0.25–0.53)	0.47 (0.32–0.70)	0.36 (0.20–0.63)
Toilet in the house	0.45 (0.25–0.81)	0.55 (0.30–1.01)	0.25 (0.12–0.54)

OR: odds ratio; 95% CI: 95% confidence interval.

Table 4 - Variables significantly associated with occurrence of three study outcomes among the population of children and adolescents in the city of São João del-Rei in the state of Minas Gerais, Brazil: multiple analysis using logistic regression models

Exposures	odds ratio	95%CI
Outcome 1: Infection by parasites in general		
Age (11 years or older)	1.35	1.03–1.77
Water filter in house	0.39	0.27–0.57
House in urban area	0.55	0.42–0.71
Outcome 2: Infection by helminthes		
Water filter in house	0.46	0.26–0.84
Toilet in the house	0.40	0.18–0.88
House in urban area	0.37	0.22–0.62
Outcome 3: Infection by protozoans		
Age (11 years or older)	1.50	1.13–1.98
Water filter in the house	0.50	0.34–0.74
Urban area	0.60	0.45–0.79

public health relevance of the diseases that may be caused by intestinal helminths and protozoans, no studies had investigated this problem in this city before.

In Brazil, the occurrence of parasitoses varies in different regions and is associated with the level of socioeconomic development of populations and with the assessment methods used in each study. Fontes *et al*[9] found that 92% of schoolchildren in Barra do Santo Antonio, Alagoas, had a positive diagnosis. Santos and Merlini[10], in turn, found a prevalence of 16% in a study that included a population sample of the city of Santa Helena, Paraná, a state in southern Brazil. In the state of Minas Gerais, although prevalence's are, in general, lower than in states with worse socioeconomic indices, there is also great data diversity[11-14].

The number of students infected by more than two parasites (22% of all infected students) may be classified as moderate when compared with studies in other areas of Brazil[12,15]. However, polyparasitism seems to be the norm rather than the exception, as its occurrence is higher than expected under assumptions of independence[16,17], which stresses the need to better evaluate the occurrence and the impact of polyparasitism on human health.

There was a significantly higher prevalence of infections by both protozoans and helminths among students in the rural area, as well as a higher number of schoolchildren with polyparasitism. Living in rural areas was associated with a higher chance of parasite contamination. Studies conducted by Ferreira and Andrade[18] and Rocha *et al*[11] also found a higher infection prevalence in rural areas. In contrast, other studies[19-21] did not find the same association, and even our study found that prevalence rates in rural schools were not homogeneous, which indicates that, when the

socioeconomic, environmental and educational conditions are adequate, the prevalence in rural regions may be similar or even lower than in urban areas. This was not the case in São João del-Rei due to the precarious living conditions found in most rural areas.

The prevalence of infections by protozoans was significantly greater than that by helminths, as demonstrated elsewhere[22-24]. In addition to the characteristics specifically associated with transmission modes of these organisms, the distribution and indiscriminate use of anthelminthic drugs may have contributed to our study results. One of the control strategies usually adopted by the municipal authorities, already described for other regions in Brazil[25], is the distribution of albendazol, which is also routinely bought by a large number of families in São João del-Rei directly from drugstores, which does not happen in the case of drugs to treat intestinal protozoan infections specifically due to cultural factors. The use of albendazol may be efficacious not only in the treatment of helminthic infections, but also to treat giardiasis[26,27]. The fact that *G. lamblia* was the least prevalent protozoan in this study supports the hypothesis that prophylactic treatments may have affected prevalence . Although a common practice to reduce morbidity in endemic areas[28] and even indicated in some situation[29], as discussed by Frei, Juncansen and Ribeiro-Paes[25], the indiscriminate use of anthelminthic drugs may mask actual sanitation and socioeconomic conditions of a population, as the prevalence of helminthic infection is reduced without improvements in living conditions and the population remains exposed to the risk of reinfection and of acquiring several other diseases that also originate from scarcity and poverty.

The analysis according to schoolchildren age revealed different results for infection by protozoans and by helminths between the two age groups into which the sample was divided. Among schoolchildren 11 years or older, there was a significantly higher rates of prevalence of infection by protozoans and infection in general, whereas there was no association of infection by helminths. Data about the occurrence of protozoan infection were consistent with those found by Raso *et al*[30]. Older individuals have been exposed to the pathogens for a longer time and were born at a time when socioeconomic conditions, sanitation and education were more deficient than the conditions experienced by individuals born more recently, which, considering the persistent tendency of infection by some protozoans, may justify the association found in this study. In the case of helminths, preventive drugs may be responsible for the fact that a significant association was not found. However, stratification by age may be a limiting factor, which, in turn, indicates that further studies should be conducted to better evaluate the role of the two factors under discussion here.

The existence of a toilet in the house was associated with fewer helminthic infections, as in the study conducted by Prado *et al*[31]. The helminth transmission mode, closely associated with ground contamination, may explain this finding. The lack of sanitation in houses that do not even have a cesspool reveals the extreme scarcity of socioeconomic conditions and may raise questions that go beyond the intrinsic value of this variable. The lack of significance of the association of wastewater destination and all outcomes may be assigned to the fact that two factors, exposure to "open sewers" and "cesspool", were combined into one alternative hypothesis to the existence of a public sewage system, which, in turn, demonstrates the protective effect of the existence of cesspools.

The use of a water filter in the house was strongly associated with a reduction in the prevalence of parasitic infection in general and infection by helminths and protozoans. Findings were not similar for treated water provided by the public system, which suggests that families themselves should additionally treat their drinking water. Our study data, together with findings of investigations that demonstrated the benefits of water filtration in the house to prevent diarrhea in all age groups[32], reinforce the importance of adopting public health measures and healthcare educational programs that promote the use of water filters in all houses in endemic areas where public water treatment does not exist or is inadequate.

This study discussed factors that are responsible for the persistence of intestinal parasitic infections in our milieu. Even in a town where the human development index is high, there are areas of high prevalence, particularly in rural regions, which confirms the inequality of living conditions that persist among the Brazilian population and that characterize the typical and unique epidemiological transition model in this country. More efficient control measures, directed to susceptible populations and that take into consideration the associations described here, should be a priority, as they are not only useful to decrease inequalities, the prevalence and the incidence of intestinal parasitic infections, but also to improve quality of life and the public health system as a whole and to promote individual dignity.

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