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Socioenvironmental conditions and intestinal parasitic infections in Brazilian urban slums: a cross-sectional study

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ABSTRACT

Intestinal parasitic infections (IPIs) are neglected diseases with limited data regarding prevalence in Brazil and many other countries. In increasingly urban societies, investigating the profile and socioenvironmental determinants of IPIs in the general population of slum dwellers is necessary for establishing appropriate public policies catered to these environments. This study assessed the socioenvironmental conditions and prevalence of IPIs in slums of Rio de Janeiro, RJ State, Brazil. Methods: A cross-sectional study covering an agglomeration of urban slums was conducted between 2015 and 2016 using participants observation, a socioeconomic survey, and the spontaneous sedimentation method with three slides per sample to analyze fresh stool specimens (*n*=595) searching for intestinal parasites. Results: *Endolimax nana* (*n*=95, 16.0%) and *Entamoeba coli* (*n*=65, 10.9%) were the most frequently identified agents, followed by *Giardia intestinalis* (*n*=24, 4.0%) and *Ascaris lumbricoides* (*n*=11, 1.8%). Coinfections caused by *E. nana* and *E. histolytica/dispar* and by *Entamoeba coli/A. lumbricoides* were significant. The use of piped water as drinking water, the presence of *A. lumbricoides*, and contamination with coliform bacteria and *Escherichia coli* were more common in major area (MA) 1. Children (0-19 years) had a greater chance of living in poverty (OR 3.36; 95% CI: 2.50- 4.52; *p* <0.001) which was pervasive. The predominance of protozoa parasites suggests that a one-size-fits-all approach focusing on preventive chemotherapy for soil-transmitted helminths is not appropriate for all communities in developing countries. It is important that both residents and health professionals consider the socioenvironmental conditions of urban slums when assessing intestinal parasitic infections for disease control and health promotion initiatives.

KEYWORDS: Urban health. Protozoan infections. Neglected diseases. Poverty. Tropical medicine.

INTRODUCTION

Intestinal parasitic infections (IPIs) are neglected diseases caused by helminths or protozoa affecting more than two billion people, or about one in four people[1]. Although they present a wide geographical distribution, presence, duration and intensity of these infections are influenced by environmental, household, nutritional and other characteristics linked to poverty[2,3]. IPIs are associated with a disability-adjusted life year (DALY) loss of 560,840 in the Americas and 5,266,000 globally[4]. In addition to the burden IPIs cause to communities, they may amplify the burden of other neglected diseases such as tuberculosis, enteroviruses, American tegumentary leishmaniasis and malaria, among others[5-8].

In Brazil, like in many countries, limited data exist on the prevalence of IPIs since only cases of schistosomiasis in non-endemic areas must be reported[9]. Underreporting and limited routine screenings lead to the dependence of estimates for public health planning. Many epidemiological studies focus on rural communities or other specific populations; however, in increasingly urban societies, investigating the profile and determinants of IPIs among the general population of slum dwellers in developing countries is necessary for establishing appropriate public policies catered to these environments. To our knowledge, this is the first epidemiological study on IPIs conducted in this large urban center. Current public policies and international guidelines related to IPIs focus almost exclusively on soil transmitted helminths (STH)[10-12], however, many recent studies have found a shift in community profiles of IPIs from a predominance of STH to protozoans[13-16]. Therefore, this cross-sectional study, following the Strengthening the Reporting of Observational Studies in Epidemiology Guidelines (STROBE), assessed the socioenvironmental conditions and prevalence of IPIs in slums of Rio de Janeiro, RJ State, Brazil.

METHODS

Study area and population

The Complexo de Manguinhos (CM) is an agglomeration of 13-19 slums in Northern Rio de Janeiro, Rio de Janeiro State (RJ), Brazil (22°52’47.04”S 43°14’57.18”W) constructed over mangrove swamps. Primary healthcare is provided for CM residents by the Family Health Strategy (FHS) program, which has divided the territory into 13 communities and 5 major areas (MAs) (Figure 1). A reported 38,461 people in 12,528 families are registered in the FHS, which reports 100% coverage of the communities[17]. Table 1 shows major characteristics of each MA. The overall study area is characterized by overcrowding, clandestine electrical and plumbing connections to official networks, free-roaming animals (e.g. dogs, rats and cats), and accumulation of trash despite regular collection. With the exception of MA1, these communities suffer from high levels of violence associated with drug trafficking and in 2013 military police regained control of these communities by installing Pacifying Police Units (UPPs is the abbreviation in Portuguese). Large-scale government construction projects (PAC) in the area began

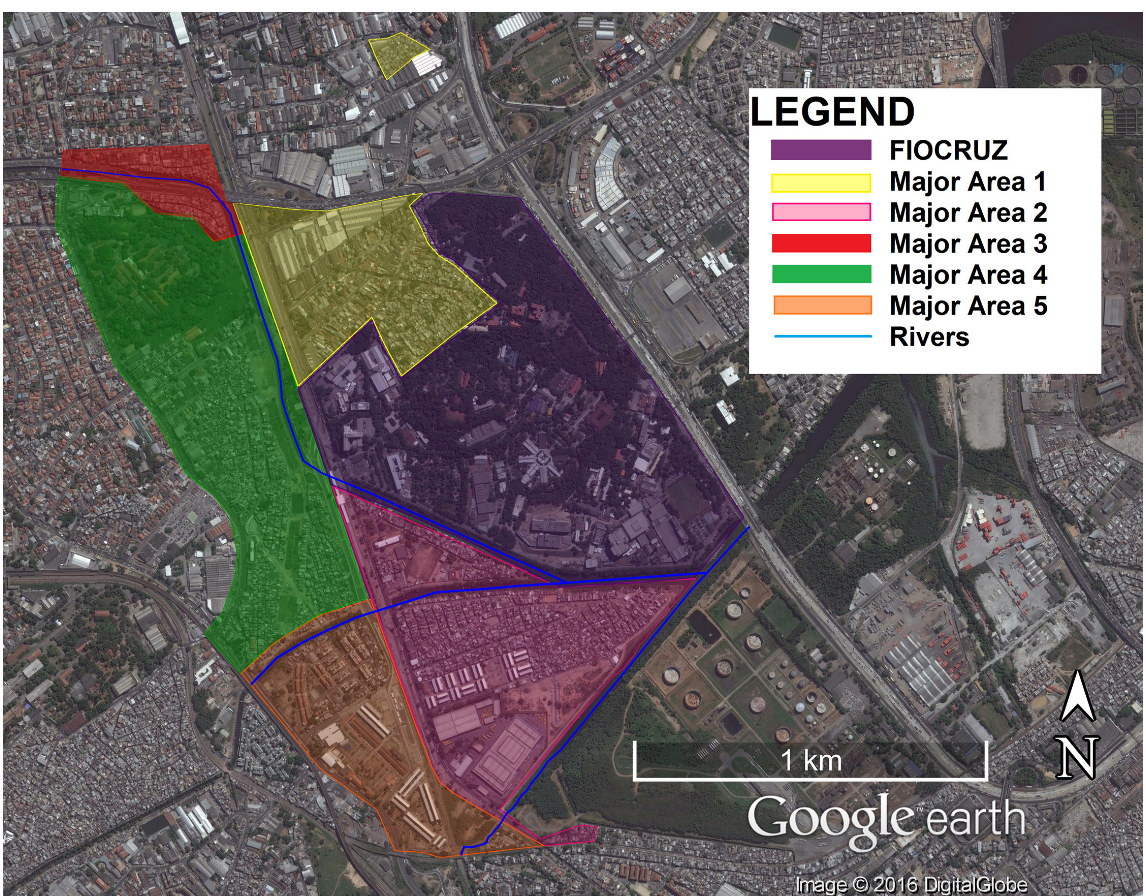

Figure 1 - Map of the Major Areas (MA) of Complexo de Manguinhos, Rio de Janeiro, Brazil

Table 1 - Characterization of Complexo de Manguinhos (CM), Rio de Janeiro, Brazil

Major Area	N. of slums	Pop.	Constructed environment	Natural environment	Socioeconomic characteristics
1	3	5325	- Some homes have yards (with trees and/or other limited vegetation) - In one of these slums a church occupies 2/3 of the territory, the remaining spaces exhibit extremely thin alleys and verticalization of homes - No playing fields	- Each community physically separated from the rest of the CM Highest elevation (39.6 meters) - Does not border any rivers	- Oldest, most established communities of the CM - Not violent - No visible drug consumption areas (*"bocas de fumo"*)
2	7	12201	- Heterogeneous housing structures - Mix of streets and alleys - One of these communities was previously demolished and is in the process of reconstruction	- Greatest periodic flooding - Borders the *Faria-Timbó River*, *Jacaré River*, Cunha Canal and Manguinhos Canal	- Pacifying Police Unit
3	2	3251	- Intercepted by a major highway with homes underneath the highway continuously demolished (by the government) and rebuilt (by the population) - Accessible by car - Predominance of streets instead of alleys	- Physically separated from the rest of the CM - Borders the *Faria-Timbó River*	- Visible *"boca de fumo"* near the highway
4	4	12690	- Thin alleys, limited accessibility by car - Verticalization of homes - Visible sewage and/or water leaks Many demolished and/or partially demolished homes (result of PAC)	- Periodic flooding - Community gardens - Presence of free-roaming swine and poultry - Borders the *Faria-Timbó* and the *Jacaré Rivers*	- Pacifying Police Unit - Visible *"bocas de fumo"*
5	3	4994	- Apartment complexes - Public housing for low-income families - Apartments originally granted to veterans of the 2nd World War (higher income families) - Heterogeneous housing structures Hub of PAC interventions	- Borders the *Jacaré River*	- Very heterogeneous socioeconomic conditions of families - Center of public services offered in the CM

in 2007 aiming at improving sanitation, however, PAC has provided mixed results, concentrating improvements in MA5 and worsening conditions in other MAs[18].

Data collection

A cross-sectional study was conducted, between 2015 and 2016 using participant observation, interviews and a socioeconomic survey based on the Basic Questionnaire Demographic Census and the Unified Registration Form for Social Programs, validated by Moraes Neto *et al*.[19-21]. Similar socioeconomic surveys have been recently used by Srinivasan *et al*.[2], Sandoval *et al*.[13], and Casavechia *et al*.[14]. Since areas with soil were limited due to the widespread presence of concrete, soil samples were collected from public areas (e.g. soccer fields, community gardens, parks) distributed throughout the slums (convenience sampling) (n=22). Predictor variables included individual socioeconomic parameters (age, sex, educational attainment level and employment status) and household characteristics (household income, presence of toilet inside the house; drinking water source and material of household floors).

For stool sample collection, wide mouth screw capped containers with scoops were labeled and distributed to every member of the selected households while oral instructions on sample collection were provided. The research team returned on two consecutive days, when necessary, to collect the fresh samples. Some visits were interrupted by violent conflicts in the territory.

The sample size of 282 was determined considering an estimated prevalence of 25% (based on a pre-test conducted in 2010) of IPIs, a sample guarantee of 5%, a design effect of 1, and a 95% confidence interval. Systematic sampling started with a randomly selected house and continuing by approaching every twenty households, respecting the proportions of families distribution throughout the MAs. Since the study area is constantly changing, the number of households was greater than that counted by health services. Therefore, by following this sampling method, a total of 318 households were included in the study.

Data analysis

The spontaneous sedimentation method, one of the most frequently used in research on IPIs in Brazil and the method of choice within the Brazilian health system (SUS) was used with three slides per sample, to identify intestinal parasites in fresh fecal samples[22,23,24]. All parasitological results were provided to residents; and, those with positive samples were referred to the participating FHS clinic for treatment.

Soil samples were analyzed by spontaneous sedimentation and the adapted Baermann techniques[22-25]. Total coliform and *Escherichia coli* levels in the soil were evaluated considering the guidelines established by the municipal legislation[26].

Monthly household income and number of residents were used to assign poverty levels where BRL$70.00 per person/month was considered the extreme poverty line and BRL$170.00 per person/month was considered the poverty line. These values coincide with the extreme poverty and poverty limits established by the *Brasil Sem Miséria* and *Bolsa Família* programs, respectively.

Data were organized within a Microsoft Access database, exported to EpiInfo 7.0 and analyzed using the χ^2 or Fisher's exact test, when appropriate. Odds ratios (ORs) and their respective 95% confidence intervals (95% CI) were calculated. Values of $p < 0.05$ were considered statistically significant. Data were included in the multivariable analysis (logistical regression or linear regression, when applicable) if significant to the univariate analysis.

Ethical Statement

This study was approved by the Instituto Oswaldo Cruz (IOC/FIOCRUZ) Committee for Ethics in Research (CAAE 55512916.3.0000.5248), in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. All study participants received an oral and written explanation of their rights, the procedures to be used and the purpose of the study in accessible language. Recruitment occurred only after obtaining written informed consent from adults and from the parents/legal guardians on behalf of minors. Each household received a copy of the Free and Informed Consent form. Information to enable the research team to contact the participants was provided, answers to the questions regarding IPIs were also provided by the research team and residents of participating households were invited to take part in a health promotion course offered by IOC/FIOCRUZ. During home visits health education activities for the population occurred through oral explanations of IPIs, leaflets on water quality and treatment, and invitations to participate in a yearly health promotion course.

RESULTS

The study included 318 households with 1,230 residents and 595 (48.4%) provided samples for analysis. Reasons provided for non-participation included: embarrassment, scheduling conflicts, constipation and violence which made the territory inaccessible to the research team; however, the profile of those that did not provide stool samples were similar, hence constituting random loss. Predictor variables are shown according to MA (Table 2). The use of piped water as the drinking source ($p<0.001$) and the poverty levels were different among MAs, being greater in MA1 with respect to MA2, and MA2 with respect to MA3. Linear regression found an association between age (years) and income per capita (US dollars/day/person) ($p<0.001$, $r^2=0.1$ after exclusion of three outliers): 35.7% (143/401) of children from 0-19 years of age were living in poverty, compared to only 14.2% (97/685) of adults (20 years or older) (OR: 3.36; 95% CI: 2.50- 4.52; $p<0.001$). IPI frequency was not different among those enrolled in *Bolsa Família* (a government assistance program for families living in poverty) or between residents with different educational attainment levels. *Bolsa Família* was being received by 21.7% (72/317) of the families. Furthermore, employment status was not associated with IPIs, however women were significantly less likely to be employed (OR: 0.26; 95% CI: 0.19- 0.36; $p<0.001$). Overall, 63.0% (373/592) of adults from 20-59 years of age were employed as well as 23.3% (42/180) of senior citizens (60 years or more). Linear regression found a negative association between employment among 20-59 year-old participants and employment among senior citizens ($r^2=0.98$). No statistically significant association was detected between poverty and employment among senior citizens; yet, interviews found that employment among the elderly was based on family needs necessity and it was common social practice for grandparents to be the guardians of grandchildren. *Giardia intestinalis* was more common among children 0-9 years of age (OR: 4.95; 95% CI: 1.96- 12.40; $p<0.001$). *Endolimax nana* was more frequent among adults 20-59 years of age ($p=0.04$) and

Table 2 - Frequency distribution of residents, households and peridomiciliary characteristics by Major Area (MA) of Brazilian urban slums (Complexo de Manguinhos, Rio de Janeiro), n (%)

Characteristics	Major Areas							Intestinal parasitic infections (n_4)	
	1	2	3	4	5	Total	*p*	[Positive/Total] %	*p*
Sex (n_1)							0.27		0.32
Male	82 (47.1)	151 (49.8)	42 (40.0)	183 (42.9)	104 (47.1)	562 (45.7)		[81/257] 31.5	
Female	92 (52.9)	152 (50.2)	63 (60.0)	244 (57.1)	117 (52.9)	668 (54.3)		[94/338] 27.8	
Age (n_1)							0.06		0.98
0-9	24 (13.8)	64 (21.1)	17 (16.2)	79 (18.5)	44 (19.9)	228 (18.5)		[32/76] 29.6	
10-19	29 (16.7)	60 (19.8)	20 (19.1)	69 (16.2)	45 (20.4)	223 (18.1)		[22/53] 29.3	
20-59	90 (51.7)	153 (50.5)	55 (52.4)	201 (47.1)	100 (45.3)	599 (48.7)		[85/198] 30.0	
≥60	31 (17.8)	26 (8.6)	13 (12.4)	78 (18.3)	32 (14.5)	180 (14.6)		[36/93] 27.9	
Residents/Household (n_1)							0.16		0.30
1-2	22 (12.6)	34 (11.2)	9 (8.6)	54 (12.6)	19 (8.6)	138 (11.2)		[22/61] 26.5	
3-4	73 (42.0)	108 (35.6)	35(33.3)	181 (42.4)	95 (43.0)	492 (40.0)		[71/191] 27.1	
5≤	79 (45.4)	161 (53.1)	61 (58.1)	192 (45.0)	107 (48.4)	600 (48.8)		[82/168] 32.8	
Poverty (n_2)							<0.001*		0.58
Not in poverty	153 (91.6)	146 (67.6)	69 (65.7)	321 (83.2)	157 (74.1)	841 (77.4)		[124/421] 29.5	
Poverty	14 (8.4)	57 (26.4)	36 (34.3)	65 (16.8)	47 (22.2)	164 (15.1)		[16/70] 22.9	
Extreme poverty	0 (0.0)	13 (6.0)	0 (0.0)	0 (0.0)	8 (3.8)	81 (7.5)		[5/12] 41.7	
Educational attainment (n_3)							0.17		0.88
Illiterate or incomplete elementary	48 (39.7)	91 (50.8)	24 (35.3)	115 (41.2)	53 (40.2)	331 (42.5)		[59/197] 29.9	
Complete elementary or higher	66 (54.5)	79 (44.1)	42 (61.8)	156 (55.9)	75 (56.8)	418 (53.7)		[60/206] 29.1	
No answer	7 (5.8)	9 (5.0)	2 (2.9)	8 (26.7)	4 (3.0)	30 (3.8)		[2/7] 22.2	
Employed (n_3)							0.04		0.31
No	55 (45.4)	72 (40.2)	31 (45.6)	130 (46.6)	69 (52.3)	357 (45.8)		[56/214] 26.2	
Yes	66 (54.6)	102 (57.0)	37 (54.4)	149 (53.4)	61 (46.2)	415 (53.3)		[64/194] 33.0	
No answer	0 (0.0)	5 (2.8)	0 (0.0)	0 (0.0)	2 (1.5)	7 (0.9)		[1/3] 25.0	
Positive for intestinal parasites (n_4)	[46/91] (50.5)	[54/177] (30.5)	[7/34] (20.6)	[42/189] (22.2)	[26/104] (25.0)	[175/595] (29.4)	<0.001*	-	-
Home ownership (n_5)							0.10		0.14
Owned	39 (78.0)	63 (82.9)	19 (76.0)	100 (89.3)	53 (96.4)	274 (86.2)		[161/523] 30.8	
Rented	11 (22.0)	12 (15.8)	6 (24.0)	11 (9.8)	2 (3.6)	42 (13.2)		[13/68] 19.1	
Borrowed	0 (0.0)	1 (1.3)	0 (0.0)	1 (0.9)	0 (0.0)	2 (0.6)		[1/4] (25.0)	
Flooring (n_5)							0.32		0.91
Ceramic	48 (96.0)	69 (90.8)	24 (96.0)	104 (92.9)	51 (92.7)	296 (93.1)		[161/547] 29.4	
Concrete	1 (2.0)	7 (9.2)	1 (4.0)	6 (5.4)	2 (3.6)	17 (5.3)		[10/34] 29.4	
Wood	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.8)	2 (3.6)	4 (1.3)		[3/12] 25.0	
Dirt	1 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.3)		[1/2] 50.0	
Water source (n_5)							0.00		0.10
Canalized	43 (86.0)	62 (81.9)	6 (24.0)	34 (30.4)	40 (72.7)	185 (58.2)		[115/360] 31.9	
Mineral water	7 (14.0)	10 (13.2)	19 (76.0)	77 (68.7)	15 (27.3)	128 (40.2)		[55/224] 24.5	
Other	0 (0.0)	4 (5.3)	0 (0.0)	1 (0.9)	0 (0.0)	5 (1.6)		[5/11] 45.4	
Toilet (n_5)							0.67		0.73
Inside	50 (100.0)	74 (97.4)	25 (100.0)	111 (99.1)	54 (98.2)	314 (98.7)		[173/585] 29.6	
Outside	0 (0.0)	2 (2.6)	0 (0.0)	1 (0.9)	1 (1.8)	4 (1.3)		[2/10] 20.0	
Median total coliform bacteria (Interquartile range)	$1.6x10^7$ ($3.0x10^6$-$2.7x10^7$)	$4.0x10^6$ ($5.3x10^5$-$6.2x10^6$)	$1.0x10^6$ ($6.7x10^5$-$1.0x10^7$)	$6.1x10^6$ ($3.2x10^6$-$1.3x10^7$)	$5.6x10^6$ ($1.4x10^6$-$5.6x10^6$)	$5.0x10^6$ ($1.1x10^6$-$9.8x10^6$)	-	-	-
Median *Escherichiacoli* (Interquartile range)	$1.4x10^6$ ($9.0x10^4$-$1.5x10^6$)	$5.0x10^5$ ($1.8x10^5$-$2.5x10^6$)	$3.5x10^4$ ($3.5x10^4$-$3.5x10^4$)	$1.3x10^5$ ($7.5x10^4$-$1.6x10^6$)	$3.2x10^5$ ($3.2x10^5$-$3.2x10^5$)	$4.1x10^5$ ($7.0x10^4$-$1.3x10^6$)	-	-	-

*Statistically significant. n_1=1,230 individuals, n_2=1,086 individuals, n_3=779 adults, n_4= 595 individuals with fecal samples analyzed, n_5=318 households the employed (OR: 1.72; 95% CI: 1.01- 2.94; *p*=0.04); however, logistical regression found that adulthood was a confounder. The presence of *Entamoeba coli* was different according to the source of drinking water, being higher when canalized piped water was used (OR: 1.81; 95% CI: 1.0- 3.2; *p*=0.04).

Infection profiles identified from residents are shown in Table 3, including both profiles of mono- and poly-parasitism. The commensal parasites *E. nana* and *Entamoeba coli* were the most frequently identified, with overall frequencies of 16.0% (95/595) and 10.9% (65 /595). *G. intestinalis* (*n*=24/595, 4.0%) and *Ascaris lumbricoides* (*n*=11/595, 1.8%) were the next most frequent agents detected. Coinfection with *Entamoeba coli* and *E. nana* was significant (OR=4.11; 95% CI: 2.35- 7.19; *p*<0.001). Coinfection with *Entamoeba coli* and *Entamoeba histolytica/dispar* appeared significant, however, logistical regression showed that this association was due to confounding factors and *E. nana* was associated with *E. histolytica/dispar* (OR=7.25; 95% CI: 1.60- 32.92; *p*=0.01). Coinfection with *Entamoeba coli* and *A. lumbricoides* was also significant (OR=4.90; 95% CI: 1.39- 17.22; *p*=0.02).

All soil samples presented improper levels of both coliform bacteria and *Escherichia coli*, the greatest contamination was found in MA1 which presented a median measurement 533 times greater than the acceptable limit for total coliform bacteria and 36 times great than the limit for *Escherichia coli* permitted allowed by legislation[26].

DISCUSSION

Globally, populations are increasingly urban and in Brazil 89.5% of the population is expected to be living in urban centers by 2020, a major portion of this population in slums[27]. Slums present a complex mixture of environmental, economic and social conditions which may affect IPIs[3]. In this study, the major areas (MA) differed significantly in terms of poverty and IPIs; however, the specific levels of poverty measured were not directly associated with IPIs in these communities where the overall conditions of poverty are pervasive. Poverty was associated with children, who are the target population of many studies regarding IPIs[2,28]. The method of determining poverty levels was limited due to its reliance solely on the income; however, even with this limitation and the heterogeneity of the communities, 22.6% of the total population was identified as living in poverty, highlighting the extremely high levels of poverty in this region.

Studies including the general population can analyze the interplay between poverty, age and parasitism. This study corroborates findings of *G. intestinalis* among children[13,29]. Kiani *et al.*[31] detected an inverse relationship between IPIs and age; however, in their study the role of age as a predictor for IPIs may have been confounded by employment, as detected with *E. nana* in this study. FIOCRUZ is a major employer of CM residents with most vacancies in janitorial and gardening services. Although type of employment was not verified, contact with soil has been found to increase the chance of infection and may be related to parasitism among the employed residents of MA1 (Table 1)[14,31]. Further studies among the employed participants are needed addressing their employment type and practices including the use of personal protective equipment like gloves and proper shoes. Urban farming, especially within marginalized slum communities, increases the chances of IPIs[32]; however, despite the presence of community gardens in MA2, this area did not have statistically significant difference in parasitism compared to the rest of the CM. This may be due to limited use of these gardens since interviews did not find residents who participated in community gardening. The areas with the highest risk of periodic flooding also did not have greater parasitism despite Sandoval *et al.*[13] identified flooding as a predictor for IPIs. In the CM, with the exception of MA1, all areas are somewhat prone to flooding due to the history of the land (originally a mangrove swamp) and controversial public development projects which exacerbated flooding in some communities[18]. Although this study did not detect correlations, it is important to establish a baseline of infection profile in these communities and strengthen public health services that combat IPIs and mitigate the impact of these recurring events[33].

Srinivasan *et al.*[2] found an association between infection and lack of access to piped water. This was not seen in the CM because even with piped canalized water, like in similar studies, connections were generally clandestine, presenting leakages and no inspection of installation or maintenance[21,34]. Moraes Neto *et al.*[21] detected high levels of contamination of canalized piped water in other Brazilian slums, and in this study *Entamoeba coli* was associated with the utilization of canalized piped water, suggesting that canalization alone is insufficient for guaranteeing potable water. MA1 presented low usage of mineral water and interviews identified greater confidence in the canalized piped water quality and direct consumption of this water without other purification methods such as filters or boiling although all areas of the CM are connected to the same public water source. In addition, cases of parasitism in residents of MA1 were often among extended family members from different households. This finding is supported by Gil *et al.*[29] who highlighted the importance of community contamination in addition to household

Table 3 - Frequency distribution of intestinal parasites identified in residents of Brazilian urban slums (Complexo de Manguinhos, Rio de Janeiro), n=595

Parasite Species	Frequency, n (%)	Major Areas (MAs) detected
Monoparasitism	129 (21.7)	1, 2, 3, 4, 5
Protozoa		1, 2, 4, 5
Entamoeba histolytica/dispar	1 (0.2)	2
Entamoeba coli	31 (5.2)	1, 2, 4, 5
Endolimax nana	58 (9.7)	1, 2, 4, 5
Iodamoeba butschlli	1 (0.2)	1
Giardia intestinalis	16 (2.7)	2, 4, 5
Helminths		1, 2, 3, 4, 5
Hymenolepis diminuta	3 (0.5)	3
Strongyloides stercoralis	2 (0.3)	4
Ascaris lumbricoides	6 (1.0)	1, 5
Trichuris trichiura	4 (0.7)	1, 2
Taenia sp.	1 (0.2)	4
Ancylostomidae	6 (1.0)	1, 2, 3, 4
Polyparasitism- 2	35 (5.9)	1, 2,3, 4, 5
Only protozoa		1, 2, 3, 4, 5
Entamoeba coli & *E. nana*	17 (2.9)	1, 2, 3, 4, 5
Entamoeba coli & *G. intestinalis*	2 (0.3)	4, 5
Entamoeba coli & *I. butshlii*	2 (0.3)	1
E. nana & *E. histolytica/dispar*	3 (0.5)	2, 4
E. nana & *G. intestinalis*	4 (0.7)	1, 2, 4
E. nana & *I. butshlii*	1 (0.2)	5
Mixed infections		1, 2, 3, 4
Entamoeba coli & *A. lumbricoides*	2 (0.3)	1
Entamoeba coli & *T. trichuria*	1 (0.2)	3
E. nana & *Ancylostomidae*	1 (0.2)	1
E. nana & *A. lumbricoides*	1 (0.2)	4
E. nana & *S. stercoralis*	1 (0.2)	2
Polyparasitism- 3	11 (1.8)	1, 2, 4, 5
Only protozoa		1, 2, 4, 5
Entamoeba coli, E. nana, & *E. histolytica/dispar*	1 (0.2)	5
Entamoeba coli, E. nana, & *G. intestinalis*	1 (0.2)	2
Entamoeba coli, E. nana & *I. butshlii*	3 (0.5)	4, 5
Entamoeba coli, I. butshlii, & *E. histolytica/dispar*	1 (0.2)	4
E. nana, E. histolytica/dispar, & *G. intestinalis*	1 (0.2)	1
Mixed infections		1
Entamoeba coli, A. lumbricoides, & *E. histolytica/dispar*	1 (0.2)	1
Entamoeba coli, E. nana, & *E. vermicularis*	1 (0.2)	1
Entamoeba coli, E. nana, & *H. diminuta*	1 (0.2)	1
Entamoeba coli, E. nana, & *A. lumbricoides*	1 (0.2)	1
Total infection frequency	175 (29.4)	-

factors. The relative superior living conditions of MA1, especially in terms of lower level of violence (an important characteristic of Brazilian urban slums), may lead residents not to acknowledge that their living conditions and health risks are shared with their neighbors in other MA which do present drug-related violence. However, this area presented the greatest measured environmental contamination and IPI prevalence.

Although the greatest prevalence was of commensal parasites, high prevalence of commensals has been found to be a predictor for pathogenic IPIs because they indicate the presence of fecal-oral transmission in the territory[13]. In this study, coinfections of *E. nana* with *E. histolytica/dispar* and *Entamoeba coli* with *A. lumbricoides* were significant. Calegar *et al*.[35] found, after PCR analysis, that most infections with the morphologically indistinguishable *E. histolytica/E. dispar* complex were of the traditionally nonpathogenic *E. dispar*. Furthermore, even infections with pathogenic parasites were asymptomatic, suggesting that dependence solely on signs and symptoms of disease are insufficient for initiating treatment[34-37]. The collection and analysis of stool samples in urban slums covered by primary public health care services is necessary for establishing control measures to meet the community needs. Current guidelines for controlling IPIs are based almost exclusively on preventive chemotherapy despite the shifting profile of infection dominated by protozoa, such as the ones identified in the CM[1,10]. This change in profile may be attributed to the consumption of anthelmintics through self-medication, deworming campaigns and prescriptions through primary health services[21]. In the CM, complete coverage by the FHS could explain the low prevalence of IPIs, specifically of helminths. Another Brazilian study developed in an area covered by the FHS found that the frequencies of infection were much lower suggesting that, although the health services may contribute to low IPI frequencies, other factors are important for considering IPI vulnerability[14]. Although other methods such as PCR analysis may have detected greater IPI frequencies, the spontaneous sedimentation method used in this study has a sensitivity of 87.5% and a specificity of 99.1% when three slides per sample are analyzed and, as the method used in public services, it can be compared in local surveillance efforts[24].

Health education and promotion initiatives developed by primary health services targeting or not targeting IPIs must consider the characteristics of these populations. Family dynamics in slum territories are complex and evolving, with employment status and income serving as important contributors to social relations. Home visits by the health professionals taking care of these communities are important for the understanding and the incorporation of lifestyle limitations imposed by the overall conditions of poverty.

CONCLUSIONS

It is important that both residents and health professionals consider the socioenvironmental conditions of urban slums when assessing intestinal parasitic infections for disease control and health promotion initiatives. This study showed that management of intestinal parasitic infections cannot be reduced in urban slums based on comparative estimates of need or a one-size-fits-all approach focusing on preventive chemotherapy for soil-transmitted helminths, since urban slums are complex socioenvironmental settings with interconnected needs. The changing profile of intestinal infections involves patient knowledge and practices in addition to community conditions. Health education, quality public sanitation (e.g. sewage collection and treatment, continued access to safe drinking water, regular trash collection), comprehensive health services acting in conjunction with other sectors (e.g. housing, education, transport, security) are required to address the needs of these communities.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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