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Prevalence of intestinal parasitic infections in preschool-children from vulnerable neighborhoods in Bogotá

Prevalencia de parásitos intestinales en niños preescolares de barrios vulnerables de Bogotá

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ABSTRACT

Introduction: Intestinal parasitic infections (IPIs) are neglected tropical diseases, even though their prevalence is high in many developing countries. The public health impact of IPIs is substantial, in particular for children due to the negative effect on growth and development. **Objectives:** This study examines the prevalence and risk factors of IPIs in preschool-children from at-risk neighborhoods, including those from internally displaced families. **Materials and Methods:** A cross-sectional study among 239 preschool-children from two vulnerable neighborhoods in Bogotá. Fecal samples were collected and microscopically examined (direct and Ritchie technique) and data regarding related factors was obtained through a questionnaire. **Results:** A prevalence of 26.4% for pathogenic parasites (*Giardia duodenalis, Blastocystis spp, Trichuris trichiura, Ascaris lumbricoides, and Hymenolepis nana*) was found. Logistic regression resulted in four risk factors: siblings ≤5 years (OR 2.33 [1.077-5.021]), stray dogs (OR 2.91 [0.867-9.767]), household members (OR 2.57 [1.155-5.706]) and child's sex (OR 2.17 [1.022-4.615]). **Discussion:** IPI presence in preschool children is an important health issue in Bogotá which should be addressed. A high protozoan prevalence was found compared to helminthes. Implementing policies addressing risk factors could be a first step in decreasing IPI prevalence.

Keywords: parasitic intestinal disease, preschool child, Colombia, human migration, cross sectional study.

RESUMEN

Introducción: Infecciones parasitarias intestinales (IPI) son enfermedades tropicales desatendidas, a pesar de que su prevalencia es alta en muchos países en desarrollo. El impacto en la salud pública de los IPI es importante, especialmente para los niños debido al efecto negativo sobre el crecimiento y el desarrollo. **Objectivos:** Este estudio examina la prevalencia y factores de riesgo de IPI en niños preescolares de barrios en riesgo, incluidos los de las familias desplazadas. **Materiales** y **Métodos:**

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estudio transversal entre 239 niños preescolares de dos barrios vulnerables de Bogotá. Se recogieron muestras fecales y se examinaron microscópicamente utilizando dos técnicas (directa y Ritchie). Se aplicó cuestionario para indagar factores relacionados con el parasitismo intestinal. **Resultados:** Se encontró una prevalencia de 26,4% de parásitos intestinales patógenos (*Giardia duodenalis, Blastocystis spp, Trichuris trichiura, Ascaris lumbricoides y Hymenolepis nana*). La regresión logística resultó en cuatro factores de riesgo: hermanos ≤5 años (OR 2.33 [1.077-5.021]), los perros callejeros (OR 2.91 [0.867-9.767]), los ocupantes de la casa (OR 2.57 [1.155-5.706]) y el sexo del niño/a (OR 2.17 [1.022-4.615]). **Discusión:** La presencia del IPI en los niños preescolar es un problema de salud importante en Bogotá y que debe abordarse. Una alta prevalencia de protozoos se encontró comparado con helmintos. La implementación de políticas que aborden los factores de riesgo podría ser un primer paso en la disminución de la prevalencia del IPI. El antecedente de desplazamiento no cambio ni el tipo de parásito ni la prevalencia de parasitismo.

Palabras clave: Parasitosis intestinales, Preescolar, Colombia, Migración Interna, Estudios de corte transversal

INTRODUCTION

The Pan American Health Organization (PAHO) estimates that over one-third of the world population is infected with an intestinal parasite. In spite of this, many intestinal parasitic infections are still considered to be neglected tropical diseases[1]. 'Intestinal parasitic infections' (IPIs) is a collective term that includes infections caused by both helminths and protozoan. The highest prevalence of IPIs is generally found among school-aged children (SAC)[1]. Children are more vulnerable to severe consequences of these infections, due to the negative effect on growth and development[1]. Data about IPI prevalence in children in Colombia is limited, especially for the category of pre-school-aged children (PSAC). This impedes public health efforts in aiming at the appropriate (sub)population. Data about IPI prevalence in a region is essential for identifying local vulnerabilities and to adapt public health programs to this[1]. Insight into the risk factors for IPIs is important in order to tailor programs to local needs and circumstances.

Parasite types

Globally, a high prevalence is found for the helminths *Ascaris lumbricoides* (roundworm) and *Trichuris trichiura* (whipworm). Common pathogenic intestinal protozoan include *Giardia duodenalis* (*intestinalis*) and *Entamoeba histolytica*[2]. *Blastocystis spp* is also highly prevalent, but its pathogenicity is controversial[3].

Pathogenic IPIs are often asymptomatic and thus go undiagnosed. This problem is amplified by the limited diagnostic value of traditional microscopy, due to a daily variation in egg excretion in feces[4]. Because of many undetected cases of IPIs, the magnitude of this health problem is difficult to estimate.

Health consequences

Negative consequences of IPIs in children include: reduced growth, reduced food intake, anemia and loss of iron, which has an impact on the child's physical, cognitive and overall societal development, even throughout adult life[1,5]. Additionally, there is a risk of acute complications; e.g. intestinal obstruction and rectum prolapse. Adequate treatment improves appetite, anthropometric measures and physical fitness[5,6].

IPIs generally cause morbidity, rather than mortality. The World Health Organization (WHO) estimated in 2002 that the burden of *Trichuris* and *Ascaris* accounted for respectively 1.6 and 1.2 million lost Disability Adjusted Life Years (DALYs)[7].

Socio-economic factors

Previous research established a relationship between IPI presence and socioeconomic factors[8]: low maternal education level, low family income, living in a rural area, poor sanitary facilities and sewage systems and limited access to healthcare services were associated with a higher IPI prevalence[8-11].

In Colombia, the SISBEN-index is used as a representation of the socioeconomic status (SES) of a family. This index is a combination of variables (e.g. housing, use of public services, and demographics) used to assess a household's eligibility for social services. The Colombian population is ranked in strata from 1 to 6. Most social programs, aiming at reducing (health) inequalities, only target strata 1 (extreme poverty) and 2 (poverty), The health insurance system in Colombia has a similar objective in offering two insurance arrangements: the subsidized regime (SR) for the poor and the contributing regime (CR) for wealthier families[12].

IPIs in Colombia

In Calarcá pathogenic IPIs were found in 42.7% of 220 PSAC[13], in the city of Armenia 24.1% of 328 children 1-7 years old was infected[14], in Guapí the prevalence was 30.6% among 136 children <2 years of age[15], while in Cali a staggering 84% of 57 SAC from indigenous communities were IPI positive[16]. In most studies, *G. duodenalis* was the most prevalent intestinal parasite. The highest prevalence of potentially pathogenic parasites (88.9%) was found in Medellín in a study among 58 children attending a feeding program[17].

According to the WHO Colombia is a country with a moderate burden of soil-transmitted helminths; between 1/3rd and 2/3rd of (P)SAC are in need of treatment[18]. In 2009 about 1.5 million SAC received deworming treatment in Colombia, a coverage of approximately 29%[1]. Unfortunately, these campaigns are not regularly organized, they are not aimed at PSACs, and no programs have been implemented to combat intestinal protozoan[18]. It is argued that solely focusing on treatment campaigns would be a mistake. Improving socio-economic determinants should be targeted as part of an eradication strategy[19].

It is generally thought that IPIs are not an important health problem in Bogotá, because of the relative high level of economic development. However, this city has large income disparities and large peri-urban areas with poor living conditions. Approximately 44% of the population from Bogota is considered as being poor (SISBEN strata 1-2)[20]. Generally, the presence of IPIs is associated with living in a rural area because urban populations generally have better access to sanitation, clean water and health care services[11]. However, some researchers found the highest level of IPIs in peri-urban areas. They argue that urbanization increases IPI prevalence, if not accompanied by an increase in accessibility to basic infrastructure (e.g. sanitation and health care)[21].

Displacement

A problem specific to Colombia is the huge numbers of internally displaced persons (IDPs), due to the country's history of violent conflict. This group is generally more vulnerable to health problems and offers an additional challenge to the health system of Colombia[22]. Therefore the IDPs are considered a separate category in this research.

Internal displacement in Colombia started to rise in the 1990s due to armed conflicts between the government and insurgent groups. An estimated 2.65-4.36 million people (5.7-9.3% of the population) are internally displaced, ranking Colombia 2nd on a global scale[23]. The influx of IDPs to the cities has caused overcrowding and straining of the social system, since these displaced persons usually end up in the 'poverty belt'. There they continue to live in extremely poor circumstances; inadequate housing, limited access to healthcare, lower education for children and very low incomes[22,23], increasing susceptibility to (parasitic) infections.

This research aims to investigate the prevalence of IPIs in PSAC living in vulnerable neighborhoods in Bogotá. In addition the prevalence of IPIs among internally displaced families and the factors associated with IPIs in this population will be examined. It is hypothesized that the scope of IPIs in Bogotá is much greater than previously thought and prevalence is higher among the displaced population.

MATERIALS AND METHODS

Study design and population

This cross sectional study was conducted between May and October 2013 in two neighborhoods in Bogotá: El Codito and Patio Bonito. Both are marginalized neighborhoods with typical characteristic of slums: lack of quality roads and public services, low education levels, poor housing conditions and high violence levels. Patio Bonito is home to many displaced families and is considered one of the most dangerous neighborhoods in Bogotá[20,24].

The 239 PSAC (age 0-6 years) and their parents were approached through community daycare centers. The majority of these children belong to SISBEN-strata 1 or 2, which is representative for the neighborhoods.

Study procedures

Field Procedures

Data collection included a feces sample and a questionnaire. The questionnaire addressed demographic factors: age, gender, household and environmental factors (e.g. housing, sanitation), behavioral factors (e.g. hygienic measures, recent antiparasitic treatment) and SES of the family (e.g. education, employment). In the case of illiteracy or a low reading proficiency of the parents, the questionnaire was administered orally by daycare teachers.

A plastic container and instructions for collection of a feces sample were given to the parents. They were

instructed to bring the samples back to the daycare centers on the day of collection, preferably as soon as possible after the collection. A cool box with an ice pack was used to store and transport the samples to the laboratory on a daily basis to ensure the freshness of the samples.

Laboratory procedures

The feces samples were processed and analyzed at the Universidad del Rosario by experienced laboratory personnel on the day of collection. Subsequently, the samples were processed by means of the Ritchie procedure for concentration, using the formol-ether technique. These concentrated samples were examined again through microscopy. Only pathogenic parasites, including *Blastocystis spp*, were included in the data-analysis, because of their negative effect on children's health and development. The pathogenic *E. histolytica* was not included, because it is morphologically indistinguishable from the commensal *E. dispar*.

Ethical considerations

The study objectives and procedures were explained to the parents (primary caretaker). Verbal and written informed consent was obtained from both parents. Data was handled confidentially. The test results were returned to the primary caretaker. If pathogenic IPIs were found, a referral note for treatment was provided. If a family did not have access to treatment, it was provided to them. Additionally, all parents received a brochure with information about preventive measures for intestinal parasites. Approval was obtained from the Ethical Committee of the Universidad Del Rosario.

Statistical analysis

Data was processed and analyzed using IBM SPSS version 21. A descriptive analysis of the characteristics of the whole study population was performed, and for subgroups (family displaced less than five years ago, displaced and non-displaced -Taking into consideration that effects of migration depend on timing-). The prevalence of pathogenic IPIs was calculated. Possible risk factors were analyzed using crosstabs, chi-square tests and t-tests, and odds ratios and p-values were calculated. Factors that appeared to be significantly ($p<0.10$) associated with IPIs were analyzed further with multiple logistic regression (backwards method), to determine independent association. The displacement variable dichotomized (yes vs. no) and categorical (no, <5 years, >5 years) were added to all final models to review the effect of this factor, and all final models were also tested for interactions. The variable neighborhood was also added to the models but it was later remove because it did not improve the final model.

When the number of participants per category was too little, it was recoded into fewer categories, e.g. civil status was recoded from five into two categories: married/union libre (common law marriage) and single/widow/separated. To aid interpretation, continuous variables were converted into dichotomous variables, based on the median. Furthermore, a hygienic score was created, combining four variables involving (hand) washing behavior (after toilet use, before cooking, before feeding and washing of fruit/vegetables). Based on the median two approximately equal groups were created, respectively considered as 'good' hygiene and 'moderate/poor' hygiene (Cronbach alpha: 0.642).

RESULTS

Characteristics

The final sample consisted of 239 children from whom stool samples were collected. For 98% of the cases questionnaires were (partially) completed. Almost 70% of the samples were collected in El Codito. In **Table 1** the characteristics of the total study population are shown, and per displacement category. The average age of the subjects is 36.6 months (s.d.15.9), the female-male ratio is 0.96 and the majority is Caucasian (50.5%), closely followed by Mestizo (mixed European and Amerindian descent) (38.3%). Most displaced families live in Patio Bonito (93.3%).

Characteristics which showed a singnificant difference between displaced and non-displaced are: siblings below five (non-displaced 31.2% vs. displaced 54.2%, p=0.002), paternal presence (76.4% non-displaced vs. 62.7% displaced, p=0.043), civil status of parents (married/union libre: 78.3% non-displaced vs. 61.7% displaced, p=0.013), education level of mother (only primary education: non-displaced 14.0% vs. displaced 43.4%, p=0.000), access to healthcare as perceived by the parents (non-displaced 91.5%, displaced 76.5%, p=0.005) and insurance regime (subsidized/no insurance: non-displaced: 57.1%, displaced 77.6%, p=0.012).

Table 1. Characteristics of study population, displaced and non-displaced

Characteristics	Displaced % (n)	Displaced ≤ 5y % (n)	Non-displaced % (n)	Total group % (n)
Neighborhood (%)*				
- El Codito	6.7 (4)	0.0 (0)	89.5 (145)	69,5 (166)
- Patio Bonito	93.3 (56)	100.0 (29)	10.5 (17)	30,5 (73)
Persons in household*				
- 1-4 persons*	46.7 (28)	51.7 (15)	61.5 (99)	56.3 (130)
- 5 or more persons	53.3 (32)	48.3 (14)	38.5 (62)	43.7 (101)
Siblings ≤ 5 yrs*				
- Yes	54.2 (32)	53.6 (16)	31.2 (48)	39.0 (87)
- No	45.8 (27)	46.4 (13)	68.8 (106)	61.0 (136)
Parental presence (%)				
- Mother	96.6 (57)	100.0 (28)	97.5 (158)	97.4 (225)
- Father*	62.7 (37)	60.7 (17)	76.4 (123)	73.0 (168)
Civil status (%)*				
- Single/alone	38.3 (23)	44.8 (13)	21.7 (35)	26.0 (60)
- Married/union libre	61.7 (37)	55.2 (16)	78.3 (126)	74.0 (171)
Family income (%)				
- < min. wage ($589.500)	61.1 (33)	74.1 (20)	58.0 (83)	59.8 (122)
- 1-2x minimal wage	38.9 (21)	25.9 (7)	42.0 (60)	40.2 (82)
SISBEN-status				
- 1	58.6 (17)	71.4 (10)	54.0 (67)	55.6 (89)
- 2 or 3	41.4 (12)	28.6 (4)	46.0 (57)	44.4 (71)
Insurance type*				
- Subsidized/uninsured	77.6 (38)	80.0 (20)	57.1 (76)	63.7 (121)
- Contributing regime	22.4 (11)	20.0 (5)	42.9 (57)	36.3 (69)
Access to healthcare*				
- Yes	76.5 (39)	69.6 (16)	91.5 (130)	86.7 (176)
- No	23.5 (12)	30.4 (7)	8.5 (12)	13.3 (27)
Education mother (%)*				
- ≤ primary school	43.4 (23)	48.0 (12)	14.0 (20)	22.9 (47)
- Secondary + media	52.8 (28)	52.0 (13)	69.9 (100)	64.9 (133)
- Tertiary	3.8 (2)	0.0 (0)	16.1 (23)	12.2 (25)

* Significant difference ($p<0.05$) between displaced and non-displaced population

Parasite prevalence and risk factors

Pathogenic IPIs were found in 26.4% of the samples (95% CI 20.5% - 31.8%), with *G. duodenalis* having the highest prevalence (15.1%) (**Table 2**). In 7 children there was poly-parasitism, of which two had a combination of helminths and protozoan. Potential factors related to IPI presence were divided into three categories: household and child characteristics, environmental, and behavioral. **Table 3** presents some of these characteristics along with prevalence rates of pathogenic IPIs per subgroup and ORs for IPIs.

Table 2. Prevalence of intestinal parasites in the study population

Pathogen	Prevalence % (n), [95% CI]
All pathogenic parasites	26.4 (63)*, [20.5 – 31.8]
Giardia duodenalis	15.1 (36), [10.5-19.7]
Blastocystis spp	9.6 (23), [5.9 – 13.4]
Trichuris trichiura	2.1 (5), [0.4 – 4.2]
Ascaris lumbricoides	1.3 (3), [0.0 – 2.5]
Hymenolepis nana	1.7 (4), [0.4 – 3.3]

* Because of polyparasitism this number does not correspond with the sum of the separate pathogenic parasites.

Factors associated with the presence of IPIs were: mother with a low level job (manual labor) or who stayed at home (28% vs. 0% in high level jobs), a large household size (OR: 2.47 [1.34-4.54], p=0.003), siblings below five, (OR: 2.86 [1.53-5.34], p=0.001), low SISBEN-status (OR: 2.52 [1.22-5.19], p=0.011), and subsidized insurance/no insurance (OR: 2.60 [1.20-5.63], p=0.013). No significant relationship was found between IPIs and age, sex, ethnicity, family income, education of the mother or displacement status.

Environmental factors significantly associated with IPIs in the study population are: stray dogs around the house (OR: 3.61 [1.32-9.87], p=0.012) and room crowding (OR: 2.34 [1.25-4.39], p=0.007). No significant relationship was found between pathogenic IPIs and access to public services (electricity, aqueduct, sewage, and garbage disposal), a private or shared toilet, or the house type (own/rented).

None of the behavioral characteristics were found to be significantly associated with IPIs. There was also no significant relationship between the hygienic score and IPI presence.

The examination of these characteristics only in the displaced population did not result in any additional risk factors for IPIs.

Logistic regression

The factors which were found to be significantly associated (at a significance level of 0.10) to the presence of IPIs were: SISBEN status, health insurance, siblings below five, household size, stray dogs, profession and education of the mother, sex, garbage disposal, floor material, and room crowding. Since the SISBEN-status and the health insurance are aggregates of socio-economic indicators and thus strongly correlated with household size and education, they were not included in the model. The profession of the mother was also excluded from the model since the low number of mothers with a technical/professional job (n=19) precluded estimation for this item. Garbage disposal was left out of the model because of missing values of 41.4%.

The backward selection procedure resulted in a model with four explanatory variables: siblings below five, stray dogs, female sex, and a large household size (**Table 4**). The inclusion of displacement status in the model did not alter the model so that it could be concluded that displacement was not a confounder. Furthermore there are no significant interaction terms between displacement status and these four factors.

Table 3. Descriptives of child/household characteristics together with prevalence, ORs and significance levels for presence of IPIs

Characteristics	% (n) of study sample	subgroup with IPI, % (n)	Subgroup without IPI % (n)	OR [95% C.I.]
Child and household				
Sex				
- Female	49.1 (114)	30.7 (35)	69.3 (79)	NS
- Male	50.9 (118)	21.2 (25)	78.8 (93)	
Neighborhood				
- El Codito	69.5 (166)	28.9 (48)	71.1 (118)	NS
- Patio Bonito	30.5 (73)	20.5 (15)	79.5 (58)	
Displaced				
- Not displaced	73.0 (162)	25.9 (42)	74.1 (120)	NS
- Yes, total group	27.0 (60)	21.7 (13)	78.3 (47)	
- <5 years	13.2 (29)	31.0 (9)	69.0 (20)	
Max. education mother				
- ≤ primary	22.9 (47)	27.7 (13)	72.3 (34)	NS
- Secondary + media	64.9 (133)	27.8 (37)	72.2 (96)	
- Tertiary	12.2 (25)	12.0 (3)	88.0 (22)	
Profession mother				
- At home/unemployed	45.3 (102)	28.4 (29)	71.6 (73)	p=0.027
- Manual work	46.2 (104)	27.9 (29)	72.1 (75)	
- Tech/prof job	8.4 (19)	0 (0)	100 (19)	
# of persons in household				
- 1-4 persons	56.3 (130)	17.7 (23)	82.3 (107)	p=0.003
- 5 or more persons	43.7 (101)	34.7 (35)	65.3 (66)	2.47 [1.34-4.54]
Presence of siblings ≤ 5y				
- Yes	39.0 (87)	36.8 (32)	63.2 (55)	p=0.001
- No	61.0 (136)	16.9 (23)	83.1 (113)	2.86 [1.53-5.34]
SISBEN				
- 1	55.6 (89)	38.2 (34)	61.8 (55)	p=0.011
- 2 or 3	44.4 (71)	19.7 (14)	80.3 (57)	2.52 [1.22-5.19]
Healthcare insurance				
- Subsidized/uninsured	63.7 (121)	30.6 (37)	69.4 (84)	p=0.013
- Contributing regime	36.3 (69)	14.5 (10)	85.5 (59)	2.60 [1.20-5.63]
House/environmental:	**% (n) of study sample**	**subgroup with IPI, % (n)**	**Subgroup without IPI % (n)**	**OR [95% C.I.]**
Type of house				
- Own house	9.5 (21)	19.0 (4)	81.0 (17)	NS
- Rented house/room(s)	83.7 (185)	27.0 (50)	73.0 (135)	
- Other	6.8 (15)	20.0 (3)	80.0 (12)	
Room crowding				
- ≤2 persons/room	51.2 (111)	18.0 (20)	82.0 (91)	p=0.007
- >2 persons/room	48.8 (106)	34.0 (36)	66.0 (70)	2.34 [1.25-4.39]
Stray dogs around house				
- Yes	7.8 (17)	52.9 (9)	47.1 (8)	p=0.012
- No	92.2 (202)	23.8 (48)	76.2 (154)	3.61 [1.32-9.87]
Behavioral:	**% (n) of study sample**	**subgroup with IPI, % (n)**	**Subgroup without IPI % (n)**	**OR [95% C.I.]**
Type of water used				
- Tap water	84.8 (189)	25.9 (49)	74.1 (140)	NS
- Boiled water	13.9 (31)	29.0 (9)	71.0 (22)	
- Other	1.3 (3)	0 (0)	100 (3)	
Recent (<6mnth ago) anti-parasitic treatment				
- Yes	14.5 (33)	27.3 (9)	72.7 (24)	NS
- No	85.5 (194)	25.8 (50)	74.2 (144)	
Hygienic score				
- Good	57.1 (121)	25.6 (31)	74.4 (90)	NS
- Moderate/poor	42.9 (91)	26.4 (24)	73.6 (67)	

Table 4. Log. Regression model (coefficients and ORs) resulting from backward selection procedure for outcome pathogenic IPIs.

	b	se	Wald	Sig.	Odds ratio [95% C.I.]
Constant	-2.526	0.426	35.222	0.000	0.080
Presence of siblings ≤ 5 yrs	0.844	0.393	4.617	0.032	2.325 [1.077-5.021]
Stray dogs	1.068	0.618	2.988	0.084	2.910 [0.867-9.767]
Sex (female)	0.775	0.385	4.063	0.044	2.171 [1.022-4.615]
Household size (categorical)	0.943	0.407	5.354	0.021	2.567 [1.155-5.706]

DISCUSSION

The low mortality rates and the mainly long term consequences of IPIs explain the lack of priority assigned to them. To adequately tackle the problem of IPIs, through treatment campaigns or social policies, it is important to have accurate prevalence estimates and a clear picture of which factors are related to IPIs. This is important for evidence-based policy at a (sub)national level to tailor health programs to local needs and to monitor and evaluate the impact of implemented programs.

Prevalence of pathogenic intestinal parasites

The 26.4% prevalence of pathogenic IPIs found in our study population is lower than that found by many other studies which have been conducted in Colombia[13,16,25,26] that reported prevalence rates varying between 42.7% and 89.7%. These studies were conducted in varying contexts; rural-urban, low-high SES and among indigenous communities. The national survey about morbidity (1980) reported that pathogenic parasites are less frequent in the Bogotá area as compared to other areas of Colombia[14]. Nevertheless, the hypothesis that IPIs are also an important health problem in Bogotá is confirmed by our results, hereby rendering IPIs a relevant health issue in Bogotá.

Low prevalence rates were found for intestinal helminths; 2.1% for *T. trichiura*, 1.3% for *A. lumbricoides*, and 1.7% for *H. nana*. Comparably low prevalence rates (0.6%-2.4%) were found in other areas in Colombia[13,14,25]. However, some research in Colombia has revealed that there is a much higher prevalence for helminths in some areas, varying from 16.7% to 26.2%[10,15,16]. Over the past decades, urban areas have shown a decline in intestinal helminths, probably due to improvements in sanitation and general living conditions[26]. This could explain the low helminthic prevalence in our sample where 86.9% of households have an aqueduct, 87.4% a sewage, and 82.7% a private toilet.

The prevalence for *G. duodenalis* (15.1%) is comparable to previous studies in Colombia which found prevalences of 7.8%-11.6% in SAC[25,27] and 13.0-16.5% in PSAC[13,14,26]. The prevalence of *Blastocystis spp* in Colombia varies greatly; 1.7%[10] to 67.9%[25]. No explanations are provided for this wide range of prevalence figures, making comparisons for *Blastocystis spp* difficult. The 9.6% prevalence found in our sample falls within this broad range.

Internally displaced persons

IDPs generally have a low SES and increased health risks[28]; therefore it was hypothesized that IPI prevalence was higher in this population. Many socioeconomic characteristics were significantly different between the displaced and non-displaced population, however, this did not result in a significant effect on IPI prevalence. The highest IPI prevalence was found among the displaced population ≤3 years; 35.5% vs. 25.9% in non-displaced (non-significant). This may be because (socioeconomic) differences in IDPs normalize over time. Only a small number of recently displaced families (n=29 for displacement ≤5 years) were recruited for this study precluding the possibility of drawing clear conclusions regarding this.

Risk factors for IPIs

As expected, the SISBEN-status and the health insurance were found to be associated with IPIs. After excluding these variables from the regression analysis due to collinearity issues, four variables remained which together were associated with the presence of pathogenic IPIs: siblings below five, large household size, stray dogs, and sex.

Siblings below five and household size

Large households are often thought to increase IPI risk due to overcrowded conditions[17,29]. However, the variable 'room crowding' did not remain significantly associated with IPIs after logistic regression. This is probably partly due to a medium correlation between these two variables (Phi coefficient of 0.55, p= 0.00).

Previous research in Colombia found a similar relationship between having siblings below five and

IPIs. Children are more frequently infected with IPIs[1], and intensive contact between siblings can result in a higher transmission risk.

Stray dogs

Previous research has found that dogs are a reservoir for intestinal parasites, and inadequate parasite control in dogs can increase IPI prevalence in children[13]. Many recreational areas in Bogotá are polluted with parasites present due to dog excrements[30]. In Bogotá there is an abundance of stray dogs[31]. In this research only a trend is observed –probably due to the sample size– that suggests an association between stray dogs and IPIs (p=0.084, CI 0.867-9.767). A strategy to reduce IPI prevalence could therefore be an increased focus on parasite control in animals (pets and stray dogs)[13].

Sex of the child

In this study, girls appear to be more at risk for IPIs. Previous research has yielded contradicting results in this regard; In Teheran (Iran) a significantly higher IPI prevalence was found among girls[32], while in Sudan this was the case for boys[33]. Also in Colombia a higher prevalence of Giardia in (pre)school boys was found by some researchers[15,34]. Generally, studies in Colombia found no difference between boys and girls[10,13,14,35]. A satisfactory explanation for the higher IPI prevalence among girls in this sample is not available.

Remaining factors

Behavioral characteristics were not significantly associated with IPIs. This should be interpreted with caution since participants may not have been completely honest when answering these questions, especially because they often received help from the daycare teacher when filling in the questionnaire. No additional risk factors were found for the displaced population, possibly due to the limited number of displaced participants.

Limitations and weaknesses

Limitations of this study lie in its design; cross-sectional research only provides information about a single point in time, thereby precluding the conclusions about causation. Data collection through daycare centers is also a potential limitation, because some populations of at risk children may not attend daycare. However, as explained by teachers it is common for all PSAC to go to a daycare center, even when they are from the most marginalized families. Another point to consider is the fact that daycare centers are often overcrowded so that children could easily contaminate each other due to the combination of less than optimal hygienic behavior and the crowded circumstances. During the sample processing *Giardia* appeared to be highly prevalent in some daycare centers. This parasite is known to occur in (small) outbreaks[36]. Unfortunately there were no questions addressing the characteristics of the day care centers, which potentially may contribute to IPI prevalence. Finally, the study did not include the child's gastrointestinal symptoms, which could have told more about the implications of the intestinal parasite infections. However, the age of the children made the inclusion of symptoms very difficult.

CONCLUSION

The WHO advises regular deworming campaigns in Colombia[18]. This is not in line with the results of this research; a low prevalence of helminths, and a much higher prevalence for protozoan was found. Because of the considerable differences in helminthic prevalence in Colombia, and because of the high protozoan prevalence, regular coprological examination for (P)SAC may be a better approach. Because of the high transmission risk among siblings, diagnosis and treatment of the 'core family' of infected persons could help to prevent reinfection within the family[13].

The presence of pathogenic IPIs is greatly influenced by socioeconomic factors. These factors are often intertwined and slow to change (e.g. economic inequalities, violent conflict) and thus do not render quick solutions[19]. Nevertheless, these factors must be considered to effectively decrease IPI prevalence in the long term. In the meantime, other measures should be taken: regular coprological examination, control strategies for parasites in dogs, examination and treatment of the core family, and health education.

Research on a larger and recently displaced population could help in understanding the effect of displacement (duration) on IPI presence.

ETHICAL CONSIDERATIONS

Ethical approval was given by the: Comité de Ética en Investigaciones (CEI) Escuela de Medicina y Ciencias de la Salud de la Universidad del Rosario

CONFLICT OF INTEREST

There are no conflicts of interest to report.

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