Journal of Helminthology (2003) **77**, 15–20 DOI: 10.1079/JOH2002142

Distribution of intestinal parasitoses in relation to environmental and sociocultural parameters in La Plata, Argentina

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Abstract

Environmental parameters influencing the distribution of parasite species in three neighbourhoods of differing socioeconomic conditions in La Plata, Argentina were analysed. Coproparasitological screenings were performed in children up to 14 years old from a marginal zone (100), a suburban neighbourhood (101), and an urban area (91) in 1999–2000. The presence of parasite species in environmental samples (water and soil) and the degree of association among parasite communities was documented and evaluated. The prevalence of infection in each population was 73.0%, 54.4% and 35.2%, respectively. The frequencies of helminths and pathogenic protozoa were both higher in the marginal zone, where sanitary and environmental conditions were significantly inferior compared with the other zones. The high prevalence of intestinal parasites in this infantile population was related to parasitic contamination of the soil and water sources in addition to deficient sanitary and sociocultural conditions. Calculation of an equitability index revealed that the specific richness was less equitable once socioeconomic conditions and hygienic practices were improved. This study demonstrates the need to implement management practices for the control of intestinal parasitoses in accordance with the environmental and sociocultural characteristics of a given ecosystem.

Introduction

The principal sources of intestinal parasitic infections are faecal pollution of drinking water (Cifuentes *et al.*, 1994), soil (Wong *et al.*, 1994) and food (Garavelli & Scaglione, 1989). These circumstances are linked directly to sociocultural parameters, such as the lack of hygienic practices, low levels of instruction, undernourishment (Mason & Patterson, 1994), inadequate sanitary installations, overcrowding, contact with animals (Minvielle *et al.*, 1993) and the improper disposal of waste (Oberg *et al.*, 1993). These factors will be the most relevant to those social sectors of the population that are the neediest (Cooper *et al.*, 1993). Moreover, host age, the type of parasite, and the length of the course of infection will influence the transmission and distribution of parasitoses (Basualdo *et al.*, 1996). These conditions become aggravated by the constant migration of populations from rural to urban zones, which results in overpopulation in the cities and the establishment of marginal settlements in peripheral areas, where the transmission and the development of intestinal parasitosis become favoured (Crompton & Savioli, 1993; Pezzani *et al.*, 1995).

Clinical and epidemiological studies have permitted a description of characteristics associated with infections by intestinal parasites. Transmission can be associated with biotic factors, such as animal reservoirs or vectors, or

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to abiotic factors, including physical conditions of soil and water, or to the sociocultural profiles such as schooling and nourishment. In Argentina, statistical information on this topic is obtained from hospitals and/or health centres. These data are not representative of the real situation with respect to intestinal parasitic infections within the geographical and ecological framework of surveyed populations. Such data do not provide appropiate information for the investigation and/or management of biological systems. This lack of precise information on the occurrence of intestinal parasitoses in different populations in Argentina would suggest the need for a study on urban and suburban areas with the aim of defining the relationship between parasites, hosts and the environment. It is recognized that parasitoses are the result of a critical linkage within space and time between man and his surroundings (Lahitte *et al.*, 1989).

The objectives of the present study were: (i) to analyse the environmental and sociocultural parameters affecting the distribution of intestinal parasites in children up to 14 years from three neighbourhoods with different socioeconomic levels; (ii) to interpret the relationship between these parasitoses (i.e. the prevalence and intensity of infection) and their hosts and the environment; and (iii) to determine the degree of interspecies association, equitability and similarity or otherwise amongst the parasite populations under investigation.

Materials and methods

The city of La Plata, 54 km south of Buenos Aires, Argentina, is close to the forest bordering La Plata River (34°55′S, 57°56′W). About 500,000 inhabitants are concentrated in the city centre and peripheral areas. The average yearly temperature and relative humidity are 16.5°C and 78.6%, respectively. In 1999, a sample of the three selected neighbourhoods was chosen in accordance with the Epi info 6 (Centers for Disease Control and Prevention, Epidemiology Program Office, Division of Public Health Surveillance and Informatics) formula for random sampling in populational studies.

Environmental and sociocultural variables

To obtain demographic data and determine sampling size, a preliminary census was carried out in selected areas of the city to include a marginal zone (MZ), suburban neighbourhood (SN), and an urban area (UA) with 459, 956 and 804 inhabitants, respectively. Population data were taken for each family unit relating to selected children (100 in MZ, 101 in SN and 91 in UA). The levels of hygiene, promiscuity, overcrowding, sources of fruits and vegetables, cooking fuel and parents' employment status were recorded. The determination of the level of hygiene (LH) was subjective, as follows: LH = 0% when there was no cleanliness and tidiness (personal and at home), LH = 25% when these characteristics were minimum, LH = 50% when there was some care (individual and/or at home), LH = 75% when there was sufficient care and LH = 100% when there was a high level of cleanliness and tidiness. In this survey the Specific Index for the Measurement of Low Socioeconomic Level, designed and used by the Corporation for Nutrition in Chile (Alvarez *et al.*, 1982; Gamboa *et al.*, 1994) was applied. This index defines the concepts of overcrowding as cohabitation of more than three persons per room and promiscuity as the use of more than one person per single bed respectively.

Examination of faecal samples

Faecal samples of children were collected in wide-mouthed screw-capped jars containing 10% (v/v) formol, over a period of five consecutive days. The modified sedimentation technique of Telemann and the flotation procedure of Fülleborn (Feldman & Guardis, 1990) were used.

For quantifying worm burdens, 23 children from MZ and 5 from SN with geohelminthiases were sampled using a modified sedimentation technique of Telemann and eggs were counted in a Sedgwick-Rafter chamber (Brown, 1970). The intensity of infection by *Ascaris lumbricoides* and *Trichuris trichiura* (Renganathan *et al.*, 1995) was measured.

Examination of water and soil

To screen the water from the three neighbourhoods, drinking water was sampled from the childrens' homes (two for each community), schools (one for each neighbourhood) and from a small lake that surrounds MZ. Techniques recommended by the American Public Health Association (American Public Health Association, 1999) were applied.

Samples of soil were only collected from MZ because in this neighbourhood soil ocurred both inside and outside the houses. Eleven soil samples were taken from homes, 14 from surrounding areas, and 7 from latrines and examined for parasites using techniques recommended by Dada & Lindquist (1979).

Statistical analysis

Comparative analyses of all results were realized through the Epi Info 6 (Centers for Disease Control and Prevention, Epidemiology Program Office, Division of Public Health Surveillance and Informatics).

Index of Association

To determine interspecies relationships between the different parasite communities, the Fager index was calculated. This measures the affinity between pairs of associated species.

$$I_{AB} = 2j/(N_A + N_B)$$

where I_{AB} is the Fager index, j is the number of hosts harbouring both parasite species A and B, N_A is the number of hosts harbouring species A, and N_B is the number of hosts harbouring species B.

From these calculations, we determined if the affinity index obtained was statistically significant using the t test (Fager, 1957).

Index of diversity

To compare the richness of parasite species within communities three indices were utilized (Morales & Arelis Pino, 1987):

1. Shannon-Weaver index of specific diversity

$$Ish = 3.322\ [LogQ - 1/Q - \Sigma q_i Logq_i]$$

where q_i is the estimated number of positive cases found for each parasite species and Q is the sum of all cases estimated positive among the species found.

2. Absolute diversity index

$$Dmax = 3.322\ \ Log\ \ N$$

where: N is the number of species present.

3. Equitability index

$$E = Ish/Dmax$$

This index varies between 0 and 1, with ascending values producing a diminution in dominance and an elevation in equitability among compared species.

Sørensen coefficient of similarity

This was used to express, as a percentage, the degree of resemblance between parasitic communities (Brower & Zar, 1977). The following formula was used:

$$C_{SS} = 2C/(S_1 + S_2)$$

where C_{SS} is the Sørensen coefficient of similarity, C is the number of species common to both communities, S_1 is the number of species present (specific enrichment) in community 1 and S_2 is the number of species present (specific enrichment) in community 2.

Results

Environmental and sociocultural variables

The marginal zone has 60% of its ground area covered with a natural small lake, and consequently the dwellings are constantly being subjected to flooding. The low parts are also used as garbage dumps. The streets are of dirt, the electrical power is weak and there is no natural gas, sewer system, public lighting or garbage service. Inhabitants exhibit a low socioeconomical and educational status.

The suburban neighbourhood displays differences in the physical, biological, and sociocultural aspects of its ecosystem. The neighbourhood has good street conditions, natural gas, electrical power, sewers, public lighting, and a refuse-collection service. Levels of hygiene and the degree of education and socioeconomic status of inhabitants are better than in MZ.

The urban area has the best conditions of the three neighbourhoods with respect to public utilities and services (paved streets, electrical power, natural gas, sewers, public lighting, and a refuse-collection system). Levels of personal hygiene and the degree of education and socioeconomic status of the inhabitants are the highest among the three ecosystems. Tables 1 and 2 summarize the socioeconomic variables with statistically significant differences among the three ecosystems.

Table 1. Socioeconomic variables in three ecosystems of La Plata, Argentina in 1999–2000.

Variable	M Z		S N		UA		
	n = 62 FU		n = 75 FU		n = 51 FU		
	No.	%	No.	%	No.	%	*P*
Level of hygiene (%)							<0.01
0	14	22.6	9	12	0	0	
25	18	29	8	10.6	0	0	
50	10	16.1	15	20	0	0	
75	12	19.3	17	22.7	14	27.5	
100	8	13	26	34,7	37	72.5	
Promiscuity							<0.01
Yes	39	63	20	26.7	4	7.8	
No	23	37	55	73.3	47	92.2	
Overcrowding							<0.01
Yes	47	75.8	27	36	5	9.8	
No	15	24.2	48	64	46	90.1	
Source of fruits and vegetables							<0.01
Central market surplus	24	38.7	18	24	0	0	
Greengrocer	38	61.2	57	76	51	100	
Cooking fuel							<0.01
Logs	1	1.6	1	1.3	0	0	
Kerosene	0	0	1	1.3	0	0	
Bottle gas	61	98.3	48	64	9	17.6	
Central gas	0	0	25	33.3	42	82.3	

MZ, marginal zone; SN, suburban neighbourhood; UA, urban area; FU, family unit.
P, statistical significance. Chi-square independence test between MZ and UA.

Table 2. Work activity of parents from three ecosystems in La Plata, Argentina in 1999–2000.

Variable	M Z No.	M Z %	S N No.	S N %	U A No.	U A %	*P*
Mother's work activity	n = 62 FU		n = 75 FU		n = 51 FU		< 0.01
Unemployed	50	80.6	49	65.3	13	25.5	
Employed	12	19.4	26	34.7	38	74.5	
Father's work activity							< 0.01
Unemployed	36	58.1	18	24	2	3.9	
Employed	22	35.5	51	68	46	90.2	
FU without father	4	6.4	6	8	3	5.9	

MZ, marginal zone; SU, suburban neighbourhood; UA, urban area; FU, family unit.
P, Statistical significance. Chi-square independence test between MZ and UA.

Examination of faecal samples

Parasite prevalences of infection were 73.0% in MZ, 54.4% in SN and 35.2% in UA. Table 3 shows the distribution of parasite species among the three areas. The occurrence of polyparasitosis was more frequent in MZ than in the other two ecosystems, where cases of infection with a single parasite species predominated.

The mean parasite burden in children from MZ was 1313.35 eggs per g of faeces for *A. lumbricoides* and 732.6 eggs per g for *T. trichiura*, with 1204 eggs per g for *A. lumbricoides* in children from SN.

Examination of water and soil

No parasites were present in water samples from homes and schools of SN and UA. In MZ, *Entamoeba coli* and *Blastocystis hominis* were detected in water associated with dwellings. *Blastocystis hominis*, *E. coli* and *Giardia* sp. in the school and *E. coli*, *Chilomastix mesnilii* and *Iodameba bütschlii* in the small lake.

Twelve of 14 samples (85.7%) from outside the houses, 7 of 11 (63.6%) from inside the houses and 5 of 7 (71.4%) from latrines had either eggs or cysts from some parasite species. (table 4).

Table 3. The prevalence (%) of parasite species in children of three ecosystems from La Plata, Argentina in 1999–2000.

Parasite species	M Z n = 100	S N n = 101	U A n = 91
Protozoans			
Giardia sp.	34	21.8	9.9
Blastocystis hominis	48	31.7	25.3
Entamoeba coli	18	5.9	3.3
Iodamoeba bütschlii	1	–	–
Enteromonas hominis	1	2.9	2.2
Helminths			
Ascaris lumbricoides	22	7.9	–
Trichuris trichiura	9	–	–
Hookworms	2	0.9	–
Hymenolepis nana	15	3.9	–
Enterobius vermicularis	10	3.9	3.3

MZ, marginal zone; SU, suburban neighbourhood; UA, urban area.

Indices of association and diversity and the coefficient of similarity

Values for the Fager index were higher in MZ than in other neighbourhoods, thus pointing to the existence of stronger interspecies associations within this population than within the inhabitants of SN or UA. Pairs of parasite species that exhibited higher values of association were *A. lumbricoides* + *Giardia* sp., *T. trichiura* + *Giardia* sp. and hookworms + *Giardia* sp. in MZ; *A. lumbricoides* + *Giardia* sp. and *Hymenolepis nana* + *Giardia* sp. in SN; and *Giardia* sp. + *B. hominis* in UA.

Values of specific diversity were: 2.70, 2.34 and 1.78 for MZ, SN and UA, respectively. The results for absolute diversity were 3.32 for MZ, 2.99 for SN and 2.32 for UA. Values of the equitability index were 0.81 for MZ decreasing gradually in the neighbourhoods of SN (O.78) and UA (0.76).

Data for the Sørensen coefficient of similarity for all three ecosystems were 0.94 (94%) for MZ-SN, 0.71 (71%) for SN-UA and 0.66 (66%) for MZ-UA.

Discussion

According to Bradley (1991), many surveys have demostrated a high prevalence of intestinal parasitic

Table 4. The prevalence (%) of parasites in soil samples from homes in the marginal zone, La Plata, Argentina in 1999–2000.

Parasite species	Inside the home n = 11	Outside the home n = 14	Latrines n = 7
Helminths			
Nematode larvae	27.3	35.7	42.8
Strongyloides stercoralis	9.1	0	0
Toxocara canis	0	28.6	14.3
Ascaris lumbricoides	0	21.4	28.6
Enterobius vermicularis	0	7.1	0
Hookworms	9.1	7.1	0
Taenia sp	9.1	0	14.3
Protozoans			
Entamoeba coli	9.1	0	0
Other amoebae	9.1	0	0
Giardia sp.	0	7.1	0
Chilomastix mesnili	9.1	0	0

infections in children from slums, shanty towns and squatter settlements. The prevalence of intestinal nematode infections indicate that there are more than a thousand million people infected, and several million cases of clinical helminthiases (Bundy, 1994). The morbidity has been underestimated and moderate intensities of infection may have important developmental consequences, particularly for children of school age. Crompton & Savioli (1993) showed that helminthic infections negatively affect school performance, cognitive processes and nutritional status and justify programmes to improve the health of school age children by control of helminthic infections.

In Argentina, information on the prevalence of intestinal parasites is obtained from health centre registers (Kreiter *et al.*, 2000; Paulin, 2000; Velazquez, 2000).

In the present study, the environmental parameters which affect the distribution of parasite species in children from three well defined neighbourhoods (MZ, SN and UA) with wide ranging socioeconomic and sanitary conditions were analysed with respect to parasite prevalence.

The marginal zone was hygienically deficient both in the homes and the surrounding areas and also in the sanitary practices of the residents. These characteristics, together with a high degree of overcrowding, low income levels, and a lack of family education, gave rise to a population with scant resources leading to the spread of parasite species, especially faecal contaminants. In contrast to MZ, values calculated for these variables in SN and UA depicted ecosystems that were progressively more conducive to human health and less favourable for parasite transmission, coinciding with relationships described by Rajeswari *et al.* (1994) for Gombak, Malaysia.

The prevalence of infection of intestinal parasites was lowest in UA, with progressively ascending values in SN and MZ. The notably lower frequency of helminth infection in SN would point to a lesser degree of faecal contamination of soil, water and foods within that neighbourhood. The complete absence of helminthiases in UA is explained by the more superior sanitary and sociocultural conditions present in such as ecosystem.

The prevalence of protozoa was higher in MZ than SN, indicating greater contamination of soil, water and food. This frequency diminished markedly in UA and is consistent with lower degrees of environmental contamination, higher levels of education, and adequate individual and communal hygienic measures. Children sampled for eggs presented a light helminth infection (Bradley, 1991), suggesting a possible decrease in the psychophysical performance of children.

Results obtained for the screening of water sources confirm the hypothesis proposed in the present study regarding the linkage between the prevalence of parasitic infections and the contamination of the surroundings. Water from the small lake, homes and school in MZ were contaminated with intestinal parasites, whereas no such findings were found from SN or UA. Positive results for the Fager index indicated that the association between pairs of parasites observed did not occur by chance. The application of the equitability index indicates that in MZ there is no clear dominance of any parasite species. In contrast, parasite distribution in SN and UA became less equitable, less random and with a greater dominance of some species over others occurring as a result of improved environmental conditions. The Sørensen coefficient of similarity revealed a greater specific richness in MZ (10 species), that decreased gradually in response to improved environmental conditions in SN (9 species) and UA (5 species).

This work is one of the first approaches to a wider population study in Argentina concerning the relationship between instestinal parasitic infections and enviromental and sociocultural parameters in children of three different ecosystems. The present study has emphasized the need to develop sanitation and sanitary-education programes. This would include comprehensive and transdisciplinary studies, community participation and control strategies against intestinal parasites relative to the environmental and sociocultural characteristics of each ecosystem. Individual and family eating practices and personal and home hygienic measures, with an adequate system for the disposal of excreta, should be considered priority points for the reduction of elevated prevalences of intestinal parasites in Argentina.

Acknowledgements

The authors are grateful to Dr Donald F. Haggerty, a native English speaker, for a critical reading and translation of the manuscript. The work was financially supported by the Universidad Nacional de La Plata, Comision de Investigaciones Científicas de la provincia de Buenos Aires y Agencia Nacional de Investigaciones Científicas y Técnicas de Argentina (Prestamo BID-802/OC-AR-PICT no. 05-00000–00762).

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(Accepted 20 August 2002)