

Intestinal parasites and the environment: Frequency of intestinal parasites in children of Neuquén, Patagonia, Argentina

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ABSTRACT. The frequency of intestinal parasites (IP) in 69 children between 2 and 14 years of age was studied within the city of Neuquén, Patagonia, Argentina in relation to socioeconomic, cultural and environmental conditions. Soil type was determined and contamination with IP was investigated in 75 soil samples. Frequency of IP in children was 50.7%. *Blastocystis hominis* was the most frequent species (24.6%). Simultaneous infection with 2 to 4 species was found in 47.5% of the infected children. Statistical association was found between parasitic infection and family hygienic level ($p < 0.001$). Socioeconomic level was defined as lower middle class, however, infrastructure and public services were adequate. The climate is continental semiarid and the soil is sandy with a low organic matter level. Intestinal protozoan organisms were found in 33.3% of soil samples and *Sarcocystis* sp. was the most frequent species (14.6%). The parasites present in soil are related to the environmental conditions that allow their viability and development. Socioeconomic and cultural factors are important for the appearance and spread of IP in communities where sanitary conditions and infrastructure are adequate.

Key words. Intestinal parasites, Patagonia, Argentina, *Blastocystis hominis*, *Sarcocystis* sp.

RESUMEN. La frecuencia de parásitos intestinales (PI) en 69 niños de 2 a 14 años en un barrio de la ciudad de Neuquén, Patagonia, Argentina se determinó y relacionó con las condiciones socioeconómicas, culturales y ambientales. El tipo de suelo se caracterizó y se analizó la contaminación con PI en 75 muestras. La frecuencia de PI en niños fue del 50.7%. *Blastocystis hominis* fue la especie más frecuente (24.6%). El 47.5% de los niños parasitados albergaba entre 2 y 4 especies parasitarias. La presencia de PI se asoció estadísticamente con el nivel de higiene del grupo familiar ($p < 0.001$). El nivel socioeconómico se caracterizó como medio bajo, que sin embargo, contaba con buena infraestructura y servicios. El clima es semiárido continental y los suelos arenosos con bajo contenido de materia orgánica. En el 33.3% de las muestras de suelo se hallaron protozoos intestinales, siendo la especie más frecuente *Sarcocystis* sp. (14.6%). Los parásitos encontrados en el suelo están relacionados con las condiciones ambientales que permiten su sobrevivencia y desarrollo. Las características socioeconómicas y culturales son importantes en la adquisición y diseminación de los PI en poblaciones con adecuadas condiciones de saneamiento e infraestructura.

Palabras clave. Parásitos intestinales, Patagonia, Argentina, *Blastocystis hominis*, *Sarcocystis* sp.

INTRODUCTION

The presence, persistence and dissemination of intestinal parasites (IP) in urban populations are directly related with specific geographic characteristics, as well as with ecological,^{13,15,16,20} sanitary,^{8,22,23} socioeconomic and cultural factors.^{12,18,19}

Environmental conditions (temperature, humidity, winds, soil) are determinants of the viability and maturation of eggs from pathogen helminthes.^{4,21,24} Protozoan cysts and oocysts are relatively more resistant against an adverse environment.^{2,3} Socioeconomic and cultural factors, and the lack of an adequate basic sanitary system are quite responsible for the environmental contamination with these agents.^{13,21}

IP transmission is favored by the fecal contamination of soil, water and food.^{21,23} It is also favored by deficient life conditions, lack of adequate hygienic personal habits and low instruction level.^{6,12}

All these factors must be analyzed as a whole when evaluating the prevalence of intestinal parasites in a given population, taking into account the parasite-host-environment relationship.⁹

Neuquén City, capital of the homonymous province, is located in the north of the Argentinean Patagonia, at 38°58' south latitude, 68°03' west longitude. The weather in the region is continental semi-arid, with warm dry summers that have a large day-to-day thermal amplitude, and cold winters that have a larger relative environmental humidity.

There are no prior epidemiological studies for this region that determine the prevalence of the parasitic infection within the community. The object in this work is to determine the IP frequency in children of a peri-urban sector in Neuquén City, and its relation with socioeconomic, cultural and environmental conditions.

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MATERIALS AND METHODS

A 30 ha sector was evaluated. It is located within the Barrio Confluencia Urbano neighborhood in the periphery of Neuquén City. It has 450 dwellings, all of which were visited (Fig. 1). Sixty-nine families, with children between the ages of 2 and 14 years, accepted to participate in this study.

The socioeconomic and cultural variables were evaluated by oral interview with the chief of each family. Home visits were made in order to obtain the following data: number of inhabitants, characteristics of the dwellings, socioeconomic status and associated cultural factors. We obtained data related to the excrement disposal system, potable water supply, and infrastructure characteristics of the neighborhood: kind of street, waste recollection, public lighting, among the principal ones. Socioeconomic level was determined applying the socioeconomic level index (SEL) proposed by the Asociacion Argentina de Marketing.¹

During the conducted interviews the hygienic-sanitary characteristics of the dwelling and the family in general were observed. Based upon such observations, a hygiene level was defined.

Copro-parasitological analyses were carried out in children of both sexes, between two and fourteen years old, randomly selecting only one child per dwelling. The 69 tested children were divided in two age groups: 1) children in pre-scholar age (2-5 years) and 2) children in scholar age (6-14 years).

5-day serial samples of fecal matter and anal scrapings were collected in 10% formaldehyde. These samples were processed by the modified Telemann and the Fülleborn methods.⁷ Microscopic observation was realized at 100X and 400X amplifications, previously adding lugol.

For the parasitic detection 75 samples were taken in front of the houses every 100 meters, distributed uniformly

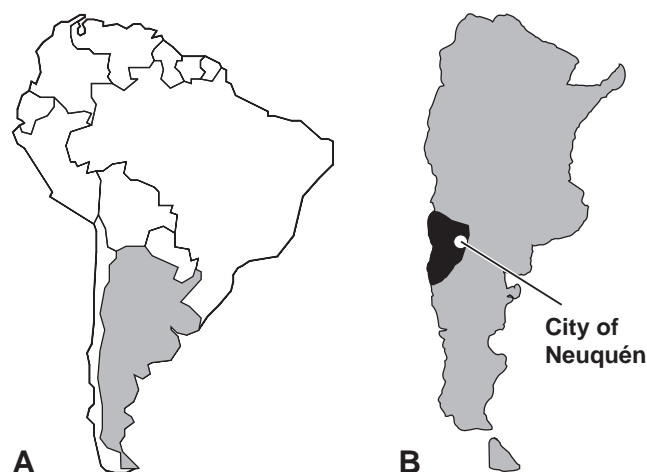


Figure 1. Geographic location. A, Argentina in South America; B, City of Neuquén in Argentina.

Table 1. Parasitic species' frequency in fecal matter of children between 2 and 14 years^a (n = 69).

Species	No. Cases	%
Protozoa		
<i>Blastocystis hominis</i>	17	24.6
<i>Entamoeba coli</i>	8	11.6
<i>Enteromonas hominis</i>	8	11.6
<i>Giardia lamblia</i>	4	5.8
<i>Endolimax nana</i>	2	2.9
<i>Chilomastix mesnili</i>	1	1.4
<i>Iodamoeba bütschlii</i>	1	1.4
Helminthes		
<i>Enterobius vermicularis</i>	13	18.8

a: More than one species per infected child can be present.

Table 2. Frequency of number of parasitic species per host in the infected population (n = 35).

No Species	No Cases	%
1	20	57.1
2	12	34.3
3	2	5.7
4	1	2.9
Total	35	100

along the analyzed sector of the neighborhood. The experimental units were obtained with a hand shovel in a 400 cm² only considering the most superficial layer of the soil. Samples were put into polyethylene bags, and kept at room temperature until their processing. For parasitic detection the Kazacos,¹¹ Dada and Lindquist,⁵ and modified Telemann²¹ techniques were employed.

During the sampling periods, daily records of temperature, relative humidity, pluviometry, direction and speed of winds were kept. Such data were obtained by the Instituto Nacional de Tecnología Agropecuaria weather station, located in Neuquén.

The Laboratorio de Servicios Agrarios y Forestales of Neuquén province determined physicochemical and structural characteristics of the soil.

Statistical analysis of the data was realized via Squared-Chi and Fisher tests (Epi Info 2000) and logit analysis (SAS, 1999) depending on the case.

RESULTS

Detection of intestinal parasites in fecal matter samples. In 35 of the studied children 69 IP were observed, co-

responding to a 50.7 % frequency. Six protozoan species were detected. *Enterobius vermicularis* was the only helminthes species found. Frequency for species is illustrated in Table 1. *Blastocystis hominis* was the most frequent species (n=17; 24.6 %) followed by *E. vermicularis* (n=13; 18.8 %).

45.7 % of the infected children hosted more than one parasitic species, with a maximum of four species by host (Table 2).

B. hominis was present in 73% of multi-parasitic cases. The most frequent associations in two-parasite infected children were *B. hominis* with *E. vermicularis*, and with *Enteromona hominis* (25% each case). Simultaneous presence of *B. hominis* and *E. hominis* was observed in 17% of the two-parasite infected children, and in the 100% of the three and four-parasite infected children.

No significant statistical association was found between the children's age or sex, and the presence of intestinal parasites.

Infrastructure, services, socioeconomic and cultural variables. The neighborhood sector analyzed had public lighting, home waste collection and unpaved streets with eventual flooding. All of the dwellings analyzed are made of rubblework with cement floors and installed bathrooms, running water available from the provincial network of potable water and electric light.

The typical family group is composed of 5 individuals with an average of three children per studied dwelling. The dominant social class within the analyzed group corresponds to the middle-low category, with incomes below US\$ 7000 a year, and an incomplete secondary level as a maximum instructional grade for at least one of the parents.

The infrastructure, the services, and the socioeconomic and cultural variables, which presented non-homogeneous results for the whole population, are detailed in Table 3. The hygiene level showed a significant statistical association with the presence of IP in children ($p < 0.001$). A posi-

Table 3. Infrastructure, services, socioeconomic and cultural variables in relationship with the parasitic frequency.

Variable	Infected (N = 35) n	Non infected (N = 34) %	n	%	X ²	p
Excrecencies' elimination						
Sewer	22	62.8	25	73.5	0.90	0.34
Cesspool	13	37.2	9	26.5		
Water supply						
Inside the house	33	94.3	34	100.0	2.00	0.15
Outside the house	2	5.7	0	0.0		
Bathroom						
Inside the house	30	85.7	31	94.1	1.34	0.24
Outside the house	5	14.3	2	5.9		
Social security						
Mutual	17	48.6	21	61.7	1.21	0.27
Non mutual	18	51.4	13	38.3		
Overcrowding ¹						
Present	8	22.8	5	14.7	0.75	0.38
Absent	27	77.2	27	85.3		
Hygiene level						
Insufficient	18	48.5	4	11.8	14.96	< 0.001
Good	17	51.5	30	88.2		
Promiscuity ²						
Present	10	28.6	4	11.8	3.01	0.08
Absent	25	71.4	30	88.2		

¹ No. persons / No. ambient > 3

² No. persons / N. simple beds > 1

Table 4. Frequency of parasitic species finding in soil samples a. (n = 75).

Species	No. Cases	%
Cysts		
<i>Entamoeba coli</i>	9	12
<i>Enteromona hominis</i>	4	5.3
<i>Giardia</i> spp.	6	8.0
<i>Endolimax nana</i>	4	5.3
<i>Iodamoeba bütschlii</i>	1	1.3
Sporocysts		
<i>Sarcocystis</i> spp.	11	14.7

^a More than one parasitic species per soil sample can be present.

tive correlation was found between the presence of IP and the overcrowding (8 / 13; 61.5%) and promiscuity (10/14; 71.4%) variables, although there was no statistical significance ($p > 0.05$). The analysis for each particular species demonstrated an association between the presence of *E. vermicularis* and the overcrowding ($\chi^2 = 4.03$; $p < 0.05$) and promiscuity ($\chi^2 = 6.63$; $p < 0.05$) indexes.

Detection of intestinal parasites in soil samples. IP were found in 25 analyzed soil samples of a total of 75 (33.3%). The frequencies of findings per species are presented in Table 4. The most frequent species were: *Sarcocystis* spp. (14.7%), *Entamoeba coli* (12.0%) and *Giardia* spp. (8.0%).

The IP-contaminated soil samples were uniformly distributed throughout the entire sampling surface.

Environmental factors.

Climatic. Climatic records stayed within historical normal ranges for the season, with exception of the amount of rain, which had values higher than the annual mean. Table 5 summarizes the obtained averages during the samplings periods.

Physicochemical and structural characteristics of the soil. The analysis carried out indicated a sandy texture of

the neighborhood's soils, with a high concentration of soluble salts, good draining and a low organic matter content (Table 6).

DISCUSSION

The neighborhood sector analyzed, although located in a mid-low socioeconomic level, counts with adequate conditions in infrastructure and services. The dwellings are made of rubblework, with an excrement disposal system, running water (inside or outside the dwelling), installed bathroom and electric light. Also, a municipal system of waste recollection exists. These characteristics, therefore, appear as not very favorable for the transmission of intestinal parasites.⁹

Within the group of analyzed children, the frequency of IP-infection was 50.7%, percentage comparable with those published by other authors on populations with similar environmental and/or socioeconomic characteristics.^{9,17,18} Nevertheless, the parasitic species found differ from the results obtained by other authors in other zones of Argentine,^{9,10} because in this work no helminthes were detected, with exception of *E. vermicularis*. This fact might be related to the particular climatic and edafic characteristics of the Patagonian region, as well as to the level of infrastructure and services studied.

In order to analyze the data of the presence of parasites in the soil, it is important to take into consideration the climatic variables of the region. Thermal, as much as eolic records during the time of the study, coincided with the habitual regional means with low temperatures prevailing, even though the amount of rain exceeded the annual mean for the time of the year.

Climatic factors, in conjunction with soil characteristics (sandy, low organic matter content, little capacity of water and nutrients retention) determine a not very favorable environment for the survival and development of parasitic eggs and larvae, that have humans as hosts.^{4,21,24}

Table 5. Climatic data of Neuquén city. April-September 2000 Period.

	T. max. ^a	T. min. ^b	H.R. max ^c	H.R. min ^d	Wind ^e	Wind S. ^f	Rain ^g
April	22.8	5.8	96	52	W-SW	11	25
May	18.1	3.4	99	65	W-SE	13	80
June	12.5	4	99	60	W-SW	12	32
July	9.5	1.5	96	46	W-NW	20	22
August	15.5	5.7	95	45	W-SE	15	52
September	18.7	6	98	45	W-SW	17	40

^a average maximum temperature (°C); ^b average minimum temperature (°C); ^c maximum relative humidity (%); ^d minimum relative humidity (%); ^e wind direction; ^f wind speed (km/hour); ^g fallen rain (mm).

Table 6. Structural and physicochemical analysis of the soil of Barrio Confluencia Urbano neighborhood.

Depth (cm)	0-25
Texture	Sandy
PH (paste)	9.23
Conductivity (dSm)	0.94
Organic Matter (%)	0.46
Organic Carbon (%)	0.27
Extractable phosphorous (ppm)	5.33
Caloric interchange capacity (cmol _c Kg ⁻¹)	13.28
Interchange bases (cmol _c Kg ⁻¹) (Na ⁺ K ⁺ Ca ⁺⁺ Mg ⁺⁺)	0.64 0.38
	presence of carbonates
PSI (%)	4.82
Soluble	
Salts (Na ⁺ K ⁺ Ca ⁺⁺ Mg ⁺⁺)	6.71 0.30 2.89 2.89
RAS	5.58
Ratio: dry weight on oven/dry weight on air	0.988

This would justify the parasitic species' distribution found in the soil samples, where only protozoan species were detected. IP (pathogenic and commensals) found in these samples indicate fecal contamination of the soil. The distribution of the samples with parasitic presence was homogeneous throughout the whole sampling area, which suggests the existence of a common contamination source, and implies infection risk for the population in that zone.

Coincidence was found between both the protozoan species detected in the soil samples, and those detected in children's fecal matter. *E. coli*, *Giardia* spp., *Endolimax nana*, *E. hominis* and *Iodamoeba bütschilii* cysts were observed in both kinds of samples—it is important to mention that the only soil sample contaminated with *I. bütschilii* corresponded to the front of the house where the child infected with that parasite dwells.

The discovery of *Chilomastix mesnili* in a child, but not in soil samples might be due to the low prevalence observed for that parasite, which is coincident with studies realized by other authors.¹⁴

In the soil samples, contamination with *Sarcocystis* spp. sporocysts was detected. Nevertheless, this agent was not detected in fecal samples. This discordance could be explained by taking into account the frequent irrigation of the zone's soil (twice a day, to avoid dust in the air) with water that comes out of superficial sources, which could be polluted with sewer waters.

In an adequate context of basic sanitation that coexists with a homogeneous distribution of parasitic contamination of the soil, IP-infection was in a statistically significant association with the family hygiene level observed. Among the children living in overcrowding and/or promiscuity

conditions, IP-frequency is elevated. This manifests the importance of these factors in the acquisition and transmission of intestinal parasites, especially when related to direct transmission species, as in the case of protozoan ones.⁶

The statistically significant association found between the presence of *E. vermicularis* and the overcrowding and promiscuity variables would support the concept that these factors intervene in the dissemination of parasitic infection by that agent.

Analysis of the data obtained in this work allows us to conclude that the frequency of the distinct IP species in the child population is tightly related with the environmental conditions that allow the surviving and development of such species. Low temperatures and ambient humidity, as well as winds and soil aridity, characteristic of the Patagonian region, constitute an unfavorable environment for the development of helminthes species, allowing instead, the survival of some protozoan ones. When the basic sanitary and infrastructure conditions are adequate, the socioeconomic and cultural characteristics of each family group play a special role in both the acquisition and dissemination of IP's.

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