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Research Note

Parasitological survey of schoolchildren from a high-altitude community from Tucumán Province, Argentina: Remarkable low detection of soil-transmitted helminths in comparison with coastal communities

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Abstract. The prevalence of intestinal parasitic infections among schoolchildren in Colalao del Valle, a high-altitude community in Tucumán province, Argentina, was investigated. The data revealed a high prevalence of parasitism (79.7%) with no significant differences in distribution by sex or age. Protozoa infections were the most common with *Blastocystis hominis* being the most prevalent (62.5%), followed by *Giardia lamblia* (29.7%), *Endolimax nana* (15.6%), *Entamoeba coli* (12.5%) and *Iodamoeba bütschlii* (3.1%). Interestingly, there was an absence of soil-transmitted helminths among the studied population which could be related to climate (variable temperatures, moderate rainfall) and soil type (clay).

Although most of the studies about intestinal parasite prevalence are normally conducted in populations situated at sea level, several surveys have been performed among communities who live in high-altitude places. Interestingly, parasite prevalence rates have shown to be affected by altitude-related factors such as climate, soil quality, moisture, etc. (Appleton & Gouws, 1996; Appleton *et al.*, 1999; Mabaso *et al.*, 2003).

Little is known about the distribution of enteroparasitosis in high-altitude communities in Argentina, and to our knowledge, most of the studies performed in Tucumán province have been conducted in populations living near sea-level (Valperga *et al.*, 1979; Silvia *et al.*, 2006; Dib *et al.*, 2012; 2014).

The current study area is Colalao del Valle, a mountain town located at 1,815 m above sea level (a.s.l.), in Tucumán province, 202 km from the capital city, within latitudes of 6° 30' and 6° 40' N, longitudes 3° 40' and 3° 50' E. The town is a rural community with a population of 1,207 who are predominantly subsistence farmers (Figure 1). The climate is primarily desert, with an average annual temperature of 14°C and large diurnal temperature variations. The average annual rainfall is 200 mm, with rainy summers and dry winters. The soils in this area are classified as entisol and aridisol, which are characteristic of arid and semi-arid climates. While entisols are defined by the absence or near absence of horizons (layers), aridisols are characterized by low organic content, by

Figure 1. A traditional adobe house in Colalao del Valle (Tucumán province, Argentina), showing the typical living conditions of the community inhabitants.

water deficiency and by a significant accumulation of translocated layer, silicate clay, soluble salts, or sodium ions (Soil Survey Staff, 1999).

This town has three public primary schools, one public secondary school and a public primary health care centre. The village has piped water provided by a public utility. The supply system gets water from an underground aquifer and is disinfected through chlorination. Sewage or water disposal facilities used by most inhabitants include a water closet with septic chambers. A small number of families have pit latrines and only two houses had open defecation. Garbage is collected twice a week, a service provided by the local government, and garbage disposal is an open pit and is located near the secondary school.

Our research focused on primary schoolchildren, who are commonly a high-risk group with the highest infection rates. Previous clinical studies among this population have shown the presumptive presence of parasitic diseases with symptoms including: anal itching, abdominal pain, sleeping disorders, diarrhoea, vomiting, appetite loss, weakness, and inexplicable fever, but to our knowledge no previous surveys were done.

The protocol for this study was approved by the Ethics Committee of the National University of Tucuman (UNT), Argentina before commencement. The participants were informed that the procedure used did not pose any potential health risks and their identities and personal information would be kept strictly confidential. During the meetings, parents and their children were informed that their participation was voluntary and they could withdraw from the study at any time without giving legitimate reason. Consent of those who agreed to participate was taken in written form (signed) by their parents or guardians (on behalf of their children).

The study was performed between June and November of 2011. The *Nº 32 Colalao del Valle* School has 108 children of which 70, distributed in 43 families, showed symptoms related to enteroparasitic infection. Twenty samples were remitted to

the laboratory. The *Nº 42 El Arbolar* School has 54 children, 39 showed signs of intestinal infection and they were distributed among 25 families. Twenty samples were remitted to the laboratory. In *Nº 325 El Bañado* School 64, with 78 students, had presumptive parasites and 24 samples were sent to the laboratory (Table 1). Selected schools were between 7 and 15 km (mean 11 km) apart and served children of a similar socio-economic status.

Each child was provided with two bottles containing 5% buffered formalin, one for serial parasitological study and the other for anal swabs. Five anal swabs from each child were collected during a time frame of five consecutive days, using sterile gauzes by cleaning the perianal zone in the morning immediately after getting up and stored in sterile containers.

In total, faecal samples were collected from 64 children (38 males and 26 females) aged between 4-13 years. Samples were analysed in the lab station by direct smear after being concentrated by the modified Ritchie method (Melvin & Brooke, 1982). The sediments were stained by lugol or carbol-fuchsine and observed by optical microscopy. In addition, the containers containing the gauzes were vigorously shaken and then, with the aid of a glass rod, the squeezed gauzes were removed. The content of each container was centrifuged at 500 ×g for 10 min and the obtained sediment was observed under optical microscopy. The results were conveyed to school authorities and the parents. The National Health Service provided antiparasitic treatments to the infected children.

The relationship between the proportions of intestinal parasites with sex was analyzed by the chi-square test and with age by the Mann-Whitney U test. A p-value of less than 0.05 was considered statistically significant.

In addition, microbiological analysis of tap water and a reservoir from the water treatment plant were carried out by the Bacteriology Laboratory from the National University of Tucuman, following standard methods and parasitological analysis was performed using a flocculation method (Vesey *et al.*, 1993).

Although containers were given to the total school population (240), only 26.66% (64) of them were sent back to the laboratory, as shown in Table 1. The frequency of infected children in the present study was 79.7% (Table 2). A total of seven parasitic species were recorded: five protozoa and two nematodes. Protozoa infections were the most common. Prevalence over the 64 samples studied was as follows: *Blastocystis hominis* (62.5%), *Endolimax nana* (15.6%), *Entamoeba coli* (12.5%), *Giardia lamblia* (29.7%) and *Iodamoeba bütschlii* (3.1%). Among helminths, only *Ascaris lumbricoides* and *Enterobius vermicularis* were detected, the latter being the most frequent (23.3%) (Table 2). No significant differences in distribution by sex or age were found ($p>0.05$). In the studied population, 37.5% of the positive samples showed one parasite, 20.3% showed two parasites and 21.9% three or more parasites.

The results presented in this work are consistent with other studies conducted in Tucumán province where up to 86.6% of primary schoolchildren from different rural

Table 1. School population analyzed in the Colalao del Valle community

School	School Population	Symptomatic children	Family groups	Sampling size
Nº 32 Colalao del Valle	108	70	43	20
Nº 42 El Arbolar	54	39	25	20
Nº 325 El Bañado	78	64	ND*	24
Total	240	173	–	64

* ND: not determined.

Table 2. Distribution of parasites in the studied population

Parasite	Prevalence (%)
Protozoa	
Blastocystis hominis	62.5 (40/64)
Giardia intestinalis	29.7 (19/64)
Entamoeba coli	12.5 (8/64)
Endolimax nana	15.6 (10/64)
Iodamoeba bütschlii	3.1 (2/64)
Helminths	
Ascaris lumbricoides	1.6 (1/64)
Enterobius vermicularis	23.3 (15/64)

regions were infected (Silvia *et al.*, 2006; Dib *et al.*, 2012; 2014).

A quite remarkable observation in this high-altitude community is the complete absence of soil-transmitted helminths (STH) among studied children. A previous survey conducted in Famaillá city (Tucumán), located more than 1,000 m lower in altitude and around 100 km away from Colalao del Valle and with comparable socio-economic and sanitary conditions, has shown significant infections prevalent of STH: *Ascaris lumbricoides* (20.8%), *Trichuris trichiura* (12.8%), and *Strongyloides stercoralis* (2.7%) (Dib *et al.*, 2012). On the other hand, the prevalence of protozoa was similar to previous studies in the same province (Valperga *et al.*, 1979; Silvia *et al.*, 2010; Dib *et al.*, 2012; 2014).

Although we report here one patient infected with *A. lumbricoides*, the microscopic analysis indicated the presence of only infertile eggs, which cannot become infectious. This child could have acquired the infection some time ago or may have been in areas with a high-rate of infection, not far from there, but at lower altitudes.

This atypical STH prevalence could be explained by environmental or climatic variables, including soil type and moisture, rainfall and temperature, which affect ecological requirements for the parasitic transmission of geohelminths (WHO, 1964). This was found in earlier studies which showed that a higher prevalence in hookworm infection is limited to areas lower than 150 m a.s.l., sandy soils with a clay content of less than 15%, warm temperatures and relatively high rainfall (Mabaso *et al.*, 2003). Studies carried out in KwaZulu-Natal, South Africa, indicated that *Necator americanus* and *Strongyloides stercoralis* infections occurred only in the coastal lowlands whereas those of *Trichuris trichiura* and *A. lumbricoides* occurred at higher altitudes, about 1,500 and 1,700 m a.s.l. (Appleton & Gouws, 1996; Appleton *et al.*, 1999). Apparently, the ecological and environmental features in Colalao del Valle, mostly altitude-related, are quite disadvantageous for the transmission of the free-living stages of nematodes normally found in other areas of the province.

In relation to microbiological analyses of the drinking water, no parasitic elements were found (eggs, larvae, cysts or trophozoites) possibly due to the low sensitivity of the method used. However, bacteriological analyses showed that the water was not suitable for human consumption. At the time when our study was done, water chlorination was stopped due to lack of a power supply.

Even though a reduction in the impact of helminths on the studied community was observed, possibly due to environmental conditions, a high prevalence of protozoa was found. The quality of drinking water should be improved and local sanitary authorities should take action on this matter.

Despite the relatively small population studied, our results shed light on a rather unexplored and undefined issue in Argentina, the epidemiology of intestinal parasites in high-altitude communities. Currently, we are expanding our studies to neighbouring populations in order to have a broader idea of the distribution and impact of protozoa and STH in such elevated areas.

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