Dramatic Decrease in Prevalence of Soil-Transmitted Helminths and New Insights Into Intestinal Protozoa in Children Living in the Chaco Region, Bolivia

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Abstract. We assessed the prevalence of intestinal parasites among 268 2–12-year-old children living in rural areas, small villages, and semi-urban areas of the Chaco region, south-eastern Bolivia. The overall parasitism was 69%. Only protozoa, helminths, or co-infections were observed in 89.2%, 5.9%, or 4.9% of the positive children, respectively. A significant progressive increase in overall parasite prevalence was found when passing from rural areas to small villages and semi-urban areas. The most commonly found species were Entamoeba coli (38.4%), Giardia intestinalis (37.7%), and Blastocystis spp. (16%). Hymenolepis nana was the most prevalent helminth (5.6%), followed by Ascaris lumbricoides and hookworms (1.5% and 0.4%) evidenced only in rural areas and in villages. Molecular diagnostics identified Blastocystis subtypes 9 and 2, and 5 infections by Entamoeba histolytica and 4 by Entamoeba dispar. The dramatic decrease in prevalence of soil-transmitted helminths with respect to that observed about 20 years ago (> 40%) evidences the success of the preventive chemotherapy intervention implemented in 1986. Health education and improved sanitation should be intensified to control protozoan infections.

In developing countries the lack of access to safe water, sanitation, and hygiene are the key factors for the high prevalence of intestinal protozoa that, in infants and children, frequently have the clinical expression of malabsorption syndrome and gastrointestinal morbidity. Moreover, Ascaris lumbricoides may contribute to nutritional deficiencies and even produce intestinal occlusion, whereas other soil-transmitted helminths (STHs) cause chronic intestinal blood loss that results in anemia, and impairing physical growth, cognition, learning and working capacities.

In the Santa Cruz Department (Plurinational State of Bolivia), studies conducted ~40 years ago showed intestinal parasitism ranging from 85.4% to 99.5%, with 65% of polyparasitism. A survey carried out in 1987 detected an overall value of 79%, with protozoa, helminths, or co-infections were observed in 89.2%, 5.9%, or 4.9% of the positive children, respectively. A significant progressive increase in overall parasite prevalence was found when passing from rural areas to small villages and semi-urban areas. The most commonly found species were Entamoeba coli (38.4%), Giardia intestinalis (37.7%), and Blastocystis spp. (16%). Hymenolepis nana was the most prevalent helminth (5.6%), followed by Ascaris lumbricoides and hookworms (1.5% and 0.4%) evidenced only in rural areas and in villages. Molecular diagnostics identified Blastocystis subtypes 9 and 2, and 5 infections by Entamoeba histolytica and 4 by Entamoeba dispar. The dramatic decrease in prevalence of soil-transmitted helminths with respect to that observed about 20 years ago (> 40%) evidences the success of the preventive chemotherapy intervention implemented in 1986. Health education and improved sanitation should be intensified to control protozoan infections.

Parasites were identified on the basis of their morphological features. Samples positive for Entamoeba histolytica complex and for Blastocystis spp. were further analyzed by polymerase chain reaction (PCR) amplification and sequencing to identify species/subtypes involved. Genomic DNA was extracted using the NucleoSpin tissue kit (Macherey-Nagel, Düren, Germany) and a 540-bp (and in the nested PCR a 374-bp) fragment of the 30-kDa surface antigen from E. histolytica complex and the small subunit RNA gene of Blastocystis spp. were PCR amplified following published protocols. Amplicons were purified (SureClean kit, Aurogene, Rome, Italy) and sequenced (Eurofins MWG Operon, Ebersberg, Germany). Sequences obtained were corrected, aligned, and compared with Blastocystis SSU rRNA gene sequences available database (http://www.ncbi.nlm.nih.gov). Subtypes (STs) were identified according to the classification proposed by Stensvold and others in 2007.

Statistical analysis (chi-square [χ²] or Fisher’s exact tests) was applied to the results, and P values < 0.05 were considered significant.

Intestinal protozoa and/or eggs from helminths were recovered in 185 of 268 children (69.0%). Only protozoa were evidenced in 165 subjects (89.2%). Helminths, and protozoa associated to helminths, were detected in 5.9% and 4.9% of the positive children, respectively. The most commonly found parasite was Entamoeba coli, followed by Giardia intestinalis, and Blastocystis spp. (Table 1). An overall 54.6% of the positive subjects harbored two or more species, and G. intestinalis was the protozoan most often found in single infections (43.6%). As for helminths, Hymenolepis nana was the species more frequently identified (overall prevalence: 5.6%), whereas eggs of A. lumbricoides and hookworms were rarely present (their prevalence was 1.5% and 0.4%), always in co-infection with protozoa, and eggs of other Cestoda (Taenia spp.) were occasionally found.

No differences in prevalence of parasitism were evidenced by sex (44.9% versus 44.3%) or by age. Lower parasitism rates (48.4% and 50%, respectively) were found in the youngest and
oldest subjects, whereas 4- to 6-year-old children had the highest rate (77.6%). The analysis of the results by area (Table 2) showed significant differences ($P = 0.01$) as a result of the progressive increase of overall parasite prevalence when passing from rural areas to small villages and semi-urban areas. This trend is mainly caused by 

<table>
<thead>
<tr>
<th>Species</th>
<th>Prevalence N (%)</th>
<th>Relative prevalence (%)</th>
<th>Single parasitem N (%)</th>
<th>Co-parasitem N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giardia intestinalis</td>
<td>101 (37.7)</td>
<td>54.6</td>
<td>44 (43.6)</td>
<td>57 (56.4)</td>
</tr>
<tr>
<td>Chilomastix mesnili</td>
<td>3 (1.1)</td>
<td>1.6</td>
<td>1 (33.3)</td>
<td>2 (66.7)</td>
</tr>
<tr>
<td>Entamoeba coli</td>
<td>103 (38.4)</td>
<td>55.7</td>
<td>17 (16.5)</td>
<td>86 (83.5)</td>
</tr>
<tr>
<td>Endolimax nana</td>
<td>16 (6.0)</td>
<td>8.6</td>
<td>2 (12.5)</td>
<td>14 (87.5)</td>
</tr>
<tr>
<td>Iodamoeba butschlii</td>
<td>10 (3.7)</td>
<td>5.4</td>
<td>0</td>
<td>10 (100)</td>
</tr>
<tr>
<td>E. histolytica complex</td>
<td>9 (3.4)</td>
<td>4.9</td>
<td>1 (11.1)</td>
<td>8 (88.9)</td>
</tr>
<tr>
<td>E. hartmanni</td>
<td>3 (1.1)</td>
<td>1.6</td>
<td>0</td>
<td>3 (100)</td>
</tr>
<tr>
<td>Blastocystis spp.</td>
<td>43 (16.0)</td>
<td>22.2</td>
<td>11 (25.6)</td>
<td>32 (74.4)</td>
</tr>
<tr>
<td>Hymenolepis nana</td>
<td>15 (5.6)</td>
<td>8.1</td>
<td>8 (53.3)</td>
<td>7 (46.7)</td>
</tr>
<tr>
<td>Taenia spp.</td>
<td>3 (1.1)</td>
<td>1.6</td>
<td>0</td>
<td>3 (100)</td>
</tr>
<tr>
<td>Ascaris lumbricoides</td>
<td>4 (1.5)</td>
<td>2.2</td>
<td>0</td>
<td>4 (100)</td>
</tr>
<tr>
<td>Hookworms</td>
<td>1 (0.4)</td>
<td>0.5</td>
<td>0</td>
<td>1 (100)</td>
</tr>
<tr>
<td>Total</td>
<td>185 (69.0)</td>
<td>84 (45.4)</td>
<td>101 (54.6)</td>
<td></td>
</tr>
</tbody>
</table>

Our findings evidenced a low prevalence of the 

E. histolytica complex ($\leq 5\%$), in general agreement with that reported in the Santa Cruz region (0.4–10%), but lower than that reported in the valleys and in the Northern Bolivian Altiplano (0.38.6%). However, using molecular diagnostics we were able to discriminate a high proportion of invasive E. histolytica (5 of 9) from the morphologically identical 

Entamoeba dispar (4 of 9), thus directing important therapeutic decisions.

The most relevant finding is the dramatic decrease in prevalence of STHs with respect to that observed about 20 years ago (hookworm from up to 50% to 0.4%, A. lumbricoides from up to 19% to 1.5%, Trichuris trichiura from up to 19 to 0%). These findings contrast with prevalence for hookworm (23%), A. lumbricoides (29%), and T. trichiura (32%) in a school-aged population of the Cordillera province, estimated in a recent study based on a geostatistical model. Furthermore, although not statistically significant, we observed a decrease in prevalence of H. nana (6% versus 9%, $P = 0.14$), with respect to that observed in 1987. Evidence of Taenia solium antigens supports the possibility of cysticercosis as a health problem for the investigated areas.

Although our study was not aimed at analyzing factors influencing epidemiological trends, we consider that implementation of the control program (delivery of single dose mebendazole to the 2- to 9-year-old child population administered approximately every 6 months), started in 1986, led to the expected results. Indeed, up-to-date knowledge of local STH prevalence, as provided in this study, should help advance public health policies that need to balance the detrimental influence of these parasites on child health with the economic and ecologic costs of continued mass distribution chemotherapeutic prevention strategies if they are no longer needed. Although our data set is relatively small and further studies may be necessary before interrupting regular deworming programs in the study area, the very low prevalence of STHs in the surveyed children is within the World Health Organization (WHO)-recommended range to reduce the frequency of drug administration (to every 2 years) and monitor the possible recrudescence of the infections.

In conclusion, our findings confirm preventive chemotherapy as a valid measure to reduce the prevalence of soil-transmitted helminths, but also the need for continuing the efforts in control strategies, including health education and improving access to sanitation.
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REFERENCES