INTESTINAL PARASITIC INFECTIONS, WITH A SPECIAL EMPHASIS ON CRYPTOSPORIDIOSIS, IN AMERINDIANS FROM WESTERN VENEZUELA

LEONOR CHACÍN-BONILLA AND YULAICY SÁNCHEZ-CHÁVEZ
Instituto de Investigaciones Clínicas, Universidad del Zulia, Maracaibo, Venezuela

Abstract. The prevalences of intestinal parasites and intensities of helminth infections were studied in two Amerindian villages in Venezuela. Single stool specimens were collected from 303 individuals from Saimadoyi and 130 from Campo Rosario. Wet mounts, iron-hematoxylin-stained smears, and formalin-ether concentrates were examined for the presence of parasites; modified Ziehl-Neelsen carbol-fuchsin staining of 10% formalin-preserved stool was used to identify Cryptosporidium parvum. Helminth ova counts were made using the standard smear egg count technique. Mixed infections (Campo Rosario = 69.9%, Saimadoyi = 71.6%) were frequent. Overall infection rates with one or more species (Campo Rosario = 79.2%, Saimadoyi = 95.4%; P < 0.01) and with any protozoans (Campo Rosario = 60.8%, Saimadoyi = 72.3%; P < 0.05) were high and predominant (P < 0.05) in Saimadoyi. Cryptosporidiosis was identified in 38 subjects (8.8%) in both villages; 60.6% were asymptomatic carriers. The mean egg counts of helminths were heavier in Campo Rosario (P < 0.05), which was probably due to the drastic reduction of their lands along with their low standard of living. This study documents the change of intestinal parasitism pattern and deterioration of the health of Amerindians by the process of acculturation.

INTRODUCTION

Reports on intestinal parasites from community-based surveys among remote Amerindian populations are infrequent. Studies among tribes that try to maintain geographic and ethnic barriers between themselves and non-Indian citizens and those with outside contact have shown that patterns of intestinal parasitism have changed. The presence of new species (e.g., Balantidium coli) and a lower average number of different species carried per person in acculturating populations have been demonstrated. Although high prevalences of parasites in indigenous populations from southeastern Venezuela and adjacent countries have been reported, their impact on the health of these people and the influence of the process of acculturation in patterns of intestinal parasitism have not been evaluated. Reports on intestinal parasites in Indians from western Venezuela are scanty. High prevalence rates have been found in some ethnic groups, but the Barís have not been evaluated for intestinal parasites. With respect to Cryptosporidium parvum in South American Indians, only one study from Bolivia has been reported.

The purpose of this work was to determine the prevalences of intestinal parasites, with emphasis on C. parvum, and the intensity of helminth infections among members of two Barí villages, and to document the pattern of intestinal parasitization in them and how this was affected by the process of acculturation.

The Barís or “Motilones” constitute a sylvatic group that number about 1,500 in Venezuela and 500 in Colombia. They accepted permanent contact with non-Indian individuals in 1960. The traditional settlement pattern included farmers, hunters, and fishermen. They lived in communal houses and occupied 1,400 km² in the tropical forest. Their lands have been taken for different entities; the Barís currently occupy only 12% of their lands, and there are about 30 small settlements with individual or family houses. Due to this new life style and the drastic reduction of their territories, a sedentary, small-scale horticulture system has been developed. The Barís exhibit little evidence of genetic admixture with non-Indian citizens; only 11% of the married couples have a non-Barí member. However, they are relatively acculturated.

SUBJECTS, MATERIALS, AND METHODS

Area and populations studied. Campo Rosario and Saimadoyi, two Barí communities located in the Sierra of Perijá, Zulia State in western Venezuela (Figure 1), were surveyed. The area constitutes the northern border between this country and Colombia.

Campo Rosario is located in arid lowlands 20 meters below sea level. The area has a tropical climate with mean temperature of 28°C, an annual rainfall of 1,400 mm, and dry tropical forest vegetation with swampy grasslands. The streets are not paved with asphalt. The economy is based upon subsistence farming and nearby cattle ranches. The latter have occupied most of the Barí lands and the Indians live concentrated in a small area. Homes contain 1–10 related occupants, and are small with concrete walls, zinc roofs, and cement or earthen floors, and contain 1–9 individuals. The households are situated close together; individuals are in daily contact with each other. A spring and nearby rivers provide drinking water. Individuals defecate in surrounding underbrush. Garbage is burned or thrown away on nearby bushes. Chickens, cats, dogs, pigs, cattle, and horses are present in the area. Medical assistance is available at a small health center. The residents of Campo Rosario have some contact with non-Indian individuals.

Saimadoyi is an isolated settlement situated in a fertile valley in the foothills of the Abusanqui Mountains 800 meters above sea level and 58 km from Campo Rosario. It has a tropical humid forest, a mean annual temperature of 24°C, and an annual rainfall of 2,000 mm. This settlement is accessible only by helicopter. The inhabitants are agricultural workers, hunters, and fishermen. They have sufficient living space compared with the inhabitants of Campo Rosario. Dwellings have wooden walls, palm roofs, and earthen floors, and contain 1–9 individuals. The households are situated close together; individuals are in daily contact with each other. A spring and nearby rivers provide drinking water. Individuals defecate close to the dwellings. Rubbish is thrown away on the adjacent bushes. Pigs, cats, dogs, horses,
cattle, and chickens are present in the area. There is a rudimentary health center with a nurse, but without any other medical assistance. The residents of Saimadoyí have little contact with non-Indian individuals.

According to the 1992 indigenous census of Venezuela, the Bari population consisted of 1,503 inhabitants. A high percentage (23.6%) of the population is 0–4 years old. At the time of the survey, Campo Rosario had a population of 192 inhabitants and Saimadoyí had a population of 334 inhabitants. One hundred thirty subjects (67.7%) nine months to 69 years of age from Campo Rosario and 303 individuals (90.7%) 1–65 years of age from Saimadoyí were studied.

Field procedures and stool examination. A medical research expedition by the Zumaque Foundation to the Sierra de Perija provided an opportunity for the study of intestinal parasites in the Bari population. An anthropologist, with the help of a missionary family and the leaders of each community, visited each house during the dry season, explained the goal of the study, obtained consent of the householders before enrollment in the study, and encouraged voluntary attendance of family groups to the health center of each village. The project and ethical aspects of the study were approved by the Zumaque Foundation and the University of Zulia.

A single stool specimen was requested from each person, and instructions were given on how to collect them. Basic information such as name, age, sex, and gastrointestinal symptoms at the time of the survey and during the previous two months were recorded for each registrant. Antiparasitic drugs were offered, when necessary. Stool containers were brought by each individual to the health center the day after distribution. Direct smears were immediately prepared and examined. Stool samples were preserved in 10% formalin and Schaudinn fixative and processed and examined in our laboratory. Iron-hematoxylin-stained smears and formalin-ether concentrates were examined for the presence of parasites. Formalin-preserved stool samples and the modified Ziehl-Neelsen carbol-fuchsin staining of formalin-ether concentrates were used for the recovery and identification of C. parvum oocysts.

Helminth ova counts were made using the standard smear egg count technique, and the results were expressed as eggs per gram feces (epg). The helminth intensity was classified as follows: Ascaris lumbricoides, < 10,000 to > 20,000 epg; Trichuris trichiura, < 5,000 to > 10,000 epg, and hookworm < 2,000 to > 5,000 epg were considered light, moderate, and heavy infections, respectively.

Statistical analysis. Data analysis was carried out using analysis of variance, the chi-square test, and the Fisher exact test.

RESULTS

The results of parasitologic examinations are shown in Table 1. At least 16 different species were identified in each village. The most common helminths were A. lumbricoides (Campo Rosario = 36.2%, Saimadoyí = 52.1%), followed by T. trichiura (Campo Rosario = 29.2%, Saimadoyí = 34.7%). Among the protozoa, Entamoeba coli showed the highest infection rate (Campo Rosario = 33.8%, Saimadoyí = 43.2%) and Giardia lamblia was the most common pathogenic protozoan (Campo Rosario = 13.8%, Saimadoyí = 28.4%), followed by E. histolytica/E. dispar (Campo Rosario = 10.8%, Saimadoyí = 17.8%), with a high rate of asymptomatic carriers (61 of 68, 89.7%) in both villages. Hookworm was the single species that predominated in Campo Rosario (P < 0.01), while Iodamoeba butschlii (P < 0.01), G. lamblia (P < 0.001), A. lumbricoides (P < 0.01), and Hymenolepis nana (P < 0.01) showed higher infection rates in Saimadoyí. Overall infection rates with one or more species (Campo Rosario = 79.2%, 103 of 130; Saimadoyí = 95.4%, 289 of 303) (P < 0.01) and with any protozoa (Campo Rosario = 60.8%, 79 of 130; Saimadoyí = 72.3%, 219 of 303) (P < 0.05) were higher in Saimadoyí. The overall infection rate with any protozoa in females was higher in Saimadoyí (Campo Rosario = 78.2%, Saimadoyí = 92.5%; P < 0.01). Blastocystis hominis, an organism of uncertain taxonomic identity and recently placed within the stramenopiles, showed high infection rates (Campo Rosario = 32.3%, 42 of 130; Saimadoyí = 28.7%, 87 of 303) in both villages.

The distribution of parasitic species by age of the individuals is shown for the combined populations of both villages (Table 1) because the profiles of distribution were homogeneous in both villages. The prevalences of A. lumbricoides and T. trichiura were significantly higher (P < 0.05) in the 7–12-year age group. In general, E. coli, Endolimax nana, and E. histolytica/E. dispar showed higher prevalences in the adult groups (P < 0.05). No other significant differences were noted.

Mixed infections were common (Campo Rosario = 69.9%, 72 of 103; Saimadoyí = 71.6%, 207 of 289). The greatest number of different species carried by an individual

![Map showing the location of the Barí villages studied in western Venezuela.](image)
was five. The mean number of different species infecting an individual did not vary by age and village; there was a notable similarity between individuals with respect to the number of intestinal parasitic species carried by each person, as indicated by the generally lower coefficients of variation (Table 2).

Cryptosporidium parvum oocysts were identified in 5.4% and 10.2% of the populations of Campo Rosario and Saimadoyi, respectively (Table 1), with an overall prevalence of 8.8% (38 of 433) in both villages. No statistically significant age- or sex-related differences were noted in the occurrence of cryptosporidiosis (Table 3). Fifteen of 38 had diarrhea (six of them were infants). Of these, seven of 15 were single infections and the remainder had other pathogenic parasites. There were no differences among age groups in the prevalence of diarrhea in individuals with cryptosporidiosis or between the number of persons with symptoms and/or diarrheic stools who harbored this parasite or not. Twenty of 38 cases of cryptosporidiosis were concentrated in six households and contact with domestic animals was evident.

In helminth-infected populations, the overall prevalences of infections of light intensity (Campo Rosario = 68.0%, 81 of 119; Saimadoyi = 89.1%, 270 of 303) and those of A. lumbricoides (Campo Rosario = 51.0%, 24 of 47; Saimadoyi = 86.1%, 136 of 158) and T. trichiura (Campo Rosario = 73.7%, 28 of 38; Saimadoyi = 93.3%, 98 of 105) were higher and predominant (P < 0.01) in Saimadoyi. In contrast, the overall prevalences of moderate-intensity infections (Campo Rosario = 26.1%, 31 of 119; Saimadoyi = 8.9%, 27 of 303) and those of A. lumbricoides (Campo Rosario = 40.4%, 19 of 47; Saimadoyi = 10.1%, 16 of 158) and T. trichiura (Campo Rosario = 21.1%, 8 of 38; Saimadoyi = 6.7%, 7 of 105) were higher (P < 0.01) in Campo Rosario. When overall populations (both infected and non-infected) were considered, significant differences were observed only for A. lumbricoides. The prevalence of light-intensity infections (Campo Rosario = 18.5%, 24 of 130; Saimadoyi = 44.9%, 136 of 303) was higher in Saimadoyi, and the prevalence of moderate-intensity infections (Campo Rosario = 14.6%, 19 of 130; Saimadoyi = 5.3%, 16 of 303) was higher in Campo Rosario (P < 0.01).

The distribution of ova load per host was highly aggregated in both villages, with the variances greatly exceeding the mean intensities in the infected and overall populations of each village. The arithmetic mean ± SD egg counts were significantly heavier in both the infected and the overall populations of Campo Rosario (Table 4).

### Table 1

<table>
<thead>
<tr>
<th>Parasite</th>
<th>No. (%)</th>
<th>No. (%)</th>
<th>No. (%)</th>
<th>No. (%)</th>
<th>No. (%)</th>
<th>No. (%)</th>
<th>No. (%)</th>
<th>No. (%)</th>
<th>No. (%)</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cryptosporidium parvum</td>
<td>21.1%</td>
<td>7/38</td>
<td>21.1%</td>
<td>7/38</td>
<td>21.1%</td>
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<td>21.1%</td>
<td>7/38</td>
<td>21.1%</td>
<td>7/38</td>
</tr>
<tr>
<td>Endolimax nana</td>
<td>9.6%</td>
<td>4/44</td>
<td>9.6%</td>
<td>4/44</td>
<td>9.6%</td>
<td>4/44</td>
<td>9.6%</td>
<td>4/44</td>
<td>9.6%</td>
<td>4/44</td>
</tr>
<tr>
<td>Iodamoeba butschlii</td>
<td>8.3%</td>
<td>3/36</td>
<td>8.3%</td>
<td>3/36</td>
<td>8.3%</td>
<td>3/36</td>
<td>8.3%</td>
<td>3/36</td>
<td>8.3%</td>
<td>3/36</td>
</tr>
</tbody>
</table>

DISCUSSION

The results in both villages indicate a great variety of parasitic species, high infection rates, and mixed parasitoses, suggesting the frequent exposure of the populations to human fecal contamination. This seems to be the rule in poor suburban and rural communities in this region.\(^{1,4}\) The prevalences of parasites among the Barı were as high or higher than those recorded in most studies of South American Indians,\(^{1,6,9–13}\) including those from Venezuela.\(^{10,12,13}\) These findings suggest that conditions are favorable in these communities for the existence and transmission of parasites. The
absence of latrines is an important factor in determining soil contamination and soil-borne helminths. In the case of protozoa, several factors may be incriminated, e.g., water or food contamination and direct person-to-person contact. However, the latter transmission mechanism appears to be an important factor in the population in Saimadoyi. This is suggested by the higher overall prevalences of *H. nana*, *I. butschlii*, and *G. lambia*, and the higher prevalence of any protozoa in females, who have more contact with infested dust, vegetables, and infected children. The close contact of individuals in Saimadoyi facilitates this mode of transmission.

*Trichuris trichiura* appears to be the predominant parasite in the Caribbean region, including Venezuela. However, it was not the most predominant parasite in the Bari communities. The dry season, during which the surveys were performed, together with open spaces and the unshaded, immediate environment of households, are factors that might explain the predominance of *A. lumbricoides* since the ova of this parasite are more resistant to these factors compared with more delicate whipworm ova. As expected, hookworm prevalences were higher than those reported in suburban areas of the region. The predominance of the infections in Campo Rosario may be explained by the fact that the loose, friable soil of its coastal region is more suitable for the development of hookworm larvae than the heavier clay and rocky soils of Saimadoyi.

In these populations, diarrhea was not a consistent feature of *C. parvum* infections; a high percentage (60.6%) of the populations were asymptomatic. However, the possibility that some of the asymptomatic cryptosporidiosis represented late episodes of oocyst shedding in resolving infections cannot be disregarded. Among those with symptoms, the contribution of the parasite to morbidity is uncertain since other pathogenic parasites were observed. In addition, our data do not show the role of other parasites, bacteria, and viruses that can cause diarrhea. Thus, the percentage of cases with a causal relationship between the parasite and diarrhea might be lower. The initial infection with *C. parvum* would probably cause diarrhea, but in these areas, because of unsanitary and crowded living conditions, people may experience a high frequency of environmental exposure to the parasite and develop acquired immunity that might explain the high percentage of asymptomatic cases. This finding is consistent with those of previous regional studies and those from developing countries.

Several reports have suggested that children are more susceptible to *C. parvum* infections. However, in this study, no statistically significant sex- or age-related differences in the prevalence of infections were noted; these results suggest that children and adults are equally exposed to the infection. These data are consistent with that of two previous local studies. In the youngest children, symptomatology was not significantly higher. However, six of these seven children were infants; three of them had watery diarrhea. This result might be a reflection of the small sample size of the infected individuals. *Cryptosporidium parvum* and *E. histolytica/E. dispar* infections were clustered within a few dwellings, suggesting person-to-person transmission, although contact with water and animals may also be involved in the spread of the infections. The fact that most of the inhabitants were long-term residents with little contact with individuals outside the villages, the relatively low prevalence of *C. parvum*, and the high percentage of symptomless infections, reflecting an equilibrium between host and parasite, may be taken as evidence of acquiring the infection inside the villages and previous long-term exposure to the parasite.

The presence of *C. parvum* and *B. coli* in both villages confirms that domestication of animals introduced by the process of acculturation have changed the human parasite ecology of the Baris. Differences in the average number of different species carried per person in the two villages were not observed; one would expect a lower number in Campo Rosario since it may be more acculturated than Saimadoyi and it has better public health facilities.

It has been pointed out that helminth egg densities are relatively light in unacculturated Amerindians, and the probability that parasitic burden has changed, but there are no data on how cultural assimilation might affect helminth infection densities. In this study, the highly significant (*P < 0.01*) mean egg counts in the population of Campo Rosario may be explained by the drastic reduction in their lands, along with their low standard of living, which have increased their likelihood of acquiring helminth infections. In contrast, the larger size of Saimadoyi, which allows a higher mobility

**Table 2**

<table>
<thead>
<tr>
<th>Age range (years)</th>
<th>Campo Rosario</th>
<th>Samadoyi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Range</td>
</tr>
<tr>
<td>0–6</td>
<td>2.6</td>
<td>1–5</td>
</tr>
<tr>
<td>7–12</td>
<td>2.7</td>
<td>1–5</td>
</tr>
<tr>
<td>13–18</td>
<td>1.7</td>
<td>1–3</td>
</tr>
<tr>
<td>19–45</td>
<td>2.0</td>
<td>1–4</td>
</tr>
<tr>
<td>≥46</td>
<td>2.4</td>
<td>1–4</td>
</tr>
<tr>
<td>Total</td>
<td>2.3</td>
<td>1–5</td>
</tr>
</tbody>
</table>

*CV = coefficient of variation.*

**Table 3**

<table>
<thead>
<tr>
<th>Age range (years)</th>
<th>No. tested</th>
<th>Infected No. (%)</th>
<th>Diarrheic No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–6</td>
<td>115</td>
<td>11 (9.6)</td>
<td>7 (63.6)</td>
</tr>
<tr>
<td>7–12</td>
<td>97</td>
<td>5 (5.2)</td>
<td>2 (40.0)</td>
</tr>
<tr>
<td>13–18</td>
<td>44</td>
<td>4 (9.0)</td>
<td>1 (25.0)</td>
</tr>
<tr>
<td>19–45</td>
<td>133</td>
<td>11 (8.3)</td>
<td>3 (27.3)</td>
</tr>
<tr>
<td>≥46</td>
<td>44</td>
<td>7 (15.9)</td>
<td>2 (28.6)</td>
</tr>
</tbody>
</table>
of its population, may have prevented more intensive helminth infections. This is not an unexpected finding, but is an important documentation of the deterioration in health status that so often occurs during cultural assimilation of Amerindians.35

In conclusion, this study showed that the intestinal parasitic infections in the Barı represent a major health problem. It also documents a higher helminthic infection intensity as evidence of the changes of intestinal parasitism patterns and the deterioration of health of Amerindians caused by acculturation.

Acknowledgments: We thank the Zumaque Foundation for providing the logistical assistance for this investigation, and the Barı people who participated in the study.

Financial support: This work was supported by a research grant from the Consejo Nacional de Investigaciones Científicas y Tecnológicas of Venezuela (CONICIT).

Authors’ address: Leonor Chacín-Bonilla and Yulacy Sánchez-Chávez, Instituto de Investigaciones Clínicas, Apartado 1151, Maracaibo, Venezuela.

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