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Max Jean de Ornelas Toledo[I,II]

Andrey Wilder Paludetto[II]

Fabiana de Toledo Moura[II]

Evaldo Silva do Nascimento[III]

Marta Chaves[IV]

Silvana Marques de Araújo[I,II]

Lúcio Tadeu Mota[V]

Evaluation of enteroparasite control activities in a *Kaingáng* community of Southern Brazil

ABSTRACT

OBJECTIVE: To analyze the parasitological state of families in an indigenous community after institution of enteroparasite control measures.

METHODS: A longitudinal study was conducted between 2004 and 2006 among 447 individuals of the *Kaingáng* ethnic group, in the municipality of Cândido de Abreu, Southern Brazil. The enteroparasite control measures were: sanitation improvements in 2003, antiparasite treatments that were administered during the study period, and health education activities that were started in 2005. Parasitological health indicators were obtained through three coproparasitological surveys (in 2004, 2005 and 2006), in which 250, 147 and 126 stool samples, respectively, were collected. These were evaluated using the spontaneous sedimentation, centrifugation-flotation and Kato-Katz methods. Housing and hygiene conditions were assessed by means of a questionnaire applied to 69 (2004), 57 (2005) and 38 (2006) of the 90 families.

RESULTS: The overall prevalences of enteroparasites were 91.6% (2004), 94.6% (2005) and 87.3% (2006) and did not show any significant reduction. The prevalence of some species decreased, while the prevalence of others increased significantly. High-intensity infections due to geohelminths presented rates of less than 2% over the study period. The proportion of the interviewees who reported using a toilet increased from 38.8% to 71.1% ($p< 0.005$) and the proportion taking antiparasite agents increased from 70.2% to 100% ($p= 0.001$).

CONCLUSIONS: There were significant improvements in the parasitological health indicators, such as reductions in the prevalence of some species of enteroparasites and maintenance of a low parasite load, thus showing the importance of combining antiparasite treatment with sanitation improvements.

DESCRIPTORS: Indians, South American. Intestinal Diseases, Parasitic. Socioeconomic Factors. Social Conditions. Indigenous Health. Primary Health Care.

[I] Departamento de Ciências Básicas da Saúde. Universidade Estadual de Maringá (UEM). Maringá, PR, Brasil

[II] Programa de Pós-graduação em Ciências da Saúde-UEM. Maringá, PR, Brasil

[III] Fundação Nacional de Saúde. Ministério da Saúde. Maringá, PR, Brasil

[IV] Departamento de Teoria e Prática da Educação-UEM. Maringá, PR, Brasil

[V] Departamento de História. UEM. Maringá, PR, Brasil

Correspondence:
Max Jean de Ornelas Toledo
Departamento de Ciências Básicas da Saúde
Bloco I-90
Universidade Estadual de Maringá
Av. Colombo, 5790, Zona 7
87020-900 Maringá, PR, Brasil
E-mail: mjotoledo@uem.br

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INTRODUCTION

The prevalence of infectious and parasitic diseases is high in Amerindian populations, which places the Brazilian indigenous population at a disadvantage in relation to other segments of national society.[7,14] Even with the implementation of sanitation actions, these infections often cannot be controlled by the health-care services because of high transmission rates that are favored by the environmental and sociocultural conditions.[14]

The records on health conditions among Indians generally refer to groups that live in the Amazon and Central-Western regions of Brazil. Little has been published on enteroparasitism among indigenous people of the *Kaingáng* ethnic group. This is among the most numerous groups in the country, and it has been estimated that it consists of 29,000 individuals, distributed among 32 indigenous territories in the states of São Paulo, Paraná, Santa Catarina and Rio Grande do Sul.[a] In Paraná, in 1998, a study detected a high prevalence (93%) of infections caused by geohelminths among *Kaingáng* schoolchildren in the Queimadas indigenous territory.[15]

To combat and prevent health problems among indigenous populations, primary healthcare actions need to consider the epidemiological profile of these populations and the particular features of their way of life. The aim of the present study was to analyze the parasitological state of families in an indigenous community after institution of control measures against enteroparasites.

METHODS

A longitudinal observational study was conducted among a population of *Kaingáng* ethnicity living in the Faxinal indigenous territory. This territory is located in the municipality of Cândido de Abreu (51°17'W 24°41'S), in the central area of the state of Paraná, Southern Brazil. It is one of 20 indigenous territories in this state and is within the coverage area of the Paraná Special Indigenous Health District. It is located 6 km from the urban area and covers an area of 2,043.89 ha. This *Kaingáng* population was composed of 447 individuals, of whom 52.3% were male and 48.5% were less than 15 years of age.[b]

Three coproparasitological surveys were conducted to identify the impact of the interventions on the population's health indicators, in 2004, 2005 and 2006.

The interventions implemented within the community were sanitation actions, treatment with antiparasitic agents and health education.

The sanitation actions in the Faxinal indigenous territory began in 2003, with sanitary improvements in homes. Water treatment began in mid-2004, three months before the baseline coproparasitological survey.

Since high rates of enteroparasites were found in the baseline survey, mass treatment with antiparasitic agents and health education was proposed for the local population. The protocol for enteroparasitosis treatment, with oral administration of the agents metronidazole, thiabendazole and albendazole, was applied in March and September 2005 and has been detailed in other papers.[13,c]

A pedagogical intervention project was carried out in the two classes at elementary education level of the local school for the indigenous population. As a development from this, a bilingual pedagogical support booklet named "Education for Health" was compiled, with contributions from the indigenous students, with the aim of raising awareness about parasitic diseases and preventing them in the community. This bilingual booklet was used to train the teachers, indigenous healthcare and sanitation agents and monitors of the indigenous school, for use among the schoolchildren.

It was decided not to use probabilistic samples, since individuals who were present in the main settlement of the community at the time of the investigation were studied. During the surveys, 300 kits for stool collection were distributed (small plastic pots with screw tops and labels, half a sheet of newspaper and a wooden stick). Over the next five days, the researchers visited these individuals' homes twice a day (morning and afternoon) to collect the material. The reliability of the results was checked using the EpiInfo software (version 3.3.2), using the parameter of an expected frequency of infection with enteroparasites of 93%[15] among the population of 447 people, thus obtaining a confidence level that ranged from 99% to 99.9%.

The aim of the investigation and the collection of material were explained in meetings with the local leaders: the tribal chief, the local head of the *Fundação Nacional do Índio* (National Indian Foundation), professionals from the primary healthcare unit (PHU), elementary school teachers and indigenous agents.

[a] Instituto Sócio Ambiental. Povos indígenas no Brasil. Brasília; 2005 [cited 2006, Jan 5]. Available at: http://pib.socioambiental.org/pt
[b] Mota TL, Cazorla ME, Rocha VF. Diagnóstico sócio-cultural e econômico da Terra Indígena Faxinal – PR [Report from research project]. Maringá: Universidade Estadual de Maringá; 2004.
[c] Montresor A, Crompton DWT, Bundy DAP, Hall A, Savioli L. Guidelines for the evaluation of soil-transmitted helminthiasis and schistosomiasis at community level. Geneva: World Health Organization; 1998. (WHO/CTC/SIP/98.1).

The parasitological tests were performed in the laboratories of the PHU and the university. Three different techniques were used on a single stool sample: the spontaneous sedimentation method;[11] the centrifugation-floatation method;[4] and the quantitative method of Kato & Katz.[9]

Based on the results from these tests, the following indicators were determined: overall prevalence of enteroparasites; prevalence according to species, sex and age group; prevalence of polyparasitism or multiinfection; and intensity of infection (parasite load) due to geohelminths (*Ascaris lumbricoides*, *Trichuris trichiura* and Ancylostomatidae). In addition, the results from the stool tests were used to determine the parasitological status of each family, thus enabling comparisons of their housing and hygiene conditions.[6]

A questionnaire about housing and sanitation conditions was applied to the person responsible for each indigenous family. Out of the 90 families, 69, 57 and 38 were interviewed during the baseline, second and third surveys, respectively.

The data were analyzed using the BioEstat software, version 5.0, with a significance level of 5%. The chi-square test was used for data summarized in proportions. For expected frequencies lower than five, Fisher's exact test was used. To test the significance of differences between means (mean number of bedrooms and mean number of people per house), Student's t test was used.

To characterize the families' parasitological status,[6] the following variables were used within the families: "number of species per family", "number of species per individual", "percentage of individuals parasitized by *A. lumbricoides*", "percentage of individuals parasitized by ancylostomids", "percentage of individuals parasitized by *T. trichiura*" and "percentage of individuals parasitized by *Hymenolepis nana*". The dependence between these variables and the variables relating to housing and hygiene conditions ("use of toilet", "toilet inside house", "consumption of water from natural sources" e "use of antiparasitic agents") was tested by means of simple or multiple logistic regression, according to the situation.

Table 1 presents the distribution of the stool samples obtained during the three surveys, according to sex and age group. Out of around 300 receptacles that were distributed for each survey, 250, 147 and 126 were returned containing a stool sample in the baseline, second and third surveys, respectively. Thus, the population presented lower adherence in the latter two surveys, with significant sample loss ($p = 0.000$). Nonetheless, the size of each sample was adequate and the sample composition according to sex and age (age groups of 0-4, 0-14 and 0-19 years) did not differ between the surveys, or in relation to the original population.

The greatest percentages of individuals examined were of school age (five to 19 years of age): 39.6%, 38.8% and 48.4%, respectively in the baseline, second and third surveys, accompanied by the age group ≥ 20 years (Table 1).

The project was approved by the *Comitê Nacional de Ética em Pesquisa* (CONEP - National Research Ethics Committee), in conformity with its report no. 815/2004. Acceptance statements were obtained from the local leaders and from the health board of the Special Indigenous Health District of the Faxinal indigenous territory, thus agreeing that the investigation could be conducted. At the time of distributing the collection kits, a consent statement approved by CONEP was signed by the person responsible for each family. At the end of each survey, the results were presented to the authorities, leaders and study subjects.

RESULTS

The prevalences of enteroparasites (presence of any species of intestinal helminth or protozoan) in the stool samples examined during the three surveys were: 229 (91.6%), 139 (94.6%) and 110 (87.3%), respectively (Table 2). Although this variation was not statistically significant, there was a marginally significant reduction ($p= 0.057$) in two by two comparison between the second and third surveys.

In the baseline survey, 14 different species of intestinal helminth or protozoan were found in the population of the Faxinal indigenous territory (Table 2). Three species of helminth detected in the baseline survey (*Strongyloides stercoralis, Enterobius vermicularis* and *Trichuris vulpis*) were not found in the second survey and five (the preceding three plus *Taenia sp*. and *Toxocara sp.*) were not found in the third. Eggs from animal parasites were found in the samples from three individuals during the baseline survey and from another three individuals in the second.

Significant variation in the four most prevalent helminth species was observed (Table 2). While the prevalences of *A. lumbricoides* and ancylostomids decreased ($p< 0.001$), the prevalences of *T. trichiura* ($p= 0.010$) and *H. nana* ($p< 0.001$) increased between 2004 and 2006.

During the baseline survey, the overall prevalence of enteroparasites varied significantly according to age ($p= 0.005$) (Table 3). The highest rates were recorded within the school age range and the prevalences of *A. lumbricoides*, *Entamoeba coli*, *H. nana*, *Giardia lamblia*, *Endolimax nana*, *Iodamoeba butschlii*, ancylostomids and *Entamoeba histolytica*/*E. dispar* varied significantly. Children between the ages of ten and 14 years

Table 1. Composition of the 523 stool samples according to age group and sex.[a] Faxinal indigenous territory, municipality of Cândido de Abreu, Southern Brazil, 2004-2006.

Age group (years)	Male	Female	Total	%
2004				
0-4	23	22	45	18.0
5-9	24	17	41	16.4
10-14	21	13	34	13.6
15-19	15	9	24	9.6
≥ 20	37	57	94	37.6
Subtotal	127	123	250	100.0
2005				
0-4	6	19	25	17.0
5-9	18	11	29	19.7
10-14	15	7	22	15.0
15-19	5	1	6	4.1
≥ 20	26	38	64	43.5
Subtotal	70	76	147	100.0
2006				
0-4	8	6	14	11.1
5-9	18	11	29	23.0
10-14	17	12	29	23.0
15-19	2	1	3	2.4
≥ 20	11	24	35	28.0
Subtotal	56	55	126	100.0
Total	253	254	523	100.0

[a] Not stated: 16 individuals (3.1%)

were the group most affected by *A. lumbricoides* and ancylostomids, while children between the ages of zero and four years were the ones most infected by *H. nana* and *G. lamblia*. The highest prevalences of *E. coli*, *I. butschlii* and *E. histolytica*/*E. dispar* were recorded among individuals ≥ 20 years of age.

During the two subsequent surveys, no significant variation in the overall prevalence of enteroparasites in relation to age was observed. Only the specific prevalence of *H. nana* in the second survey varied significantly ($p< 0.005$) according to age group, and children aged one to four years were the individuals most affected (data not shown).

No statistical association was observed between the prevalence of enteroparasites and sex (data not shown).

The prevalence rates of polyparasitism did not vary significantly between the surveys: 74.0%, 72.1% and 68.3% of the individuals, respectively in 2004, 2005 and 2006, presented multi-infection. The prevalences of monoparasitism were 17.6% (2004), 22.5% (2005) and 19.4% (2006), and no significant differences in overall prevalence were observed between age groups (data not shown).

The intensity of the infection due to *A. lumbricoides* varied from moderate (most prevalent in the baseline survey) to low in the subsequent surveys (Table 4). For *T. trichiura,* no high parasite loads were observed, and moderate loads were recorded in only 0.9% of the individuals in 2006.

Comparing the intensity of infection between the three surveys, a significant reduction ($p< 0.01$) in the prevalence of moderate parasite load of *A. lumbricoides* and a significant increase ($p= 0.01$) in the prevalence of low parasite load of *T. trichiura* was observed (Table 4). High intensity of infection due to *A. lumbricoides* always remained at rates of less than 2%.

Significant changes were also observed in the housing and hygiene conditions. The presence of a toilet inside the house went up from 19.4% to 45.6% ($p< 0.05$) (Table 5). Increases in the proportions of interviewees who reported using a toilet (from 38.8% to 71.1%, $p< 0.005$) and taking antiparasitic agents (from 70.2% to 100.0%, $p= 0.001$) were observed. On the other hand, there was a reduction ($p< 0.001$) in the proportion of the interviewees who said that they consumed water coming from natural sources such as rivers or pits, from around 90% (2004) to 53% (2006). Regarding the type of housing, more than 84% were made of masonry or prefabricated materials both in 2005 and in 2006.

Logistic regression analysis indicated that the variables of housing and hygiene conditions did not show any associations with the "number of species in the family" or "number of species per individual" that were detected in the surveys. On the other hand, the variable "medication taken" explained the percentages of infection due to *A. lumbricoides* and ancylostomids. The chance that a family that had not taken medication would be infected by *A. lumbricoides* was 2.7 times greater ($p= 0.013$, OR= 2.7 and 95% CI: 1.24;5.91) than for a family that took medication. In relation to ancylostomids, the chance was 3.9 times greater ($p= 0.022$, OR= 3.86 and 95% CI: 1.21;12.27). The proportion of the individuals within a family who were infected with *T. trichiura* and *H. nana* did not present any association with the variables of housing conditions and hygiene.

DISCUSSION

Coproparasitological surveys among indigenous populations in Brazil have revealed high prevalences of enteroparasites and a great variety of species, thus reflecting the precarious healthcare infrastructure

Table 2. Evolution of overall prevalence (%) and according to enteroparasite species. Faxinal indigenous territory, municipality of Cândido de Abreu, Southern Brazil, 2004-2006.

Species	2004 (n=250)	2005 (n=147)	2006 (n=126)	p
Ascaris lumbricoides	63.2	56.5	34.1	< 0.001
Entamoeba coli	58.0	66.0	65.8	NS
Endolimax nana	31.6	40.1	34.9	NS
Iodamoeba butschlii	26.4	22.4	22.2	NS
Ancylostomids	16.0	6.1	0.8	< 0.001
*Trichuris trichiura***	16.0	22.4	29.4	0.055
Hymenolepis nana	12.8	21.1	31.7	< 0.001
Giardia lamblia	11.2	3.4	10.3	NS
Entamoeba histolytica/ E. dispar	4.4	6.8	2.4	NS
Strongyloides stercoralis	3.2	0.0	0.0	NS
Enterobius vermicularis	2.0	0.0	0.0	NS
Trichuris vulpis	0.8	0.0	0.0	NS
Toxocara sp.	0.4	2.0	0.0	NS
Taenia sp.	0.4	1.4	0.0	NS
Total**	91.6	94.6	87.3	NS

NS = Not significant; ***T. trichiura* 2004 versus 2006, p = 0.010; **Overall prevalence 2005 versus 2006, p = 0.057;

in indigenous territories.[3,12,15,a] In the present study, although the number of species went down after the baseline survey, from 15 to nine, high prevalences of enteroparasites were also found even after implementing control measures.

During the baseline survey, the species with highest prevalence were four helminths and four protozoa (*A. lumbricoides*, *T. trichiura*, ancylostomids and *H. nana; E. coli*, *E. nana*, *I. butschlii* and *G. lamblia*), reaching rates greater than 11%. These data are concordant with most other studies on indigenous populations, with reports of these same species except for *H. nana*.[a] The prevalence of this helminth species among the *Kaingáng* individuals studied was between 12.8% and 31.7%. Similar prevalences of *H. nana* have only been observed among the *Suruí* (state of Rondônia, northern region) (19.4%)[2] and the *Yawalapiti* (state of Mato Grosso, central-western region) (26.1%).[5] Since the eggs of *H. nana* present little resistance to external environments, transmission of hymenolepiasis generally occurs within domestic environments. Cultural characteristics of the *Kaingáng*, such as the high number of people living in the home (six) and low number of bedrooms per house (< 2), along with the precarious hygiene conditions, may explain the results that were found.

Comparisons between studies on indigenous communities need to take into account geographical, climatic, environmental and, particularly, cultural differences. Furthermore, the realities for Amazon villages are very different from those of villages in southern Brazil, where indigenous people have greater contact with the society that surrounds them. Nevertheless, the high prevalence of *A. lumbricoides* among the *Kaingáng* of the present study was similar to what has been observed in other Brazilian indigenous communities. Regarding the prevalence of *T. trichiura*, which in the present study ranged from 16.0% to 29.4%, rates lower than 10% have been recorded in most studies on indigenous populations.[a] For example, among the *Kaingáng* schoolchildren in the Queimadas indigenous territory (Paraná), the prevalence observed was 2.0%.[15] However, high rates of this helminth were recorded among different ethnic groups in Amazonas, ranging from 43.3% among the *Yanomami*[a] to 91% in an unspecified ethnic group.[10]

E. coli, *E. nana* and *I. butschlii* occurred at rates ranging from 22.2% to 66.0%. These amoebae, which previously were considered to be commensal protozoa of the human intestinal tract, are now accepted as parasites of variable pathogenicity, depending on the environmental and/or individual conditions of the host. It has been shown that the species *E. nana* may be associated with diarrhea among children, if at high prevalence and intensity.[8]

G. lamblia presented varying prevalence over the period, probably due to discontinuous treatment with

[a] Vieira GO, Santos RV, Coimbra Jr CEA. Parasitismo intestinal em populações indígenas no Brasil: uma revisão sistemática da literatura científica. Porto Velho: Centro de Estudos em Saúde do Índio de Rondônia; 2005 [cited 2006, Jan 1]. Available at: http://www.cesir.unir.br/pdfs/doc11.pdf

Table 3. Overall prevalence (%) and according to enteroparasite species, in relation to age groups. Faxinal indigenous territory, municipality of Cândido de Abreu, Southern Brazil, 2004.

Species	Age group (years)					p
	0 to 4 (n= 51)	5 to 9 (n= 42)	10 to 14 (n= 30)	15 to 19 (n= 27)	≥ 20 (n= 100)	
Ascaris lumbricoides	49.0	66.7	83.3	70.4	60.2	< 0.001
Entamoeba coli	37.3	64.3	56.7	59.3	67.0	< 0.001
Hymenolepis nana	27.5	19.0	3.3	11.1	4.5	< 0.001
Giardia lamblia	25.5	14.3	10.0	11.1	2.3	< 0.001
Endolimax nana	15.7	33.3	33.3	48.1	34.1	< 0.001
Iodamoeba butschlii	11.8	19.0	23.3	18.5	42.0	< 0.001
Trichuris trichiura	9.8	23.8	16.7	33.3	10.2	NS
Ancilostomídeos	3.9	19.0	30.0	18.5	14.8	0.002
Entomoeba histolytica/ E. dispar	0.0	2.4	3.3	3.7	6.8	0.005
Strongyloides stercoralis	3.9	2.4	10.0	3.7	1.1	NS
Enterobius vermicularis	0.0	4.8	3.3	0.0	2.3	-
Trichuris vulpis	0.0	2.4	0.0	0.0	1.1	-
Toxocara sp.	0.0	0.0	3.3	0.0	0.0	-
Taenia sp.	0.0	0.0	3.3	0.0	0.0	-
Total	74.5	90.5	93.3	88.9	74.0	0.005

NS = Not significant

metronidazole, occurrences of reinfection (mainly among children) and a standard chlorine concentration for water treatment that was insufficient to destroy all of the cysts.

Four species of enteroparasites occurred at prevalences of less than 7%: *E. histolytica/E. dispar*, *S. stercoralis*, *E. vermicularis* and *Taenia* sp. Low prevalences of *E. histolytica/E. dispar* have been recorded among ethnic groups in the southeastern and central-western regions of Brazil and after mass treatment, ranging from 2.0% to 4.9%.[a] However, high prevalences have been recorded among ethnic groups in the northeastern and northern regions, ranging from 36.7% to 82.4%.[6,12,a] The prevalences of *S. stercoralis*, *E. vermicularis* and *Taenia* sp. may have been underestimated, since the techniques used were not the ones most recommended for their diagnosis.

The finding that some individuals were eliminating eggs from animal parasites leads to reflection on whether the samples examined were really from humans. Experiences from investigations among needy communities like indigenous villages have shown that it is possible to receive flasks containing feces from domestic animals instead of human stools. Another possibility is involuntary contamination of the sample with animal feces because indigenous people do not cover the defecation site adequately when they defecate into the ground. Four feces samples presented eggs that were morphologically similar to those of *Toxocara* sp., which is a parasite of dogs and cats, and there were two feces samples with eggs of *T. vulpis,* which is a common parasite among dogs. Closer analysis of the results from the tests on those samples made it possible to dismiss the first possibility and accept the second hypothesis, given that in addition to the animal parasites, human parasites were found in greater proportion in all of the six samples. The possibility that the subjects might hand in flasks containing domestic animal feces as if they were human was minimized by the relationship of confidence that the indigenous community maintained with the group of investigators. The investigators included an anthropologist with great experience among indigenous people in Paraná. Occurrences of cross-infection by eggs of *Capillaria* sp. (a common parasite of rodents) and *Balantidium coli* (a parasite of pigs) are possible, as seen among Brazilian indigenous populations.[2,3] Findings of eggs from animal parasites in human feces does not necessarily indicate parasitism: these eggs may simply have passed through the human intestine. By excluding such samples from the present analysis, the sample loss from the baseline and second surveys would be 1.2% and 2.0%, respectively. Taking the most prevalent species (*A. lumbricoides*)

[a] Vieira GO, Santos RV, Coimbra Jr CEA. Parasitismo intestinal em populações indígenas no Brasil: uma revisão sistemática da literatura científica. Porto Velho: Centro de Estudos em Saúde do Índio de Rondônia; 2005 [cited 2006, Jan 1]. Available at: http://www.cesir.unir.br/pdfs/doc11.pdf

Table 4. Intensity of infection by geohelminths among the population. Faxinal indigenous territory, municipality of Cândido de Abreu, Southern Brazil, 2004-2006.

Variable	2004 (n=250)	2005 (n=139)	2006 (n=112)	p**
Ascaris lumbricoides				
Intensity of infection (%)				
Low (1-4,999 epg*)	22.8	30.9	18.8	NS
Moderate (5,000-49,999 epg)	24.8	19.4	8.0	< 0.01
High (≥ 50,000 epg)	0.4	0.7	1.8	NS
Trichuris trichiura				
Intensity of infection (%)				
Low (1-999 epg)	11.6	15.1	26.8	0.01
Moderate (1,000-9,999 epg)	0.0	0.0	0.9	NS
High (≥ 10,000 epg)	0.0	0.0	0.0	-

***** Eggs per gram of feces
****** Comparison between the years for the different severities of infection

as an example, its prevalence would go from 63.2 to 62.0% in the baseline survey and from 56.5 to 54.5% in the second survey. Hence, this would not result in significantly different estimates.

Several studies have indicated high levels of polyparasitism in indigenous populations.[6,12,a] In the present study, although the proportion of individuals with multi-infection did not decrease significantly, polyparasitism did not come to represent the rule among the *Kaingáng* studied (despite its high level), unlike the case of the *Pankararus* in Pernambuco.[6]

The lack of previous surveys on this population makes it difficult to monitor the impact of the control measures that were implemented. With regard to the intensity of infection by geohelminths, an epidemiological survey among schoolchildren aged five to 15 years in the Queimadas indigenous territory in 1998 (when there was still no sanitation) recorded rates that were higher than those found in the present study.[15] The "ideal" prevalence of high-intensity infections in a community is close to zero, as seen in Faxinal, with a range from 0.4% to 1.8%. If the prevalence reaches 10% or more of the population, intervention measures appropriate to this category of community (level I) should be adopted, such as universal treatment repeated periodically, along with sanitation improvements and health education.[b,c]

Among the parasitological indicators, the parasite load is the first to be impacted by sanitation improvements within a community.[b] The results obtained from the three surveys showed that the overall prevalence of enteroparasites remained high (> 50%) in Faxinal, although with a declining trend, while the prevalence of high-intensity infections was low. This community was therefore classified as World Health Organization (WHO) level II. The interventions recommended for geohelminth control at this level are sanitation improvements, health education and treatment for high-risk groups regarding enteroparasitosis (women of reproductive age, preschool children and schoolchildren).[c]

Although the sample loss was significant, the sample size remained within a high confidence level. Its composition regarding the variables of sex and age (taking different age groups into account) did not differ between the surveys or in relation to the original population. This was because the prevalence of enteroparasites was very high in the indigenous territory studied, thus validating the estimates and conclusions. Among the housing condition variables, only the variable "antiparasitic agents taken" showed a significant association with the parasitological status of the families. In communities with a high prevalence of enteroparasites, antiparasitic treatment is a control measure that, over the short term, has a direct impact on prevalence.[13,c] As seen in this community, the low prevalence of high parasite load in the baseline survey remained close to zero in the subsequent surveys, probably because of the sanitation improvements and educational activities, given that antiparasitic treatment for the whole community

[a] Vieira GO, Santos RV, Coimbra Jr CEA. Parasitismo intestinal em populações indígenas no Brasil: uma revisão sistemática da literatura científica. Porto Velho: Centro de Estudos em Saúde do Índio de Rondônia; 2005 [cited 2006, Jan 1]. Available at: http://www.cesir.unir.br/pdfs/doc11.pdf

[b] Montresor A, Crompton DWT, Bundy DAP, Hall A, Savioli L. Guidelines for the evaluation of soil-transmitted helminthiasis and schistosomiasis at community level. Geneva: World Health Organization; 1998. (WHO/CTC/SIP/98.1).

[c] Montresor A, Gyorkos TW, Crompton DWT, Bundy DAP, Savioli L. Monitoring helminth control programmes at community level. Guidelines for monitoring the impact of control programmes aimed at reducing morbidity caused by soil-transmitted nematodes and schistosomes, with particular reference to school-age children. Geneva: World Health Organization; 1999. (WHO/CDS/CPC/SIP/99.3).

Table 5. Housing and hygiene conditions. Faxinal indigenous territory, municipality of Cândido de Abreu, Southern Brazil, 2004-2006.

Housing and hygiene factors	2004	2005	2006	p
Number of families interviewed	69	57	38	
Homes with a toilet (%)	62.7	75.4	66.0	NS
Toilet inside the house (%)	19.4	45.6	29.0	< 0.05
Toilet used (%)	38.8	71.9	71.1	< 0.005
Treated water installed (%)	-	98.3	92.1	NS
Treated water used (%)	91.1	100.0	92.1	NS
Water consumed from natural sources (%)	89.6	57.9	53.0	< 0.001
Stool test undergone previously (%)	-	75.4	82.0	NS
Antiparasitic agents taken (%)	-	70.2	100.0	0.001
Housing type (%)				
Masonry	-	45.0	52.6	NS
Prefabricated panels	-	39.5	31.6	NS
Thatching/wood	-	13.2	12.3	NS
Others	-	3.0	1.8	NS
No. of inhabitants per home (mean)	5.7	4.7	5.3	NS
No. of bedrooms per home (mean)	1.5	1.6	1.4	NS

was not carried out in 2004. Although the prevalence did not decrease, the community benefited from the sanitation improvements and educational activities through reductions in morbidity[a] and lack of clinical complications.

The results from the present study corroborate the findings of other investigators who studied the *Parakanã*,[12] *Tukano* and *Aruak*[1] indigenous populations in the Amazon region. In their studies, there were no reductions in the overall prevalence of enteroparasites after mass treatment, but there were significant reductions in the prevalence of some species.

Comparing the housing and hygiene conditions during the three surveys, more than 92% of the homes had and used treated water. However, around 30% of the homes in Faxinal still did not have sanitation installations. Another finding that indicated an improvement in hygiene conditions was the significant reduction in the proportion of interviewees who said that they still consumed water from rivers and pits, from 90% in 2004 to 53% in 2006.

The decreases in prevalence of *A. lumbricoides* and ancylostomids and the increases in prevalence of *T. trichiura* and *H. nana* suggest that replacement of the species occupying certain niches took place. On the other hand, the efficacy of albendazole for curing patients with trichuriasis was very low, probably because of the differentiated location of this worm in the mucosa of the large intestine and rectum, thus making it difficult for the medication to act.[13] Paradoxically, the changes in housing structure may have contributed towards increasing the prevalence of hymenolepiasis. This, together with the continuing precarious hygiene conditions, would have favored its transmission within homes.

The number of parasitized individuals continued to be high in this *Kaingáng* village in Paraná. This shows that the sanitation improvements and treatment alone were insufficient for satisfactorily reducing the infection rates among the population: Health education also needed to be implemented. Because of the persistence of habits such as defecating in the ground close to homes and walking around barefoot, among others, the reinfection rates continued to be high. To turn this situation round, continuation and expansion of the educational activities are fundamental for the community, given that these activities were developed for an insufficient time among the schoolchildren.

Despite the probable occurrence of reinfection and the increased prevalence of certain species of enteroparasites, the data showed that the set of interventions had a positive impact on the parasitological health indicators of the *Kaingáng* in Faxinal. Annual treatment for groups that are at risk should continue and new therapeutic approaches should be adopted for the enteroparasitoses that did not respond to the treatment. This should be done simultaneously with the health education activities and maintenance of the sanitation improvements.

[a] Montresor A, Crompton DWT, Bundy DAP, Hall A, Savioli L. Guidelines for the evaluation of soil-transmitted helminthiasis and schistosomiasis at community level. Geneva: World Health Organization; 1998. (WHO/CTC/SIP/98.1).

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