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Intestinal parasites in two indigenous ethnic groups in northwestern Amazonia

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ABSTRACT

Approximately 90% of the population in the northwestern Amazonia is composed of indigenous people and their healthcare is still a challenge. The objective of this study was to determine the frequency of parasites in two indigenous ethnic groups (Baré and Baniwa) in northwestern Amazonia. Stool samples from 270 individuals (199 Baniwa and 71 Baré) were analyzed using Richie's method and the spontaneous sedimentation method. Statistical differences among the proportions of infected individuals based on gender, age, and ethnicity were determined. All individuals were infected by protozoans or helminths. The most frequent parasites in the indigenous people were *Ascaris lumbricoides* (73%), *Entamoeba* spp. (53%), and *Giardia intestinalis* (48%). Protozoan parasites were more common among children aged 0-12 years; however, the frequency of helminths, such as hookworms and *A. lumbricoides*, was higher in adults. There were no significant differences in parasite frequencies between different genders or ethnic groups. Mixed infections by two or more protozoan and/or helminth species were detected in 96% of individuals. One individual was infected by 14 species. A high frequency of intestinal parasites was found in Baré and Baniwa ethnic groups. Improvements to infrastructure and health education programs are required to reduce risk of infection by intestinal parasites.

KEYWORDS: Indigenous Population, Parasitic Diseases, Stool samples, Amazon region.

Parasitos intestinais em dois grupos indígenas no noroeste da Amazônia

RESUMO

Aproximadamente 90% da população no noroeste da Amazônia é composta de grupos indígenas e o acesso deles aos serviços de saúde ainda é um desafio. O objetivo deste estudo foi determinar a frequência de parasitos em dois grupos indígenas (Baré e Baniwa) no noroeste da Amazônia. Amostras de fezes de 270 indivíduos (199 Baniwa e 71 Baré) foram analisadas pelos métodos de Richie e sedimentação espontânea. Foram determinadas diferenças estatísticas entre as proporções de indivíduos infectados com base no sexo, idade e etnia. Todos os indivíduos estavam infectados por protozoários ou helmintos. Os parasitos mais frequentes nos índios foram *Ascaris lumbricoides* (73%), *Entamoeba* spp. (53%), e *Giardia intestinalis* (48%). Protozoários parasitos foram mais comuns entre as crianças com idade entre 0-12 anos; no entanto, a frequência de ancilostomídeos e *A. lumbricoides* foi maior em adultos. Não houve diferenças significativas nas frequências de parasitos entre os diferentes sexos ou grupos étnicos. Infecções mistas por duas ou mais espécies de protozoários e/ou helmintos foram detectadas em 96% dos indivíduos. Um indivíduo estava infectado por 14 espécies. Uma alta frequência de parasitos intestinais foi encontrada em indígenas dos grupos Baré e Baniwa. Melhorias dos programas de infra-estrutura e educação em saúde são necessárias para reduzir o risco de infecção por parasitos intestinais.

PALAVRAS-CHAVE: Populações indígenas, doenças parasitárias, amostras fecais, Região Amazônica.

INTRODUCTION

Most of indigenous people worldwide live poor health conditions, which are associated with malnutrition, overcrowding, poor hygiene, and environmental contamination (Stephens *et al*. 2005; Gracey and King 2009). In Brazil, many indigenous communities lack basic sanitation (Coimbra 2014). This situation makes it easier for various parasitic diseases to spread (Santos and Coimbra 2005).

High frequencies of intestinal parasites have been observed in indigenous peoples throughout Brazil, such as Xavante (Santos *et al*. 1995), Hüpda (Bóia *et al*. 2009), Kaingáng (Moura *et al*. 2010), Maxakali (Assis *et al*. 2013), Terena (Neres-Norberg *et al*. 2014), and other ethnic groups in Amazonia (Martins *et al*. 2015). The process of economic expansion in the Brazilian Amazon region has been accompanied by a significant deterioration in the health conditions of the indigenous communities, and a strong presence of infectious and parasitic diseases has historically been seen (Coimbra 2014). In the Brazilian state of Amazonas, studies have shown a very high prevalence of helminths in indigenous communities (Lawrence *et al*. 1983; Genaro and Ferraroni 1984). This situation was found to be persistent in more recent studies in the region (Rios *et al*. 2007; Escobar-Pardo *et al*. 2010; Santos *et al*. 2010; Martins *et al*. 2015).

In the Negro River region, which is located in northwestern Amazonia, approximately 90% of the population is composed of indigenous ethnic groups. Few urban centers are located in this region, including the municipalities of Barcelos, Santa Isabel do Rio Negro, and São Gabriel da Cachoeira. The geographic location of these communities hinders access to public services, and indigenous healthcare is still a challenge for local authorities. The prevalence of *Ascaris lumbricoides* and hookworms is very high (45-95%), and protozoans such as *Giardia intestinalis* and *Entamoeba* spp. are also frequent in indigenous people from this region (Lawrence *et al*. 1983; Genaro and Ferraroni 1984; Rios *et al*. 2007; Escobar-Pardo *et al*. 2010; Santos *et al*. 2010; Martins *et al*. 2015). However, little is known about the occurrence of parasites among different ethnic groups in Amazonia. Thus, the aim of the research was to determine the frequency of protozoans and intestinal helminths in indigenous communities represented by two ethnic groups in the municipality of São Gabriel da Cachoeira, in the state of Amazonas, Brazil, in 2014.

MATERIALS AND METHODS

The current research represents a cross-sectional study with a non-probability sample of indigenous people from the communities of Boa Vista (0° 27' N, 67° 19' W) and Assunção do Içana (01° 03' N, 67° 36' W), which are located on the upper Rio Negro within the municipality of São Gabriel da Cachoeira in the Brazilian state of Amazonas. This municipality is located in the extreme northwest of the country; it borders Venezuela and Colombia to the north and the Brazilian municipality of Santa Isabel do Rio Negro to the south and to the east.

These communities are inhabited by people from various ethnic groups (e.g. Baré, Tukano, Baniwa, Wanano, and Tariana). Approximately 100 families and 500 people live there in total. The information on the number of inhabitants and households was obtained from data from the Special Indigenous Sanitary District of São Gabriel da Cachoeira. Indigenous people representing two ethnical groups (Baré and Baniwa) were sampled.

The communities were selected because of their low socioeconomic levels and their difficulty in accessing healthcare services. Both children and adults in the families who agreed to participate in the study and who signed the authorization form were included. The study was approved by the Ethics Committee on Human Research of the University of Brasília (No. 042342/2012). The results of parasitological examinations were given to each individual, and they were referred to medical health assistance program to receive specific treatment. Before the stool collection process, a presentation was carried out in the communities to explain the purpose of the research and the methods. This activity was supported by an indigenous healthcare agent who translated the presentation and the authorization forms into the Nheengatu language. No remuneration was given to participants.

Two stool samples per individual were collected in 80-g plastic bottles between March and April 2014. The families were instructed on how to collect the stool, which was delivered to the researchers in communities. The maximum range between each collection was 3 days. The samples were identified, preserved in 10% formaldehyde, stored in polystyrene boxes, and transported to the Laboratory of Medical Parasitology and Vector Biology of the University of Brasília where they were processed.

The parasitological diagnosis was performed using Richie's method (Ritchie 1948) and the spontaneous sedimentation method (Hoffmann *et al*. 1934). For each sample, eight microscope slides were stained with Lugol and examined using an optical microscope at 400x magnification for the visualization and identification of parasites, as described elsewhere (Machado *et al*. 1998). Chi-square or Fisher's exact tests were applied to verify statistical differences between the proportions of infected individuals according to gender, age, and ethnicity. Statistically significant differences were considered when $p < 0.01$. Tests were performed using the statistical package Graphpad (GraphPad Software, Inc. California, USA).

RESULTS

In total, stool samples from 199 individuals of the Baniwa ethnic group (109 women and 90 men) and 71 individuals of the Baré ethnic group (34 women and 37 men) were analyzed. Ninety-one individuals (34%) were between 0 and 12 years of age. All individuals were infected by protozoans or helminths. There were no significant differences in parasite frequencies between different genders or ethnic groups.

Among the helminths, *A. lumbricoides* was the most common species, followed by hookworms. *Entamoeba* spp. and *Giardia intestinalis* were the most frequent protozoan species (Figure 1). *Giardia intestinalis* and *Entamoeba* spp. were more common among children aged 0-12 years. However, the frequency of helminths, such as hookworms and *A. lumbricoides*, was higher in adults (Figure 2). Other parasites (*Balantidium coli*, *Enterobius vermicularis*, *Hymenolepis* spp.,

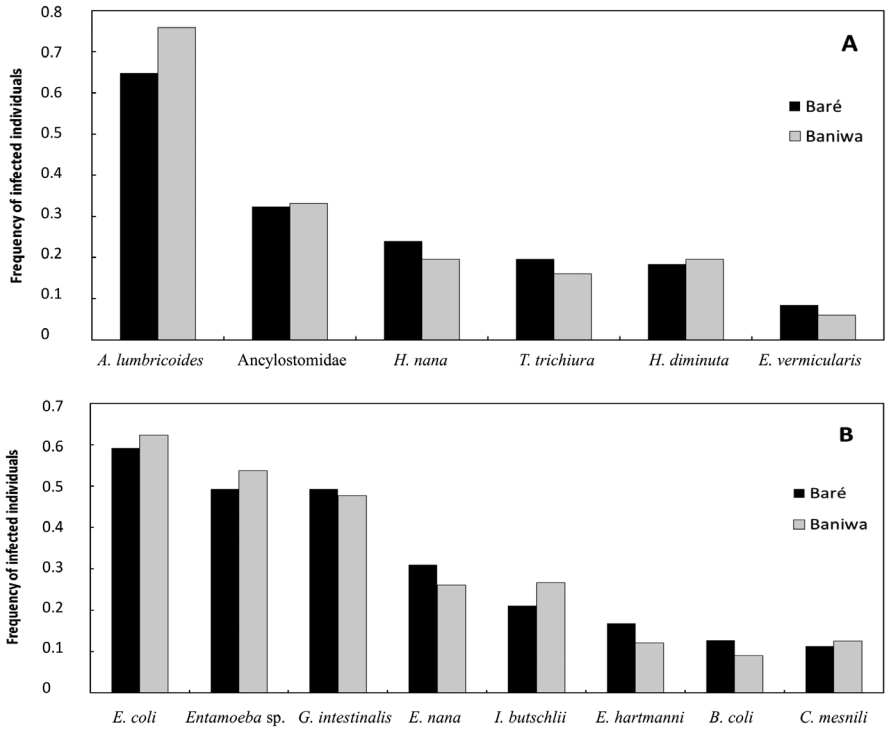

Figure 1. Distribution of helminths (A) and protozoans (B) found in individuals from two ethnic groups (Baré and Baniwa) in the municipality of São Gabriel da Cachoeira, Amazonas State, Brazil, in 2014.

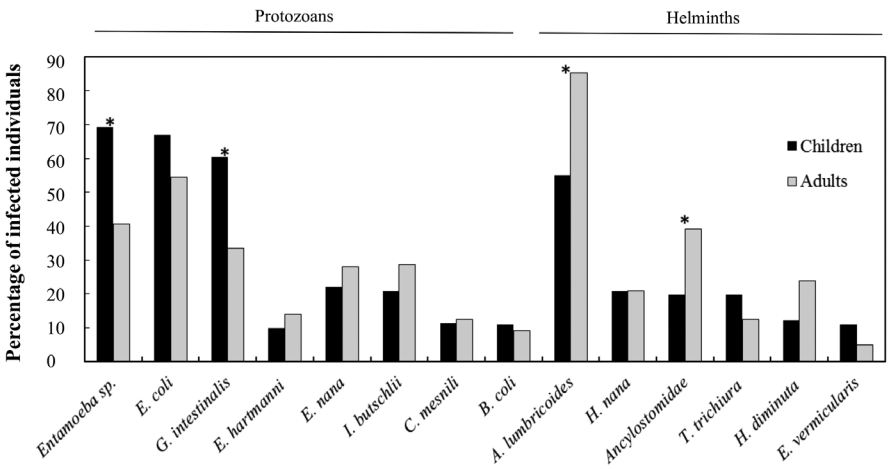

Figure 2. Helminth and protozoan distribution in adults and children from indigenous communities in the municipality of São Gabriel da Cachoeira, Amazonas State, Brazil, 2014. *significant differences among the groups ($p<0.01$).

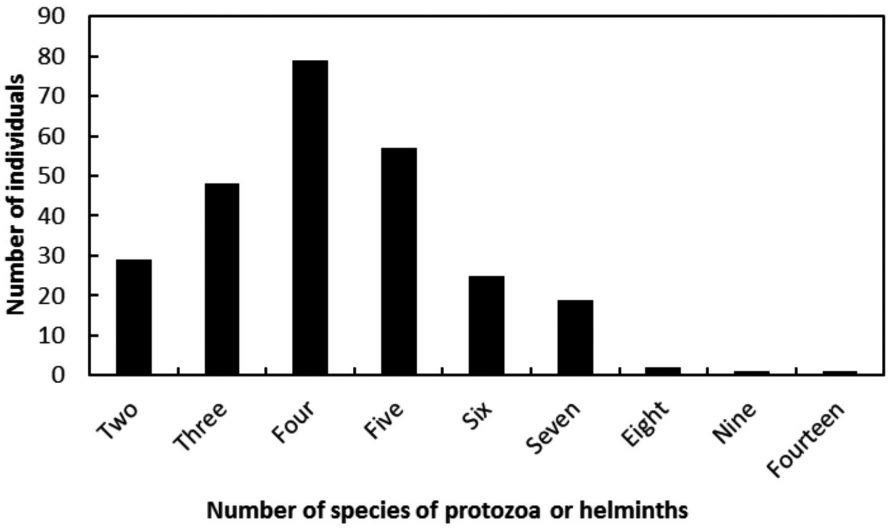

Figure 3. Mixed infections by two or more protozoan and/or helminth species in individuals from two indigenous communities in the municipality of São Gabriel da Cachoeira, Amazonas State, Brazil, 2014.

and *Trichuris trichiura*) and commensals (*Endolimax nana*, *Iodamoeba butschlii*, *Entamoeba hartmanni*, and *Chilomastix mesnili*) were also detected (Figure 1).

Two hundred and sixty individuals (96%) had mixed infections by two or more protozoan and/or helminth species. Most mixed infections were by three to five species, which were most commonly *A. lumbricoides* and *G. intestinalis*, *A. lumbricoides* and *E. coli*, or *E. coli* and *G. intestinalis*. One 10-year-old-girl was infected by 14 species (Figure 3).

DISCUSSION

In Brazil, high frequencies of intestinal parasites have been observed in different regions and ethnic groups, particularly in Amazonia (Santos and Coimbra 2005; Bóia *et al*. 2009; Martins *et al*. 2015). In the current study, higher frequencies of parasites in Baniwa and Baré indigenous groups were found when results were compared to those reported by Rios *et al*. (2007) in their analysis of the Tariano and Tukano ethnic groups from the same region. However, no differences were observed in frequency of parasites between the Baniwa and Baré ethnic groups; this similarity probably occurred because these communities share the same environmental conditions that favor transmission.

The frequency of *A. lumbricoides* among the Baniwa ethnic group (76%) was higher than that observed in other indigenous groups in the state of Amazonia (Genaro and Ferraroni 1984; Rios *et al*. 2007; Martins *et al*. 2015). Although the frequency of hookworms in the present study (33%) was higher than that observed by Rios *et al*. (2007) (5%), it did not reach values as high as those reported by Genaro and Ferraroni (1984) (96%). The same pattern was observed in the case of infections by *T. trichiura*. *Entamoeba* species were found to be the most common protozoans in these communities, a result which was similar to findings from other studies (Genaro and Ferraroni 1984; Miranda *et al*. 1998; Rios *et al*. 2007; Martins *et al*. 2015). The differences in prevalence found in these studies may be due to the parasitological methods employed, to different sample sizes, or to the testing of ethnic groups.

The high prevalence of parasitic diseases in indigenous people may be associated with poor living conditions and inadequate healthcare services (Gracey and King 2009). Some behaviors favor the transmission of parasites among indigenous peoples, including defecation around the home and most of the population's lack of shoes. Environmental factors such as soil moisture and high temperatures in the Amazon region favor the development and maintenance of infective stages of these parasites (Coimbra 2014). In addition, basic sanitation indicators are poor in indigenous communities: only 0.6% of indigenous households in the northern region of Brazil have indoor bathrooms. Moreover, drinking water is not properly treated. These examples show that indigenous villages generally lack minimally adequate healthcare infrastructure in Brazil (Coimbra 2014).

In this study, no correlation was found between gender and parasitism, a result which agrees with other studies that also compared the frequency of parasites between indigenous peoples of different genders (Miranda *et al*. 1998; Rios *et al*. 2007). A higher frequency of intestinal parasites in children has been previously observed in indigenous communities (Genaro and Ferraroni 1984; Miranda *et al*. 1998). In the current study, however, *A. lumbricoides* was found to be more

frequent in adults. This result was unexpected, because other studies on indigenous and non-indigenous populations have reported *A. lumbricoides* to be more frequent in children due to their relatively poor hygiene and to immunological factors (Genaro and Ferraroni 1984; Miranda *et al*. 1998; O'Lorcain and Holland 2000).

Mixed infections by 3-5 species have been found to be very common in different communities. More than half of the Parakanã indigenous population in the Brazilian state of Pará was also found to have two or more species of parasites (Miranda *et al*. 1998). Meanwhile, 33% of the Nadëb-Maku population in the state of Amazonas was found to be infected by three species of parasites (Genaro and Ferraroni 1984). Multiple infections by helminth species during childhood can have a negative impact on the host's nutrition through various mechanisms, including chronic blood loss and malabsorption (Sayasone *et al*. 2015). These mechanisms can directly influence cognitive ability and motor performance and may also influence the growth process in children living in endemic areas (Weatherhead and Hotez 2015).

Though two parasitological techniques were used to detect intestinal protozoans and helminths, parasites commonly found in some indigenous populations were not detected, such as *Cryptosporidium*, *Cyclospora cayetanensis* (Borges *et al*. 2009), and *Strongyloides stercoralis* (Santos *et al*. 1995). Further analysis, including other methods of detection and staining of intestinal parasites (Clarke and Mclntyre 1996; Machado *et al*. 1998), may reveal the prevalence of these species in Baniwa and Bare communities and may strengthen our evidence of a high frequency of intestinal parasites among these indigenous populations. Additionally, the inclusion of other parasitological techniques could reveal occurrence of *B. hominis*, since other studies reported a high prevalence of *B. hominis* in indigenous communities in the Brazilian states of Pará (Borges *et al*. 2009) and Mato Grosso do Sul (Aguiar *et al*. 2007).

The high frequency of intestinal parasites in Baré and Baniwa communities indicate that primary and secondary healthcare assistance should be increased in the region immediately. Bathrooms, clean water supplies, and specific treatment of infections could be provided to prevent and control intestinal parasites in these regions (Gracey and King 2009). There is a need to develop healthcare programs in order to monitor parasite infection every six months as part of the specific treatment to reduce infection rates. Moreover, the Brazilian Ministry of Health recommends mass treatment of children in the municipalities with the highest prevalence rates to control geohelminthiasis (Martins *et al*. 2015). In the current study, a multidisciplinary intervention was carried out in the communities analyzed. It included health education lectures, new parasitological examinations, tests for hepatitis A, HIV, tuberculosis, and dental and medical care. The first stage of the intervention was followed by the distribution of medications according to the disease diagnosed. It was supported by the Municipal Health Secretariat of São Gabriel da Cachoeira, the local Military Hospital (Hospital de Guarnição do Exército), and the District Council of Indigenous Health (Conselho Distrital de Saúde Indígena). Finally, improvements in infrastructure and health education programs are also required to reduce environmental contamination, which will, in turn, reduce the risk of infection by intestinal parasites among indigenous people in northwestern Amazonia.

CONCLUSIONS

A high frequency of intestinal parasites was found in Baré and Baniwa ethnic groups. *Ascaris lumbricoides* was found at frequencies higher than 70%, and mixed infections by 3-5 species were very common in the communities. Species distribution differed between children and adults. Helminths (*A. lumbricoides* and hookworms) were more common in adults, while protozoans (*Entamoeba* spp. and *G. intestinalis*) were more common in children.

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