



# Intestinal parasitic infections in a population of BaAka Pygmies inhabiting the Congo Basin in the Central African Republic

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## Abstract

**Introduction.** Pygmy tribes inhabit tropical environment of Central Africa. After expulsion from their original habitat by the Bantu people, they settled in a local forest ecosystem where they live with very low sanitary standards. Their actual morbidity remains unknown.

**Objective.** The aim of the study was to analyze the prevalence of intestinal parasitic infections in BaAka Pygmies inhabiting the Congo Basin in the Central African Republic.

**Materials and method.** The study was conducted in 2015, and involved a group of 950 Pygmies living in the Sangha-Mbaere and Lobaye prefectures. Single stool samples were collected from study participants, fixed in 10% formalin, transported from Africa to Europe, and analyzed by light microscopy using 5 different diagnostic methods (direct smear, decantation with distilled water, Fülleborne's flotation, Kato-Miura thick smear, DiaSys/PARASYS system sedimentation) at the Military Institute of Medicine in Warsaw, Poland.

**Results.** Microscopic examination revealed infections with 14 different species of intestinal nematodes, cestodes, trematodes and protozoa. According to the study findings, 90.5% of BaAka Pygmies were found to be infected with intestinal parasites, and 70.8% had mixed infections. Most of the pathogenic intestinal parasites were nematodes (85.0%), with *Ascaris lumbricoides* (29.8%), hookworm (29.4%) and *Trichuris trichiura* (10.7%) being predominant.

**Conclusions.** Poor sanitation, limited the high prevalence of intestinal parasitic infections in the community of Pygmies. The negative test results may prove the effectiveness of periodic deworming campaigns which, implemented by non-governmental organizations, are voluntary with respect to the informed consent principle.

## Key words

risk factors, intestinal parasites, Central African Republic, Pygmies

## INTRODUCTION

Gastrointestinal parasitic infections remain one of the biggest challenges to modern medicine. Depending on the region, from 5–90% of the global population may be affected. The World Health Organization (WHO) estimates that approximately 25% of the world population is infected with at least one intestinal parasite species [1, 2]. Intestinal parasitic infections are commonly named *neglected diseases* and are still disregarded by medical services in many countries, which results in the spread of infections beyond endemic regions [3]. Poor sanitary conditions, low level of medical care, and the presence of reservoirs of the intestinal parasites in endemic regions, all contribute to the spread of parasitic diseases, both in developing as well as in developed countries [4, 5, 6].

Nematodes are one of the most common pathogens inhabiting the human digestive tract. It is estimated, that approximately 1 billion people worldwide are infected with

*Ascaris lumbricoides*. Infections of hookworm (*Ancylostoma duodenale*, *Necator americanus*) are also very common (500–700 million infected) globally [3]. In most cases, the source of infection with *A. lumbricoides* is food, water and soil contaminated with the parasite's eggs. Ancylostomidae infection, on the other hand, occurs by direct penetration of invasive larvae through the skin of the host; this type of infection is easily transmitted in areas where people walk barefoot; transmission usually occurs through contact with wet soil contaminated with parasite larvae. Another intestinal helminth which has a worldwide distribution is *Trichuris trichiura* (500 million infected); an infection by this species is caused by consumption of water or food contaminated with the parasite's eggs [7].

The Central African Republic is an example of a developing country where sanitary conditions fail to reach universal standards, and where access to uncontaminated water sources and safe and nutritious food is seriously limited [8]. Exceptionally high birth rates and poor living standards on the African continent, especially in sub-Saharan Africa, contribute to the rapid spread of parasitic diseases, especially those transmitted via the faecal-oral route.

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Pygmy tribes (e.g. Mbuti, Twa, BaAka) inhabiting tropical forests in Central Africa, are an example of a population living under very poor sanitary conditions. Additionally, their socio-economic status is extremely low. Pygmies lead a semi-nomadic lifestyle, and because they are regularly expelled from their habitats by sedentary Bantu people, they are forced to move from one place to another across the rainforests in the Democratic Republic of Congo, Gabon, Cameroon and the Central African Republic. The current Pygmy population in the Congo Basin has been estimated to be over 100,000. Pygmies lead their lives in harmony with nature, are a population of hunter-gatherers and do not cultivate land or breed animals. Therefore, their diet is very poor in nutrients. Additionally, they have limited access to uncontaminated drinking water, and have very poor personal hygiene habits. Their nomadic lifestyle is a relevant risk factor for gastrointestinal parasitic diseases [9].

In 2008, the Pygmy people were listed on the UNESCO's Representative List of the Intangible Cultural Heritage of Humanity, in recognition of their unique lifestyle and tribal traditions [9]. Because Pygmies live in small, closed groups in hardly accessible regions of the Africa rainforests, there has been very little medical or epidemiological research into the population. Therefore, little is known about the health status of the Pygmy people and the rates of infectious diseases within the community.

## OBJECTIVES

The aim of this study was to assess the prevalence of intestinal parasitic infections in the BaAka Pygmies population inhabiting the Congo Basin rainforests in the south-western parts of the Central African Republic.

## MATERIALS AND METHOD

**Study population.** The study was conducted in 2015, and involved a group of 950 BaAka Pygmies inhabiting the region of Monasao (Sangha-Mbaere prefecture) and Bagandou (Lobaye prefecture) in the south-western parts of the Central African Republic. Each patient could participate in the project, regardless of age, gender and health condition. Information for the patient and an informed consent form were translated to the Sango language which is widely used within the local population. The mean age of the study subjects was 16.8; the majority were  $\leq 18$  years old (63.2%). Females accounted for 62.2% of the study group, while males represented 37.8% of the sample.

**Sample collection and laboratory procedures.** The biological material for coprological diagnostics consisted of single stool samples provided by the patients. Stool samples were collected into special containers provided by local healthcare centres located in the vicinity of the Catholic missions in Monasao and Bagandou, in the south-west Central African Republic. The samples were delivered to the healthcare facility on a collection day. Next, the material was fixed in 10% formalin and after 1–2 weeks it was transported to the Department of Epidemiology and Tropical Medicine of the Military Institute of Medicine in Warsaw, Poland, where laboratory examination by light microscopy was performed

using 5 different diagnostic methods (direct smear in Lugol's solution, decantation in distilled water, Fülleborne's flotation, Kato-Miura thick smear, DiaSys/PARASYS system sedimentation) [10, 11]. Thus, a total of 4,750 parasitological tests were performed. Microscopic examination allowed determination of the number of parasitic infections in the study group.

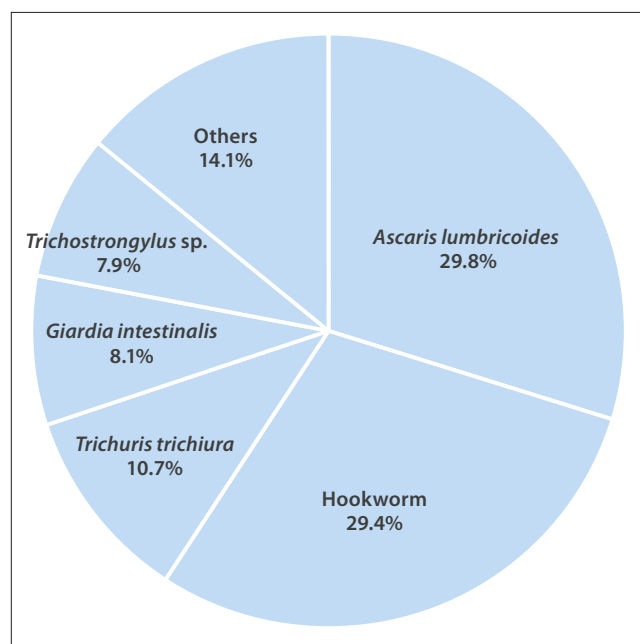
**Statistics.** All statistical calculations were performed using the suite StatSoft Inc. (2014) STATISTICA version 12.0 (www.statsoft.com, and an Excel spreadsheet. The quantitative variables were characterized by the arithmetic mean and minimum/maximum value (range). The variables of the qualitative type were presented in terms of counts and percentages. In all calculations, the level of statistical significance was set at  $p=0.05$ .

## RESULTS

Microscopic examination of the samples obtained from the 950 BaAka Pygmies revealed that 860 of them (90.5% of the study group) were infected with intestinal parasites. The total number of infections was 2,150, with nematodes responsible for the majority of infections (85.0%). Coprological examination of the stool specimens revealed 14 different species of pathogenic intestinal parasites, with *Ascaris lumbricoides* (29.8%), hookworm (29.4%) and *Trichuris trichiura* (10.7%) being predominant. A significant number of infections was caused by protozoa (14.2%), mostly *Giardia intestinalis* (8.1%). The lowest ratio of detected pathogens was represented by trematodes and cestodes infections (Tab. 1, Fig. 1).

**Table 1.** Distribution of pathogenic intestinal parasites detected in the group of BaAka Pygmies (n=950), south-west Central African Republic in 2015

Intestinal parasites	Number (percentage) of infections	Percentage of infected patients (n=860)	Percentage of tested patients (n=950)
<b>Nematodes</b>	<b>1827 (85.0)</b>		
<i>Ascaris lumbricoides</i>	640 (29.8)	74.4	67.3
Hookworm	633 (29.4)	43.6	66.6
<i>Trichuris trichiura</i>	229 (10.7)	26.6	24.1
<i>Trichostrongylus</i> sp.	169 (7.9)	19.6	17.8
<i>Strongyloides stercoralis</i>	114 (5.3)	13.3	12.0
<i>Capillaria</i> sp.	35 (1.6)	4.1	3.7
<i>Enterobius vermicularis</i>	7 (0.3)	0.8	0.7
<b>Cestodes</b>	<b>5 (0.2)</b>		
<i>Hymenolepis nana</i>	3 (0.1)	0.3	0.3
<i>Taenia</i> sp.	2 (0.1)	0.2	0.2
<b>Trematodes</b>	<b>12 (0.6)</b>		
<i>Dicrocoelium dendriticum</i>	7 (0.3)	0.8	0.7
<i>Fasciola hepatica</i>	3 (0.1)	0.3	0.3
<i>Schistosoma mansoni</i>	2 (0.1)	0.2	0.2
<b>Protozoa</b>	<b>306 (14.2)</b>		
<i>Giardia intestinalis</i>	175 (8.1)	20.3	18.4
<i>Entamoeba histolytica</i> sensu lato	131 (6.1)	15.2	13.8
<b>Total</b>	<b>2150 (100.0)</b>		



**Figure 1.** The most common pathogenic intestinal parasites detected in the group of BaAka Pygmies (n=950), south-west Central African Republic in 2015

Most infections found in the group of BaAka Pygmies (n=673, 70.8%) were mixed invasions (polyparasitism); the co-invasion of *Ascaris lumbricoides* with hookworm was predominant (Tab. 2).

**Table 2.** The most common co-invasions of intestinal parasites detected in the group of BaAka Pygmies (n=950), south-west Central African Republic in 2015

Co-invasions	Number of co-invasions	Percentage of all co-invasions
<i>A. lumbricoides</i> + Hookworm	456	67.8
<i>A. lumbricoides</i> + <i>Trichuris trichiura</i>	154	22.9
<i>A. lumbricoides</i> + <i>Giardia intestinalis</i>	106	15.8

## DISCUSSION

Gastrointestinal parasitic diseases usually reflect the economic status of a given population, its social and living conditions, access to healthcare facilities, and the level of health education. In developed countries, the rates of intestinal parasitic infections remain at a low level, and the most common infections are those caused by *Enterobius vermicularis* nematode (especially in the population of children) and *Giardia intestinalis* protozoa [12, 13]. In developing countries, especially those with a hot climate, the epidemiological situation is entirely different. In African countries, for example, parasitic infections are a serious public health issue. The situation is additionally worsened by the coexistence of many other infectious diseases, such as AIDS, tuberculosis and malaria [14, 15], and by the fact that a large number of food handlers are reported to have gastrointestinal infections. Screening tests conducted among street food handlers in Ethiopia showed that 45% of the study subjects were infected with at least one parasitic species; the infections with *Ascaris lumbricoides* were the most prevalent [16]; hookworm and *Trichuris trichiura* infections were also

found to be widespread [17]. The presented findings are consistent with the results of previous studies according to occurrence of parasitic species.

Pygmy tribes inhabiting the rainforests of the Congo Basin are an example of a population exhibiting high rates of parasitic infections. Their unique semi-nomadic lifestyle, combined with the consumption of water and food from uncontrolled sources (which is not properly heat processed), increase the risk of infection with intestinal parasites, especially with nematodes and protozoa [9]. According to the findings of the, 90.5% of the tested group (n=950) were found to be infected with pathogenic parasites, of which the most common were infections caused by *Ascaris lumbricoides* (67.3% of tested patients), hookworm (66.6%), *Trichuris trichiura* (24.1%) and *Giardia intestinalis* (18.4%). Unfortunately, very little data is available on the prevalence of parasitic infections in the Central African Republic. Screening tests performed in the capital city of Bangui in the 1980's in a group of 3,352 residents revealed gastrointestinal parasitic infections in 46.8% of the subjects, with a clear domination of *Ancylostoma duodenale* (26.7%); infections with more than one parasite species were found to be common [18]. A high rate of parasitic infections (88.2%) with a domination of *Ascaris lumbricoides* (40.1%) and *Necator americanus* (18.6%), and large numbers of mixed infections (33.3%), were revealed by screening tests conducted between 2015 – 2016 among 102 children living in rural areas in the southern parts of the Central African Republic [19]. The presented study which involved a group of BaAka Pygmies revealed polyparasitism in 70.8% of the study participants, with co-invasions of *Ascaris lumbricoides* and hookworm, *Trichuris trichiura* and *Giardia intestinalis* being the most common. It is very likely that the number of mixed parasitic infections would be even higher than the results suggest if more sensitive diagnostic methods were applied. Parasitological screening conducted in Mozambique seems to confirm this thesis; the number of co-invasions was found to be significantly higher when methods of molecular biology were used for testing [20].

Pygmy tribes, which are at a particularly high risk of exposure to a number of environmental and health risk factors, require special attention of the medical services. Because of the high prevalence of parasitic diseases in Central Africa, a large scale WHO-recommended deworming programme was initiated in the region [21]. The treatment of nematodes requires the use of albendazol (400 mg) or mebendazol (500 mg), while elimination of trematodes, especially *Schistosoma* flukes, requires the use of praziquantel (40 mg/kg) [22, 23]. Because the cost of deworming treatment is relatively low, it is an excellent method of preventing the spread of infections, especially from asymptomatic carriers. Although deworming programmes have clear advantages, they also have their limitations. The effects of such campaigns are often only temporary. In areas where parasitic infections are endemic, people have limited access to healthcare facilities and show poor personal hygiene habits, resulting in a significant proportion of patients quickly became reinfected. Therefore, the only effective method to eliminate intestinal parasitic infections in a community such as the Pygmy is not only the implementation of effective deworming programmes, but also to initiate ongoing health awareness campaigns.

## CONCLUSIONS

The prevalence of intestinal parasitic infections are high in the community of Pygmies inhabiting the south-western parts of the Central African Republic. Low economic status, limited access to uncontaminated drinking water and safe food, combined with poor sanitary conditions, contribute to the rapid spread of parasitic diseases in the Pygmy population. The negative test results obtained may prove the effectiveness of the periodic deworming programmes implemented by non-governmental organizations among local residents, and are voluntary with respect to informed consent principle.

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