



## A survey of intestinal parasites including associated risk factors in humans in Panama

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### ABSTRACT

**Background:** Intestinal parasitic infections are among the most common infections worldwide, leading to illness with serious and long lasting implications in children and immunocompromised people. Transmission of intestinal parasites is more frequent in tropical and sub-tropical areas where sanitation is poor and socioeconomic conditions are deficient. Panama is a country where climate and social conditions could be reflected in a high number of people infected with intestinal parasites. The presence, prevalence, and distribution of intestinal parasites in this country have been approached to date only in very restricted areas and population groups, but the impact of intestinal parasite infections at the national level is unknown.

**Methodology/principal findings:** We conducted a cross-sectional survey between 2008 and 2010 to determine the prevalence of intestinal parasites across Panama. Overall, 14 municipalities in seven provinces of Panama were surveyed. The presence of eggs, cysts, and larvae was assessed by microscopy in 1123 human fecal samples using a concentration technique. A questionnaire to identify risk factors associated with the frequency of intestinal parasites in the study population was also prepared and performed. Overall, 47.4% of human samples presented parasites. Variables including community type, age group, occupation, co-presence of commensals and socioeconomic factors (use of shoes and type of sanitation) were significantly associated with intestinal parasites ( $p < 0.05$ ).

**Conclusions/significance:** The preliminary data obtained in the current study, showing a high prevalence of fecal–oral transmitted parasites in Panama, place intestinal parasitism as a major health problem in this country. Specific interventions should be planned for the indigenous population, the group most afflicted by intestinal parasites.

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### 1. Introduction

Intestinal parasitic infections are endemic and widespread in socio-economically deprived communities in the tropics and

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subtropics (Norhayati et al., 2003). These are among the major public health problems due to their negative effect on nutritional status, development, cognitive functions and learning ability of infants ([www.who.int/neglected\\_diseases](http://www.who.int/neglected_diseases); Garbossa et al., 2013). Prevalence of intestinal parasites in a specific country depends on environmental, socioeconomic and demographic factors, including health-related behavior of the population and access to hygienic latrines and to treated water (Garbossa et al., 2013; Cook et al., 2009; Rayan et al., 2010). Policies for the control of intestinal parasites should be based on epidemiological data such as infection prevalence and associated risk factors, but up-to-date data are not available for many countries.

In Panama, according to the 2008 living standard report from the Panamanian authorities, 96% of the indigenous population, 51% of the rural population and 18% of the urban population lived in poverty (Pan American Health Organization, 2012). Health facilities have notably improved in the last decades, although the national averages conceal major inequalities in access to health services, to the detriment of rural and indigenous populations. The increase of physical infrastructures related to sanitation and water systems are also of paramount importance to improve the health of the population. In this respect, the Panamanian national statistics for 2010 show that 55% of houses in indigenous areas lack potable water supply and 60.5% lack hygienic sanitation, either connected with the sewage or with a septic tank. In non-indigenous rural areas, 15% lack potable water and 7.2% lack hygienic sanitation, while in urban areas percentages drop to 0.7% and 1.1% (<http://www.unicef.org/panama/spanish/Sitan2011-web.pdf>).

This combination of climatic, socioeconomic and sanitary factors found in Panama could be the key to support the active transmission of intestinal parasites at high rates. Nevertheless, surveys of intestinal parasites have been only done in specific population groups and very limited areas of the country, and no national survey in the different provinces or for different community types are available.

We therefore conducted a comprehensive review of previous studies on intestinal parasites in Panama and planned a preliminary epidemiological survey of intestinal parasites to evaluate the evolution and update the situation in the country regarding prevalence of intestinal parasites. A cross-sectional descriptive study following STROBE (Elm et al., 2007) to assess the prevalence of intestinal parasites in 14 municipalities of seven provinces, representing the different groups of population and climatic and socio-economic conditions present in Panama, was designed. We also investigated the influence of specific potential risk factors on the prevalence of these parasites.

## 2. Methods

### 2.1. Literature review

An exhaustive review of the literature on the prevalence and epidemiology of intestinal parasitism in Panama was performed. Literature was searched in PubMed, Google Scholar, the PAHO repository, the Revista Médica de Panamá, the Revista Médica Científica de la Universidad de Panamá and the Gorgas Institute repository. Search terms were: Panama or Panamanian plus intestinal, helminths, parasites, Chiriquí, Coclé, Herrera, Los Santos, Veraguas, Colon, Darien or Bocas del Toro. Available data from each of the retrieved documents were extracted in an excel table, including year and place of sampling, number of samples, sample processing (concentration method), parasite species/genus found in the samples, number of positive samples for each parasite, prevalence, studied population group, associated risk factors and potential biases of the approach.

### 2.2. Ethics statement

Official permission and ethical clearance for the collection of human fecal samples was obtained from the Regional Directorate of Health in each sampled province. For each sampled municipality, a meeting at the corresponding health center to inform about the study was announced in advance to the population. The meeting also included representatives of the health centers and primary schools. During the meeting, people were informed that sampling will take place in the health center 2 weeks after the meeting. Informed written consent was obtained from individuals who

participated in the study. Individuals found to be positive for intestinal parasites were informed and referred to the nearby health center for appropriate treatment. For children and dependents, their parents and guardians or the relevant adult signed the consent.

### 2.3. Study design, sample size and distribution

A cross-sectional study was carried out from 2008 to 2010 in urban, semi-rural, rural and indigenous population of Panama, including male and female individuals of any age. Due to the lack of data on prevalence rates, the minimum number of human samples was calculated as the sample size for an infinite population with an unknown probability of parasitism ( $p, q$ ), using a confidence level of 95% ( $Z$ ) and an allowed error of 3% ( $d$ ), following the formula described in (Martín-Andrés and Luna del Castillo, 1993):

$$n = Z^2 * p * q / d^2$$

With the above-mentioned parameters, the minimum sample size resulted in 1067, statistically representing the total population of Panama in this study. Human sample collection was planned in 14 representative municipalities of Panama belonging to seven different provinces (Fig. 1), selected on the basis of their differences in total population, living standards, and climatic and orographic conditions (Fig. 1; Table 1). 2010 data on population, land elevation, percentage of population with agricultural activity, access to potable water, access to sanitation facilities, and climatic and land data, were gathered for each sampled municipality from the National Institute of Statistics in Panama (<http://www.contraloria.gob.pa/inec/>; Table 1).

Regarding the two main population groups that could be screened in Panama (indigenous and non-indigenous), a confidence level of 95% ( $Z$ ) and an allowed error of 6% was calculated as appropriate to evaluate intestinal parasite prevalence levels. With those statistical parameters, the minimum sample size for indigenous individuals are 163, and for non-indigenous population are 267.

### 2.4. Sample collection and questionnaires

Health centers close to each sampled neighborhood in the different municipalities were localized and contacted for sample collection (one per municipality). Participants of each municipality were instructed to deposit their fecal samples in their closest eligible health center. The list of neighborhoods sampled in each municipality in the different provinces is shown in Table 2, including community type, number of samples and number of samples with parasites, and single latitude and longitude coordinates registered for each neighborhood at points of sampling, extracted from the Geo-Postal Codes Database Mapanet, available at <http://www.mapanet.es/en/Postal.Codes>

Pre-labeled wide mouth screw capped containers with scoop were distributed in the health centers to each participant, instructed to scoop a thumb size fecal sample into the container. Participants were asked to return the samples to the corresponding health center within a maximum of 24 h after collection. Samples were fixed in 7% formalin and delivered to the Environmental Parasitology Laboratory of the University of Panama for analysis.

The participants were asked by a trained field assistant to answer each of the questions in the questionnaire, and an interpreter from the community was used when needed for indigenous groups, to assess the potential risk factors for intestinal parasitic infections (Table 3). For children and dependents, the questionnaire was completed by interviewing their parents and guardians. Parents/guardians provided consent on behalf of all child participants and all adults provided consent for themselves. Questionnaires

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