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School-based prevalence of intestinal parasitic infections and associated risk factors in rural communities of Sana'a, Yemen

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ABSTRACT

Yemen is a developing country overwhelmed with a triad of poverty, diseases and social conflicts. Moreover, the majority of its population live in rural communities and suffer from intestinal parasitic infections (IPIs). Therefore, the present school-based, cross-sectional survey aimed to detect the prevalence of such infections and associated risk factors among schoolchildren in the rural communities of Bani Alharith, Hamdan and Bani Hushaysh districts of Sana'a, north of Yemen. Socio-demographic data and certain behavioral risk factors as well as stool samples were collected from 1218 schoolchildren from ten randomly schools in the study area. Fresh stool samples were examined for parasites by direct saline and iodine preparations and after concentration with formol-ether technique. The overall prevalence of IPIs was 54.8%, with a higher frequency of protozoal than helminthic infections (37.6 *vs.* 17.2%, respectively). Parasite species recovered were *Entameba histolytica* (21.5%), *Giardia lamblia* (16.1%), *Ascaris lumbricoides* (8.3%), *Hymenolepis nana* (5.3%), *Schistosoma mansoni* (2.6%), *Trichuris trichiura* (0.5%) and *Enterobius vermicularis* (0.4%). Univariate analysis showed that the male gender and illiteracy of fathers and/or mothers were the socio-demographic factors significantly associated with higher infection rates. The illiteracy of mothers was also confirmed as an independent risk factor by multivariable analysis. On the other hand, not washing hands before eating, not washing fruits and vegetables before consumption, eating uncovered food and not clipping fingernails were the risk behaviors significantly associated with higher infection rates, with the last three ones being confirmed as independent risk factors. Therefore, control measures should include regular treatment of protozoal infections and deworming of schoolchildren, promotion of hygiene in rural schools through health education programs, regular inspection of schoolchildren for personal hygiene practices and the provision of a healthy school infrastructure.

1. Introduction

Parasitic infections represent a major public health problem worldwide, being most prevalent in developing countries, particularly among children in rural communities (Harhay et al., 2010). Common parasites causing intestinal infections include *Ascaris lumbricoides*, *Trichuris trichiura* and hookworms (*Ancylostoma duodenale*/*Necator americanus*), *Strongyloides stercoralis*, *Schistosoma mansoni*, *Taenia* species, *Hymenolepis nana*, *Enterobius vermicularis*, *Entamoeba histolytica* and *Giardia lamblia.* Soil-transmitted helminth (STH) infections, caused by *A. lumbricoides*, *T. trichiura* and hookworms, are the most predominant and have been recently estimated to affect more than two billion people (World Health Organization, 2012). Although it is estimated that *S. stercoralis* infects 30–100 million people, it is considered one of the most neglected tropical parasites (Olsen et al., 2009). On the other hand, schistosomiasis is endemic in 78 countries, with an estimate of more than 261 million people requiring treatment in 2013 (World Health Organization, 2015). Of this total estimate, 46.4% are school-age children and 92.0% are residents in Africa. Chronic STH infections and schistosomiasis have been associated with significant morbidity and mortality, particularly among young children.

Intestinal protozoal infections are a global public health problem, predominantly among children in developing countries (Harhay et al., 2010). *G. lamblia* is one of the most common diarrhea-causing organisms worldwide, being responsible for about 200 million cases annually and with a potential of zoonotic transmission (Feng and Xiao, 2011). On the other hand, *E. histolytica* is

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one of the most important intestinal protozoa in terms of morbidity and mortality, annually infecting about 500 million cases, causing clinical disease of amoebic dysentery and invasive amebiasis in about 50 million and killing about 100,000 individuals (Baxt and Singh, 2008; World Health Organization, 1997). Low hygienic standards, environmental fecal contamination and the lack of sanitary infrastructure are among the factors associated with the prevalence of infections with parasitic infections. In addition, ecological, behavioral and socio-economic conditions play a major role in determining the burden of intestinal parasitic infections (IPIs) among communities. In this context, conducting large-scale baseline surveys of IPIs and associated risk factors can provide essential evidence to assume appropriate prevention and control interventions, including deworming of school-age children.

In Yemen, the published literature on IPIs is chronologically sparse compared to the magnitude of the problem. One of the earliest large-scale studies on IPIs among the Yemeni population reported a prevalence rate of 53.0% based on the examination of over 37,000 stool samples over the period of 1980–1982 (Farag, 1985). Several studies have also been published among different population groups in different Yemeni governorates, including Sana'a (Al-Qobati et al., 2012; Al-Shibani et al., 2009a,b; Alyousefi et al., 2011; Azazy and Al-Tiar, 1999; Azazy and Raja'a, 2003; Bin Mohanna et al., 2014; el-Qirbi et al., 1987), Aden (Kopecký et al., 1992), Taiz (Al-Shamiri et al., 2010; Hazza et al., 1983; Thuriaux, 1973), Ibb (Al-Haddad and Assabri, 1998; Alsubaie et al., 2016; Raja'a et al., 2000), Sadah (Raja'a and Mubarak, 2006), Hadhramout (Al-Haddad and Baswaid, 2010; Baswaid and AL-Haddad, 2008) and Al-Mahweet (Alwabr and Al-Moayed, 2016).

Studies conducted in Sana'a were mostly conducted in urban areas, though small sample sizes were included from rural schoolchildren. The situation of IPIs in rural communities of Sana'a remains vague and neglected to a great extent. Therefore, the present study was designed to determine the prevalence of intestinal parasites and associated risk factors among schoolchildren in rural communities of Sana'a, north of Yemen.

2. Subjects and methods

2.1. Study design, setting and population

This cross-sectional study was conducted among the schoolchildren of the rural communities of Sana'a in the period from March 2013 to March 2015. Sana'a is located in the north of Yemen at the geographical coordinates of 5°20′54″N 44°12′23″E. A total of 1218 schoolchildren (418 males, 796 females and 4 cases with missing gender during data collection) were randomly selected from ten schools from three districts in the study area; namely, Bani Alharith, Hamdan and Bani Hushaysh, where previous mass albendazole and praziquantel treatment campaigns had been carried out among schoolchildren. The protocol of the study was approved by the Research Ethics Committee of the Faculty of Medicine and Health Sciences, Sana'a University, Yemen. Participation of schoolchildren was voluntary after explaining the aim of the study and obtaining informed consent from the schoolchildren and their guardians before data and sample collection (Fig. 1).

2.2. Data and stool sample collection

Socio-demographic data and possible risk factors associated with IPIs were collected using a pre-designed, structured questionnaire. A single fresh stool sample was collected from each participating child into a clean, plastic container. Containers were labeled with the child's name and identification number, school name, date and place of collection. The specimens were transported immediately to the Parasitology Laboratory of the Faculty of Medicine and Health Sciences, Sana'a University. A part of stool specimen was used for the preparation of saline and iodine wet preparations, while the remainder of the specimen was preserved using 10% formalin to be used in the concentration technique.

Table 1
Prevalence of intestinal parasitic infections among schoolchildren in rural communities of Sana'a, Yemen (2013–2015).*

Parasite species	Number positive (%)	95% CI
Overall	668 (**54.8**)	51.0.–56.7
Protozoa		
E. histolytica/dispar	262 (**21.5**)	19.2–23.9
G. lamblia	196 (**16.1**)	14.1–18.2
Total	458 (**37.6**)	34.9–40.4
Helminths**		
A. lumbricoides	103 (**8.5**)	6.9–10.2
H. nana	64 (**5.3**)	4.1–6.6
S. mansoni	32 (**2.6**)	1.8–3.7
T. trichiura	6 (**0.5**)	0.2–1.1
E. vermicularis	5 (**0.4**)	0.1–1.0
Total	210 (**17.2**)	15.2–19.5
Type of infection***		
Single	422 (**34.6**)	0.32–0.37
Double	103 (**8.5**)	0.07–0.10
Triple	12 (**1.0**)	0.01–0.02

* The total number examined is 1218.
** Difference between helminthic infections is statistically significant ($P < 0.001$).
*** One case was infected with four parasite species.

2.3. Stool examination for parasites

Direct saline and iodine wet preparations of stool samples were prepared and microscopically examined using 10× and 40× objectives as soon as possible after collection. In addition, stool sediments were also examined after concentration using formol-ether sedimentation technique following standard guidelines (Cheesbrough, 2009).

2.4. Statistical analysis

Data were analyzed using the IBM SPSS Statistics version 20.0 for Windows (IBM Corp., Armonk, NY, USA). Categorical variables were reported as frequencies and percentages. Chi-square or Fisher's exact tests were used to test the significance of differences or associations between the variables, which were considered statistically significant at P values <0.05. Moreover, univariate and multivariable logistic regression methods were used to determine the possible risk factors associated with IPIs.

3. Results

Of the 1218 schoolchildren recruited in the present study, 34.4% were males while 65.6% were females, with a mean age of 9.3 years (range: 5–15). Fathers of the majority (67.4%) of the schoolchildren were literate compared to about a half of the mothers.

3.1. Prevalence of intestinal parasitic infections

Table 1 shows that the overall prevalence rate of IPIs among the 1218 examined rural schoolchildren in Sana'a was 54.8%. Protozoal infections were more frequent than helminthic ones, being 37.6% and 17.2%, respectively. Of IPIs, *E. histolytica/dispar* and *G. lamblia* were prevalent among 21.5 and 16.1% of schoolchildren, respectively. On the other hand, *A. lumbricoides* was the most frequent (8.5%) helminth followed by *H. nana* (5.3%) and *S. mansoni*