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Strategies to Decrease the Prevalence of Soil-Transmitted Helminths in Central India

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Abstract

Background Intestinal parasites are a major public health problem in tropical countries. Over 1.5 billion people are infected with soil-transmitted helminths (STH), of which 225 million are in India. Parasitic infections are associated with poor sanitation, lack of safe potable water, and improper hygiene.

Materials and Methods The study was undertaken to ascertain the impact of control strategies, namely open-defecation free drive and mass drug administration of single dose albendazole. Stool samples received at AIIMS Bhopal Microbiology laboratory, across all age groups, were studied for protozoan trophozoites/cysts and helminthic ova.

Results Out of 4,620 stool samples, 389 (8.41%) were positive either for protozoal or helminthic infections. Protozoan infections were more common than helminthic infections with *Giardia duodenalis* infection being the most common, 201 (51.67%), followed by *Entamoeba histolytica*, 174 (44.73%). The helminthic infections constituted 14 (3.5%) of the positive stool samples with Hookworm ova in 6 (1.5%) cases.

Conclusion This study proves that strategies, namely "Swachh Bharat Abhiyan" and "National Deworming Day" started in 2014 and 2015 led to significant reduction of intestinal parasite infections in Central India, with a higher reduction of STH compared with protozoan parasite infection being ascribed to the activity spectrum of albendazole.

Keywords
- soil-transmitted helminths
- neglected tropical disease
- central India
- National Deworming Day
- Swachh Bharat Abhiyan

Introduction

Protozoan and helminthic infections inflict a substantial burden on the underprivileged populations living in rural and urban settings in developing countries.[1] Parasitic infections are associated with poor sanitation, lack of safe and potable water, and improper hygiene.[2] The frequency of parasitic infections varies with age and sex of the general population. Intestinal parasitic infections (IPIs) are more common in children and lead to nutritional deficiency, anemia, growth retardation, and impaired learning ability.[3] Intestinal protozoa of significance in humans are *Entamoeba histolytica* and *Giardia duodenalis/Giardia intestinalis*. Opportunistic protozoa such as *Cryptosporidium* sp. and *Isospora* sp. have been identified as the causes of diarrhea in

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children and immunocompromised patients.[2] Another common intestinal protozoan is *Blastocystis hominis* whose parasitic status is under debate. Soil-transmitted helminths (STH) chiefly include the roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*), and hookworms (*Necator americanus* and *Ancylostoma duodenale*).

Ascaris and Trichuris primarily affect children, whereas hookworm involves both children and young adults. It leads to iron deficiency anemia, protein energy malnutrition, and stunted growth. Severe infections lead to intestinal obstruction and gangrene. It is important to know the epidemiology and their clinical features to take necessary preventive measures to eradicate them completely.[4]

Global Burden

G. duodenalis/G. intestinalis is the most prevalent protozoan parasite worldwide with approximately 200 million people being currently infected.[5] The incidence of giardia infection in industrialized nations has been estimated to be between 2 and 5% of the population and between 20 and 30% in developing nations.[6] It has been estimated that approximately 12% of the world's population is infected with *E. histolytica* of which only 10% are symptomatic.[6] Among the helminthic infections, STH are the most prevalent neglected tropical diseases (NTDs) globally. About 1.22 billion people are estimated to be infected by STH worldwide.[7] Asia contributes 67% of the global prevalence of STH, of which the highest prevalence is seen in India (21%) followed by China (18%).[4] In India alone, 225 million children are estimated to be at the risk of STH. IPIs are rarely a cause of death but because of the size of the problem, the global number of related deaths is substantial.[8] About 39 million disability-adjusted life years are attributed to IPIs, and these infectious thus represent a substantial economic burden.[7,9]

Control Strategies

According to World Health Organization (WHO), preventive chemotherapy, or the periodic large-scale administration of anthelminthic agents to at-risk populations, can dramatically reduce the burden of worms caused by STH infections. However, decreasing the worm burden of STH decreases morbidity among individuals heavily infected by these helminths. Because preventive chemotherapy does not break the cycle of infection and reinfection, populations living in contaminated environments continue to be at risk of infection and need frequent administrations of anthelminthic medicines. As the prevalence and intensity of STH infections are related, only light-intensity infection and low morbidity are expected where the prevalence of any STH infection at baseline is lower than 20%. WHO recommends preventive deworming, annual or biannual a single-dose albendazole (400 mg) or mebendazole (500 mg), as a public health intervention for all young children (12–23 months of age), preschool (24–59 months of age), and school-age children living in areas where the baseline prevalence of any soil-transmitted infection is 20% or higher among children, to reduce the worm burden of STH infections.

Control Strategies in India

The initiation of Swachh Bharat Abhiyan (SBA), or Swachh Bharat Mission (Clean India Mission), led to nation-wide campaign in India for the period 2014 to 2019 that aimed to clean up the streets, roads, and infrastructure of India's cities, towns, and rural areas. The objective was to eliminate open air defecation through the construction of household-owned and community-owned toilets and establish an accountable mechanism of monitoring toilet use. The mission was established well by open defecation-free India by October 2, 2019, on the occasion of the 150th birth anniversary of Mahatma Gandhi, by constructing 90 million toilets in rural India at a projected cost of 1.96 lakh crores (US$30 billion).[10] Another milestone was on 10 February 2015, India's Ministry of Health and Family Welfare launched the first "National Deworming Day (NDD)"—a massive school-based deworming effort in 12 states covering nearly 241 million children with STH infection or at risk of developing the infection.[11] It marked the start of a groundbreaking national deworming program to treat all children at risk for parasitic worms across the country.[12] The success of the NDD program incrementally increased with each round as the coverage increased from 8.9 crores in Feb 2015 to 22.69 crores in the last round in August 2018. NDD took place at all Anganwadis and schools which provided a safe, cost-effective, and potent way to reach crores of children quickly. Deworming had shown reduction in absenteeism in schools; improve health, nutritional, and learning outcomes; and increase the likelihood of higher-wage jobs later in life.[13] Also, worldwide acceptance of single-dose regimen was considered safe and beneficial as albendazole tablet is an evidence-based, globally accepted, and effective solution to controlling worm infections.[14] NDD had played vital role in reaching all children, regardless of socioeconomic background with substantial evidence based results, hence proven with this study too. The purpose of this study was to know the prevalence of IPIs and STH such as *A. lumbricoides*, *T. trichiura*, hookworms, and protozoan parasites. Looking retrospectively, this study gives positive result of control strategies as an important role in reducing the burden of STH.

Materials and Methods

This was an observational study undertaken in the Department of Microbiology, All India Institute of Medical Sciences, Bhopal, from period April 2014 to April 2017. Stool samples received in our laboratory from both out patients and inpatients treated at the hospital, all age group and both sexes, were included in this study. As this was not a prevalence based study, we considered only those cases that were referred by the clinicians based on complaints of diarrhea and other gastrointestinal symptoms such as nausea, vomiting, flatulence, and abdominal pain to the laboratory for stool examination. Stool samples received for investigation other

than routine stool microscopy for IPIs were excluded from the study. Samples were collected in wide-mouthed containers provided by the Department of Microbiology containing no preservative and were transported to the laboratory within 2 to 3 hours of collection. Stool samples were examined grossly for color, consistency, presence or absence of blood, mucus, and worms. Routine stool microscopic examination of saline and iodine preparation was done for red blood cells, pus cells, trophozoites and cysts of protozoa, and ova of helminths. Parasites were identified under low and high power of microscope. Modified acid fast stain was done to visualize oocysts of coccidian parasites only in cases specified by the clinician. The percentages of the parasites were calculated to find out the prevalence of parasitic infections, and data were analyzed for interpretation.

Result

Total 4,620 stool samples were included in the present study, out of which 389 (8.41%) were positive either for protozoal or helminthic infections. Protozoan infection was found to be more common than helminthic infection, in 375 (96.4%). *G. duodenalis* infection was the most common in protozoan infection constituting 201 (51.67%), followed by *E. histolytica* 174 (44.73%) (►**Table 1**). The helminthic infections put together constituted to 3.5% of the positive stool samples. Hook worm ova was observed in six cases accounting for 1.5% of the total infections. *Hymenolepis nana* and *Strongyloides stercoralis* (►**Fig. 1**) were seen in three and four cases, respectively. *Cytoisospora belli* was seen in one sample (< 1%; ►**Fig. 2**).

Discussion

This study showed that the spectrum of parasitic infections prevalent in this part of the country has more protozoans than helminths. In this study, we found a prevalence of 8.41% of parasitic infections in our locality which is comparably low against studies reported elsewhere. A study conducted in the year 2013 by Steinmann et al estimated the prevalence of IPI of 40.7% in school children.[14] In another study by Ajjampur SSR et al in Southern India, the overall prevalence of STH

Table 1 Number and percentage distribution of intestinal parasitic pathogens in stool specimen

Parasitic pathogen	Number ($n = 389$)	Percentage (%)
Giardia duodenalis	201	51.67
Entamoeba histolytica	174	44.73
Hookworm	6	1.54
Strongyloides stercoralis	4	1
Hymenolepis nana	3	< 1
Cytoisospora belli	1	< 1

Note: Among 4,620 stool samples, 389 were positive for either protozoal or helminthic infections, of which Giardia duodenalis made up more than half (51.67%, 201) followed by Entamoeba histolytica (44.73%, 174).

Fig. 1 Size, shape, and overall morphological features of helminths in stool specimen (400× magnification). The figure on the left demonstrates the nonbile stained egg of *Hymenolepis nana* in iodine mount. Egg is ovoid in shape, 35 to 45 µm in size with two membranes and hooklets. The figure on the right shows Rhabditiform larva (L1 larva) of *Strongyloides stercoralis* in saline wet mount. L1 Larva measures 100 to 380 µm in length with prominent genital primordium.

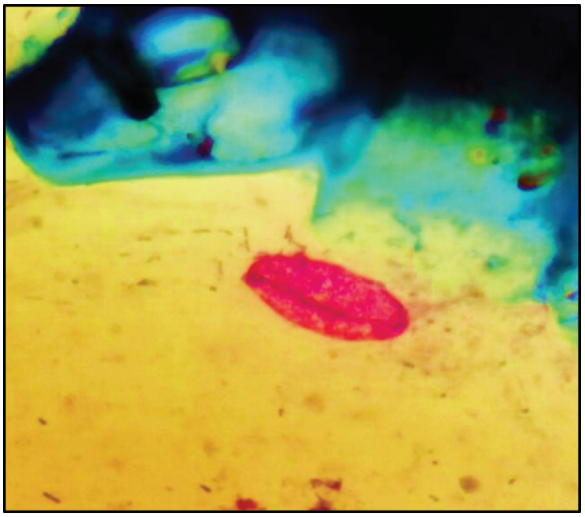

Fig. 2 The figure demonstrates the oocysts of *Cystoisospora belli* in stool sample stained with modified acid fast at 400× magnification. The oocysts are 25 to 30 µm in size with ellipsoidal shape.

was found to be 17%.[15] In a study by Gupta et al in urban settlement in Delhi, the prevalence of STH infection in children was found to be 54.8%.[16] The differences in prevalence could be due to demographic differences in the study population. Our study included all age groups, while Kiran et al included only school children in the age group of 6 to 12 years which is a known high prevalence population.[17] A prevalence of 38, 26.4, and 31.5% for IPI has been reported from rural areas of Ghaziabad,[18] Karnataka,[19] and Pauri Garhwal,[20] respectively. A survey of the target population showed a prevalence of 12.5 and 15.19% for IPI in urban slum areas of Chandigarh[21] and central Gujarat,[22] respectively. Likewise, prevalence of IPIs in Nepal and Sri Lanka has been reported at 29.4 and 34.56%, respectively. In context to our finding, low prevalence of 13.4% has been reported in a study from our vicinity.[23] In another study by Greenland et al, the prevalence of STH was found to be very high of 68% in school going children.[24]

G. duodenalis was the most common protozoan isolated. The prevalence of Giardiasis is 3 to 7% in developed countries,

it is as high as 20 to 30% in developing countries.[25] Giardiasis can present with a spectrum of signs and symptoms which are mostly self-limiting. In context to school children, the extra intestinal and long-term consequences of Giardiasis is of recent interest and are equally alarming.[26] Ocular complications, arthritis, skin allergies, and myopathy can occur in affected children besides the well-established complications like failure to thrive, stunting and growth retardation, cognitive disorders, and chronic fatigue. All these factors are of immense public health importance owing to the high occurrence of giardiasis in young children. *Entamoeba* sp. was the most prevalent parasite in this study. It could not be commented whether the cysts of *Entamoeba* sp. were from pathogenic variety (*E. histolytica*) or nonpathogenic variety (*E. dispar/moshkovskii*). Motile trophozoites were also observed in 15% of the stool samples positive for *Entamoeba* sp. Another important aspect revealed in this study should be discussed. STH accounts for 27% of entire school-age and preschool-age children population worldwide.[27] The WHO 2030 targets for onchocerciasis and STHs are to interrupt the transmission in 31% of endemic countries and to achieve and/or maintain the elimination as public health concern.[28] The current deworming strategy STH focuses on preschool and school-aged children and women in the reproductive age to eliminate morbidity. However, mathematical modeling and meta-analysis show that STH could be eliminated if the entire population, including adults, were treated.[29] WHO recommended Mass Drug Administration to all residents of endemic areas with frequency once or twice a year based on the prevalence.[28,29] The widespread administration of anthelminthic drugs as part of the government initiatives has already shown striking reduction in STH burden in some parts of India. This is in concurrence with the findings of our study where the prevalence of helminthic infections was very low compared with other protozoan infections. The low prevalence of STHs could also be due to improved standard of hygiene as our hospital caters to the urban area.

Limitations

The demographic data and clinical details of the patients were not readily available. As it was a hospital based study, so prevalence of this study cannot be generalized to whole population of central India. Hence, there is a need for future research and analysis to study the demographic characteristics and their impact or correlation to STH infections.

Conclusion

This study proves that the measures such as 'SBA' and 'NDD' started in 2014 to 2015 led to the significant reduction of intestinal parasite infections in Central India. The higher reduction in STH infections compared with protozoan parasite infection can be ascribed to the activity spectrum of albendazole.

Funding
None.

Conflict of Interest
None declared.

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