

## Soil-transmitted Helminths Infection in India

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### Abstract

Soil-transmitted Helminths (STHs) form one of the most significant groups of infectious agents that cause major public health problem in tropical and sub-tropical countries. The roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*) and hookworms (*Ancylostoma duodenale* and *Necator americanus*) are the major species that infect people and causes ascariasis, hookworm disease and trichuriasis respectively. According to WHO STHs is regarded as a neglected tropical disease.

**Keywords:** Soil-Transmitted Helminths (STHs); Ascariasis; Hookworm; *Trichuris trichiura*; WHO; Tropical

### Introduction

Soil-transmitted helminths (STHs) form one of the most significant groups of infectious agents that are cause of a major public health problem in tropical and sub-tropical countries [1]. It infects nearly 2 billion people of world's population of which children are mostly affected [2,3]. According to the World Health Organization (WHO) it is estimated that more than 870 million children live in the endemic areas [4].

### Disease burden

Globally the most significant STHs are roundworms (*Ascaris lumbricoides*), whipworms (*Trichuris trichiura*) and hookworms (*Necator americanus* or *Ancylostoma duodenale*). According to the latest data the estimated number of people infected with roundworms is 807 million, whipworms is 604 million and hookworm is 576 million [5,6]. Sub-Saharan Africa (SSA), East Asia, China, India and South America are the most affected countries with this commonly neglected tropical disease [3]. Nearly 25% to the total global cases with 220.6 million children need preventive chemotherapy in India [7].

### Disease transmission

The most vulnerable group of people affected by the disease are school going children. Water quality, sanitation, hygiene practices and socio-economic status in the affected areas are closely associated with the prevalence of STH infection [5]. It is regarded as one of the world's most important causes of malnutrition, poor school performance, delayed physical growth and impaired cognitive function [6].

### Aim and treatment

Aim of the World Health Organization (WHO) is to control of STH in children to reduce morbidity by 2020 through conducting the deworming program in schools [8]. The WHO recommends biannual treatments in areas with over 50% prevalence of STH and annual

treatment in the areas with 20% to 50% prevalence [9]. However, this program is with temporary effects on the transmission and unable to prevent reinfection. The transmission of the STHs is related to multiple factors, such as behavior, environment, health system and socio-economic status. Long term control and elimination need an integrated approach by improvement of water access, sanitation (improved latrines and fecal sludge management) and hygiene (hand washing habits and wearing shoes) practices along with deworming [2-6].

### Types of worms

Infection is caused specifically by intestinal worms that are transmitted through soil contaminated with fecal matter and are hence called soil transmitted helminths. The roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*) and hookworms (*Ancylostoma duodenale* and *Necator americanus*) are the major species that infects people and causes ascariasis, hookworm disease and trichuriasis respectively.

### *Ascaris lumbricoides* (Roundworm)

The disease caused by the worm *Ascaris lumbricoides* is called ascariasis. *A. lumbricoides* is the largest intestinal nematode living in the lumen of the small intestine, usually in the jejunum or ileum and is most the common nematode affecting human. Due to the cylindrical shape this parasite is popularly known as roundworm. Sizes of the adult worm are 15 - 25 cm x 3 mm and 25 - 35 cm x 4 mm male and female respectively. They have a life span of approximately 1 - 2 years. Female worm produces up to 200,000 fertilized ova per day in presence of male worm in the intestine. When infections with only female worm occur, infertile eggs are produced. No egg is formed when only male worm infects. Unembryonated eggs are passed in feces, many of which become embryonate in favorable environmental conditions and withstand for up to 15 years. Humans are infected by ingestion of embryonated eggs through fecal contamination. Sizes of corticated fertilized and excorticated unfertilized eggs are 60 x 45 microns and 90 x 40 microns respectively. The infective form will hatch into larvae in the small intestine after ingested by humans. The larvae then exit through the wall into the circulatory system or lymphatic system and go to the lungs, trachea, pharynx, esophagus and swallowing enter to the small intestine. Then the larvae turn into adults in small intestine. The life cycle of the worm lasts for 2 - 3 months [11-17].

The majority of infection with *Ascaris lumbricoides* are asymptomatic and a small number of patients showing clinical symptoms. However, globally the burden of the symptomatic cases is still fairly high because of high prevalence of the disease. When symptoms do occur, they relate to migration of larvae and adult worms. During larval migration an acute transient pneumonitis (Löffler syndrome) relate with cough and wheezing (hypersensitivity), fever and noticeable eosinophilia may occur. Heavy worm loads can lead to intestinal blockage and impair growth in children. Children are more vulnerable to this complication because they have smaller diameters of the intestinal lumen and heavy worm burden. Acute obstructive jaundice may occur also due to bile duct obstruction. Malnourished children are infected most and the most infected age group is 3 to 8 years. Children are more susceptible due to their frequent exposure to the contaminated water, eating raw vegetables and fruits and often putting unwashed hands inside their mouths [13-16]. Severe *Ascaris* infections cause approximately 60,000 deaths per year globally mainly in children [18].

### Whipworm (*Trichuris trichiura*)

Trichuriasis is an intestinal helminthic infection caused by a parasitic worm called *Trichuris Trichiura*. This worm is known as whipworm because of its whip-like appearance. Humans are the definitive host and it mainly inhabits in the large intestine of man although it can also be found in cecum and appendix. Its thin, thread-like anterior portion (whip) buries into the colonic mucosa in the intestinal wall to sucking blood and the thicker posterior portion (whip-handle) is noticeable within the lumen. Some minor inflammatory changes at the site of insertion are produced by the worm.

The clinical manifestations mainly depend on the parasite burden in the host. Heavy infections could lead to acute symptoms like diarrhea, abdominal pain, failure to thrive, acute appendicitis, dysentery, rectal prolapse and chronic symptoms such as growth retardation and impaired cognitive development. An adult female worm is capable of producing 3000 - 20000 barrel can shaped eggs with two distinct mucoid polar plugs per day in cecum. The immature state and non-infective eggs are passed out with feces and the eggs will mature in soil. It takes 3 - 6 weeks to form infective eggs containing embryos. These infective eggs are ingested through oral route by humans, and then the eggs will hatch into larvae that will penetrate the mucosa of the small intestine for 3 - 10 days [20,21]. Larvae will slowly down to ascending colon and become mature there, especially in the cecum. It produces minor inflammatory changes at the site of insertion and the clinical manifestations depend on the burden of the parasite. Heavy worm loads can lead diarrhea, abdominal pain, failure to thrive, acute appendicitis, dysentery and rectal prolapse. Chronic and severe infection results of severe anemia and bloody diarrhea. Identification of characteristic eggs in stool specimen is the major diagnostic approach. Although the sensitivity of stool studied under microscope is very low with light worm infestation or male worm predominant infection with no eggs. According to a current estimate, nearly 800 million people are infected by this helminth and majority of the victims are children [19-22]. Medical conditions are more serious since co-infection with protozoan parasites such as *Giardia lamblia* and *Entamoeba histolytica* with other nematodes is common.

### Hookworms (*Ancylostoma duodenale* and *Necator americanus*)

There are two species of hookworms that cause disease in humans, which is *Ancylostoma duodenale* and *N. americanus* are the most common hookworm globally, whereas *A. duodenale* is more geographically restricted [23]. The disease caused by a hookworm is known as necatoriasis and ancylostomiasis. In an infected host the eggs of both species are deposited in the feces and, following deposition, embryonate. In about 2 days the eggs will develop into the first rhabditiform larvae in warm and moist soil that is sandy or loamy in composition. From these stage infective filariform larvae develops after molt twice. Once the larvae contact the skin of host, they penetrate by way of hair follicles or through open wounds or lesions on the skin's surface. After cutaneous and subcutaneous penetration, the filariform larvae must reach the lung to carry on the next phase of life cycle. Then the larvae are swallowed and finally gain access to the alimentary tract of the host. After reaching in the larvae molt for the third and become the adult worm with parasitic feeding stage. Adult female of *N. americanus* will produce up to 10,000 eggs each day, while adult female of *A. duodenale* can produce three times as many eggs per day. Mild infections cause diarrhoea and abdominal pain. More severe infections create serious health problems, especially for newborns, children, pregnant women, and malnourished adults. In fact, it is the leading cause of anaemia and protein deficiency in developing nations [23,24]. This disease affects about 740 million people in developing nation. Unlike ascariasis and trichuriasis, high-intensity hookworm infections are more frequent in adults than in children, specifically women. Roughly, 44 million pregnant women are estimated to be infected. The disease causes severe adverse effects in both the mother and infant, such as low birth weight, impaired milk production, and increased risk of mortality [23-25].

### Prevalence of STHs in India

In Southeast Asia there are eight countries namely India, Sri Lanka, Nepal, Pakistan, Afghanistan, Bangladesh, Bhutan and Maldives which are affected. India contributes to 21% of overall global prevalence of STHs [3]. In India, prevalence of *A. lumbricoides*, *T. trichiura* and hookworm are 140 million, 73 million, 71 million respectively. In India, the maximum prevalence is seen in Uttar Pradesh (75.6%). The prevalence of STHs in seven North-eastern states of India is variable ranging from 45% - 64.54%. In this region 53.50% of total study population were found to be infected with one or more soil transmitted helminths. In Assam and Arunachal Pradesh, two Indian States, the prevalence of STHs is 49.67% and 61.2% respectively. In Manipur and Meghalaya the prevalence is around 49% and 54.71% respectively. Whereas neighboring state Tripura showed the least infection rate (i.e. 45%) among all. The highest prevalence among the North-eastern states is in Nagaland 64.54%). Others states in India like Karnataka (47%) and Andhra Pradesh (40%) also show a high prevalence of STHs. In Uttar Pradesh the most common STH is *A. lumbricoides* with a weighted prevalence of 69.6% and the prevalence of hookworm and *T. trichiura* infections is 22.6% and 4.6% respectively. STHs prevalence in school going children from Puducherry was

34.56% and the most common infection was *A. lumbricoides* (43.21%) followed by hookworm (28.8%), *T. trichiura* (10.87%), and *Hymenolepis nana* (7.68%) and the most affected age group is 1 - 10 years [26-28].

### Control and prevention

STHs is regarded as a neglected tropical disease according to WHO because it poses a major health problem in tropical and subtropical regions of the world. Moist climate of these regions favour hatching and embryonation of the helminths egg. Additionally, inadequate sanitation, open defecation, poor hygiene standards and socio-economic status of those countries contribute to the transmission of the infection and high disease burden among the population [28]. In order to minimize the risk of transmission and reduce the disease burden, WHO recommends a series of operational approaches. The global strategy to control the morbidity rate due to soil transmitted helminthiasis is based on 1) regular anthelmintic treatment 2) Sanitation and proper personal hygiene maintenance 3) health education. WHO has recommended regular drug treatment to be administered in high risk groups mainly involving school going children for the reduction of worm burden in the community over time. Drug delivery strategy and treatment frequency are decided after the assessment of the available epidemiological data of the specific region [29]. Systematic treatment strategies have been mentioned in figure as suggested by WHO [30,31]. In accordance with the WHO, the recommended drugs for use in public health interventions to control STH infections are: Albendazole (400 mg) tablets given in a single dose, reduced to 200 mg for children between 12 and 24 months; Livamezole (40 mg) tablets given in a single dose by weight (2.5 mg/kg). The drug Levamisole at a dose of 80 mg has been successfully used in primary school-age children; Mebendazole (500 mg) tablets- single dose; Pyrantel pamoate (250 mg) tablets given in a single dose by weight (10 mg/kg). A combined preparation of pyrantel-oxantel is more effective than pyrantel alone in treating *T. trichiura* infection [29]. School based deworming has been proved to be of major success to treat children and the adults in the community by reducing the transmission rate in the community as a whole. Health education to increase hygiene awareness and improve health-related behavior is of great importance in reducing dissemination of these infections. Imparting knowledge on the mode of transmission of such diseases and their possible preventive measures will result in reduction in disease burden at the community level. Fecal-oral contamination can be reduced by recommending the use of properly built toilets, washing hands and proper food handling. Other preventive measure include avoiding skin-soil contact i.e. barefoot walking in order to evade hookworm infection. These knowledges can be conveyed in schools as well as in the community in order to build an increased health-related awareness in the entire population. Sanitation, housing condition and water supply are known to influence this kind of infection. Therefore, these factors must be monitored with proper care in order to cut down the possibility to disease occurrence.

#### Recommended treatment strategies for schistosome and soil-transmitted helminth infections<sup>a</sup>

##### Soil-transmitted helminth infections

Community category	Intervention in schools (enrolled and non-enrolled children)	Health services and community-based intervention
I High prevalence or high intensity	Targeted treatment of school-age children, 2-3 times a year	Systematic treatment of preschool children and women of childbearing age in mother and child health programmes
II Moderate prevalence and low intensity	Targeted treatment of school-age children, once a year	Systematic treatment of preschool children and women of childbearing age in mother and child health programmes
III Low prevalence and low intensity	Selective treatment	Selective treatment

##### Schistosome infections

Community category	Intervention in schools (enrolled and non-enrolled children)	Health services and community-based intervention
I High prevalence	Targeted treatment of school-age children, once a year	Access to PZQ <sup>b</sup> for passive case treatment <sup>c</sup> ; community-directed treatment for high-risk groups recommended
II Moderate prevalence	Targeted treatment of school-age children, once every 2 years	Access to PZQ <sup>b</sup> for passive case treatment <sup>c</sup>
III Low prevalence	Targeted treatment of school-age children twice during primary schooling (once on entry, again on leaving)	Access to PZQ <sup>b</sup> for passive case treatment <sup>c</sup>

<sup>a</sup> Treatment strategies should always be accompanied by efforts to improve water supply and sanitation.

<sup>b</sup> PZQ = praziquantel.

<sup>c</sup> Can be done on presumptive grounds, according to diagnostic algorithms adapted to the endemic situation.

### Conclusion

Soil-transmitted Infections are major problems in area where sanitation is poor. It is considered a neglected tropical disease. Efforts are being made to eliminate the Soil-transmitted infections. Albendazole is used for the treatment STIs. Improvements of sanitation and hygiene are important for elimination.

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