

Status of Soil-Transmitted Helminths Infection in Ethiopia

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Abstract: Soil-transmitted helminth infections are among the most common infections worldwide and affect the poorest and most deprived communities. The three major soil-transmitted helminths (STHs), i.e., *Ascaris lumbricoides*, *Trichuris trichiura* and *Necator americanus/Ancylostoma duodenale* are among the most widespread parasites worldwide. It is estimated that more than 880 million children are in need of treatment for these parasites globally. Several studies in Ethiopia also revealed that intestinal parasite infections are widely distributed with high prevalence rates. This paper reviews status of soil-transmitted helminths prevalence, their impact on health and measurement now taken to monitor the infection in Ethiopia context.

Keywords: Soil-Transmitted Helminth, Parasite, *Ascaris lumbricoides*, *Trichuris trichiura*, Hookworm

1. Introduction

STH infections are among the most prevalent and widespread chronic human infections worldwide (Stoll, 1999). The most common STHs which is found worldwide are: *Ascaris lumbricoides*, *Trichuris trichiura* and the hookworms, (*Necator americanus* and *Ancylostoma duodenale*), with an estimated 5.3 billion people worldwide, including 1.0 billion school aged children, living in areas of stable transmission for at least one STH species (Pullan and Brooker, 2012), with the greatest public health burden occurring in developing countries, particularly in sub-Saharan Africa (Bethony *et al.* 2006). The majority of these infections result from low standard of living, poor socioeconomic status, poor personal hygiene, and poor environmental sanitation (Bundy and Gutatt, 1996). STH infections are widely distributed in tropical and sub-tropical areas, especially in poor populations.

For all human STHs studied to date, which so far includes *Ascaris*, *Trichuris*, both hookworms, and *Enterobius* worm burdens exhibit a highly over-dispersed distribution so that most individuals harbor just a few worms in their intestines while a few hosts harbor disproportionately large worm burdens (Bundy, 1995). These heavily infected individuals are simultaneously at highest risk of disease and the major source is environmental contamination (Bundy, 1995). In the case of *Ascaris* and *Trichuris* infections, over-dispersed distributions also exhibit age dependency, with a peak in the childhoods, but with a subsequent decline among adults

(Bundy, 1995).

The highest prevalence and intensity of infection are usually observed in school-aged children (WHO, 2003). Numerous studies covering a diversity of geographic regions worldwide also indicate that for *Ascaris* and *Trichuris* infections maximum worm burdens occur in human populations at 5-10 years of age (Bundy, 1995). Although heavy hookworm infections occur in childhood, frequency and intensity commonly remain high in adulthood, even in elderly people (Bethony *et al.* 2002).

In Ethiopia, numerous epidemiological surveys of STHs were conducted and varying infection rates were reported from different regions and communities (Mengistu *et al.* 2007). Unsafe and inadequate provision of water, unhygienic living conditions and unsanitary waste management allow intestinal parasites and other communicable diseases to flourish in various localities (Habtamu and Kloos, 2006). Because of this and other reasons also in Ethiopia parasitic helminthic infections are the second most predominant causes of outpatient morbidity in the country.

According to Deribe *et al.* 2012 report, Ethiopia stands out for having the largest number of Neglected Tropical diseases (NTD) cases following Nigeria and the Democratic Republic of Congo. Ethiopia is estimated to have the second highest burden in terms of ascariasis, and the third highest burden of hookworm. Infection like trichuriasis is also common. A third of Ethiopians are infected with ascariasis, one quarter is

infected with trichuriasis and one in eight Ethiopians lives with hookworm.

STH infections have not been targeted for control in Ethiopia (Tadesse *et al.* 2008), though mass de-worming as a component of the Enhanced Outreach Strategy (EOS) targeting under five children started in 2004 (FMoH, 2004). Low-cost, high-coverage delivery of anti-helminthic treatment has been achieved in some settings (Montresor *et al.* 2007) but improving sanitation is more complex. In Ethiopia, for example, levels of access to improved sanitation in rural areas are very low (5.4%) making evaluation of other components of intervention important (CSA and ORC Macro, 2006). Thus, this paper aimed to assess current status of STH infection, controlling activities and progress of the disease in Ethiopia.

2. Review

2.1. Burden of Soil-Transmitted Helminth Infection

2.1.1. Ascariasis

Ascariasis is cosmopolitan and its distribution is largely determined by local habits in the disposal of faeces, because its eggs reach the soil in human faeces and so contaminate the human environment (Kightlinger *et al.* 1998). The parasite is one of the major public health problems in communities where the prevailing social environment is characterized by poverty, poor housing, inadequate sanitary practices and overcrowding (Chan, 1997 and Chan *et al.* 1994).

The worldwide prevalence of ascariasis is estimated to be more than 1.3 billion, approximately one quarter of the world population (Crompton, 1999), and over 250 million suffer from associated morbidity. It is estimated that 204 million cases of ascariasis occur in East Asia and the Pacific, 140 million in India, 97 million in South Asia, 84 million in Latin America and the Caribbean, 23 million in the Middle East and North Africa and 173 million in sub-Saharan Africa (De Silva *et al.* 2003). Ethiopia has the second highest burden rank of ascariasis in sub-Saharan Africa: 26 million people are infected, which covers 15% of the overall burden in sub-Saharan Africa (Hotez and Kamath, 2009).

Ascariasis found among literally all segments of the Ethiopian society. Of all the parasitic illnesses infecting adults and children in Ethiopia this is probably the most common parasitic disease, particularly in the malaria-free highlands (Belete and Kloos, 2006).

The prevalence among school aged children in different areas of Ethiopia was recorded at 39.8% in North Gondar (Mathewos *et al.* 2014), 28.9% in South Gondar (Jemaneh, 2000), 83.4% in Wondogenet (Erko and Medhin, 2003), 37.2% in Bushillo village (Terefe *et al.* 2011), 39.5 % in Jimma town and the national prevalence is estimated at 37% (Tadesse *et al.* 2008). Indoor and outdoor biotic contamination of the living environment arising partly from improper disposal of human waste, and partly from the integration of the lives of humans and animals accounts for the epidemic nature of parasitic

infection in the country.

2.1.2. Trichuriasis

Infection with *T. trichiura* (trichuriasis) is the third most common helminth infections of humans (Peters and Pasvol, 2005). The distribution of trichuriasis is worldwide, being most abundant in the warm moist regions of the world. It afflicts about 1 billion people throughout the world (Pearson, 2002). In Ethiopia there are 21 million people infected with this parasite, which accounts 13% of the disease burden in sub-Saharan Africa (Tadesse *et al.* 2008). It is spread via fecal-oral transmission and high prevalence occurs in areas with tropical weather and poor sanitation practices (Bethony *et al.* 2006). The parasite commonly occurs together with *Ascaris lumbricoides* and likewise mainly affects children.

Although there are very few studies in Ethiopia regarding trichuriasis, a recent literature review has shown that trichuriasis incidences tend to follow the same pattern of occurrence as ascariasis, including the altitudinal pattern. On the central and northern plateau, *T. trichiura* was found in more than 90% of 50 communities, with a mean prevalence of 49% (Belete and Kloos, 2006). Prevalence of trichuriasis among school age children reported at 86.4 % in Wondogenet (Erko and Medhin, 2003), 9.5% in South Gondar (Jemaneh, 2000) and 47.6% in Jimma town (Serkadis D. *et al.* 2013). Infection results from the ingestion of eggs in contaminated soil. Transmission may occur through the medium of food or water or directly from the hands of individuals. Children may be heavily infected and constitute important reservoirs.

2.1.3. Hookworms

Hookworm infection in humans is caused by an infection with *Necator americanus* and *Ancylostoma duodenale* and is transmitted through contact with contaminated soil. It is one of the most common chronic infections, with an estimated 740 million cases in areas of rural poverty in the tropics and subtropics (De Silva *et al.* 2003). Hookworm infection is among the most important tropical diseases in humans. The use of disability-adjusted life years as a quantitative measure of the burden of disease reveals that this infection outranks African trypanosomiasis, dengue, chagas disease, schistosomiasis, and leprosy (Hotez *et al.* 2003).

Hookworms are amongst the most widespread of soil-transmitted intestinal helminth parasites (Chan *et al.* 1994). An estimated 1.2 billion people worldwide have been infected (Chan, 1997), mainly in the tropics and subtropics, with the foci predominantly in areas of rural poverty within Asia, sub-Saharan Africa, and Latin America (De Silva *et al.* 2003). The greatest number of hookworm cases occurs in Asia, followed by sub-Saharan Africa.

In Ethiopia it is estimated that there are 11 million people infected with hookworm. Which makes the country to have the third highest burden rank in sub-Saharan Africa (Tadesse *et al.* 2008). According to the study conducted in different areas of Ethiopia the prevalence of hookworm among school age children was 22% in Northwestern Ethiopia (Hailu and Yimer, 2014), 28.4% in southern Ethiopia (Terefe *et al.* 2011), 6.7% in eastern Ethiopia (Girum, 2005) and 4.9% in northern

Ethiopia (Mathewos *et al.* 2014). The national prevalence of hookworm is now estimated at 16% (Tadesse *et al.* 2008).

Necator americanus is more common than *Ancylostoma duodenale* in the country, and hookworm infections are most prevalent in communities located between 800 and 1200m altitude. Infection rates ranged between 7% and 67% among 10 school populations in the lowlands of Gondar Region and

at community level rates ranged from 4% to 75% among 16 villages in west Abaya (Park, 2004). In most areas, older children have the greatest incidence and intensity of hookworm infection. In rural areas where fields are fertilized with night soil, older working adults may also be heavily infected.

Table 1. Prevalence of STH infections in several areas of Ethiopia.

Area	Year	Prevalence (%)			References
		Ascaris	Trichuris	Hookworm	
North Gondar	2012	39.8	6.1	4.9	Mathewos <i>et al.</i> 2014
Wendogenet	1999 and 2002	83.4	86.4	-	Erko and Medhin, 2003
South Gondar	2000	28.9	9.5	12.9	Jemaneh, 2000
Jimma Town	2011-2012	39.5	47.6	12.9	Serkadis <i>et al.</i> 2013
Northwestern Ethiopia	2012 -2013.	0.7	-	22	Hailu and Yimer , 2014
Zarima town	2009	22	2.5	19	Alemu <i>et al.</i> 2011
Bushulo village	2007	37.2	41.5	28.4	Terefe <i>et al.</i> 2011
South eastern Ethiopia	2003	6.2	14.7	60.2	Legesse and Eriko, 2004
Chencha town	2012	60.5	9.7	2.2	Abossie and Seid, 2014
Lumame town	2011-2012	26.2	1.7	7.7	Mengistu <i>et al.</i> 2014
Wukro town	2011-2012	5.7	3.1	3.9	Kidane <i>et al.</i> 2014

2.2. Risk Factors Associated with Soil-Transmitted Helminth Infection

2.2.1. Behavior, Household Clustering, and Occupation

Specific occupations and behaviors influence the prevalence and intensity of soil-transmitted helminth infections. Because of the high rates of hookworm infection among adults, occupation probably has a greater influence on hookworm epidemiology. Engagement in agricultural pursuits remains a common denominator for human hookworm infection (Hotez, 2002).

2.2.2. Poverty, Sanitation, and Urbanization

Soil-transmitted helminths depend for transmission on environments contaminated with egg-carrying feces. Consequently, helminths are intimately associated with poverty, poor sanitation, and lack of clean water. The provision of safe water and improved sanitation are essential for the control of helminth infection. Although the STH infections are neglected diseases that occur predominantly in rural areas, the social and environmental conditions in many unplanned slums and squatter settlements of developing countries are ideal for the persistence of *A. lumbricoides* (Crompton and Savioli, 1993).

Ascaris and *Trichuris* commonly occur both in urban environments, especially urban slums, and in rural areas. In some instances the prevalence of *Ascaris* infection is actually greater in urban environments (Phiri *et al.* 2000). In contrast, high rates of hookworm infection are typically restricted to areas where rural poverty predominates (Albonico *et al.* 1997). The urban-rural dichotomy between *Ascaris*-*Trichuris* versus hookworm can be partly understood by fundamental differences in the life cycles of these soil-transmitted helminths. The infective stages of *Ascaris*-*Trichuris* are embryonated eggs having enormous capacity for withstanding the environmental extremes of urban environments. Contained within the inner layer of *Ascaris*

eggs is an unsaponifiable lipid known as ascaroside, which confers many of its hardy properties. In addition to ascaroside, *Ascaris* eggs are coated with a mucopolysaccharide that renders them adhesive to a wide variety of environmental surfaces; this feature accounts for their adhesiveness to everything from door handles, dust, fruits and vegetables, paper money and coins, etc (Kagei, 1983). Transmission through the ingestion of *Ascaris* eggs adhering to vegetables is a major route of transmission (Raisanen, 1985).

The social and environmental conditions in the unplanned slums of developing countries are ideal for the persistence of *A. lumbricoides* and *T. trichiura*. Many surveys have shown a high prevalence of these infections in children of slums, shanty towns and squatter settlements (Crompton and Savioli, 1993). However, the population density in urban slums should facilitate drug delivery and opportunities for health education. Individuals should also have easier access to purchasing anthelmintic drugs for treatment of their families (Crompton, 2001).

2.2.3. Climate, Water, and Season

Adequate warmth and moisture are key features for each of the soil-transmitted helminths. *Ascaris* and *Trichuris* eggs are hardier than hookworm L3 and therefore survive drier climates better. However, even for *Ascaris* and *Trichuris*, the rates of infection are low in arid climates. At low humidity (atmospheric saturation less than 80%), human *Ascaris* ova do not embryonate; there appears to be no upper lethal limit on relative humidity (Brooker and Michael, 2000). For hookworm, moisture is especially critical. The infective third-stage larvae (L3) migrate along films of moisture. The presence of moisture will therefore allow L3 to travel vertically in the soil, particularly at night.

Since the presence of vegetation tends to prevent evaporation and conserve soil moisture, this feature has been

used as a useful proxy measure of soil moisture (Hotez, 1995). It has been suggested that total rainfall in an area and its seasonal distribution may also help explain observed patterns of infection: wetter areas are usually associated with increased transmission of all three major soil transmitted helminth infections (Brooker and Michael, 2000). A study of the prevalence of helminth infections along the coastal plains of South Africa found transmission of *A. lumbricoides* to correlate with variables based on annual data, particularly rainfall and temperature (Appleton *et al.* 1999). Studies from West Africa suggest that a minimum of 1400 mm annual rainfall is necessary for the prevalence of *A. lumbricoides* to exceed 10% (Brooker and Michael, 2000).

2.3. Impact of Soil-Transmitted Helminths in Human Health

STHs are one of the world's most important causes of physical and intellectual growth retardation (Hotez *et al.* 2006). The principal public health significance of STH infections lies in their chronic effects on health and nutrition. In addition to interference's in digestion and absorption of foods, *Ascaris lumbricoides* has been observed to decrease micro-nutrients and vitamin A absorption, probably by causing a structural abnormality of the mucosa in the small intestine ((Bundy *et al.* 1995). *A. lumbricoides* have been shown to play a significant role in childhood malnutrition, which leads to growth retardation, cognitive impairment, and poor academic performance, resulting in a poorer quality of life and less ability to contribute to society (Drake *et al.* 2000).

Hookworm infection is a recognized major contributor to gastrointestinal blood loss, iron and energy deficiencies, protein and zinc deficiencies and these thereby causing malnutrition and anemia which are most profound in women at childbearing age. Some 44 million pregnancies are currently complicated by maternal hookworm infections, placing both mothers and children at higher risk of death during pregnancy and delivery (Bundy *et al.* 1995). In the same way, *Trichuris trichiura* is now established to be associated with blood loss, malnutrition, and immunological disturbances (Stephenson *et al.* 2000).

Helminths co-infection with HIV has an impact on health of HIV infected individuals. Helminth infection leads to significant stimulation of the host immune response as these infections are characterized by the production of eggs, excretory products, and secretions. Helminth-infected individuals display increased levels of eosinophilia, increased IgE levels, and a Th2 immune bias (Kassu *et al.* 2003). Immuno-regulation in response to helminth infection may suppress HIV-1-specific CD4+ and CD8+ proliferation and cytokine production which may compromise control of HIV-1 replication (Brown *et al.* 2006). Immune activation may also result in increased cellular susceptibility to HIV-1 infection.

It was already well established that immune activation is a major enhancing factor for HIV-1 viral replication and hence plasma HIV-1 viral load (VL), and so pre-existing immune

activation in the host. Since people infected with helminths are immune-activated, they will be more prone to infection with HIV-1, and that once infected, they may have higher VL, and will therefore transmit the virus more easily and the infection will progress faster. Due to their dominant Th2 response, they will not develop potent HIV-1-specific cellular immune responses, which will be detrimental for the progression of the disease and for responding to vaccination against HIV-1 (Bentwich *et al.* 1998).

2.4. Prevention and Control Measures

2.4.1. Improved Sanitation

Improved sanitation is aimed at controlling transmission by reducing soil and water contamination. Sanitation is the only definitive intervention to eliminate STH infections but should cover a high percentage of population to be effective (Hotez *et al.* 2006).

2.4.2. Health Education

Health education is aimed at reducing transmission and re-infection by encouraging healthy behaviors. For STH infections, the aim is to reduce contamination of soil and water by promoting the use of latrines and hygienic behavior. Without a change in defecation habits, periodic deworming cannot attain a stable reduction in transmission (Hotez *et al.* 2006).

Health education can be provided simply and economically and presents no contraindications or risks. With this perspective, it is reasonable to include this component in all helminth control programs (Hotez *et al.* 2006).

2.4.3. Morbidity Control Through Deworming

The safe, inexpensive and efficacious single-dose oral drugs are now considered the cornerstone for morbidity control of STH targeting school-aged children and other high-risk groups (WHO, 2003). It is aimed at reducing morbidity by decreasing the worm burden (Bethony *et al.* 2003). Nowadays, it is not restricted to the treatment of symptomatic soil-transmitted helminth infections; the drugs are now used also for large-scale morbidity reduction in endemic communities. The causal link between chronic infection and impaired childhood development is extrapolated from the recorded improvement in these features after deworming (Awasthi *et al.* 2000).

Regular treatment with benzimidazole anthelmintic drugs in school-age children reduces and maintains the worm burden below the threshold associated with disease (Savioli *et al.* 2002). The benefits of regular deworming in this age group include improvements in iron stores, growth and physical fitness, cognitive performance, and school attendance. In younger children, studies have shown improved nutritional indicators such as reduced wasting, malnutrition, and stunting, and improved appetite (Stoltzfus *et al.* 1997).

However, there are obstacles that diminish the effectiveness of periodic deworming such as: the low efficacy of single-dose mebendazole and albendazole for the

treatment of hookworm and trichuriasis due to high rates of post treatment reinfection for STHs in areas of high endemicity and diminished efficacy with frequent and repeated use possibly because of anthelmintic resistance (Bethony *et al.* 2003). According to Quinnell *et al.* (1993), after community-wide treatment, rates of hookworm infection reach 80% of pretreatment rates within 30–36 months. *A. lumbricoides* infection reached 55% of pretreatment rates within 11 months and *T. trichiura* infection reached 44% of pretreatment rates within 17 months. Despite re-infection, however, regular treatment to reduce the worm burden consistently could prevent some of the sequelae associated with chronic infection.

The effectiveness of drugs also must be closely monitored, especially in areas where drug pressure is high. As well, deworming without improved water supplies and sanitation cannot be relied on sustainable reductions in parasite frequency or intensity of infection (Bethony *et al.* 2003). Such strategies could result in substantial reductions in the worldwide disease burden in the years to come.

3. Conclusion

Soil-transmitted helminths have a high prevalence rate globally, especially in those societies living in impoverished conditions. In Ethiopia also, the disease affects millions people as a result of several risk factors. Health education using Medias, morbidity control through deworming and improving sanitation are now taken as a measurement to control the transmission rate. Further studies should be done to understand current status of the infection and measurements should continue to achieve worm eradication mellinium goal.

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