



Perspective

A One Health approach toward the control and elimination of soil-transmitted helminthic infections in endemic areas

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ABSTRACT

Soil-transmitted helminths (STHs) pose significant health challenges, particularly in developing countries. Over 2 billion people are estimated to have been infected with at least one STH species. These parasites rely on the soil for part of their life cycle and are transmitted to humans through ova ingestion or skin penetration. Key risk factors include poor water, sanitation, hygiene practices, limited healthcare access, and poverty. Globally, STHs are primarily controlled through chemo-preventive deworming of high-risk groups in moderate (where prevalence of STHs is between 20 % and 50 %) to highly endemic areas (prevalence > 50 %). Despite the use of deworming to control the STHs in endemic areas, infections still occur. The aim of this article is to explore the potential for enhancing STH control and elimination as Neglected Tropical Diseases (NTDs) in endemic areas through an integrated approach—the One Health approach. The current control program has a single strategy of chemoprophylaxis; in the integrated approach to control of STHs, the parasite control strategies besides being based on the epidemiology of the parasite (endemicity), also include strategies based on the biology (transmission cycle) of the parasites and human behavior patterns in endemic areas. Through the involvement of local communities, healthcare authorities, and stakeholders, participatory approaches foster collaborative efforts to devise and implement control measures. By integrating this integrated approach into existing healthcare and educational initiatives, more effective results can be achieved. The promotion of health education, clean water access, improved sanitation, and hygiene awareness can further enhance control strategies and reduce STH prevalence sustainably. Here, we highlight the benefits of adopting an integrated (One Health) approach to tackle STHs in endemic areas. Through community empowerment and multi-sectorial collaboration, we can strengthen our collective efforts to combat STHs and alleviate the burden of these NTDs.

Introduction

Soil-transmitted helminths (STH) are an important group of parasites that cause severe health issues, particularly in developing countries in sub-Saharan Africa, Asia, and South America. STHs are parasitic organisms that undergo part of their life cycle in the soil and infect humans through the ingestion of embryonated ova or the penetration of the skin by filariform larvae. The most prominent STHs globally are

Ascaris lumbricoides, *Trichuris trichiura*, the two hookworms species of *Necator americanus* and *Ancylostoma duodenale*, and *Strongyloides stercoralis* [1–3]. Even though STH prevalence has decreased from 44 % in 2000 to 13 % in 2018 among children aged 5–14 years in sub-Saharan Africa, the impact of STH infections remains alarming with over 2 billion people estimated to be infected by at least one species [4]. Despite the burden it places on affected populations, this health concern receives little attention [3].

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Children living in poor sanitation conditions are more prone to STHs, and effects on morbidity and mortality are more severe in malnourished individuals [3,5]. Notably, adult worms of STHs can persist in the human gastrointestinal tract for years, underscoring the importance of addressing these infections in control programs [5]. Among the factors that contribute to the persistence and endemicity of STHs in endemic areas are inadequate hygiene practices, poor healthcare systems and facilities, poverty, social indifference, and low levels of education, all of which render impoverished communities particularly vulnerable to infection [6–8]. The development of effective and sustainable strategies to combat STH infections requires addressing these underpinning factors.

Understanding of transmission dynamics and the environment

A thorough understanding of the transmission dynamics of STH is essential for the design and implementation of control and elimination measures. The four species of STH have distinct characteristics, but they are considered one group based on their similar transmission dynamics and prevention and control measures [5]. The *A. lumbricoides* is a roundworm that infests the small intestine; the adult hookworm of the *Necator* and *Ancylostoma* genera parasitize the upper part of the human small intestines; and the adult *T. trichiura* lives in the large intestines, especially in the cecum. The STH vary greatly in size, and female worms are larger than the males [9]. Figure 1 illustrates a general life cycle of STH infection; the parasite in its adult stages inhabits part of the host's intestine, reproduces sexually, and produces eggs, which are passed in human feces and deposited in the external environment. Adult worms survive for several years in the environment and lay several eggs. Eggs can remain viable in the soil for several months (*A. lumbricoides* and *T. trichiura*); and larvae can survive for several weeks (hookworms), depending on the prevailing environmental conditions. Infection occurs through accidental ingestion of eggs (*A. lumbricoides* and *T. trichiura*) or penetration of the skin (hookworm larvae) [6,10,11].

Strategies for control and elimination of STHs and how it can be improved

Currently, global strategies for STH control focus on reducing morbidity in people at risk living in endemic areas through periodic treatment. The risk groups targeted include preschool children, school-aged children, women of reproductive age, including pregnant women during their second and third trimesters, breastfeeding women, and adults in certain high-risk occupations such as tea-pickers or miners. The World Health Organization (WHO) guidelines for STHs control is solely based on Mass Drug Administration (MDA) programs, with the main aim of reducing morbidity in preschool-aged children and school-aged children by lowering the prevalence of moderate to heavy intensity infections to < 1% [1,12,13]. When the endemicity is low (prevalence < 20%), chemo-preventive therapy is not routinely administered, but is administered once a year for moderate endemicity (prevalence 20–50%), and twice a year for high endemicity (prevalence > 50%). In most cases, populations are only evaluated after 5–6 years [13].

These current STHs control strategies have serious limitations [13]. In areas with low endemicity, the strategy works well, but in moderate or high areas, it does not. This is because deworming programs are insufficiently implemented, inconsistently monitored, and typically focus on at-risk populations. Research and evaluations have indicated that antihelminth drug resistance could occur [14]. In the implementation phase, there is a lack of diagnosis to identify the program's needs. There are gaps in drug availability, limited data on the efficacy of the current medicines, and often the program is vertical, with less attention paid to water, sanitation, and hygiene [5,12,13,15]. A geospatial analysis of the prevalence and intensity of soil-transmitted infections of children in sub-Saharan Africa found that about a quarter of areas implementing the MDA still have an estimated prevalence of moderate to high intensity, exceeding the 20% in the endemic countries of Nigeria, Democratic Republic of Congo, Ethiopia, Cameroon, Angola, Mozambique, Madagascar, Equatorial Guinea, and Gabon [4]. Among the most commonly used drugs for preventing STHs are

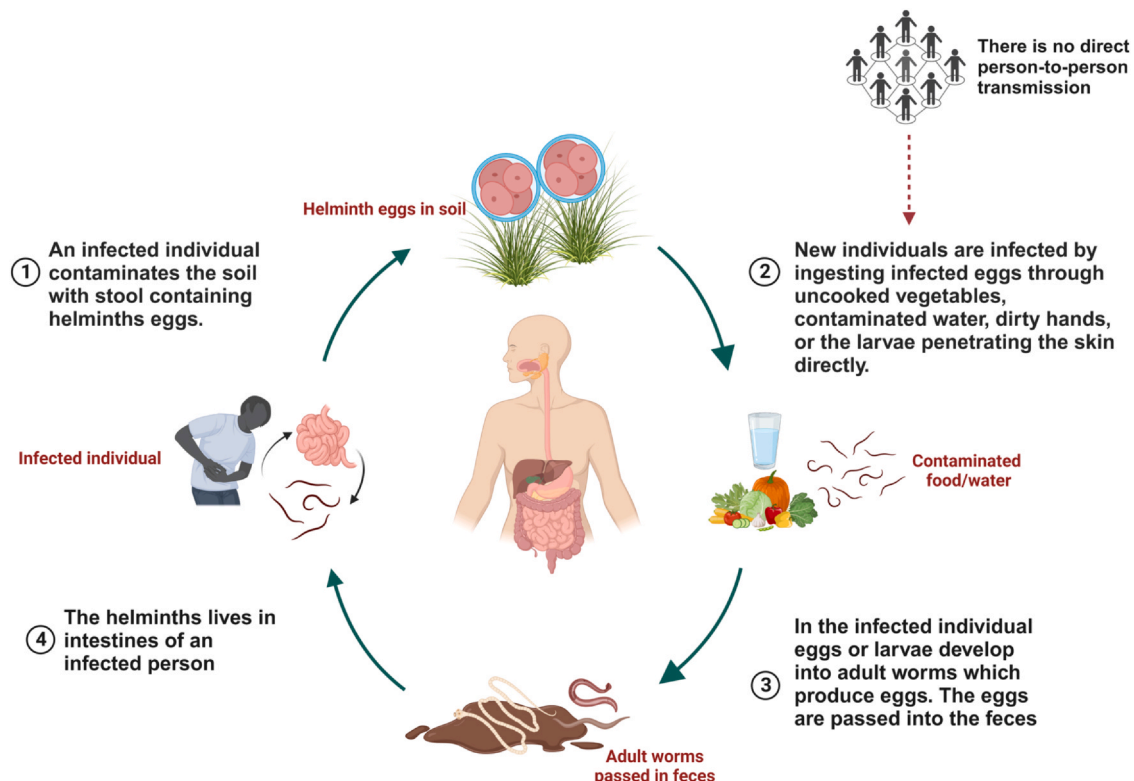


Figure 1. Lifecycle of soil-transmitted helminths. Created by Biorender.com.

mebendazole and albendazole [16], and the cure rates were found to be 6.6 % and 2.7 % for *A. lumbricoides* and *T. trichiura*, respectively [17]. Re-infection is common even after treatment [7]. Despite the low coverage of these preventive therapies due to low levels of education, poor record keeping, poor follow-up, and information dissemination, chemo-preventive therapy needs to be offered to all individuals in areas of STH transmission regardless of risk status and local endemicity [18,19].

Integrating multidisciplinary approaches with current control programs and practices not only enhances control and elimination strategies but also aligns with the aspirations outlined in declarations like the London Declaration on NTDs launched in 2012 and the subsequent Kigali Declaration in 2022. These declarations advocate for heightened program momentum and collaborative efforts among various stakeholders, including donor countries, philanthropists, private sector companies, non-governmental organizations, academia, and research organizations, to address the prevention, control, and elimination of NTDs [20].

Studies in low- and middle-income countries have shown that improving access to and practices of Water, Sanitation, and Hygiene (WASH) reduces STH infection rates [1,21–23]. Simple and low-cost interventions aimed at improving handwashing techniques have proven to be effective in reducing STHs [24]. Water intervention reduced hookworm prevalence by 31 %, and sanitation reduced the prevalence of all STHs by about 29 % [22]. Furthermore, access to latrines has resulted in a reduction in the prevalence of STHs compared to those without latrines, which is 13.4 % and 27.5 %, respectively [25]. Further, low prevalence has been reported among 72.8 % of school-going children who wear shoes or slippers outside [26].

Health education about prevention of STHs is effective in reducing infection rates in the community [27]. Health education has been perceived to lead to attitude change and improve intervention uptake against STHs among at-risk children [28]; additionally, a clustered-randomized trial found a reduction in the prevalence of STHs by 58 % among school-going children who have knowledge of STHs [29]. In Ethiopia, it has been noted that schoolchildren are well-informed about helminth preventive measures and many of them are aware of them [30].

According to a review of diagnostic techniques and their impacts on STH control, laboratory testing using highly sensitive and specific techniques would be a more effective tool for detecting STHs in combination with clinical examinations and imaging. Strengthening laboratory services is required to accomplish this [9]. It would be very beneficial to have anti-STH-vaccines available, but despite an increase in STH vaccine research, there are currently no anti-STH vaccines available for humans. To bring antihelminth vaccines to trials, it is therefore imperative that international pharmaceutical companies provide attention and support in the future [11].

It is important that operational research be strengthened and integrated with control programs, that the research takes a multidisciplinary approach, and that social research be combined with operational research to co-produce innovative solutions and adaptations of STH programs across the board. The research should address how barriers to access can be overcome while strengthening health systems and MDA approaches, supporting more equitable service delivery, and empowering those living with STH infections [15]. Continuous surveillance is a critical approach that should be strengthened in the control of STH through monitoring social and demographic, sanitation, environmental, and climate-related conditions. Furthermore, there is an urgent need to create a single integrated database for each country [5]. An illustration of an integrated approach for controlling and eliminating STH infections is shown in Figure 2.

Addressing a broader One Health scope for the control of helminth infections

As part of their One Health initiative, the WHO has devised a method for eliminating the likelihood of STHs interacting with humans, animals, and the environment. This is termed the “One Health: Approach for Action against Neglected Tropical Diseases 2021–2030”. WHO developed this road map with the aim of supporting a range of stakeholders especially countries where NTDs are endemic, international organizations, and non-state actors to achieve control through a transdisciplinary, cross-cutting, One Health approach. The One Health approach is an integrated unifying approach that recognizes links between the health of people, animals, and ecosystems. STHs involve animals, soil, and humans throughout its life cycle; it presents a unique opportunity for sustained infestation, making the One Health approach an ideal choice [31]. A strategy like this holds tremendous potential for improving public health outcomes, particularly in low- and middle-income countries since a range of stakeholders are considered and engaged to find common ground for collaboration. Control of STHs would yield sustained improvement as opposed to the current strategy of using only MDAs for high-risk populations. This strategy includes eradicating STHs eggs from the soil, which can be achieved through the proper disposal of stool and the prevention of contamination of water bodies [6,10,11]. These measures are critical to avoid accidental ingestion of the eggs or skin penetration, further emphasizing the interconnectedness of human, animal, and environmental health. Moreover, the timely administration of necessary treatments is essential to alleviate the suffering of infected individuals and prevent further transmission [32].

Although there are challenges, there are also opportunities to mitigate the burden of STHs [1]. In alignment with the One Health approach, WHO has formulated a comprehensive roadmap for the elimination of STHs beyond 2020, encompassing various strategies such as periodic treatment of at-risk populations to combat STHs infections effectively [33]. This effort is further reinforced by initiatives aimed at improving the social, economic, and health status of populations, and integrating STH elimination into the broader framework of sustainable development goals [31]. By embracing the One Health approach and WHO's strategic roadmap, we can collectively work toward eliminating STH, fostering not only improved health outcomes but also a more sustainable and healthier future for both humans and animals. This integrated approach underscores the significance of addressing helminthic infections as a multifaceted challenge that transcends traditional health boundaries.

Roles of different stakeholders

Health workers and community drug distributors are the lynchpins of MDA for STH control and elimination. It is of critical importance to advocate for and support the needs of the health workforce, who are often overstretched and overworked but are the cornerstone of ongoing service delivery [20].

Community participation plays a vital role in control and elimination of STHs. Programming must be informed by the experiences of those who have been infected. Early recognition of STHs signs and symptoms is also recognized as critical to reducing disease progression and morbidity. Community members must be able to access and accept different control and elimination programs if they are to be implemented effectively [1].

Resources provided by governments include research, the payment of health workers, formulation of policies, the administration of mass drugs, logistical support, training of public health officers, resource mobilization, and partnerships. In addition to developing STH control

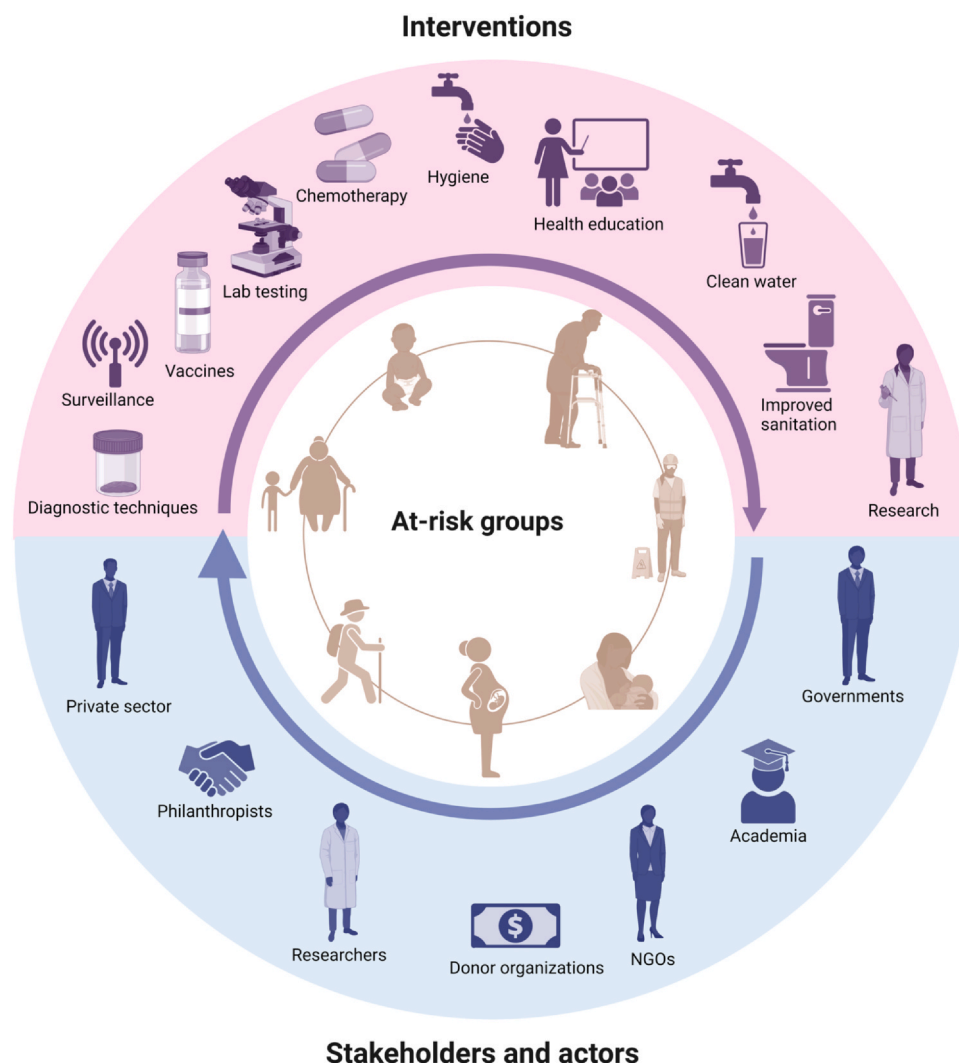


Figure 2. An integrated approach for the control and elimination of soil-transmitted helminth infections.

programs, the government also oversees their implementation, monitoring, and evaluation [3,17,20].

Conclusion

In conclusion, STH infections predominantly afflict impoverished countries, significantly impacting maternal and child health. Control measures are complicated by the persistence of adult worms in infected individuals, and by the enduring infectivity of STH eggs in soil. Currently, chemo-preventive therapy is targeted at high-risk groups, but an integrated approach is necessary. Using a One Health approach and integrating WASH access, health education, improved diagnostics, surveillance, and research will strengthen control programs. Collaborative efforts among governments, healthcare authorities, non-government organizations, researchers, and local communities are crucial for effective STH control and elimination. By combining resources and expertise, we can address STH morbidity, alleviate the burden of these infections in endemic regions, and improve public health outcomes.

Ethical approval

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CRediT authorship contribution statement

All authors contributed substantially to the Conceptualization, Data curation, drafting of the manuscript and final approval of the manuscript for submission.

Declaration of Competing Interest

The authors declare no conflicts of interests.

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