World Health Organization

Assessing schistosomiasis and soil-transmitted helminthiases control programmes

Monitoring and evaluation framework

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WHO Technical Advisory Group on schistosomiasis and soil-transmitted helminthiases control and elimination* sub working group on monitoring and evaluation

Souad Bouhout,* Ministry of Health, Rabat, Morocco

Moses Chimbari,* University of KwaZulu-Natal, Durban, South Africa

Hala Elmorshedy,* University of Alexandria, Alexandria, Egypt

Paul Emerson (Chair), Task Force for Global Health, Decatur, United States of America

Darin Evans, United States Agency for International Development, Washington, United States of America

Fiona Fleming, Unlimit Health, London, United Kingdom of Great Britain and Northern Ireland

Christy L. Hanson, Bill & Melinda Gates Foundation, Seattle, United States of America

Lydia Leonardo,* University of the Philippines, Manila, Philippines

Sultani Mantendechero,* Ministry of Health, Nairobi, Kenya

Mark Minnery, Evidence Action, Washington, United States of America

Otavio Pieri,* Fiocruz, Rio de Janeiro, Brazil

Laura Rinaldi, University of Naples Federico II, Naples, Italy

Moussa Sacko,* Institut National de Recherche en Santé Publique, Bamako, Mali

William Evan Secor,* Centers for Disease Control and Prevention, Atlanta, United States of America

Doudou Sow,* Université Gaston Berger, Saint Louis, Senegal

Cara Sumi, Bill & Melinda Gates Foundation, Seattle, United States of America

Ploi Swatdisuk, United States Agency for International Development, Washington, United States of America

Susana Vaz Nery,* University of New South Wales, Sydney, Australia

* Member of the WHO Technical Advisory Group.

WHO also thanks the group of programme managers that revised the first draft:

Shaali Ame, Ministry of Health, Zanzibar, United Republic of Tanzania

Prudence Beinamaryo, Ministry of Health, Kampala, Uganda

Vinay Garg, National Centre for Diseases Control, New Delhi, India

George Kabona, Ministry of Heath, Dar es Salaam, United Republic of Tanzania

Safari Kinunghi, National Institute for Medical Research, Dar es Salaam, United Republic of Tanzania

Stephen Mwambo, Ministry of Heath, Dar es Salaam, United Republic of Tanzania

Collins Okoyo, Kenya Medical Research Institute, Nairobi, Kenya

Wyckliff Omondi, Ministry of Health, Nairobi, Kenya

Fikre Seife, Ministry of Health, Addis Ababa, Ethiopia

Mahamadou Traore, Ministry of Health and Public Hygiene, Bamako, Mali

Peer reviewers

Narcis Kabatereine, Independent Public Health Expert (retired), Kampala, Uganda

Eliezer Kouakou Ngoran, University of Cocody, Attoban, Côte d'Ivoire

Yaobi Zhang, Senior Scientific Advisor, Neglected Tropical Diseases, Helen Keller International, New York, United States of America

WHO secretariat

The following WHO technical staff drafted and guided the development of the manual:

Antonio Montresor, Amadou Garba Djirmay, Denise Mupfasoni, Pamela Sabina Mbabazi and Jonathan King (WHO Global Neglected Tropical Diseases Programme, Geneva, Switzerland); Pauline Mwinzi (WHO Regional Office for Africa, Brazzaville, Congo); Supriya Warusavithana (WHO Regional Office for the Eastern Mediterranean, Manila, Philippines); Aya Yajima (WHO Regional Office for South-East Asia, New Delhi, India); Kazim Hizbullah Sanikullah (WHO Regional Office for the Western Pacific); and Ronaldo Carvalho Scholte (WHO Regional Office for the Americas).

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Glossary of terms and abbreviations

The terms defined below relate to their use in this manual and may not be valid in other contexts.

anthelminthic

A medicine used to treat parasitic worm infections.

baseline assessment

An assessment of the prevalence and intensity of soil-transmitted helminth or schistosome infections before any large-scale control interventions.

benzimidazoles

A group of anthelminthic medicines that includes albendazole and mebendazole.

coverage

effective coverage

A measure, when relating to soil-transmitted helminthiases and schistosomiasis control programmes, defined by the World Health Organization (WHO) as treating ≥ 75% of the target population.

geographical coverage

The proportion of endemic administrative units that are implementing preventive chemotherapy of all administrative units that require the intervention.

national coverage

The proportion of individuals in an endemic country requiring preventive chemotherapy who have ingested the medicines from all those requiring the intervention at national level.

programme coverage

The proportion of individuals in the target population ingesting the preventive chemotherapy medicines in the designated endemic area targeted for treatment.

treatment coverage

The proportion of individuals in a defined population who took the treatment. The defined population can be (i) a target group for treatment, for instance, school-aged children; (ii) the entire population of a geographical region, administrative area or community where the diseases are endemic; or (iii) the entire population of a country.

deworming round

The distribution of an anthelminthic medicine to a population during a defined period according to WHO guidance on control and elimination of schistosomiasis and soil-transmitted helminthiases. The number of rounds can vary from one round to several rounds of treatment in a year to less frequent rounds such as one round every 2 or 3 years.

disability-adjusted life year (DALYs)

A measure of overall disease burden, expressed as the number of years lost due to ill health, disability or early death; DALYs for a disease or health condition are calculated as the sum of the years of life lost due to premature mortality in the population and the years lost due to disability resulting from the health condition or its consequences.

disease burden

The cumulative mortality, disability and morbidity attributable to a disease.

ecological zone

A geographical area that is homogeneous in terms of humidity, rainfall, vegetation, use of same water bodies, population density, and sanitation level.

eggs per gram (epg) and eggs per 10 mL

The number of parasite eggs per gram of faeces or eggs per milliliter of urine. When using the Kato–Katz method, the number of eggs counted per slide should be multiplied by 24 to calculate the number of eggs per gram (when using the standard 41.7 mg template). These measures provide an indirect measure of the intensity of helminth infection. See also **intensity of infection**.

elimination as a public health problem (EPHP)

A term related to both infection and disease, defined by achievement of measurable public health targets set by WHO in relation to a specific disease. When reached, continued actions are required to maintain the targets and/or to advance to the interruption of transmission. The process of documenting achievement of this goal is called **validation**.

For soil-transmitted helminthiases and schistosomiasis, EPHP is the elimination of acute morbidity caused by the infection. WHO has identified the following indicators indicative of reaching EPHP:

- soil-transmitted helminthiases: < 2% prevalence of moderate and heavy intensity infections
- schistosomiasis: < 1% prevalence of heavy intensity infections

endemic area

A geographical area where infection is transmitted. Specifically, in the context of soil-transmitted helminthiases and schistosomiasis, the term “endemic” is more commonly used to refer to areas where ongoing transmission occurs, and substantial morbidity is seen.

female genital schistosomiasis and male genital schistosomiasis

A granulomatous reaction to eggs of *Schistosoma haematobium* causing genital signs and symptoms similar to those of sexually transmitted infections. Female genital schistosomiasis commonly includes vaginal bleeding, inflammation of the cervix, tubal obstruction, pain during sexual intercourse, nodules in the vulva and infertility. Male genital schistosomiasis causes haemospermia and pain when ejaculating.

granuloma

A focal lesion resulting from an inflammatory reaction caused, in the case of schistosomiasis, by schistosome eggs. The initial lesion can evolve into fibrosis of the liver and urinary tract following the production of reactive fibrous tissue.

haematuria

A condition frequently present in individuals infected by *S. haematobium* characterized by red blood cells in the urine. Visible haematuria refers to blood present in sufficient quantity to be detectable by visual inspection of the urine. Micro hematuria refers to blood that is visible or not to the naked eye, but that is detectable using a reagent strip or microscopy.

helminths

A group of parasites commonly referred to as “worms”. The group includes nematodes (roundworms), trematodes (flukes) and cestodes (tapeworms). The helminth species covered by this manual are **soil-transmitted helminths** (nematodes) and **schistosomes** (trematodes).

hepatosplenomegaly

The enlargement of the liver and the spleen due, in the case of intestinal schistosomiasis, to the reaction to parasite eggs (granuloma). This condition interferes with blood circulation in the two organs and causes portal hypertension (high blood pressure in the venous system entering the liver) and ascites (accumulation of serous fluid in the abdominal cavity). Hepatosplenomegaly and ascites can result in considerable enlargement and discomfort of the abdomen ("big belly").

hotspot (for schistosomiasis)

persistent hotspot

Communities with baseline prevalence of *Schistosoma* spp. infection ≥ 10% who demonstrate lack of an appropriate response to at least 2 years of preventive chemotherapy, despite effective treatment coverage (≥ 75%). The lack of an appropriate response should be (provisionally) defined as a reduction in prevalence of less than one third between the baseline prevalence survey and a repeat prevalence survey completed after two annual rounds of preventive chemotherapy.

potential hotspot

Communities with baseline prevalence of *Schistosoma* spp. infection ≥ 10% who, because of frequent water contact behaviour, low coverage WASH, ecological or environmental situation, including the presence of irrigation schemes or dams, are considered at risk of being an area of high transmission and where potentially the normal control measures may be not sufficient to control morbidity.

implementation unit (IU)

An administratively defined area in which the same control intervention is applied. This is normally the district in the case of soil-transmitted helminthiases but can be a smaller unit (such as a subdistrict or communities) in the case of schistosomiasis (because schistosomiasis is more focal and is more intensely acquired near fresh water bodies where the intermediate snail host is present).

intensity of infection

The number of adult helminths infecting an individual (also known as worm burden). In the case of soil-transmitted helminths, it can be measured directly by counting expelled worms after anthelminthic treatment. However, for both soil-transmitted helminths and schistosomes, it is more usually measured indirectly by counting helminth eggs excreted in faeces (expressed as eggs per gram) or urine (schistosome eggs per 10 mL). Indirect methods are less intrusive, more convenient and more commonly used as proxy markers. The intensity of infection is often categorized as light, moderate or heavy. Infections classified as moderate and heavy (for soil-transmitted helminthiases) and heavy (for schistosomiasis) intensity are largely responsible for the morbidity.

mass drug administration

In the case of helminths, the administration of anthelminthic medicines at regular intervals to the entire eligible population of an area (e.g. state, region, province, district, subdistrict, village/community), irrespective of the individual infection status. Mass drug administration is one form of preventive chemotherapy.

morbidity

The clinical consequences of infections and diseases that adversely affect an individual's health. In the case of helminth infection, evident morbidity can be overt (e.g. haematuria, diarrhoea or ascites) or subtle (e.g. malabsorption, stunted growth or infertility). Subtle morbidity is that

attributable to either schistosomiasis, soil-transmitted helminthiases or other infection that is not normally identified in the clinical case definition for that infection, such as anaemia, growth impairment, decreased cognitive and work performance, and synergy with other infections.

neglected tropical disease (NTD)

A group of diseases linked to poverty and mainly transmitted in tropical and sub-tropical countries that are considered to have received insufficient attention from the donor community and public health planners. The World Health Organization lists 21 NTDs,[1] including schistosomiasis and soil-transmitted helminthiases.

One Health

A collaborative, multisectoral and transdisciplinary approach – working at local, regional, national and global levels – with the goal of achieving optimal health outcomes for people, animals and ecosystems/environment. This approach acknowledges the interconnectedness of humans, animals, plants and their shared environment to effectively address health challenges.

preschool-aged children (pre-SAC)

Children aged between 24 and 59 months (2–4 years).

prevalence of infection

The proportion of infected individuals in a population. It is calculated as the number of infected individuals divided by the total number of individuals tested.

preventive chemotherapy

Large-scale use of medicines, either alone or in combination, in public health interventions. There are several forms of preventive chemotherapy: (i) mass drug administration (when the entire population is treated); (ii) targeted drug administration (when specific population groups such as school-aged children and women of childbearing age are treated); (iii) selective chemotherapy (when treatment is provided after screening); and (iv) event-based treatment (e.g. when treatment is distributed to preschool-aged children at a particular immunization visit, to school-aged children at school enrolment and graduation, and to women of reproductive age at antenatal care).

recrudescence (rebound)

The tendency, after reduction of the frequency of preventive chemotherapy, of infection prevalence and intensity to return to the levels observed before implementing a control programme. To promptly identify potential recrudescence, it is crucial to maintain surveillance after reducing the frequency of preventive chemotherapy. If recrudescence is identified, restarting previous levels of preventive chemotherapy is essential before new morbidity emerges.

schistosomes (SCH) and their life cycle

Schistosome infections in humans are caused by six species of trematodes: *Schistosoma mansoni*, *S. haematobium, S. japonicum*, *S. mekongi*, *S. intercalatum* and *S. guineensis.* The species that predominate globally are *S. haematobium* and *S. mansoni*. Adult schistosomes live in the blood system and produce eggs of which some are expelled in the faeces or urine of the host. Free-swimming larvae (miracidia) hatch from eggs when they come into contact with fresh water and infect specific snails (intermediate host) where they develop into mother sporocysts and undergo

1 Buruli ulcer; Chagas disease; dengue and chikungunya; dracunculiasis; echinococcosis; foodborne trematodiases; human African trypanosomiasis; leishmaniasis; leprosy; lymphatic filariasis; mycetoma, chromoblastomycosis and other deep mycoses; noma; onchocerciasis; rabies; scabies and other ectoparasitoses; schistosomiasis; soil-transmitted helminthiases; snakebite envenoming; taeniasis/cysticercosis; trachoma; yaws.

asexual multiplication to give rise to daughter sporocysts which in turn produce numerous free-swimming larvae (cercariae) that leave the infected snail to penetrate the skin of humans or other mammals (definitive host). The cercariae transform into schistosomula that migrate in the body and mature into adult schistosomes.

school-aged children (SAC)

Children aged between 5 and 14 years, regardless of their school enrolment status. The exact ages of school enrolment can vary slightly between different countries. In some countries, a primary school's enrolment may include individuals aged older than 14 years.

soil-transmitted helminths (STH) and their life cycle

Soil-transmitted helminths are so called because transmission relies on contamination of the environment with fertile eggs passed in faeces from infected humans. They are grouped together because their diagnosis can be made with the same diagnostic technique, and they respond to the same preventive and curative interventions.

Soil-transmitted helminth infections are caused by a group of intestinal nematodes: *Ascaris lumbricoides* (roundworm), *Trichuris trichiura* (whipworm), *Necator americanus*, *Ancylostoma duodenale* and *A. ceylanicum* (hookworms).

Adult soil-transmitted helminths live in the intestine of the human host and produce eggs which are expelled in the host's faeces and contaminate the environment. After a period of maturation, the parasite eggs hatch, as infective larvae, in the soil (hookworms) or, after ingestion, in the intestinal tract of humans (*A. lumbricoides* and *T. trichiura*). After penetration respectively of the skin or the digestive mucosa, the larvae of hookworms and *A. lumbricoides* penetrate blood vessels and go through a heart–lung migration, reaching the alveoli and going up to the pharynx, from where they are swallowed to enable them to re-enter the intestine where they develop into adult parasites. The larvae of *T. trichiura* develop from the ingested eggs into the adult form of the parasite in the intestine without migrating.

Strongyloides stercoralis is also classified as an STH; however, its control requires different diagnostic techniques and a different drug treatment, so the intervention and the consequent monitoring and evaluation activities are normally separate from those for other STHs. The WHO NTD road map 2021–2030 does not include targets for control of morbidity caused by *S. stercoralis* infection and control of this parasite is therefore not included in this manual.

transmission assessment survey

A standardized survey designed to measure whether evaluation units have lowered the prevalence of infection to a level where recrudescence is unlikely to occur, even in the absence of mass drug administration interventions.

water, sanitation and hygiene (WASH) interventions

Safe, clean water, basic sanitation and good hygiene practices are essential for the survival and development of children and are human rights for all individuals. WASH interventions incorporate activities aimed at improving the infrastructure (sanitation and access to water) and promoting behavioural changes (use and maintenance of latrines, handwashing and reduction of contact with contaminated water). These activities that accompany the distribution of medicines for the control of schistosomiasis and soil-transmitted helminthiases play a key role in reducing environmental contamination with human faeces and urine and then the transmission of the parasite.

women of reproductive age

Usually defined as women aged between 15 and 49 years.

Young girl, Tahoua Region, Niger, 2011.
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1. Introduction

1.1 Objective of this manual

The objective of this manual is to guide managers of schistosomiasis and soil-transmitted helminthiases control programmes towards the elimination of these diseases as public health problems informed by evidence generated through monitoring and evaluation of these programmes. The manual complements the objectives outlined by the World Health Organization (WHO) in the road map for neglected tropical diseases 2021–2030 ("the road map") (WHO, 2020a) and the monitoring and evaluation framework (WHO, 2021a), a companion document to the road map.

This manual provides guidance on:

- the timing of monitoring activities;
- the indicators to be collected and their calculation; and
- how to interpret the results in order to
  - select the appropriate treatment (at baseline or following interventions) and
  - allocate resources more efficiently for new phases of the programme.

The target audience is health ministry staff, particularly national programme managers for schistosomiasis and soil-transmitted helminthiases control programmes; programme staff working at national, regional and district levels; partners involved in programme implementation; regional programme review groups or technical advisory groups; and focal points for neglected tropical diseases (NTDs) in WHO country offices.

1.2 Main messages

The prevalence of soil-transmitted helminthiases and schistosomiasis will change as control programmes are implemented. It is therefore important to measure the epidemiological situation at specific times to: (i) assess the achievement of programme objectives; (ii) adapt control interventions to the changing epidemiological situation; and (iii) allocate resources efficiently.

As disease epidemiology evolves, the frequency of interventions will change accordingly. Monitoring the prevalence of infection will inform how the intervention will need to be adapted, and it will provide an estimate of the amount of drug needed.

The first objective of schistosomiasis and soil-transmitted helminthiases control programmes is to prevent and eliminate chronic morbidity caused by these infections. Chronic morbidity is elimination of the diseases as a public health problem (EPHP). Monitoring the intensity of infection is necessary to assess if EPHP targets have been reached, because infections with many parasites (moderate and heavy intensity infections) cause substantially more morbidity than infections of light intensity.

Achievement of EPHP does not mean that treatment can be stopped. Once the diseases are eliminated as public health problems, drug administrations will need to be continued to maintain this achievement. Post-validation surveillance will provide an early signal if there is a tendency for infection to rebound.

1.3 Explanatory notes

This manual is intended for programme managers and their partners to determine the frequency of preventive chemotherapy for treatment of schistosomiasis and soil-transmitted helminthiases. By following the guidance provided, country programmes can determine the appropriate timing for reducing the frequency of preventive chemotherapy when indicated; for instance, when to transition from twice a year to annual treatment, then further adjust to once every 2 years, and eventually implement periodic treatment. It is not intended to provide guidance on submitting a dossier to declare EPHP. Future documents will provide guidance on validation of EPHP. Two separate documents for schistosomiasis and soil-transmitted helminthiases are in development to guide the validation of EPHP, as the criteria for this decision will differ.

The focus of the manual is on the "what" rather than the "how" of programme monitoring. A variety of survey methods is suggested to provide data at the level for which the treatment decision is made (implementation unit level, i.e. district, sub-district or community), each offering varying precision, sensitivity and cost. By not recommending a specific survey method to determine the prevalence and intensity of infection, the manual avoids restricting country programmes either to methods they cannot afford or to methods that may not allow countries with greater resources to collect more frequent, detailed and precise data. In this way, country programmes are empowered to make informed decisions based on their contextual factors.

Innovation in control of NTDs is rapidly advancing, especially in diagnostics, integrated survey protocols and the use of geostatistical modelling. Guidelines are explicitly developed to foster innovation and expand options for country programmes. This approach allows for flexibility and encourages the adoption of emerging methods and techniques in NTD programming.

Comprehensive guidelines already exist or are being developed for water, sanitation and hygiene (WASH); snail control; supply chain monitoring; and One Health. Readers interested in these specific topics should refer to the respective publications for detailed guidance and information.

This manual focuses on schistosomiasis and soil-transmitted helminthiases, which are targeted for EPHP by WHO by 2030. Although *Strongyloides stercoralis* is considered a soil-transmitted helminth (STH), its control requires a different diagnostic technique and large-scale control programmes are not in place at the moment; it is therefore not addressed in this manual.

1.4 Approach to development

The WHO Technical Advisory Group on schistosomiasis and soil-transmitted helminthiases control and elimination was created in November 2021. At its first meeting, priority areas for guidance were identified, including the preparation of a monitoring and evaluation framework. Members of the group and observers volunteered to be part of the drafting group. The manual was developed following the WHO procedures on technical product development (WHO, 2022a).

1.5 Management of conflicts of interest

The management of conflicts of interest was a key priority throughout the development process of the manual. Before the first meeting of the group, all experts submitted written disclosures of competing interests and disclosed academic or scientific activities that were relevant for consideration before their confirmation as members of the meeting (see Annex 1).

A writing team produced the first draft of the document, which was shared with the working group members and discussed during online meetings. The successive drafts went through an iterative revision process including working groups members, observers and WHO regional advisors. Each new draft shared included a short document presenting the main changes and why some of the proposed amendments were not included. Online working groups meeting were organized in October 2022, February 2023, May 2023, August 2023 and September 2023.

Disagreements mainly concerned the recommendation of using a unique survey methodology versus multiple survey methodologies to allow countries more flexibility, which was finally agreed, the diagnostic methodologies for assessments and the direct relationship between intensity of infection and morbidity.

The fourth draft of the manual was reviewed by a group of programme managers, the main target of the document, from Ethiopia, India, Mali, Kenya and the United Republic of Tanzania, Zanzibar (see Acknowledgements) during a specific workshop held on 25–27 July 2023 in Dar es Salam, United Republic of Tanzania. The participants found the manual useful and clear, and provided significant technical inputs that were addressed by the writing team.

In addition, the main guidance of the manual (preventive chemotherapy round, timing for conducting impact assessment, change in frequency of preventive chemotherapy after impact assessment, identification and management of hot spots) was presented during several meetings (of the Neglected Tropical Disease NGO Network (NNN), the Coalition for Operational Research on Neglected Tropical Diseases (COR-NTD) and the WHO Regional Office for Africa programme managers' meetings) to get input from the community.

The prefinal draft document was reviewed by an external peer review group to ensure rigorous review of available evidence and clarity of the recommendations.

The final version was then shared with the Technical Advisory Group on schistosomiasis and soil-transmitted helminthiases control and elimination and adopted through a voting process in March 2024.

1.6 Endorsement

This document was endorsed by the Technical Advisory Group on schistosomiasis and soil-transmitted helminthiases control and elimination in March 2024.

Water supply and dishes in the river, Saga Fondo, Niger, 2009.
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2. Background

2.1 Morbidity caused by schistosome and soil-transmitted helminth infections

Schistosome (SCH) and soil-transmitted helminth (STH) infections cause nutritional impairment and tissue reaction and can also cause damage that may require surgical intervention (Table 1). Initially, morbidity is usually reversible (with treatment and subsequent removal of parasites from the human host); however, especially in schistosomiasis, infections of heavy intensity can cause permanent anatomical changes (e.g. fibrosis, hydronephrosis, cancer of the bladder and lower genital tract damage). At that stage, the morbidity is irreversible, and, even with complete cure of the infection, the human hosts may not return to their original condition. The main clinical manifestations of *S. intercalatum* are lower abdominal pain and dysentery. The clinical manifestations of *S. mekongi* are similar to those *of S. japonicum* (WHO, 1985; McManus et al., 2018). Countries endemic for *S. mekongi* have reached EPHP and are awaiting validation for formal confirmation (Khieu et al., 2019).

Table 1. Main forms of morbidity caused by STH and SCH infections

Effect	Sign of morbidity	Parasite	Reference
Nutritional impairment	Intestinal bleeding, impaired iron status, anaemia, enteropathy	Hookworms *Trichuris trichiura* *Schistosoma mansoni*	Stoltzfus et al., 1996 Koukounari et al., 2006 Hall et al., 2008
	Urinary tract bleeding (haematuria), impaired iron status, anaemia	*S. haematobium*	Gryseels B et al., 2006 Mutapi et al., 2021
	Malabsorption of nutrients	*Ascaris lumbricoides*	Solomons, 1993 Crompton and Nesheim, 2002
	Competition for micronutrients	*A. lumbricoides*	Curtale et al., 1993
	Impaired growth[a]	*A. lumbricoides* *S. haematobium*	Taren et al., 1987 Stephenson et al., 2000
	Loss of appetite and reduction of food intake	*A. lumbricoides*	Stephenson et al., 1993
	Diarrhoea or dysentery	*T. trichiura* *S. mansoni*	Callender et al., 1998 McManus et al., 2018

(Continued)

Table 1. Contd.

Effect	Sign of morbidity	Parasite	Reference
Cognitive impairment	Reduction in fluency and memory	*T. trichiura* *A. lumbricoides* *S. haematobium*	Nokes et al., 1992 Kvalsvig, Cooppan and Connolly, 1991 Mutapi et al., 2021
Conditions requiring surgery	Intestinal obstruction	*A. lumbricoides*	de Silva, Chan and Bundy, 1997
	Rectal prolapse	*T. trichiura*	WHO, 1981
	Cancer of the bladder[a]	*S. haematobium*	WHO, 1985
Tissue reactions	Granulomatous reactions to eggs in the mucosa of the urogenital system, intestine, and in liver, organomegaly, exercise intolerance	*S. haematobium* *S. mansoni* *S. japonicum*	Gryseels et al., 2006
	Genital signs and symptoms similar to sexually transmitted infections, commonly including vaginal bleeding, inflammation of the cervix, tubal obstruction, pain during sexual intercourse and nodules in the vulva,[a] infertility, female genital schistosomiasis; haemospermia, pain during ejaculation, obstructive uropathy, calcified bladder[a]	*S. haematobium* *S. mansoni* *S. japonicum, S. mekongi*	WHO, 2015 Vennervald and Dunne, 2004 Kjetland, Leutscher and Ndhlovu, 2012 Bustinduy et al., 2022
	Fibrosis of the portal tracts,[a] hepatomegaly,a portal hypertension, liver atrophy,[a] ascites,[a] haematemesis	*S. mansoni, S. haematobium*	McManus et al., 2018 Ross et al., 2012
	Neurological manifestations, myelopathy, encephalopathy		

[a] irreversible morbidity.

Source: adapted from *Helminth control in school-age children: a guide for managers of control programmes* (WHO, 2011).

In endemic areas, humans inhabit a contaminated environment and accumulate infections over time. Thus, if not treated, an infection with a few parasites can become an infection with hundreds of parasites. This increase is due repeated reinfections, as parasites do not replicate inside the human host. For both STH and SCH infections, associated morbidity is linked to the number of parasites infecting the human host: infections with many parasites (i.e. infections of moderate and heavy intensity infections) cause morbidity that is several orders of magnitude greater than morbidity caused by infections of light intensity infections (Stoltfuz et al., 1996). Subtle morbidity due to light intensity SCH infections has been described (King and Dangerfield-Cha, 2008). This form of morbidity is much less severe than that caused by moderate and heavy intensity infections.

It is complex and cumbersome to count the number of adult worms infecting an individual, so, the number of eggs per gram (epg) of faeces and the number of eggs per 10 mL of urine (produced by the adult worms in the case of *S. haematobium*) is used as a proxy to classify the intensity of infections as light, moderate or heavy (Table 2).

Table 2. Thresholds for classifying the intensity of STH and SCH infections

Species	Light	Moderate	Heavy
Ascaris lumbricoides	1–4999 epg	5000–49 999 epg	≥ 50 000 epg
Trichuris trichiura	1–999 epg	1000–9999 epg	≥ 10 000 epg
Hookworms	1–1999 epg	2000–3999 epg	≥ 4000 epg
Schistosoma mansoni/ *S. japonicum*[a]	1–99 epg	100–399 epg	≥ 400 epg
S. haematobium	1–49 eggs/10 mL urine		≥ 50 eggs/10 mL urine

Source: adapted from *Prevention and control of schistosomiasis and soil-transmitted helminthiasis: report of a WHO Expert Committee* (WHO, 2002) and *The control of schistosomiasis: report of a WHO Expert Committee* (WHO, 1985).

[a] This classification is applied also to *Schistosoma intercalatum* and *S. mekongi*.

2.2 Groups at highest risk of morbidity

The groups at highest risk of infection and subsequently for the development of morbidity are the primary targets for control interventions. Groups at highest risk are slightly different for STH and SCH infections.

2.2.1 Schistosomiasis

The three groups at highest risk of morbidity from schistosomiasis are:

- pre-SAC (this group is currently not included in mass drug administration because an adapted drug formulation is not available). A paediatric formulation of praziquantel adapted to this age group is in development.
- SAC, including children not enrolled in school;
- adolescent and adult populations, with particular attention to:
  - women of reproductive age and
  - occupational groups at higher risk of heavy parasite exposure (e.g. fishermen, farmers).

All groups at risk should receive preventive chemotherapy. However, when resources are limited, SAC are sometimes prioritized for allocation of medicine, followed by other groups most at risk. With regard to presently donated medicines, the balance after covering SAC may be used for other groups at risk.

2.2.2 Soil-transmitted helminthiases

The four groups at highest risk of morbidity from soil-transmitted helminthiases are:

- pre-SAC (aged 2–4 years);
- SAC (aged 5–14 years), including children not enrolled in school;
  - women of reproductive age (aged 15–49 years), particularly adolescent girls (aged 15–19 years) and pregnant/lactating women; and
  - occupational groups at higher risk of heavy parasite exposure (e.g. miners, tea plantation workers).

These groups are identified based on the recognition that children's growth and development require optimal intake of micronutrients and vitamins, which are resources that STH worms compete for. Women of reproductive age experience blood loss with menstruation, and inadequate iron stores or inadequate iron intake from food sources may frequently result in anaemia. STH infections that cause additional blood loss (i.e. *Trichuris trichiura* and hookworms) increase the risk of anaemia.

2.3 Road map 2030 targets for schistosomiasis and soil-transmitted helminthiases

The road map sets targets for EPHP of soil-transmitted helminthiases and schistosomiasis by 2030 (WHO, 2020a). The 2030 global targets and the thresholds under which these diseases are considered eliminated as public health problems at the country level are presented in Table 3.

Table 3. Road map global targets for 2030 and thresholds for EPHP of STH and SCH infections and elimination of transmission of human schistosomiasis

Disease	2030 road map global targets	Thresholds for declaring the infection eliminated as a public health problem
Soil-transmitted helminthiases	• To eliminate the disease as a public health problem in children from 96 of the 101 presently endemic countries. • To establish an efficient programme to reach women of childbearing age with deworming at opportune times when they encounter health services.	< 2% prevalence of moderate and heavy intensity infections in all endemic units
Schistosomiasis	• To eliminate the disease as a public health problem among school-aged children in all 78 endemic countries. • To eliminate infections in humans from at least 25 endemic countries.	< 1% prevalence of heavy intensity infections in all endemic units Zero autochthonous incidence in humans for at least 5 consecutive years.

Source: the road map (WHO, 2020a).

Importantly, countries in which transmission of STH or SCH infections was interrupted (Hasegawa et al., 2020; Kajihara and Hiryama, 2011; Hewitt and Willingham, 2019, Abdul-Raheem et al., 2021, Wang et al., 2021) all established an efficient sanitation infrastructure or implemented environmental changes that impeded environmental contamination with human excreta. Additionally, for schistosomiasis, integrated environmental interventions were undertaken to remove snail habitats (Hewitt and Willingham, 2019; Wang et al., 2021). Eliminating transmission in the short term is achievable in only a minority of countries endemic for STH and SCH infections. For this reason, the main objective of WHO for 2030 is to eliminate or reduce the development of new morbidity in the groups most vulnerable to infection and interrupt transmission of human schistosomiasis in selected countries.

3. Control interventions

Interventions that address both the direct and indirect factors contributing to the transmission and persistence of STH and SCH are crucial for effective control programmes. While there are similarities in control interventions for both diseases, such as mass distribution of deworming medicines and improving access to WASH, specific approaches to their control may vary due to differences in the transmission routes and life cycles of the causative parasites. When designing control interventions, it is therefore important to align strategies where possible while also recognizing the need for divergent approaches when necessary.

3.1 Preventive chemotherapy

To control schistosomiasis and soil-transmitted helminthiases, WHO recommends coordinated, regular administration of benzimidazoles (albendazole or mebendazole and, when necessary, ivermectin) for STH and praziquantel for SCH to groups at risk of morbidity. This intervention is referred to as preventive chemotherapy. It involves large-scale distribution of these medicines, either alone or in combination, within a selected population of a given administrative setting (e.g. a district), irrespective of symptoms or infection status. Currently, some countries receive donated benzimidazole and praziquantel for use in preventive chemotherapy campaigns (see section 4.2 for additional information).

Since 2010, WHO has coordinated three large donations of benzimidazoles and praziquantel to countries in which schistosomiasis and soil-transmitted helminthiases are endemic for use in preventive chemotherapy campaigns. The previous road map (WHO, 2012) aimed at achieving ≥ 75% coverage with preventive chemotherapy as the target for 2020. From 2010 to 2020, medicine donations were used to cumulatively treat more than 3.9 billion children with benzimidazoles and over 626 million SAC with praziquantel, reaching coverage of 60% in SAC (WHO, 2019).

Globally, these efforts, and interventions other than preventive chemotherapy, have significantly impacted morbidity related to SCH and STH infections . In 2019, the number of disability-adjusted life years (DALYs) lost due to STH infections was estimated at 1.9 million, a reduction from 4 million in 2000. For SCH infections, DALYs reduced from 2.2 million in 2000 to 1.6 million in 2019 (Montresor et al., 2022; WHO, 2020b). This equates to a reduction in the number of DALYs lost in the order of 53% for soil-transmitted helminthiases and of 24% for schistosomiasis. A systematic review of the effect of preventive chemotherapy on schistosomiasis during the past 20 years showed a prevalence reduction of 60% in SAC (Kokaliaris et al., 2022).

3.1.1 Informing the selection and frequency of drug distribution

Monitoring and evaluation activities are crucial to determine the frequency of drug distribution and to select the appropriate medicines for effective intervention. Preventive chemotherapy must be administered regularly because, without changes in behaviour and improvements in water and sanitation, the parasites will continue to contaminate the environment and the prevalence and intensity of infection will tend to return to pre-intervention levels. Repeating the intervention at regular intervals aims to keep the number of parasites in each individual from accumulating, thus keeping morbidity low (Gabrielli et al., 2011).

To obtain maximum efficacy at minimum cost, the frequency of preventive chemotherapy interventions should be adapted to the current epidemiological situation (details on assessing the epidemiological situation are provided in Chapters 4 and Annex 4). The initial intervention is generally non-restrictive to ensure that everyone in need is treated. However, the frequency of preventive chemotherapy is progressively adapted to the impact of the intervention in different areas (i.e. the frequency can be increased in the case of SCH hotspots or high prevalence settings or reduced in the case of successful impact). Prevalence thresholds to guide decision-making on the number of treatment rounds needed at baseline and after 5 years of implementation are provided within their respective chapters and in the decision trees in Annex 2, A2.1 (for STH infection) and A2.2 (for SCH infection).

The thresholds for intervention following a baseline assessment are presented in Table 4. When prevalence estimates are available for each group at risk, group-specific treatment decisions should be made based on the group-specific prevalence estimate. However, if separate prevalence estimates are not available, the prevalence estimate for SAC can be used to guide treatment decisions for other groups at risk.

Table 4. Prevalence thresholds for preventive chemotherapy intervention for STH and SCH infections before any intervention (i.e. no previous control activities; see also decision trees in Annex 2, A2.1 for STH and A2.2 for SCH)

Soil-transmitted helminthiases	< 20% prevalence	≥ 20 and < 50% prevalence	≥ 50% prevalence
	No PC needed	PC once a year targeting all	PC twice a year targeting all
	(Use clinical approach)	groups at risk	groups at risk
Schistosomiasis	< 10% prevalence	≥ 10 and < 50% prevalence	≥ 50% prevalence
	- No PC needed (test and treat or clinical approach)	PC once a year for the entire population aged 2 years and older	PC once a year for the entire population aged 2 years and older[a]

PC: preventive chemotherapy.

[a] If financially possible, communities where baseline prevalence is ≥ 50% in school-aged children should be administered two treatments a year to the entire population and encouraged to conduct early prevalence surveys after 3 years with ≥ 75% coverage (WHO, 2022b).

3.1.2 Reaching groups at risk

Preventive chemotherapy interventions should be implemented for all groups at risk of morbidity from SCH and STH infections (see section 2.2) at the recommended frequency (based on survey results).

For STH infections, pre-SAC are normally reached through child health days, vaccination campaigns, vitamin A supplementation campaigns, or similar health campaigns. SAC are normally reached efficiently through schools, while women of reproductive age are reached through well-woman clinics, and antenatal and postnatal clinics.

For SCH infections, where there is a need to include adults and pre-SAC, these groups are reached through community-based distribution, which also allows SAC not attending school to be reached. Since there are different modalities for reaching the different groups at risk, it is essential to coordinate service providers to avoid duplication of efforts. Several delivery platforms can be coordinated to increase coverage and integrate deworming in existing programmes, such as school health and maternal and child health, for sustainability. For example, in the case of schistosomiasis, efforts to reach the entire community can be coordinated with school-based interventions for the soil-transmitted helminthiases control programme.

3.2 Improvement of access to water, sanitation and hygiene

STH and SCH cannot be transmitted without environmental contamination with human excreta: faeces (for intestinal SCH and STH) and urine (for urogenital SCH). Only improvements in access to safe, managed water sources, sanitation facilities, and appropriate changes in human behaviour to a level that impedes this contamination will permanently interrupt transmission of these parasites (Jourdan, Montresor and Walson, 2017; Hewitt and Willingham, 2019).

Managers of neglected tropical disease (NTD) control programmes in health ministries have neither the expertise nor the resources to directly implement large-scale WASH improvements. As such, the role of the NTD programme manager is to promote behavioural change through health education and to coordinate closely with sectors other than health under which WASH falls (i.e. environment, water, local government) to ensure that resources are allocated and interventions are focused in areas endemic for STH and SCH.

For additional strategic priorities and guidance on WASH, see *Ending the neglect to attain the sustainable development goals: a Global Strategy on water, sanitation, and hygiene to combat neglected tropical diseases 2021–2030* (WHO, 2021b), a companion document to the road map. More specific guidance on achieving these priority actions is outlined in *WASH and health working together: a 'how-to' guide for NTD programmes* (WHO, 2023a).

3.3 Implementation of environmental controls

Schistosomiasis has an intermediate snail host and, where feasible, requires vector ecology management (WHO, 2017a) consisting of drainage, water canal cleaning and the use of biological and chemical agents to reduce snail populations (molluscicide). Focal molluscicide can be recommended in specific situations, such as in areas of persistent transmission, when cases of schistosomiasis are identified in new areas not normally associated with transmission, or when interruption of transmission is the goal.

3.4 Integration of the One Health approach

Interventions to control and eliminate schistosomiasis and soil-transmitted helminthiases consider the interconnection among people, animals (including veterinary interventions) and their shared environment and are essential to achieve optimal health outcomes. This One Health approach relies on shared and effective governance, communication, collaboration and coordination among different sectors. Indeed, *S. japonicum* is now largely transmitted among animal reservoirs, which contributes largely to human transmission. A One Health approach makes it easier for people to better understand the co-benefits, risks, trade-offs and opportunities to advance equitable and holistic solutions (WHO, 2023b).

Dr Miguelhete J. Lisboa performing a parasitological test on urine samples, Pemba Province, Mozambique, 2011. © WHO/Amadou Garba Djirmay

4. Monitoring and evaluation framework

4.1 Programme phases and monitoring and evaluation activities

To assist programme managers in planning interventions to achieve the road map targets for 2030, an integrated control programme overview for soil-transmitted helminthiases and schistosomiasis is presented below. Four distinct programme phases are identified along with key control interventions and monitoring and evaluation activities for each phase.

Importantly, this structure is intended to serve only as a blueprint, as the actual evolution of a country's programme will vary. The actual time required to move from one phase to another will be context-specific and dependent on factors such as the baseline prevalence, the coverage and frequency of deworming, WASH coverage, environmental control, One Health implementation and impact assessment. In addition, progress through the phases is not expected to be uniform throughout the country; it is possible that morbidity is eliminated in some areas but is still present in others. The collection of epidemiological data will allow the programme to focus on those areas where infections are still problematic and reduce the frequency of drug administration where the situation is under control.

Fig. 1 presents the phases of a control and elimination programme.

4.1.1 **Nascent phase** (1st and 2nd programme year)

In the nascent phase, the programme collects baseline data and distributes preventive chemotherapy interventions that have been pilot tested in limited areas. The programme manager becomes familiar with the process and the associated programmatic activities, and identifies facilitators and barriers at a scale where it is easy to address before scaling-up.

4.1.2 **Maturing phase** (3rd and 4th programme year)

In the maturing phase, the programme is scaled up and reaches all endemic areas needing treatment. For populous countries, interventions are scaled up through a phased approach before reaching national coverage of all endemic areas. Several rounds of preventive chemotherapy may be needed before effective coverage (i.e. ≥ 75%) among pre-SAC and SAC is reached.

4.1.3 **Mature phase** (5th to 9th programme year)

In the mature phase, the programme is scaled up to implement full distribution with effective coverage. As administrative units reach the end of this phase, impact assessments are undertaken. Programmes should consider that in an area with an extremely high baseline prevalence and intensity, 5–6 years of preventive chemotherapy distribution will likely be insufficient to eliminate morbidity; in this case, the "mature" phase will be extended.

4.1.4 Elimination as a public health problem

If the impact survey results demonstrate that the prevalence of moderate and heavy intensity STH infection is < 2% or that the prevalence of heavy intensity SCH infection is < 1% in all formerly endemic areas, a validation process can be initiated (with details forthcoming in the disease-specific EPHP manuals).

Programmes should realize that progress towards achieving EPHP targets will not be homogeneous throughout the country. In this case, parts of the country will continue the intervention (as described in the mature phase), while the other parts will enter the maintenance phase until the entire country achieves EPHP and the dossier for validation is submitted to WHO.

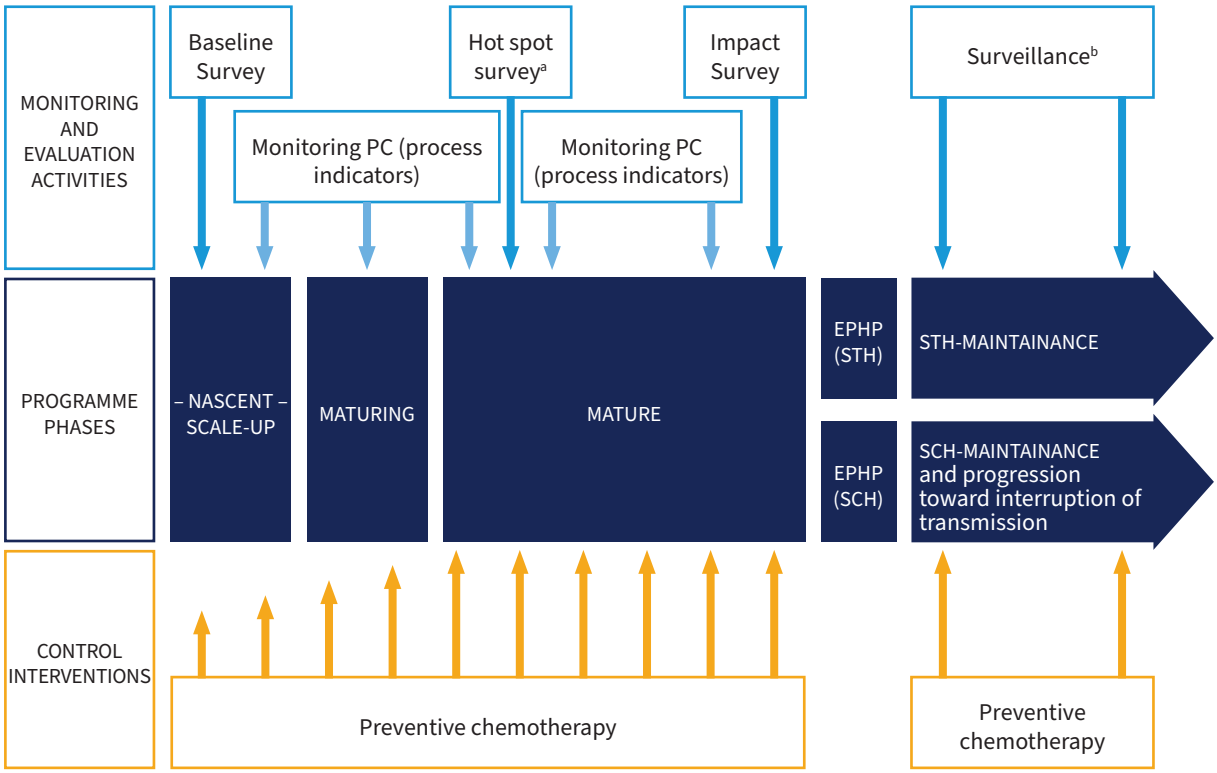
4.1.5 Maintenance (ongoing)

In the maintenance phase (after EPHP), a low prevalence of infection may still be present. Prevalence is expected to decline progressively, and reducing the frequency of preventive chemotherapy administration may be necessary to maintain programme gains and prevent rebound of infection. Surveillance is undertaken until there is no risk of rebounding of prevalence and intensity of infection. Additional details on surveillance are forthcoming in the EPHP manuals.

Schoolchildren, São Tomé and Príncipe, 2014.
© WHO/Mariama Sani Lamine

Fig. 1. Phases of control and EPHP programmes with corresponding intervention and monitoring and evaluation activities

The programme phases are marked in blue: for STH and SCH, control and monitoring activities are normally conducted jointly until EPHP is achieved. However, the validation process for EPHP is separate for the two diseases because of their different characteristics. The monitoring activities are marked in blue: the surveys are in dark blue, and the collection of other information (e.g. PC coverage) is in pale blue; the preventive chemotherapy interventions are marked in orange and do not represent the number of rounds to provide: the figure presents the linear progression of the programme into different phases, assuming the monitoring results confirm the expected impact. Corrective measures should be taken if this is not the case (see decision trees in Annex 2, A2.1 for STH infection and A2.2 for SCH infection). Arrows are for illustrative purposes only and do not represent the number of rounds of PC or years of PC.



EPHP: elimination as a public health problem; PC: preventive chemotherapy; SCH: schistosome; STH: soil-transmitted helminth.

[a] To be conducted in selected areas (with suspected high transmission of SCH infection) after at least 2 years of PC (see Chapter 4 and Annex 2, A2.2c).

[b] After a country has been validated for EPHP, post-validation surveillance is recommended. However, surveillance is also recommended in any implementation unit that has reduced the frequency of PC distribution or achieved the EPHP target. Sentinel site surveillance may also be conducted throughout the programme (see Chapter 4).

4.2 Indicators for monitoring and evaluation

Monitoring the implementation of preventive chemotherapy interventions, including the proper management and allocation of medicines, is an essential activity for all programmes. Along with morbidity-related impact indicators, monitoring typically involves using process and performance indicators (i.e. indicators that measure the effective implementation of the control programme).

4.2.1 Epidemiological indicators

The epidemiological indicators to be calculated to guide programme activities are shown in Tables 5 and 6.

The prevalence of any STH or any SCH infection provides information about the efficiency of transmission in the surveyed area (in case of a baseline survey, in the absence of control activities). It is used to assess the need and frequency of interventions.

The prevalence of moderate and heavy intensity infections for STH and the prevalence of heavy intensity infections for SCH provide information about the proportion of individuals within the risk group of interest who may be suffering more because of the infections. These indicators evaluate whether morbidity due to STH or SCH infections has been eliminated as a public health problem.

Table 5. Key parasitological and morbidity indicators collected during baseline and impact assessments

Parasitological indicator	Use	Calculation	Expectations or goals
Prevalence of any STH infection Prevalence of any SCH infection	To evaluate the proportion of individuals infected and to identify the appropriate control intervention	*Numerator*: number of individuals testing positive[a] *Denominator: number of individuals providing a specimen*	The prevalence of infection is progressively reduced, allowing a parallel adaptation of the frequency of PC. For SCH, this indicator can be used to identify potential hotspots.
Prevalence of STH infection, by species	To evaluate if any STH species is more prevalent and to select the most appropriate medicine for the PC intervention	*Numerator*: number of individuals testing positive *for each species* *Denominator: number of individuals providing a specimen*	The prevalence of infection is progressively reduced, allowing a parallel adaptation of the frequency of PC.
Prevalence of SCH infection, by species	To evaluate the need for additional activities (i.e. targeting female genital schistosomiasis in the case of *S. haematobium*)		Additional control activities are implemented to control female genital schistosomiasis in areas of high prevalence of *S. haematobium* (i.e. training of health personnel, screening of women, health education).
Morbidity indicators			
Prevalence of any MHI infection due to STH	To evaluate the proportion of individuals with potential morbidity attributable to STH and SCH	*Numerator*: *number of individuals with MHI infection* *Denominator: number of individuals providing a specimen*[a]	The prevalence of MHI or HI infection is progressively reduced. The diseases are EPHPs.
Prevalence of any HI infection due to SCH	To evaluate the progression of the programme towards EPHP of STH and SCH	*Numerator*: *number of individuals with HI infection* *Denominator: number of individuals providing a specimen*[a]	

EPHP: elimination as a public health problem; HI: heavy intensity; MHI: moderate and heavy intensity; PC: preventive chemotherapy; SCH: schistosome; STH: soil-transmitted helminth.

[a] Care should be taken to properly account for coinfections when calculating these indicators.

The assessment of morbidity due to STH and SCH infections in a control programme is based mainly on the measurement of infections of moderate and heavy intensity. Under certain operational conditions, additional indicators such as haematuria, blood in stool and ultrasound lesions can be considered. These indicators could provide supplementary information on morbidity (Table 6).

Table 6. Additional indicators of morbidity in schistosomiasis and soil-transmitted helminthiases control programmes

Infection	Additional indicator	Method
Soil-transmitted helminthiases and schistosomiasis	Mean STH/SCH epg in the population	Arithmetic or geometric
Urogenital schistosomiasis	Prevalence of blood in the urine	Reporting of blood in urine, visual examination or reagent strips
	Prevalence of lesions in the urinary tract	Ultrasound (WHO, 1996)
	Prevalence of genital manifestations of schistosomiasis[a]	Clinical examination, colposcopy, ultrasound of pelvic organs
Intestinal schistosomiasis	Prevalence of blood in stool (including persistent bloody diarrhoea)	Reporting, visual observation, reagent strips
	Prevalence of lesions in the liver, spleen and portal veins, presence of ascites.	Ultrasound (WHO, 1996)

epg: eggs per gram; SCH: schistosome; STH: soil-transmitted helminth.

[a] Known as female and male genital schistosomiasis.

4.2.2 Process indicators

Once the control programme has started, the first monitoring activity is to assess the appropriateness of the drug procurement process. This includes the timely arrival of medicines in the central pharmacy and peripheral storage depots; the storage conditions; the appropriateness of the quantity of medicines and their expiry dates; the availability of weighing scales or tablet poles for the administration of praziquantel; the availability of reporting forms and education materials; and the appropriateness and quality of training and the attendance and competencies of trainees. These data are normally derived from forms completed when the medicines and other materials are received in the central pharmacy and during training activities. Additional aspects may also be evaluated, such as the training of all categories of people involved in delivering the programme's activities (health workers, teachers, community drug distributors, etc.) and the content of health education activities. The condition of latrines and the quality of water supplies in schools may also be monitored if their improvement is one of the programme's objectives.

The specific process indicators collected will depend on the activities the programme is implementing. Indicators are normally more accurate if collected immediately after the relevant event (e.g. for attendance at training sessions, it is better to compile the list of participants immediately after the training). Selection of process indicators, their calculation and use, and the expectations or goals of an effective deworming programme are presented in Table 7.

Selection of appropriate medicines

Several considerations are relevant when selecting a medicine for distribution against STH. Firstly, the age of the target group is important. For pre-SAC, it is preferable to use dissolvable or chewable formulations, such as mebendazole, to prevent choking incidents. Secondly, the prevalence of different STH species should be considered. If hookworms are the predominant species, albendazole is the preferred choice. Conversely, if *T. trichiura* (whipworm) is dominant, albendazole is preferable, potentially supplemented with ivermectin (Hürlimann et al., 2022) as provided by preventive chemotherapy for treatment of lymphatic filariasis. Importantly, it is advisable not to treat the entire population for STH to mitigate the risk of drug resistance. Instead, targeting only the population groups at risk of morbidity ensures effective intervention while minimizing the emergence of resistance. Donated albendazole and mebendazole are available for the treatment of soil-transmitted helminthiases.

For SCH infections, the recommended medicine is praziquantel. Unlike STH infections, treating the entire population is necessary for schistosomiasis. Praziquantel is available as a donation with priority given to distribution among SAC. Paediatric praziquantel is now available for the treatment of pre-SAC.

Estimated number of tablets needed per round of preventive chemotherapy

Benzimidazoles (for STH) are administered as a single tablet (500 mg mebendazole/400 mg albendazole) to all members of groups at risk for each round of preventive chemotherapy.

Praziquantel (for SCH) is administered at 40 mg/kg using, generally, a dose pole for mass treatment. Therefore, the dose for each individual will differ. To estimate the number of tablets needed in a population, it is suggested to use an average of 2 tablets needed for each SAC and 3 tablets needed for each adult for a single round (Garba et al., 2024).

For donation requests to WHO, the tablet quantities are automatically calculated based on the populations provided in the *Joint Request for Selected PC Medicines* (JRSM) form (WHO, 2024).

To optimize distribution, it is suggested to send approximately 85% of tablets to the peripheral distribution sites and to keep the remaining tablets at the central level. The remaining tablets can be distributed from the central level to fulfil additional needs. System and financial resources should be made available to the national programme to cover inter-district shipment and movement of medicines.

Balance of unused tablets

Special attention should be given to the balance of unused tablets to avoid expiration and maximize benefits. There are different options for using unused tablets that depend on the quantities, the storage conditions (open or closed containers), the expiration date and the cost of reverse logistics.

The following strategies should be considered:

- Open containers and closed containers with short expiration dates. if quantities are sufficient, organize distribution to groups at risk who have not been initially targeted (for example, after a school distribution of benzimidazoles, the remaining medicine can be used to treat women of reproductive age and cases of female genital schistosomiasis); if the quantities are limited, the medicine can be transferred to nearby health units for use in

clinical services. The number of people treated with the open containers tablets need to be reported.

- Closed containers with long expiration date (over one year). These tablets should be kept in the health units for use in future preventive chemotherapy interventions or collected and stored at the central level (the cost of reverse logistics should be evaluated).

In any case, the presence and use of the unused tablets should be reported in the Joint Application Package (see Annex 3, A3.11).

Table 7. Process indicators, their calculation and use, and expectations or goals

Use	Process indicator	Calculation	Expectations or goals
To evaluate the efficiency of the drug procurement and storage process; to evaluate management of the drug supply	Drug quality and shelf-life	- Quality control (for non-donated medicines[a]) - shelf-life exceeds 2 years	Drug of appropriate quality received at least 2 years[b] before the expiration date
	Drug procurement[c]	*Numerator:* Quantity of the drug self-procured *Denominator:* Quantity of drug needed	The country becomes progressively self-sufficient in drug procurement
	Drug distribution at peripheral units	*Numerator:* Number of distribution points (schools / health units) receiving the drug supply in time and appropriate quantity for the drug administration *Denominator:* Total number of schools/health units targeted by the programme	≥ 95% of the participating distribution points received the drug(s) at the appropriate time and in adequate quantity
	Drug expiration	*Numerator:* Number of tablets expired in the central storage facility *Denominator:* Number of tablets procured	< 5% of tablets are expired
	Theoretical drug balance	Number of tablets procured – Number of tablets distributed	N/A
	Drug tablets lost or unaccounted for	*Numerator:* Theoretical drug balance – actual drug balance (i.e. stock) *Denominator:* Number of tablets procured	< 10%

(Continued)

Table 7. Contd.

Use	Process indicator	Calculation	Expectations or goals
To evaluate the efficiency of the distribution of supporting materials	Presence of tablet poles or weighing scales for praziquantel administration	*Numerator:* Number of distribution points (schools/ health units) receiving drug administration tools on time and in appropriate quantity for the campaign *Denominator:* Total number of distribution points (schools/ health units) covered by the programme	All schools/health units receiving praziquantel also received tablet poles or weighing scales for distribution
	Presence of reporting forms	*Numerator:* Number of distribution points receiving reporting forms on time and in appropriate quantity for the campaign *Denominator:* Total number of distribution points covered by the programme	All schools/health units received reporting forms
	Presence of health education materials	*Numerator:* Number of distribution points receiving health education materials on time and in appropriate quantity *Denominator:* Total number of distribution points covered by the programme	All schools/health units received education materials in time to organize health education sessions
	Presence of training materials	*Numerator:* Number of trainers receiving material on time and in appropriate quantity for organization of training sessions *Denominator:* Total number of distribution points (schools/ health units) covered by the programme	All trainers received training materials in time to organize training sessions
Training need assessment	Number of training sessions and their adequacy	Questionnaire, pre-test, and post-test conducted during the training activities	Supervisors, teachers, peripheral health workers, nurses, community drug distributors, laboratory technicians, etc. are trained

N/A: not applicable.

[a] For donated medicines, WHO assures their quality.

[b] At the moment, the total shelf-life of praziquantel is 2 years.

[c] Self-sufficiency in drug procurement is one of the targets of the road map (WHO, 2020a).

Source: adapted from *Helminth control in school-age children: a guide for managers of control programmes* (WHO, 2011).

4.2.3 Performance indicators

Performance indicators assess the programme's success in reaching the target population(s). These indicators and their calculations are listed in Table 8. Data for their calculations are normally obtained from the forms completed during drug administration at the drug distribution points.

These indicators should be collected immediately after administering a round of deworming medicines to increase accuracy.

Drug coverage (i.e. the proportion of individuals in each group at risk receiving the medicine) is the key indicator collected to assess the programme's performance. For school programmes, both enrolled and non-enrolled SAC should be included in the distribution and coverage calculations (Montresor et al., 2001). It is advisable to periodically conduct a "confirmation survey" in a small sample of schools to compare the data reported by distributors with those collected in the survey.

These indicators should be collected immediately after administering a round of deworming medicines to increase accuracy. The timely collection of the reports will allow the programme to report treatment results and drug utilization and request enough drugs for the next campaign. Evaluation meetings are organized in some countries to facilitate the prompt collection of the results immediately after the campaign.

Table 8. Performance indicators, their calculation and use, and expectations or goals

Use	Performance indicator	Calculation	Expectations or goals
Evaluating the extent of the programme and its relevance in the school/ health system	Percentage of distribution points (e.g. schools/ health units, communities) participating in the programme	*Numerator:* Number of distribution points (schools/ health units, communities) participating *Denominator:* Total number of (schools/health units) in the targeted areas	≥ 90% of the points (schools /health units) in the area participated
To optimize the amount of medicine provided to the different distribution points (schools/health units)	Number of tablets administered Number of distribution points (schools /health units, communities) with an insufficient amount of medicine Number of unused tablets	From programme forms (preferably electronic forms)	Each distribution point (schools/health units) received enough medicine < 10% of tablets are unused
Determining the proportion of individuals receiving the intervention	Coverage[a]	*Numerator:* Number of individuals[b] receiving the medicine(s) (by group at risk) *Denominator:* Total number of individuals[b] in the area of intervention (by group at risk)	≥ 75% of individuals receiving the medicine in each group at risk

[a] This indicator is the most important performance indicator: reaching at least 75% of the target risk group has been identified by WHO as a minimal coverage target for endemic countries. Guidance on coverage evaluation surveys is available in Annex 3, A3.10, and on data quality assessment in Annex 3, A3.9.

[b] In the case of a school programme, both numerator and denominator should include non-enrolled school-aged children.

Source: adapted from *Helminth control in school-age children: a guide for managers of control programmes* (WHO, 2011).

4.2.4 WASH and snail control indicators

The control interventions implemented by the NTD control programme to progressively reduce the prevalence and intensity of soil-transmitted helminthiases and schistosomiasis consist primarily

of preventive chemotherapy accompanied by health education and behavioural change, WASH, environmental management and snail control (for SCH) in order to reduce transmission.

The quality of data on preventive chemotherapy for NTDs received by national programmes is at times incomplete, untimely and of questionable accuracy. As the goals for control and elimination of NTDs, as endorsed by the World Health Assembly and published in the road map (WHO, 2020a), approach, programmes must ensure that high-quality data are available and used effectively for decision-making. WHO guidance is available on improving the quality of reported data (WHO, 2019); see also Annex 3, A3.9.

Indicators of water and sanitation interventions

Interventions to improve the standard of sanitation are essential for long-term improvement. These interventions are normally not implemented by the NTD control programme but by other sectors that are more competent in this area, such as the Ministry of Labour or the Ministry of Infrastructure (Boisson et al., 2016; WHO, 2021b). Water and sanitation interventions should have very high coverage and require long-term implementation before an impact on transmission is observed.

WASH data are challenging to collect in a standardized way, so regular collection of these data is not normally conducted by personnel in soil-transmitted helminthiases and schistosomiasis control programmes. However, the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) produces estimates of national, regional and global progress on WASH (JMP, 2024a). This information, along with the JMP WASH indicators presented in Table 9, could be considered to better interpret the epidemiological data collected by the programme. For example, a significant reduction in prevalence and intensity may be considered stable if accompanied by improved sanitation indicators.

Table 9. WASH indicators

Indicator	Definition	Global target
Water supply	Proportion of population using basic drinking-water from an improved source[a]	100%
Sanitation	Proportion of population using improved facilities that are not shared with other households	100%
	Proportion of population practicing open defecation	0%
Hygiene	Proportion of population using hand-washing facilities with soap and water at home	100%

[a] Provided collection time is not more than 30 minutes for a round trip, including queuing.

Source: JMP website (JMP, 2024b).

Indicators of snail control interventions

The following indicators are identified for snail control interventions: (i) snail presence/absence; (ii) snail infection rate; and (iii) human infection rate where water contact takes place. More details can be found in the WHO manual *Field use of molluscicides in schistosomiasis control programmes* (WHO, 2017b).

4.3 Epidemiological assessment

4.3.1 Diagnostic techniques

Preferred techniques

For over 40 years, STH and intestinal SCH infections have been diagnosed by direct microscopic examination of parasite eggs in the stool using the Kato–Katz technique. Eggs from urogenital SCH are detected in urine using filtration techniques. These techniques are relatively simple, can be performed in endemic areas, provide the prevalence of infection and can classify the intensity of infection (a potential proxy for associated morbidity). However, these techniques are demanding logistically, may miss infections of light intensity (as egg excretion may be sporadic) and require laboratory technicians who are specially trained in these techniques (Archer et al., 2020). Despite these limitations, Kato–Katz and urine filtration currently remain the best choice for monitoring and evaluating the impact of soil-transmitted helminthiases and schistosomiasis control programmes (Vaillant et al., 2023). Importantly, programme targets and thresholds have been developed using data collected using microscopic techniques.

Alternative techniques

For urogenital SCH, a valid alternative to microscopic methods is the detection of blood in urine with a reagent strip (Wiegand et al., 2021). This semi-quantitative method allows users to estimate the severity of micro-haematuria with the ranges of colouration. Circulating cathodic antigen is another diagnostic test recommended for detection of *S. mansoni* (WHO, 2021a); however, it needs to be validated by positive Kato–Katz or by the presence of intermediate host snails for this parasite in the area.

Recognizing the need for improved diagnostic tools, in 2021 WHO published diagnostic target product profiles for soil-transmitted helminthiases (WHO, 2021c) and schistosomiasis (WHO, 2021d) to promote the development of novel tests (see Annex 3, A3.7 and A3.8). Alternative diagnostic techniques have been developed (Archer et al., 2020; Lim et al., 2018) but are not currently reaching the minimal standards set by WHO diagnostic target product profiles.

4.3.2 Baseline surveys and determination of treatment strategies and targets

Purpose

The purpose of the baseline survey is to:

- identify communities that will require preventive chemotherapy;
- determine the baseline prevalence (i.e. before treatment) that will determine the recommended frequency of preventive chemotherapy (see Annex 2, A2.1 and A2.2);
- evaluate the morbidity caused by the infections in groups at risk (presence of moderate and heavy intensity infections for STH or heavy intensity infections for SCH);
- develop a plan of action and enable integrated interventions targeting different NTDs;
- determine activities for critical interventions other than preventive chemotherapy: WASH, behaviour change, vector ecology management and veterinary public health; and
- provide a reference against which future evaluations can be compared.

Implementation units

Given their differences in distribution and the focal nature of SCH, implementation units (IUs) for STH are normally larger than those for SCH. For STH, the IU normally corresponds to the district. For SCH, the IU is the area at the lowest possible level of implementation (normally communities, villages or sub-districts). The division of a district into multiple IUs is important if certain parts of the district are adjacent to freshwater bodies whereas other areas are not, because SCH transmission occurs primarily in close proximity to fresh waterbody habitats for intermediate host snails.

It is important to evaluate the prevalence and the intensity of STH and SCH infections in each IU of the country. For STH, however, it is not always necessary to conduct surveys in each IU to do this. Rather, it is sometimes sufficient to collect data from only some IUs within an ecological zone to evaluate the prevalence and intensity of IUs in the area. Similarly, for SCH, for villages situated near large water bodies and having the same exposure, it will not be required to survey all the villages; according to the distance from the water bodies (5 km generally), groups of villages can be assumed as having the same level of endemicity for schistosomiasis and surveys carried out in only a few of them. The application of model-based geostatistics and surveys among a limited number of sites can facilitate generation of maps to estimate prevalence and identify areas whose populations are in need of preventive chemotherapy.

Programme initiation

It is important to assess the baseline situation before any preventive chemotherapy intervention has been implemented because this represents the natural level of endemicity and the stable level of transmission of infection in the environment. The baseline prevalence depends on several factors, such as the sanitation level, the population density, the distance and level of contact with contaminated freshwater sources (for SCH), and the humidity and temperature (for STH).

If no control interventions are in place, the prevalence and intensity of infection measured at baseline is normally stable, in the absence of environmental changes such as dam building or new agricultural practice such as irrigation with canals in the case of SCH, and is not expected to increase or decrease significantly over time. Normally, if the baseline prevalence is low (i.e. < 20% for any STH infection and < 10% for SCH infection), it is not necessary to intervene with regular, mass preventive chemotherapy according to the current recommendations.

If epidemiological data are collected after the start of preventive chemotherapy distribution (for example, STH data collected after the implementation of a lymphatic filariasis control programme that distributed albendazole), the data should be analysed as resulting from an impact assessment (even if collected for the first time). This is because the initial STH prevalence will have been affected by the distribution of albendazole targeting lymphatic filariasis.

Ethical aspects

Informed consent, and assent, should be obtained, whenever a preventive chemotherapy programme is being implemented, including for the survey. This consent should be obtained based on the country's requirements and the local context. For example, community sensitization on SAC or parent meetings may be sufficient in most cases; however, more formal consent approaches may be required in some contexts following the specific health ministry procedures in each country.

Where distribution of preventive chemotherapy is not anticipated immediately following a survey, it is important to provide treatment to any positively diagnosed individual. If the prevalence in a

specific setting (e.g. a school) exceeds the thresholds requiring the intervention, all individuals in that setting (e.g. the entire school) should be given preventive chemotherapy.

4.3.3 Impact assessments

Purpose

The main goal of a soil-transmitted helminthiases/schistosomiasis control programme is to reduce morbidity resulting from infections. An *impact assessment* is conducted to evaluate if interventions put in place to achieve this goal are serving their intended purpose. The assessment is a formal, rigorous evaluation (often a parasitological survey) that allows programmes to measure predetermined indicators to understand the current burden of disease following interventions, evaluate the success of the interventions and direct future programming to areas in which morbidity from STH/SCH infection persists and away from areas where morbidity is controlled.

Normally, preventive chemotherapy, if well implemented for 5 years, produces a dramatic reduction in STH and SCH prevalence and intensity of infection in most of the targeted areas. The results of the impact assessment should be used to adapt the intervention to the new epidemiological situation; this adaptation (that frequently consists of a reduction of the frequency of drug administration) will:

- enable better use of existing resources by focusing activities in areas where prevalence is still high, while establishing a surveillance system to avoid rebound;
- reduce the risk of resistance developing in the parasites (studies in the veterinary field have demonstrated that high drug pressure in a population with low prevalence may be counterproductive (Claerebout et al., 2020);
- reduce the cost of the intervention and facilitate programme sustainability; and
- demonstrate programme success and maintain support.

Populations targeted for impact assessments will be similar to those measured during the baseline survey. Indicators collected for impact assessments will be similar to those measured during the baseline assessments.

The possible approaches to conducting impact assessments are similar to those that can be used at baseline (Table 11). It is not necessary to use the same method as that used at baseline; if a more efficient method becomes available, it can be used. For example, the geostatistical approach can be applied to design the impact survey. This approach considers baseline epidemiology, coverage and frequency of drug administration to inform the selection of the sample and efficiencies in the cost of the survey.

Recommended timing of impact assessment

Timing from the start of the programme

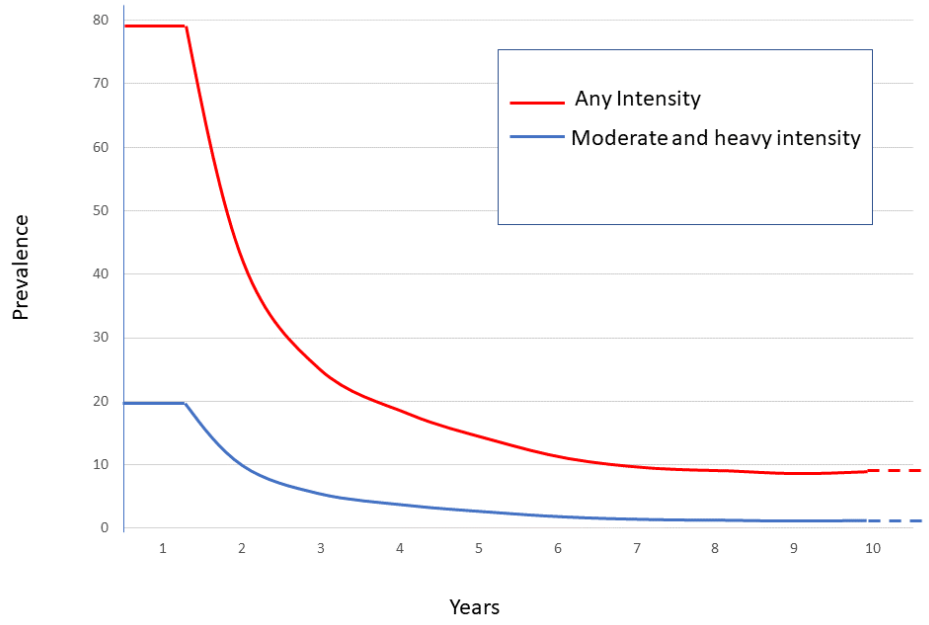
WHO recommends an assessment following, typically, 5 years of preventive chemotherapy distribution with a mid-term evaluation after 2 years in a suspected SCH hotspot and/or sentinel site. During those years, ideally, distribution should have been continuous, regular (typically 1–2 times per year) and have achieved effective coverage (≥ 75% among targeted groups at risk) during each distribution. If there are significant deviations from these conditions, the impact assessment

may be postponed. However, if the deviations are only minor (e.g. only one year of < 75% coverage), the assessment can be done. In moderate or low prevalence areas for SCH, there may be only 2–3 rounds of treatment in 5 years.

The reason for performing the impact assessment after, typically, 5 years from the start of the drug distribution is that, after this time, normally:

- there is a dramatic reduction in the prevalence of infections of moderate and heavy intensity (for STH) or of heavy intensity (for SCH) and an assessment determines if the first objective of the intervention has been reached; and
- the prevalence curve plateaus (Fig. 2) and, once this level has been achieved, programmes should adapt the intervention to the new equilibrium attained.

Fig. 2. Decrease in the prevalence of infection during an STH/SCH control programme



Source: adapted from *Elimination of iron deficiency anemia and soil transmitted helminth infection: evidence from a fifty-four month iron-folic acid and de-worming program* (Casey et al., 2013).

Timing of the survey relative to distribution of preventive chemotherapy

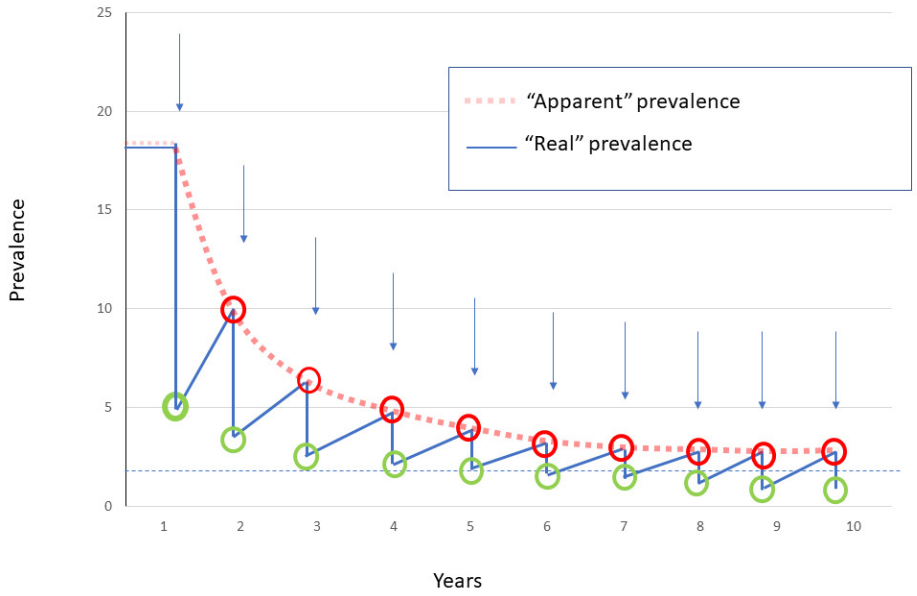
The optimal time for impact assessments is just before distribution of preventive chemotherapy.

- If distributed once a year (or less frequently), logistical considerations might result in the survey being conducted at least 6 months after the distribution.
- If distributed twice a year, the survey window is narrower, and efforts should be made to survey as close to the upcoming distribution as possible, but not more than one month prior.

In this way, both the drug impact and the maximum reinfection observable after the drug distribution will be measured. Data collected at this time point, in a way, represents the worst scenario (Fig. 3) and allows for the measurement of the programme's impact rather than the impact of the previous deworming round.

Fig. 3. Timing of collection of epidemiological data relative to drug distribution

Arrows indicate the preventive chemotherapy distribution rounds; green circles indicate the reduction in prevalence just after the round; red circles indicate the maximum reinfection level just before the next round.



Source: adapted from *Evaluating and mitigating the potential indirect effect of COVID-19 on control programmes for seven neglected tropical diseases: a modelling study* (Borlase et al., 2022).

Interpretation and use of the results

Selecting preventive chemotherapy intervention after assessment

The prevalence of infection measured at impact assessment should be used to select the frequency of preventive chemotherapy for the next part of the programme. The thresholds for frequency are presented in Table 10 and in Annex 2, A2.1 and A2.2. Thresholds are based on the prevalence of infection as measured by microscopic methods (e.g. Kato–Katz for STH and intestinal SCH and urine filtration, or microhaematuria dipsticks for urogenital SCH) and circulating cathodic antigen. Proposed equivalence prevalence thresholds between circulating cathodic antigen and Kato–Katz for *S. mansoni* infection are also available (WHO, 2022b).

When prevalence estimates are available for each group at risk, group-specific treatment decisions should be made based on the group-specific prevalence estimate. If separate prevalence estimates are not available, the prevalence estimate for SAC can be used to guide treatment decisions for other groups at risk.

Note that the interpretation of the results of an impact assessment is different from that of a baseline assessment (Table 10) because the same prevalence has different significance at the two time points. For example, an STH prevalence of 15% at baseline indicates that the infection is not transmitted intensively; normally, infections of moderate and heavy intensity are absent, and therefore no preventive chemotherapy intervention is needed (Montresor et al., 2015). However, an STH prevalence of 15% after 5 years of preventive chemotherapy indicates that transmission of

STH infection is still present despite preventive chemotherapy, and interventions are still needed to avoid rebounding to baseline levels.

Table 10. Prevalence thresholds for preventive chemotherapy intervention for STH and SCH after multiple years of intervention

STH				
Prevalence of infection	< 2%	≥ 2% and < 10%	≥ 10 and < 20%	≥ 20%
Recommended PC frequency	Event-based[a]	Once every 2 years targeting all groups at risk	Once a year targeting all groups at risk	Twice a year targeting all groups at risk
SCH				
Prevalence of any intensity infection	< 10%		≥ 10%[b] ≥ 10%[b]	≥ 50%
Recommended PC frequency	Maintain or reduce frequency[c]		Once a year	Twice a year

PC: preventive chemotherapy; pre-SAC: preschool-aged children; SAC: school-aged children; SCH: schistosome; STH: soil-transmitted helminth; WRA: women of reproductive age.

[a] Several strategies are possible to reach groups at risk with low PC frequency. Example strategies include distributing to pre-SAC at a particular immunization visit; distributing to SAC at school enrollment and graduation; and distributing to WRA at antenatal care.

[b] If resources are available, in case of prevalence ≥ 50%, or hotspot, twice-a-year distribution is recommended.

[c] The choice to maintain or reduce PC frequency (one round every 2 or 3 years) should be based on historical evidence such as the baseline prevalence and transmission factors (in case of baseline prevalence ≥ 50%, it is suggested to maintain once a year).

Identifying and managing hotspots for SCH

A persistent SCH hotspot is defined as an area that demonstrates a < 1/3 reduction in prevalence of *Schistosoma* spp. infection between an initial survey (with prevalence ≥ 10%) and a follow-up survey conducted after at least 2 years of preventive chemotherapy with effective (≥ 75%) treatment coverage (WHO, 2022b).

Potential persistent hotspots for SCH may be identified qualitatively at baseline. Following at least 2 years of preventive chemotherapy where treatment coverage has been ≥ 75%, a survey can be conducted to confirm identification and/or detect persistent hotspots which were not predicted from baseline data. Hotspots may be limited in size and population and are frequently a community or cluster of communities within a sub-district (Kittur et al., 2020).

The baseline assessment could be an opportunity to identify potential hotspots for SCH. For example, if a school or a community has a significantly higher prevalence of SCH infection than that in surrounding communities, and additional sources of information corroborate the infection levels (see below), these may be considered potential persistent SCH hotspots.

- Clinical reports from health units that demonstrate regular (at least monthly) diagnosis of SCH-related morbidity and/or infection (e.g. positive diagnostic tests, blood in urine or stool, dysuria, oliguria, abdominal pain, hepatosplenomegaly, haematemesis/blood vomiting).

- Evidence of frequent human–water contact (e.g. communities where the dominant occupations are itinerant fishing, irrigated agriculture, seasonal migration for livestock grazing, recreational swimming) and where there is a lack of access to safe water sources that leads to use of surface water sources for domestic activities and bathing.
- Proximity (< 5 km) from a water body with *Biomphalaria* and *Bulinus* spp. of snails.
- Evidence of high levels of open defecation and/or low household latrine coverage.
- Historical data or surveys within the previous 3 years that show evidence of the above, including the introduction of infrastructure such as dams or irrigation channels in addition to other ecological, anthropogenic, parasite or host factors (Mawa et al., 2021) and which demonstrate high levels of infection.
- Community outcry.
- Evidence of potential never treated population.

Identifying hotspots for SCH

There is currently limited evidence to support the most efficient design and sample size for a survey that can detect hotspots by robustly measuring a less than one-third relative reduction in prevalence from baseline after at least 2 years of annual preventive chemotherapy. Operational research is ongoing, but, until further evidence is available, this survey could be approached by a programme in several ways.

a) Where resources are limited, data collection for a separate hotspot survey may not be feasible and the detection of hotspots could be built into an impact assessment following five rounds of annual preventive chemotherapy for SCH.

Primary school students learning to identify the intermediate snail host of schistosomiasis, Jiangling County, Hubei Province, 2012. © NIPD Shanghai, China/ Xia Li

b) Where baseline infection (and water contact behaviour), ecological, environmental and possibly anthropogenic (e.g. land or water use changes) data are available *and* where there is geostatistical capacity, spatial analyses can be performed to identify potential hotspots using these data sources.

c) Where there are sufficient resources, a separate hotspot survey can be conducted following at least 2 years of annual preventive chemotherapy. This survey could use:

- a sentinel site approach, in which infection prevalence and additional data have identified potential persistent hotspots at baseline. These locations and their closest neighbours could be sampled after 2 years of effective preventive chemotherapy distribution. Sample size should be sufficient to detect a 1/3 relative reduction from baseline.
- an adaptive sampling approach, in which one might first fit a geospatial model to predict hotspot certainty (see b) and then adaptively sample locations of high uncertainty with good spatial coverage to confirm these are not hotspots.

Managing hotspots for SCH

If SCH prevalence in the suspected hotspot is reduced by less than 1/3 from the baseline, the presence of a persistent hotspot is confirmed. Increasing distribution of preventive chemotherapy from once-a-year to twice-a-year for the entire population is recommended (WHO, 2022b) and can be maintained for the following 3 years until the impact assessment is conducted.

In addition to preventive chemotherapy, increasing coordination with WASH stakeholders locally is recommended to increase initiatives aimed at improving water and sanitation interventions and infrastructure. Additionally, intensifying and tailoring social and behavioural change communication, along with snail mapping and vector ecology management are crucial. In specific contexts, veterinary public health interventions are also needed to reduce the transmission potential.

Example

A baseline survey for STH and SCH was conducted using a stratified sampling method in a region comprising five districts. A total of 18 schools were surveyed in the region. Results indicated a SCH prevalence of 9% in the districts not bordering the lake and of 25% in the districts bordering the lake (Fig. 4). An annual intervention with single, annual administration of praziquantel was selected for the three districts bordering the lake, whereas no SCH interventions were planned in the districts not bordering the lake.

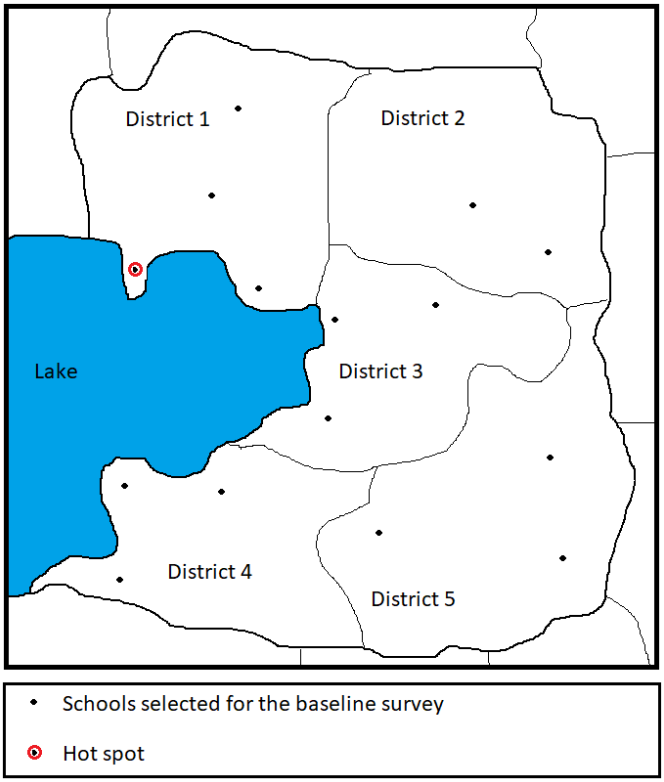
However, the baseline survey identified one school (which had a prevalence of 45%) as a suspected SCH hotspot. Therefore, a hotspot survey was conducted after 2 years of effective preventive chemotherapy distribution. Results indicated an estimated prevalence of 35%. The percentage reduction in prevalence was calculated to be:

$$\frac{(45\% - 35\%)}{45\%} \times 100 = 22\%$$

Because the reduction was less than 33%, the hotspot was confirmed, and the frequency of preventive chemotherapy was increased to twice a year.

The location of the hotspot suggested investigations of nearby schools in district 3 were warranted to assess if similar high-prevalence situations are occurring.

Fig. 4. Map showing the location of the hotspot



Practical approaches to reducing the frequency of preventive chemotherapy

Reducing the frequency of preventive chemotherapy from once-a-year to once every 2 or 3 years does not mean that the programme stops for one year. Rather, the programme staff and activities will rotate from year to year (e.g. half of the districts warranting preventive chemotherapy will be treated in even years and the other half in odd years). For event-based preventive chemotherapy, annual treatment continues, as a new cohort warrants treatment each year (e.g. students entering their first year of school). For sustainability, at the same time, the programme should aim to improve health facility-based treatment and integrate distribution into child and reproductive health programmes.

Assessing elimination as a public health problem

The prevalence of the classes of infection intensity measured by an impact survey should be used to assess if the programme has met the EPHP target in the IU. For STH, the EPHP target has been achieved in the IU if the prevalence of moderate and heavy intensity infection is < 2%, and for SCH, if the prevalence of heavy intensity infection is < 1%.

If the impact survey results demonstrate that EPHP has been achieved in all formerly endemic IUs in the country for at least 3 consecutive years, the programme manager should initiate the validation process (see Annex 3, A3.12 and A3.13).

Communicating findings to WHO

Survey results are used by WHO to demonstrate progress and to allocate resources to countries. There is an ethical implication to withholding data, as the absence of data can hamper programme implementation. For example, groups at risk may not receive the most appropriate treatment frequency, or resources may be wasted if treatment continues to be allocated to those no longer at risk.

Therefore, IU-level survey results should be communicated to WHO by the programme manager within 3 months of the end of the survey (using the Epidemiological Reporting Form); see Annex 3, A3.11). This timeline should also be adhered to where a research institute has been responsible for the survey. Sharing the survey results should not be postponed for any reason (e.g. after publication in a scientific journal), as these data are essential to assess the global progression towards the road map targets, to forecast the need for future medicine supplies, to allocate available resources properly and to allow for the validation of elimination of these diseases as public health problems.

Individual-level data shared with WHO are not publicly available. Site-level prevalence estimates are made publicly available for the WHO African Region through the ESPEN portal.

4.3.4 Sentinel site surveillance

After the impact survey is conducted, a general decrease of the prevalence and intensity of STH and SCH infections is normally observed. It is not expected that all the areas of the country will respond in the same way to the first 5 years of preventive chemotherapy, but, generally, in several IUs it will be possible to decrease the frequency of the intervention (see Table 10).

Following a decrease, it is recommended to maintain monitoring of the prevalence of STH and SCH to confirm that the reduced frequency is sufficient to maintain the benefits obtained by the previous frequency of preventive chemotherapy. This monitoring should be cost–effective and should not be designed to precisely estimate the prevalence. Instead, the objective should be to identify the early signs of a rebound in prevalence. This way, the programme can take prompt action in response.

Decentralized and integrated monitoring systems are advised. One suggested method for this surveillance is by **sentinel sites**. By exploring the results of the baseline and impact surveys, a programme may be able to identify schools/communities where the risk of rebound is high, for example:

- schools/communities where the prevalence/intensity of infections was particularly high at baseline or impact assessment;
- schools/communities where the prevalence of infection was reduced by less than 1/3 from baseline to impact assessment;
- schools/communities where the prevalence was higher at impact assessment; and
- schools/communities where the environmental indicators are suggestive of sustained transmission.

The focus is therefore on identifying the schools/communities with the highest risk of rebound. The assumption is that if rebound does not occur in these high-risk sites, it is unlikely to happen in sites with lower risk.

While little evidence is available to support what an appropriate signal might be, an increase of approximately 10 percentage points in the sentinel site seems to be a reasonable threshold to trigger a more detailed investigation.

4.3.5 Epidemiological survey methods and approaches

Multiple approaches are possible for conducting an epidemiological assessment. The selection of the most appropriate or most convenient method will depend on the size of the country (or region, district, or IU), the previous experience of those responsible for the collection and analysis of the parasitological data, the capacity for data analysis, the availability of technical support and the availability of funding, among other considerations.

Table 11 presents possible approaches to conducting surveys for epidemiological assessments. Historically, cluster surveys conducted among SAC have been recommended by WHO and have been frequently used by country programmes to estimate prevalence at baseline. The principle is that all individuals living in the same contaminated environment are at risk, and if SAC need interventions, other community members do as well (e.g. pre-SAC, women of reproductive age and all adults (for SCH)).

The main drivers of cost in NTD surveys are the personnel (per diem, hotel) and transportation (car rental, fuel) costs. This is linked to the number of days survey teams are required to spend in the field, which is directly related to the number of clusters (schools/communities) surveyed (Slaven et al., 2020; Elhag et al., 2020). The more clusters required to generate prevalence estimates, the more costly the surveys become. WHO recommends decentralized surveys by district teams after training with appropriate and strict supervision (e.g. cross-checks by referral public health laboratories). This aims to obtain the best survey results with minimum cost and help integrate and sustain survey activities in the health system instead of a national team moving around the entire country.

Hematuria testing using a dipstick, Sirignere, Niger, 2010.
© Anna Phillips

Table 11. Possible approaches to conducting surveys for STH/SCH epidemiological assessments

Survey method	Approach overview	Evaluation unit	Assumptions	Advantages & disadvantages	Indication
Stratified sampling (with or without clusters)	To determine ecological zone level prevalence and support treatment decisions. 1. Area to be surveyed is divided into strata (according to disease ecology) 2a. In each stratum, random sampling is conducted to select the schools or communities to be investigated 2b. Or in each stratum, several clusters are identified where schools or communities are randomly selected for investigation	Multiple IU in the same ecological zones Evaluation unit is the strata, prevalence is the average across IU within strata	STH/SCH epidemiology is uniform in each stratum of the area surveyed	Provides prevalence estimates at strata level only. Performs better for STH than SCH due to known spatial heterogeneity A high risk of under/over treatment due to the variation of prevalence within the strata	Baseline surveys in settings where limited information is available on the epidemiology of the diseases
Cluster[a] survey	To determine IU level prevalence and support treatment decisions. 1. In each IU schools are randomly selected 2. In each school, children are randomly selected	IU (district, group of districts, ecological zone) Decision unit is the IU (district, group of districts, ecological zone) with a precise prevalence value determined for each	STH/SCH epidemiology is uniform in each IU	Provides prevalence estimates at the IU only. Does not account for sub-district heterogeneity. Routine methodology used for other standardized surveys. Reduces risk of undertreatment	Baseline surveys for SCH and STH Could be used for impact assessments acknowledging an increased risk for under or over treatment because of heterogeneity
Lot quality assurance sampling	Rapid and accurate identification of communities according to a threshold for decision-making 1. Clusters (e.g. schools or communities) are randomly selected from a given implementation unit 2. Subjects are randomly selected within each cluster, but the data collection stops when the number of positive case is likely to be greater than a predetermined threshold	Multiple IU in the same ecological zones	STH/SCH epidemiology is uniform in each stratum of the area surveyed	Rapid and cost effective method allowing a team to survey many communities in a day; the amount of data to be collected is less than methods 1 and 2 above The survey indicates if a defined prevalence threshold is exceeded; Requires surveying many sites and allow including all the communities (schools) of the area	May be suitable for determining where PC is required using a prevalence threshold. Would need adapting around an intensity threshold for use in validation of EPHP

(Continued)

Table 11. Contd.

Survey method	Approach overview	Evaluation unit	Assumptions	Advantages & disadvantages	Indication
Sentinel surveillance	It aims at period collection of data in the same sites for monitoring changes in prevalence and intensity. Some sentinel schools/communities are purposefully selected to represent all schools/communities in an ecological zone or an area selected on other criteria (i.e. persistent high prevalence, /transmission type where mass drug administration is followed over time)	Multiple IU in the same ecological zones	The changes in STH and SCH epidemiology occurring in sentinel sites are similar to the changes in the area the sentinels are representing	Few sentinel sites are placed in areas with different epidemiological situations; Sentinel sites are, in general, selected to represent the worst case scenario and monitor the impact of PC	More suitable for routine program monitoring; may play a role in surveillance after reducing the PC frequency; and post-validation surveillance alongside other active surveillance activities. Gives an overall indication of changes in infection but does not account for spatial heterogeneity of infection Not appropriate for IU-level treatment decisions
Model-based geo-statistical sampling[b]	The purpose is to predict the spatial distribution using available prevalence data and estimates of the effect of environmental, climatic and socio-demographic etc. for decision making. Sites (schools or communities) are selected systematically to provide efficient coverage of the entire area to be surveyed and ensuring local variation in prevalence can be measured. Location of sites to be surveyed are informed by available information on epidemiology (prevalence at baseline), programmatic interventions (number of rounds and their coverage), and geographical characteristics (temperature, humidity, sanitation coverage, population density). The data collected are analyzed using geostatistical models, and a prevalence range is produced or the probability of being above a prevalence threshold for each IU.	The method provides a prevalence surface across a country, region, down to IU and sub-IU dependent on how the survey has been designed. Decision unit is at the IU or sub-IU based on the survey design and prevalence can then be estimated at different levels of administration (e.g. IU, sub-IU)	Available information can be used to identify the more informative schools or communities in which to conduct the investigation Georeferenced sampling frame is available (that is, the location of all villages/schools is known)	Smaller sample size and number of sites required compared to standardized cluster surveys Significantly increases the estimation precision. Provides a prevalence range with details at the sub-district level More cost-precision than the WHO five schools per district/ecological zone approach Demanding in terms of information needed, computer equipment, and statistical capacity. Interpretation can be challenging if boundary maps are not available (e.g. sub-IUs for SCH). To reduce the uncertainty in the geostatistical models, sampling locations need to be sufficient in number and spatially regulated	Can be used for baseline assessment determining where PC is needed and for impact assessment. There may be increased certainty around estimates where there is sufficient quality and quantity of baseline epidemiological and intervention data available.

(Continued)

Table 11. Contd.

Survey method	Approach overview	Evaluation unit	Assumptions	Advantages & disadvantages	Indication
Practical assessment	The approach has been designed to identify districts where the same treatment decision is appropriate for all sub-IUs in the district; the approach is designed to save time and money while making the appropriate treatment decision.	IU (e.g. district) Decision unit: sub-IU	Appropriate for settings with sparse data or where historical data or environmental data and knowledge on local risk factors suggest the prevalence may be universally low or high (relative to the 10% threshold)	Less resource-intensive than surveys at every sub-IU. Simple for survey teams to implement. Results may indicate that the prevalence is too heterogeneous for IU-wide decision-making and sub-IU surveys (precision assessments) are needed in the future. Risk of under or overtreatment	Can be used for baseline or impact assessments for SCH. Could also be used for STH where there is co-endemicity with SCH Intended for SCH decision-making around a 10% prevalence threshold
Precision assessment	To make appropriate and efficient treatment decisions at the sub-district or community level by classifying the SCH prevalence as above or below 10%.	Sub-IU (e.g. sub-district) Decision unit: sub-IU	Appropriate to use at the sub-district level in settings where the prevalence of SCH is expected to vary around the 10% threshold	Improved accuracy of treatment decisions at the sub-district or community level leading to an efficient use of PC. Is simple for survey teams to implement. In districts with many sub-districts, this approach will take more time and money.	Suitable for SCH baseline and impact assessments. Intended for SCH decision-making around a 10% prevalence threshold Could also be practical for integrated STH–SCH assessment Could be used for baseline if used within the SPPA framework.
Integration with other surveys	Faecal and urine specimens are collected from individuals surveyed for other purposes.	Depending on the other survey	A sampling scheme designed for other diseases is appropriate for assessing STH/SCH epidemiology	Marginal additional costs since the infrastructure to reach the schools/communities is already present. Sampling methodology may not be ideal for STH or SCH (e.g. insufficient sites/people per site, site not located next to water bodies (SCH) or inappropriate age group)	Particularly suitable in the case of Transmission Assessment Survey conducted for lymphatic filariasis to inform a decision on the need to continue distributing benzimidazoles for STH. Opportunity to collect community data for SCH

IU: implementation unit; PC: preventive chemotherapy; SCH: schistosome; SPPA: schistosomiasis practical and precision assessment; STH: soil-transmitted helminth.

[a] Clusters can be, for example, districts in the same ecological zone.

[b] Geostatistical analysis can also be conducted on data collected with other survey methods.

Note: see Annex 3 for additional WHO guidance and Annex 4 for examples of applying the different survey methods. Annex 5 provides the details of contacts for procurement of diagnostic material.

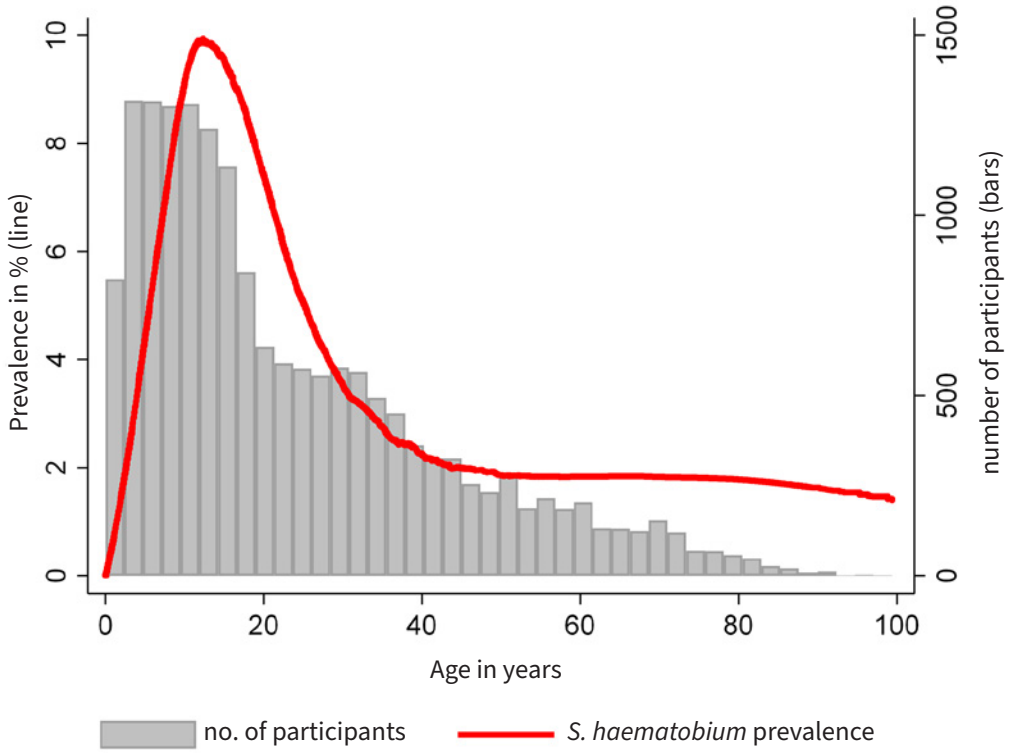
Survey target populations

The prevalence within all groups at risk is best estimated by conducting population-based surveys; however, these surveys are more complex to conduct and much more expensive than school-based surveys. Where resources are limited, and school enrollment is > 75%, school-based surveys may be used to estimate the prevalence of infections in SAC. When SAC are the target population of the survey, it is preferable to select them from children aged 10–14 years, as future changes in prevalence in this group will provide better information on the impact of preventive chemotherapy as younger SAC (i.e. children aged 6–7 years) would have received only a few rounds of preventive chemotherapy.

The prevalence estimates measured among SAC may be used as a rough proxy of the situation in the rest of the community. It has been demonstrated (Manz et al., 2020, Renganathan et al., 1995; Davis et al., 2014; Exum et al., 2019; Dana et al, 2020, Schur et al., 2011) that the prevalence measured among SAC corresponds to the peak of prevalence for schistosomiasis (Fig. 5), ascariasis and trichuriasis (Fig. 6). In these settings, the prevalence estimated among SAC would therefore probably be higher than the prevalence in the other groups at risk. Conversely, the peak prevalence of hookworm infections is generally in young adulthood. So the prevalence measured in SAC in these settings will likely be lower than the prevalence in adults.

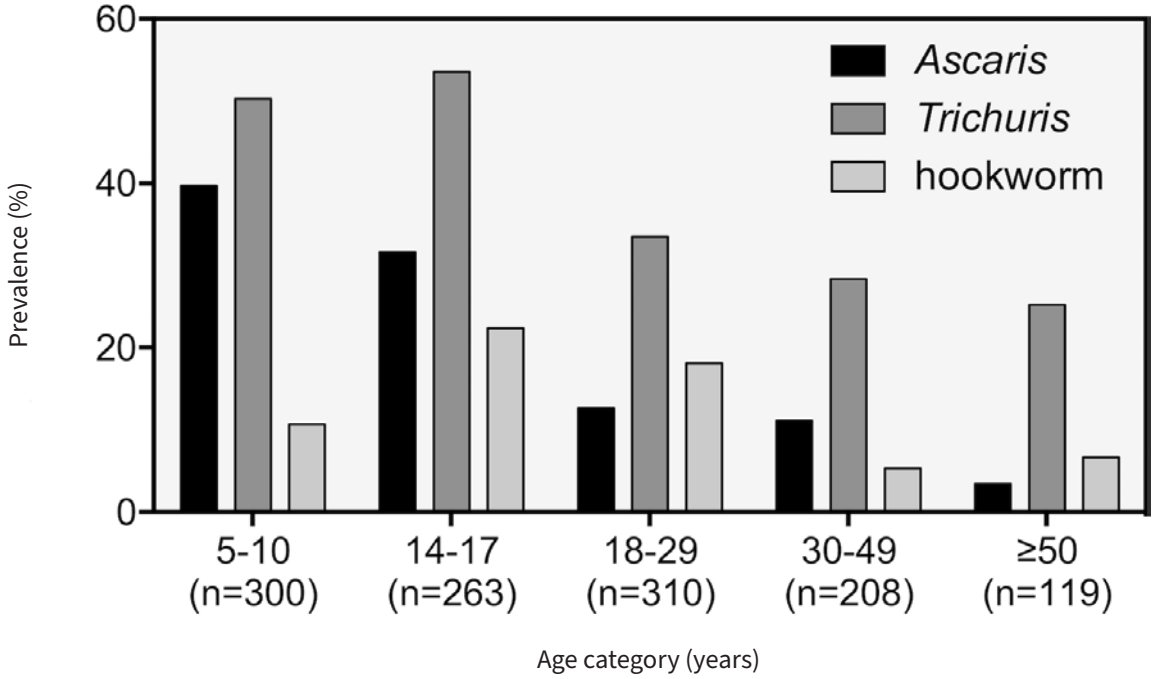
Fig. 5. Prevalence of *S. haematobium* infection by age

The red line shows LOWESS-smoothed *S. haematobium* infection prevalence; grey bars indicate the number of participants in each age stratum.



Source: *Schistosoma haematobium* infection and environmental factors in Southwestern Tanzania: A cross-sectional, population-based study (Manz et al., 2020).

Fig. 6. Prevalence of STH infections across five age groups in Jimma Town, Ethiopia



Source: *Evaluation of copromicroscopy and serology to measure the exposure to Ascaris infections across age groups and to assess the impact of 3 years of biannual mass drug administration in Jimma Town, Ethiopia* (Dana et al., 2020).

Data analysis and indicators to be calculated

After data have been collected, they can be analysed using either a design-based or a model-based approach.

Design-based approaches are normally used for all the survey designs listed in Table 11, except for the geostatistical approach. This approach estimates the prevalence from the raw data without any adjustment. In other words, the prevalence is assumed to be homogenous within each stratum, and the average of the prevalence data collected is considered as the prevalence in the cluster and the strata. In some case, the maximum prevalence could be used as the prevalence of the area.

Model-based approaches are normally used for the geostatistical approach. The data analysis does not assume homogeneity in each IU: the result is a "surface" with areas of different prevalence within the IU depending on risk and population distribution (see Fig. 7). The average prevalence can be calculated at several levels (e.g. district, sub-district).

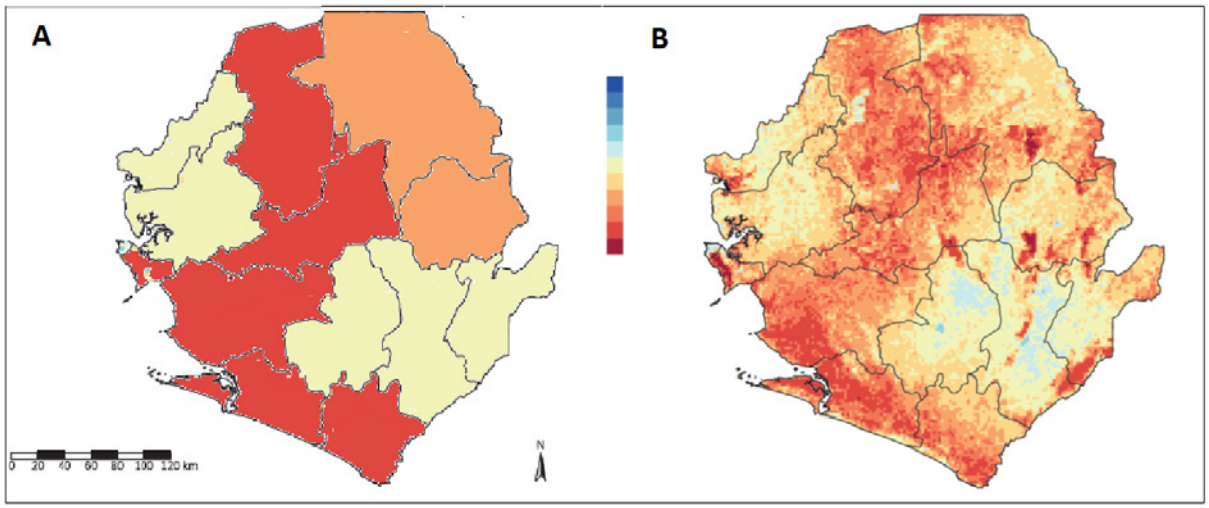
The data used in a geostatistical analysis do not need to be necessarily collected using a geostatistical survey approach. If the geo-location (longitude and latitude) of the units sampled (school or village) is known, this method can be applied to data collected using any other sampling method listed in Table 11.

Interval of confidence of the estimations

The prevalence estimated with any survey methodology will consist of a point estimate and a confidence interval; the width of the confidence interval depends on the sample size and the dispersion of the individual values measured. A wide confidence interval (because, for example,

the sample size was too small or because of the variability of the values at different survey points) suggests that limited confidence should be put on the estimated prevalence.

Fig. 7. Mapping STH prevalence data in Sierra Leone to show (A) the average district prevalence and (B) the prevalence surface obtained using a geostatistical approach



Source: adapted from *Model-based geostatistical methods enable efficient design and analysis of prevalence surveys for soil-transmitted helminth infection and other neglected tropical diseases* (Johnson et al., 2021).

Young mother and baby, Tahoua Region, Niger, 2004.
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Annex 1. Summary of declarations of interests and their management

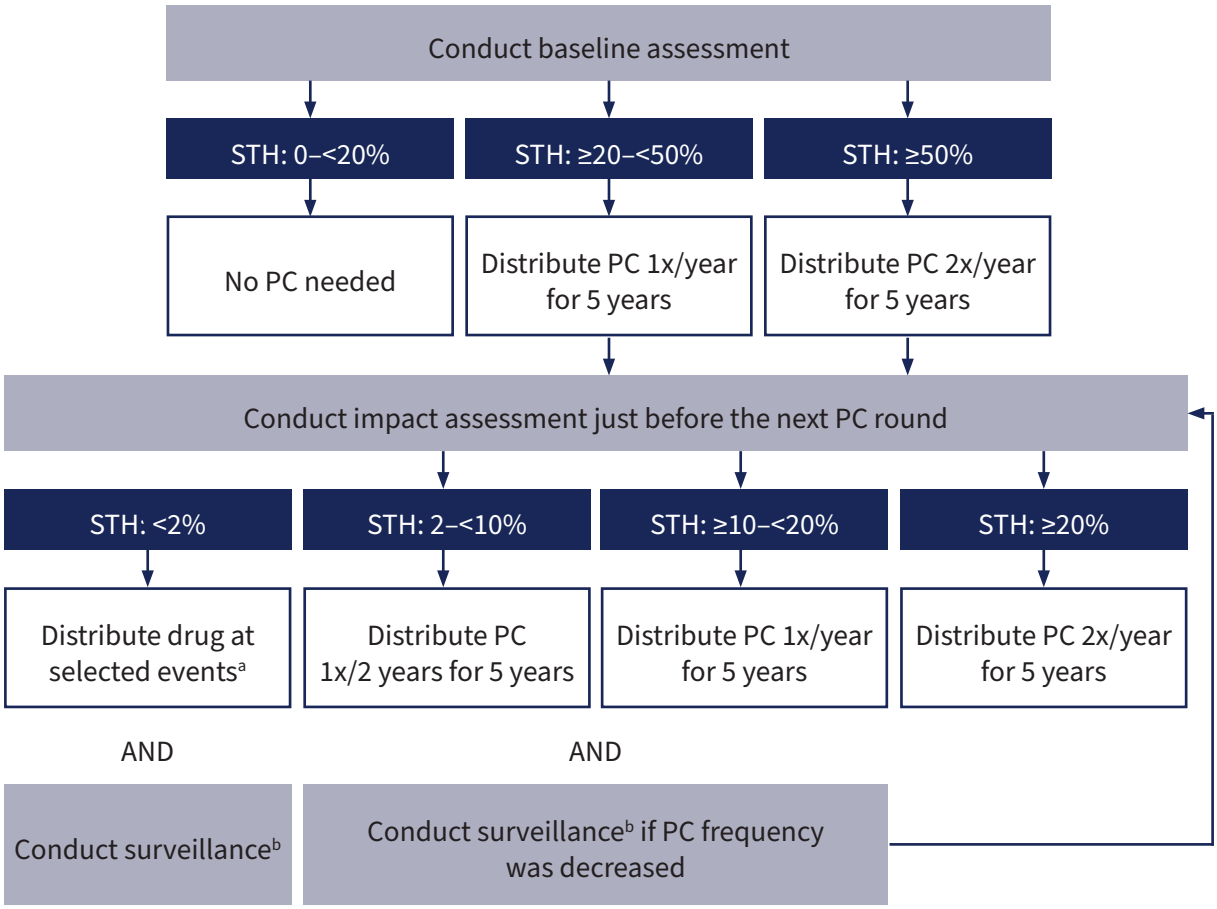
Schistosomiasis		Country	Declared interest	Management
1.	Louis-Albert Tchuem Tchuente	Cameroon	None declared	
2.	Uwem Friday Ekpo	Nigeria	Developed health educational board games "Schisto and ladders" and "Worms and ladders" to be used in schools to create awareness about schistosomiasis and soil-helminthiases control, sold at production cost	The assessment concluded that no financial interests could directly affect, or could appear to affect, the professional judgement of the expert were identified.
3.	Jean Bosco Mbonigaba	Rwanda	None declared	
4.	Doudou Sow	Senegal	None declared	
5.	Moses John Chimbari	Zimbabwe	None declared	
6.	Narcis Bujune Kabatereine	Uganda	None declared	
7.	Song Liang	United States of America (USA)		
8.	William Evan Secor	USA	None declared	
9.	Otávio Sarmento Pieri	Brazil	None declared	
10.	Souad Bouhout	Morocco	None declared	
11.	Bonnie L. Webster	United Kingdom of Great Britain and Northern Ireland (UK)	None declared	
12.	Joanne P. Webster	UK	Awarded UKRI research funding (£ 80 000–250 000) for non-commercial purposes/no conflict of interest	The assessment concluded that no financial interests that could directly affect, or could appear to affect, the professional judgement of the expert were identified.
13.	John Russell Stothard	UK	None declared	
14.	Hala Elmorshedy	Egypt	None declared	
15.	Lydia R. Leonardo	Philippines	None declared	

Soil-transmitted helminthiases		Country	Declared interest	Management
1.	Jean Tena Coulibaly	Côte d Ivoire	None declared	
2.	Hadley Matendechero Sultani	Kenya	None declared	
3.	Clara Fabienne Rasoamanamihaja	Madagascar	Received a US$ 2500 travel grant from SCIF to attend the programme managers' meeting in Addis Ababa in 2019	The assessment concluded that no financial interests (resulting from funding sources) that could directly affect, or could appear to affect, the professional judgement of the expert were identified.
4.	Moussa Sacko	Mali	None declared	
5.	Theresa Gyorkos	Canada	Awarded research grants from BMGF (ended in 2017) and a travel grant from CWW (US$ 1000)	The assessment concluded that no financial interests (resulting from funding sources) and employment that could directly affect, or could appear to affect, the professional judgement of the expert were identified.
6.	Judd Walson	USA	Awarded research grants for research into the feasibility of interruption of soil-transmitted helminthiases transmission from BMGF and CIFF (amount not specified)	The assessment concluded that no financial interests (resulting from funding sources) and employment that could directly affect, or could appear to affect, the professional judgement of the expert were identified.
7.	Waleed Rabbani	Pakistan	None declared	
8.	Jennifer Keiser	Switzerland	None declared	
9.	Francisca Mutapi	UK	None declared	
10.	Yael Velleman	UK	Awarded research grants from Bayer (€ 30 000) and Merck (€ 30 000)	The assessment concluded that no financial interests (resulting from funding sources) and employment that could directly affect, or could appear to affect, the professional judgement of the expert were identified.
11.	Chandra Aggarwal	India	None declared	
12.	Nilanthi de Silva	Sri Lanka	Received a research grant (US$ 34 000) to carry out a national survey of intestinal nematode infections in Sri Lanka in 2017 from CWW (work completed)	The assessment concluded that no financial interests (resulting from funding sources) that could directly affect, or could appear to affect, the professional judgement of the expert were identified.
13.	Susana Vaz Nery	Australia	None declared	
14.	Virak Khieu	Cambodia	None declared	
15.	Somphou Sayasone	Lao People's Democratic Republic (the)	None declared	

BMGF: Bill & Melinda Gates Foundation; CIFF: Children's Investment Fund Foundation; CWW: Children Without Worms; UKRI: the United Kingdom Research and Innovation.

Annex 2. Decision trees for determining the frequency of preventive chemotherapy distribution and impact assessments for soil-transmitted helminth and schistosome infections

A2.1 Soil-transmitted helminth infections



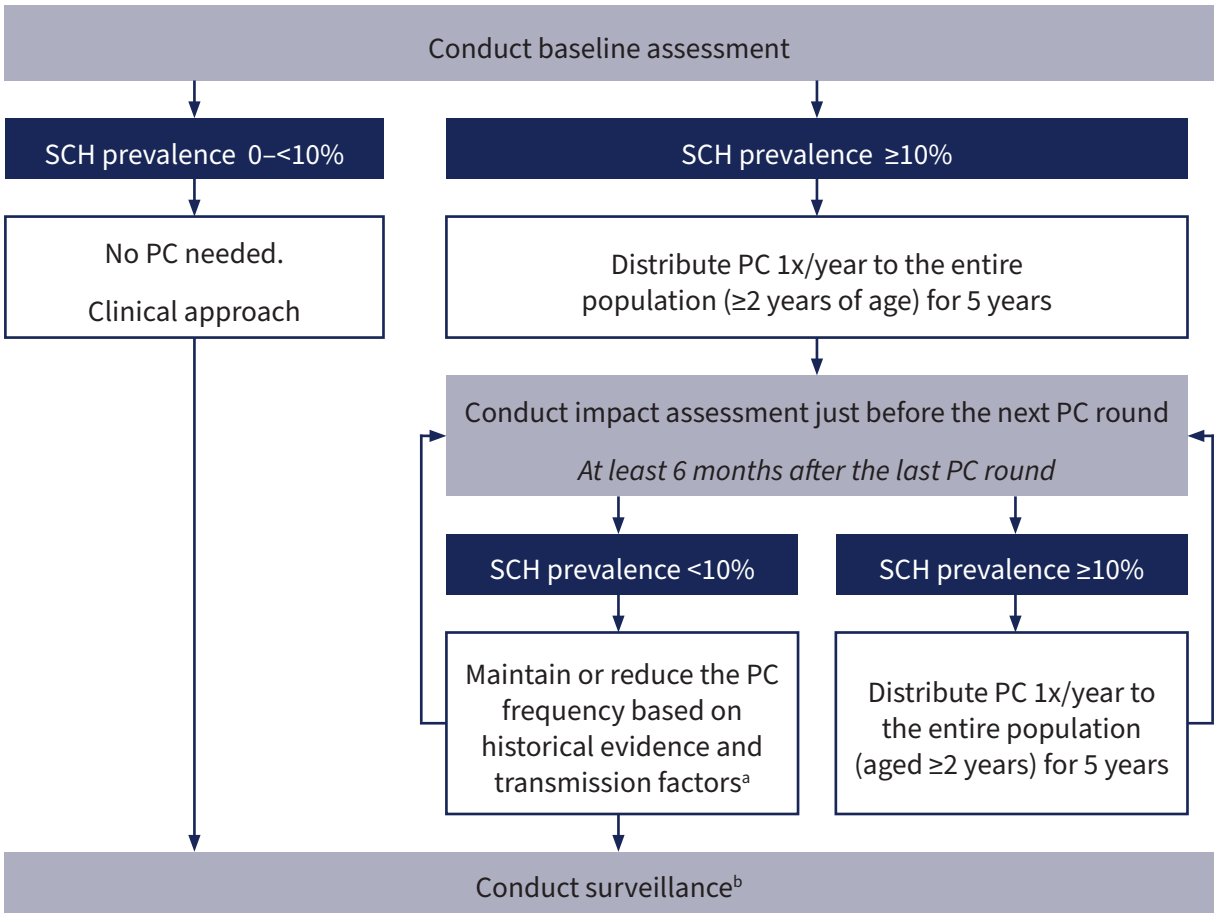
STH: soil-transmitted helminth; PC: preventive chemotherapy.

[a] PC distribution targeting entire groups at risk may be suspended, but distribution may continue in appropriate settings (e.g. selected child-health visits, selected school years or at antenatal care visits).

[b] If a signal is detected, a more detailed investigation is recommended (before any planned impact assessments).

Note: The elimination of soil-transmitted helminthiases as a public health problem is defined as a prevalence of moderate-to-heavy intensity infection of < 2% among school-aged children. While this is an important indicator for assessing the elimination of morbidity, it is not considered for the purpose of making decisions on the frequency of PC distribution.

A2.2a Schistosome infections and impact assessment: standard approach



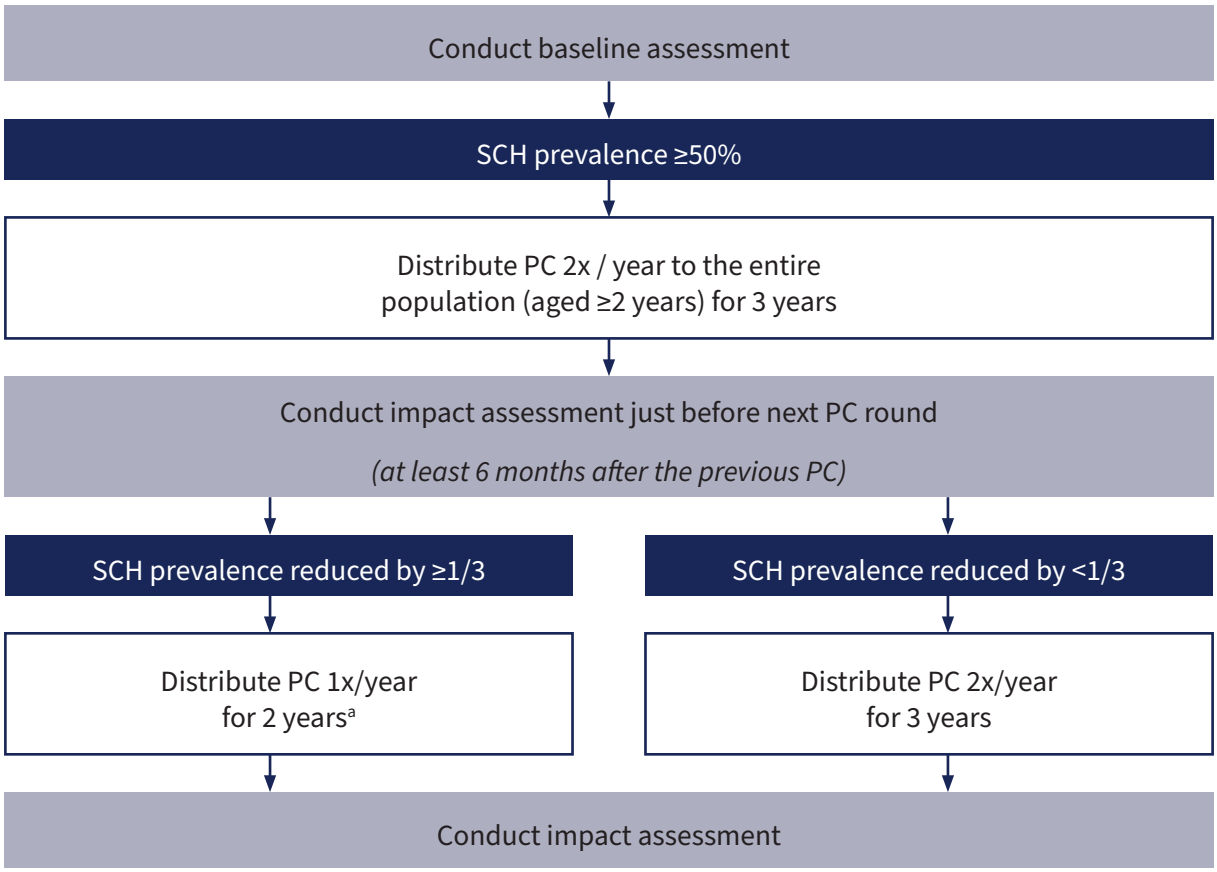
SCH: schistosomes; PC: preventive chemotherapy.

[a] The choice to maintain or reduce PC frequency should be based on historical evidence such as the level of baseline prevalence and the presence of factors facilitating transmission (in case of very high baseline prevalence or intense water contact, it is suggested to maintain PC once a year).

[b] If a signal is detected, a more detailed investigation is recommended (before any planned impact assessments).

Note: The elimination of schistosomiasis as a public health problem is defined as a prevalence of heavy intensity infections of < 1% among school-aged children. While this is an important indicator for assessing the elimination of morbidity, it is not considered for the purpose of making decisions on the frequency of PC distribution.

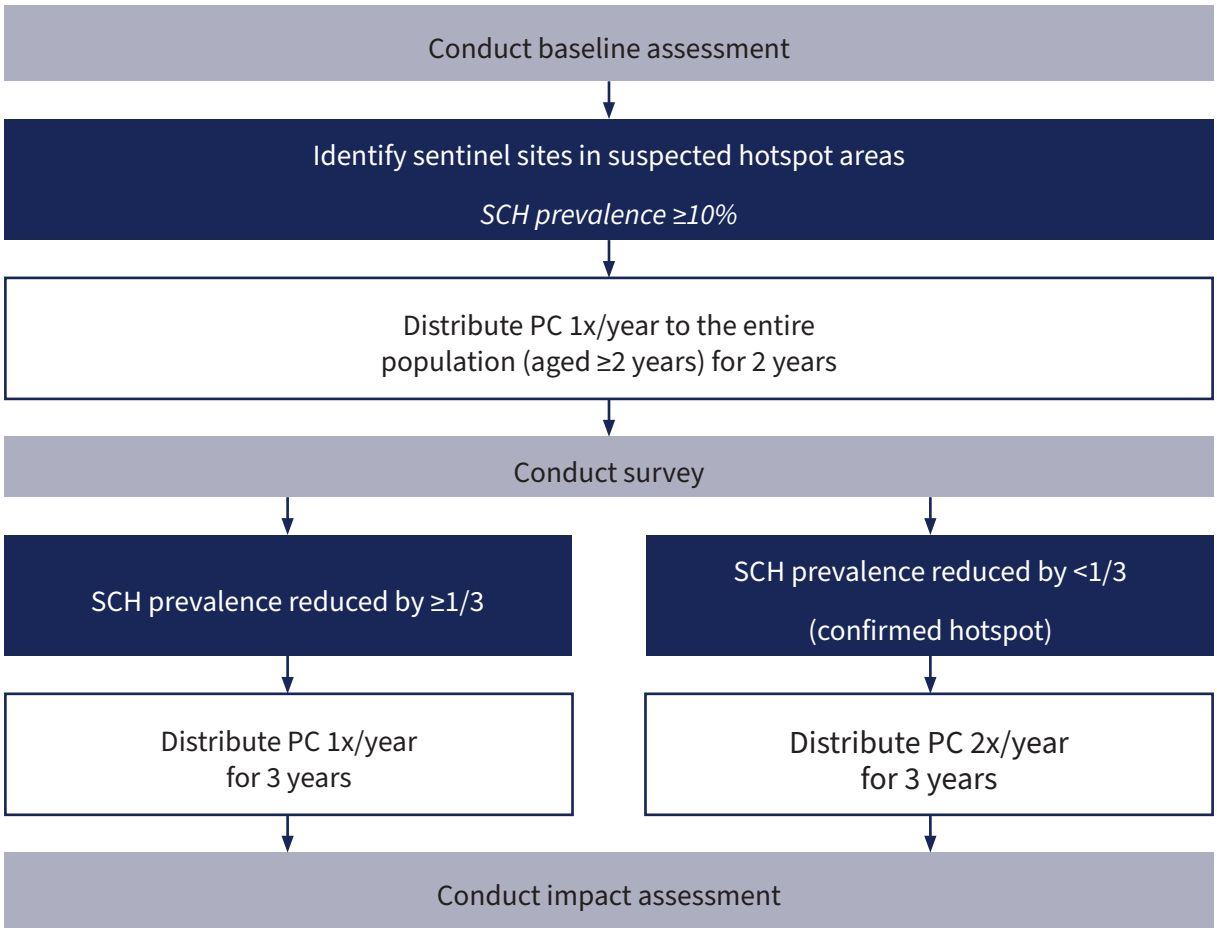
A2.2b. Schistosome infections and impact assessment. Special case 1: To be used if additional resources are available to distribute preventive chemotherapy more frequently in areas of high prevalence at baseline



SCH: schistosomes; PC: preventive chemotherapy.

[a] After this impact assessment, follow the standard approach (see A2.2a).

A2.2c. Schistosome infections and impact assessment. Special case 2. To be used if additional resources are available to distribute preventive chemotherapy and conduct surveys for hotspots more frequently



[a] After this impact assessment, follow the standard approach if the reduction in prevalence is ≥ 1/3 (see A2.2a).

Annex 3. Additional WHO guidance

Survey methods

A3.1 Cluster survey

Collection of epidemiological data in sentinel sites [Chapter 5]. In: *Helminth control in school-age children: a guide for managers of control programmes, second edition*. Geneva: World Health Organization; 2011 (https://iris.who.int/handle/10665/44671).

Note: Guidance is provided on the number and location of schools to be selected in the survey, the method to select the children to be investigated in the school, the personnel needed, the handling of biological specimens, and the data analysis.

A3.2 Lot quality assurance

Assessing the epidemiology of soil-transmitted helminths during a transmission assessment survey in the global programme for the elimination of lymphatic filariasis. Geneva: World Health Organization; 2015 (https://iris.who.int/handle/10665/153240).

Available at https://www.who.int/publications/i/item/9789241508384

Note: Guidance is provided on collecting STH data during a transmission assessment survey conducted in the context of a lymphatic filariasis elimination programme.

A3.3 Sentinel surveillance

ESPEN and WHO documents. In: Expanded Special Project for the Elimination of Neglected Tropical Diseases. Brazzaville: World Health Organization Regional Office for Africa (https://espen.afro.who.int/tools-resources/documents/espen-and-who-documents).

A3.4 Manual on geostatistical approach for impact assessment

Note: This manual is in development.

A3.5 Manual on practical and precision assessments for schistosomiasis

Practical assessment and precision assessment for schistosomiasis: a manual for impact assessments. In: Training materials [website]. Brazzaville: WHO Regional Office for Africa; 2024 (https://espen.afro.who.int/tools-resources/documents/training-materials).

A3.6 Manual on precision assessment surveys of schistosomiasis

See also: Practical assessment and precision assessment for schistosomiasis: a manual for impact assessments. In: Training materials [website]. Brazzaville: WHO Regional Office for Africa; 2024 (https://espen.afro.who.int/tools-resources/documents/training-materials).

A3.7 Diagnosis

Diagnostic target product profile for monitoring and evaluation of soil-transmitted helminth control programmes. Geneva: World Health Organization; 2021 (https://iris.who.int/handle/10665/342539).

Note: The minimum and ideal characteristics of an STH diagnostic technique to monitor control programmes are presented.

A3.8 Diagnosis

Diagnostic target product profiles for monitoring, evaluation and surveillance of schistosomiasis control programmes. Geneva: World Health Organization; 2021 (https://iris.who.int/handle/10665/344813).

Note: The minimum and ideal characteristics of an SCH diagnostic technique to monitor control programmes are presented.

A3.9 Preventive chemotherapy

Preventive chemotherapy: tools for improving the quality of reported data and information. A field manual for implementation. Geneva: World Health Organization; 2019 (https://iris.who.int/handle/10665/329376).

Note: The manual provides guidance on organizing a coverage evaluation survey and in data quality assessment. It also includes supervisor coverage tools to guide the organization of a coverage survey.

Young schoolgirls, Tahoua Region, Niger, 2004.
© WHO/Amadou Garba Djirmay

A3.10 Coverage evaluation surveys

Preventive chemotherapy: tools for improving the quality of reported data and information: a field manual for implementation. Geneva: World Health Organization; 2019 (https://iris.who.int/handle/10665/329376).

Coverage evaluation surveys. In: COR NTDs [website]. Coalition for Operational Research on Neglected Tropical Diseases (https://www.cor-ntd.org/resources/coverage-evaluation-surveys).

Notes: On the website, it is possible to access the Coverage Survey Builder which helps calculate the sample size and interpret the results.

A3.11 Forms to report treatment and survey results and request donated medicines

Joint Application Package: planning, requesting medicines and reporting. In: WHO/Control of Neglected Tropical Diseases [website]. Geneva: World Health Organization (https://www.who.int/teams/control-of-neglected-tropical-diseases/interventions/strategies/preventive-chemotherapy/joint-application-package).

A3.12 Manual on validation of elimination of soil-transmitted helminthiases as a public health problem

Note: This manual is in preparation.

A3.13 Manual on validation of elimination of schistosomiasis as a public health problem

Note: This manual is in preparation.

A3.14 Monitoring and evaluation

Ending the neglect to attain the sustainable development goals: a framework for monitoring and evaluating progress of the road map for neglected tropical diseases 2021–2030. Geneva: World Health Organization; 2021 (https://iris.who.int/handle/10665/341313).

Annex 4. Examples and principles of survey design

A4.1 Stratified sampling

Example 1: Baseline survey in Kenya (Mwandawiro et al., 2013)

Parasites investigated

- Soil-transmitted helminths (STH): *Ascaris lumbricoides*, *Trichuris trichiura*, hookworms
- Schistosomes (SCH): *Schistosoma mansoni*, *S. haematobium*
- Data on anaemia were also collected in a sub-sample in 10 schools.

Country characteristics

- Target population of the programme is 5 million school-aged children (SAC).
- 66 endemic districts in four endemic provinces (Western, Rift Valley, Coast, Nyanza)
- The implementation units (IUs) are the districts.

Setting

The survey was organized in schools.

Sample calculation

- In each school, the sample was designed to detect a 5% point change in prevalence across years.
  - targeted power of the statistic test (1 - β) = 0.80
  - targeted level of significance (α) = 0.05

  Number of children per school = 100

Sample size of the survey

- in each province: 30–60 schools, 100 children per school
- country: total sample 200 schools, 20 000 children

Method used for sample selection

- The 66 endemic districts were stratified into four strata corresponding to the provinces.

In each stratum (province), the number of schools to be surveilled was calculated proportionally to the province population (i.e. Western Province: 60 schools; Rift Valley Province: 30 schools: Coast Province: 50 schools; Nyanza Province: 60 schools).

- The schools to be investigated were randomly selected from the provincial list of schools provided by the Ministry of Education.

Diagnostic technique

- Kato–Katz (2 slides per child) for STH and *S. mansoni*
- Urine filtration (1 filtration per child)

Data analysis

- Prevalence and classes of intensity were presented at the national, provincial, district and school levels.
- Averages were presented with 95% confidence intervals.

Data presentation

- Data were presented in tables and maps providing the prevalence for each parasite separately by school and district.

A4.2 Cluster survey

Example 2: Baseline survey in Guinea (Montresor et al., 1997)

Parasites investigated

- STH (*A. lumbricoides*, *T. trichiura*, hookworms)
- SCH (*S. mansoni*, *S. haematobium*)
- *Plasmodium falciparum*
- Data on anaemia were also collected.

Country characteristics

- Target population of the programme was 1 million SAC
- 33 prefectures in four natural regions (Coastal, Middle altitude, High altitude, Forest)
- The IUs are the prefectures.

Setting

- The survey was organized in schools.

Sample calculation

- In each school, sample to detect with 95% confidence 10% prevalence precision
  - targeted power of the statistic test (1 - β) = 0.80
  - targeted level of significance (α) = 0.10

  Number of children per school = 45

Sample size of the survey

- In each natural region: 1–3 prefectures (five schools/prefecture) were surveyed according to population size.
- Country total sample: seven prefectures, 33 schools, (50 children per school); total: 1650 children

Method used for sample selection:

- The 33 prefectures in the country were divided into four strata corresponding to the natural regions.
- In each stratum (region) the number of sub-prefectures to be surveyed was calculated proportionally to the population and to the number of administrative regions (i.e. Coastal Region: three prefectures; Middle altitude Region: one prefecture; High altitude Region: one prefecture; Forest Region: two prefectures) and were selected randomly.
- In each prefecture selected, a sub-prefecture was randomly selected.
- In each sub-prefecture selected, five schools were randomly selected.

Diagnostic method

- Kato–Katz (1 slide per child) for STH and *S. mansoni*
- Urine filtration (1 filtration per child)

Data analysis

- Prevalence and classes of intensity were calculated at national, regional, prefectural and school levels.
- Averages were presented with a 95% confidence interval.
- The prevalence value of the natural region was calculated as the average among the prevalences of the sub-prefectures surveilled.

Data presentation

- Data were presented in tables providing the prevalence for each parasite separately by school, sub-prefecture and natural region.
- Needed preventive chemotherapy intervention in each natural region was presented.

A4.3 Lot quality assurance sampling

The method does not allow for calculating the prevalence in an IU; instead, it evaluates the chances that the prevalence observed is over a defined threshold.

This method can also be used to assess STH prevalence during transmission assessment surveys (see Annex 2, A2.2).

Sample calculation

- In each IU, sample to detect with 95% confidence that the measured prevalence is not higher than the interval identified.
  - targeted power of the statistic test $(1 - \beta) = 0.95$
  - targeted level of significance $(\alpha) = 0.10$

Number of children per IU = 164

Setting

The survey is normally organized in schools.

Sample size

- The sample size is fixed: if cluster sampling is utilized (assumed design effect = 2), the total sample size is 332 children (aged 8–10 years).

Selection of the school/children

- 7–8 schools are randomly selected in the IU
- In each school, 40–50 children are randomly selected among children aged 8–10 years.

Diagnostic technique

- Kato–Katz (1 slide per child) for STH and *S. mansoni*
- Urine filtration (1 filtration per child)

Analysis of the results (see Table A4.1).

Table A4.1 Critical cut-off values (number of children with a positive specimen) and relative classification

Sample size	332				
Classification of the IU	< 2%	≥ 2% <10%	≥ 10% < 20%	≥ 20% < 50%	≥ 50
Critical cut-off values[a]	0	1–20	21–48	49–144	≥ 145

[a] Cut-offs are valid for the sample size of 332 children.

Example of the use of the cut-offs:

If, among the 332 children sampled:

- 14 children are found positive, the unit is classified with a prevalence between 2% and 10%.
- No children are found positive, the unit is classified with a prevalence of < 2%.

Note that the prevalence range identified by the cut-off is normally higher than the prevalence among the children in the sample. For example, an LQA survey can conclude that the prevalence is in the interval of ≥ 10% to < 20%, while the number of children positive in the sample is only 8%.

A4.4 Sentinel surveillance

Sentinel surveillance is an approach consisting of following the epidemiological situation occurring in a small number of sites that represent the situation of a larger area. However, in case of SCH sentinel sites are meant to reflect the situation of the foci rather than the situation of the disease in the overall country. Establishment of sentinel sites should be based on the resources available, the country's technical capacity, the areas of interest according to the distribution of the disease, and the areas where the programme may anticipate problems. This approach is normally used to identify trends and therefore is particularly suitable as an "alarm bell" in case of rebound after preventive chemotherapy has been suspended.

Sentinel sites for schistosomiasis are critical for monitoring the programme in order to detect any problems such as low impact of the treatment, high reinfection and resurgence and to correct these issues immediately. Sentinel sites should be located in each homogeneous ecological zone.

After suspension/reduction of preventive chemotherapy, it is possible that, with reduced drug pressure, the prevalence and intensity of infection could return to the pre-intervention levels. If this is the case, the prevalence increases before moderate or heavy intensity infections reappear in the target population.

A sentinel surveillance approach will allow for the detection of a rebound in prevalence before the intensity of infection reaches levels that cause morbidity. It will provide an early indication that PC is still necessary to maintain the absence of morbidity reached by the control programme.

Normally, for STH one sentinel site is suggested for every 100 000 target population.

It is good practice to select the sentinel(s) in those areas where the prevalence and intensity of infection were highest at baseline. This is because areas with higher baseline levels are more likely to experience rebounds, allowing for early detection in such cases.

By comparing the prevalence observed over time in the sentinel sites, it will be possible to assess if the prevalence is stably low or if a trend indicates a rebound.

Young girl, Tahoua Region, Niger, 2008.
© Anna Phillips

A4.5 Integration with other surveys

Collecting STH and SCH data during surveys conducted for other purposes should always be considered. This permits a reduction in the survey cost because the personnel and transport costs are the main drivers of the survey cost.

Efficiency gains from integrated surveys depend on co-endemicity. Gains may be most applicable at sub-national levels where climatic and other determinants are suitable for transmitting more than one disease. Note that it may be necessary to adapt the ideal structure of STH and SCH surveys to that planned survey (for example, restricting the collection of biological specimens to a sub-group of the population).

Examples of surveys in which it has been possible to integrate the collection of STH and SCH data:

- transmission assessment survey conducted for lymphatic filariasis (Kim et al., 2020; WHO, 2015)
- trachoma survey (Saboya Diaz et al., 2022)
- nutritional survey (Djuradi et al., 2021)
- malaria survey (Drassah et al., 2022)
- oral health survey (Monse et al., 2013)

A4.6 Geostatistical sampling

Impact survey in Kenya (Fronterrè et al., 2023)

This methodology has been recently developed, and there are no examples of surveys conducted with the sample size calculated with this approach. However, Fronterrè and colleagues calculated the sample size needed with this method to conduct an impact survey in Kenya capable of obtaining results with the same accuracy as the one conducted with the stratified sampling presented in Annex 3, A3.1 (i.e. 200 schools; 100 children/school).

The geostatistical method takes into consideration:

- the baseline data;
- the number of rounds of preventive chemotherapy distributed;
- the coverage of each round; and
- environmental factors related to STH prevalence.

It obtains the same accuracy and precision with a sample of 51 schools and 25 children/school. In other words, it reduces the sample size needed by more than two-thirds. Similar reductions in the sample size needed have also been demonstrated to be possible from Sierra Leone and Zimbabwe datasets.

This approach has limitations:

- It requires strong computational power and trained statisticians to select the more informative schools to be included in the sample and to analyse the epidemiological data collected with a geostatistical approach.

- Optimal performances are obtained in planning impact survey (when the baseline data and the information about the preventive chemotherapy intervention are available).
- It requires geo-locations (latitude and longitude) of the schools in the baseline.
- It works only where there is a geospatial correlation between the areas where data have been collected and the epidemiological data (if this spatial correlation does not exist, the method has limited advantages in terms of the reduction of sample size).
- A web application is in development to assist programme managers in applying this method.

A4.7 Practical assessments (for SCH impact assessments)

When is it appropriate: Practical assessments are appropriate for making SCH treatment decisions at the district-level in areas where the prevalence is believed to be mostly high (e.g. most villages/schools have > 10% prevalence) or homogenously low (e.g. the vast majority of villages/schools have < 10% prevalence). In settings where the village/school prevalence is expected to vary relative to the 10% threshold, it is advisable to do precision assessments.

Survey area: Practical assessments should be conducted at the district (IU) level.

Survey overview: This is a 15 site x 30 SAC survey, resulting in a total sample size of 450 SAC per district.

Detailed methods

Primary sampling unit (PSU): The preferred primary sampling unit is the school; however, either schools or communities are valid choices for the primary sampling unit.

Site selection: Practical assessments require sampling in 15 PSUs using systematic sampling. A two-step sampling process is required to select these 15 sites. To do this, it will be necessary to obtain a list of all the PSUs by sub-district. It is not necessary to include the population of each PSU.

Selecting children: In each PSU, 30 primary school-aged children should be randomly selected for testing.

A4.8 Precision assessment (for SCH impact assessments)

When is it appropriate: Precision assessments are appropriate for making SCH treatment decisions at the sub-district-level in districts where the prevalence is heterogeneous around 10%, either based on the results of a Practical Assessment or from historic program data.

Survey area: Precision assessments should be conducted at the sub-district (sub-IU) level.

Survey overview: This is a 4 sites x 20 SAC survey, resulting in a total sample size of 80 SAC per sub-district.

Detailed methods

Primary sampling unit (PSU): The preferred primary sampling unit is the school. However, either schools or communities are valid choices for the primary sampling unit.

Selecting PSU: Precision assessments require the purposeful selection of 4–5 PSUs per sub-district, based on sites that are expected to have the greatest risk of schistosomiasis. High baseline prevalence, poor program coverage, proximity to infected water sources, high-risk occupations and migration from high-risk areas may all be used to select the highest-risk PSU.

Selection of individuals: Within each of the four purposefully selected PSUs, 20 children should be randomly selected.

References for Annex 4

Dassah S et al. (2022). Urogenital schistosomiasis transmission, malaria and anemia among school-age children in Northern Ghana. Heliyon;8(9):e10440.

Djuardi Y et al. (2021). Soil-transmitted helminth infection, anemia, and malnutrition among preschool-age children in Nangapanda subdistrict, Indonesia. PLoS Negl Trop Dis;15(6):e0009506.

Fronterrè C et al. (2023). Survey design and geospatial analysis using data on baseline prevalence, environmental risk-factors and treatment history drastically reduces the cost of STH impact surveys Preprint, medRxiv 2023.01.03.23284146; doi: https://doi.org/10.1101/2023.01.03.23284146

Kim SH et al. (2020). A first nation-wide assessment of soil-transmitted helminthiasis in Fijian primary schools, and factors associated with the infection, using a lymphatic filariasis transmission assessment survey as surveillance platform. PLoS Negl Trop Dis;14(9):e0008511.

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Mwandawiro CS et al. (2013). Monitoring and evaluating the impact of national school-based deworming in Kenya: study design and baseline results. Parasit Vectors;6:198.

Saboyá-Díaz MI et al. (2022). Associated factors of the co-occurrence of trachoma and soil-transmitted helminthiases in children 1 to 9 years old in rural communities of the Amazon basin in Loreto Department, Peru: Results from a population-based survey. PLoS Negl Trop Dis;16(7):e0010532.

WHO. (2015). Assessing the epidemiology of soil transmitted helminth during a transmission assessment survey in the global programme for the elimination of lymphatic filariasis. Geneva: World Health Organization (https://iris.who.int/handle/10665/153240).

Annex 5. Contacts for procurement of diagnostic material

The WHO Global Neglected Tropical Diseases Programme can be contacted to obtain laboratory material to conduct baseline or impact survey. In case of need of large quantities, the following producer can be contacted.

Kato–Katz kits

- Shenzhen Combined Biotech Co., Ltd
  Email: cbd@biocbd.com
- Neolab – hydrophilic cellophane for Kato–Katz
  http://www.neolab.de
  Email. info@neolab.swiss
- Sterlitech schistosome test kit
  http://www.sterlitech.com/membrane-disc-filters/polycarbonate-membranes/schistosome-test-kit.html
- Vestergaard Frandesen Group
  http://www.vestergaard-frandsen.com/
  Email: sales@vestergaard-frandsen.dk

Urine filtration equipment

- Shenzhen Combined Biotech Co., Ltd
  Email: cbd@biocbd.com
- Millipore for filter holders
  http://www.millipore.com/catalogue/module/C160
- Sefar for filters
  http://www.sefar.com
  Email: hans-peter.brunner@sefar.ch
- Sterlitech schistosome test kit
  http://www.sterlitech.com/membrane-disc-filters/polycarbonate-membranes/schistosome-test-kit.html

Young boy, Kracheh, Cambodia, 2012.
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Global Neglected Tropical Diseases Programme
World Health Organization
20 avenue Appia
1211 Geneva 27
Switzerland

Website: https://www.who.int/teams/control-of-neglected-tropical-diseases