INTERNATIONAL
MEDICAL
OUTREACH

Rapid Appraisal on
Soil-transmitted helminthiasis in

Msundwe, Malawi

January 2015

Preface

An International Medical Outreach (IMO) team collected the data used in this report and reached the conclusions presented under the direction of Dr. Todd M. Price, IMO Director. The team measured the height and weight of the children tested and collected the stools used in the study. They also conducted the stool analysis on site in Msundwe, Malawi. The Dream Lab in Lilongwe, Malawi performed the blood analysis.

Questions or comments on the study can be directed to info@imoutreach.com.

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Introduction

Soil-transmitted helminthiasis (STH) refers to a set of parasitic diseases caused by a group of intestinal worms collectively called soil-transmitted helminths (STHs) that are transmitted primarily through contaminated soil. Approximately two billion people worldwide are infected with STHs and an additional four billion are at risk. Of these, children are most susceptible to infection due to their frequent exposure to a contaminated environment through playing, eating raw vegetables and fruits, and direct contact with soil and water. Heavy infections of STHs decrease nutritional status, affect school performance, and lower resistance to other infectious diseases while chronic infections lead to malnutrition, stunted growth, and diminished intellectual capacity.

Explanation of Rapid Appraisal

In January 2015, an International Medical Outreach team conducted our own independent testing for STH in Msundwe, Malawi. This independent testing, or Rapid Appraisal, measured a sample group of children throughout the area on five parameters: stool analysis, blood analysis, height, weight, and malaria. These parameters are described below.

Stool Analysis

Microscopic examination of a simple stool smear is sufficient in diagnosing STH because of the enormous daily output of eggs by gravid female worms. The procedure is simple: collect a fresh (same day) stool sample, prepare slide, examine sample under a microscope, and record findings. This process of observing and identifying eggs in the feces under a microscope is enough to determine the presence of ascariasis, enterobiasis, hookworm infection, and strongyloidiasis and can be performed on site, given that there is a power source for the microscope.

Height and Weight

Children are highly susceptible to dietary deficiencies that lead to malnutrition. Malnutrition can cause a higher susceptibility to disease, a significant drop in IQ, and stunted physical growth. Interpretation of measurements of height and weight for children in relation to a standard growth chart is essential to confirm a child's healthy growth and development. An International Growth Chart released by the World Health Organization depicts the growth of children from birth to 5 years who had been raised in six different countries (Brazil, Ghana, India, Norway, Oman, and USA) according to recommended nutritional and health practices. The optimal growth displayed in this growth chart represents the prescribed gold standard for children's growth or the way all healthy children should grow.

Blood Analysis

Anemia

The blood analysis involves performing a Complete Blood Count (CBC). The CBC is a common blood test that evaluates overall health and detects a wide range of disorders including anemia, infection, and leukemia. The CBC test measures the following components:

- **White blood cells (WBC),** which fight infection
- **Red blood cells (RBC),** which carry oxygen
- **Hemoglobin (Hg),** which carries the oxygen within the red blood cells
- **Hematocrit (Hct),** which is the proportion of red blood cells to the fluid in the blood
- **Platelets,** which help with blood clotting

Abnormal levels of any of these components, high or low, may indicate an underlying condition that calls for further evaluation.

Anemia occurs when there is an insufficient number of red blood cells (RBCs) necessary to carry nutrients and oxygen to the tissues of the body. It is identified by a decrease in the number of red blood cells, hemoglobin (HGB) and hematocrit (HCT) and can cause symptoms such as lightheadedness, fatigue, and weakness.

All intestinal parasites can contribute to the incidence of anemia. Hookworms, for example, feed on red blood cells by attaching to mucosal tissues. The loss of blood is exacerbated by an anticoagulant released by the parasite that remains active even after the worm has migrated to another site along the intestinal wall. Anemia is an issue especially in countries where the dietary intake of iron is already marginal and where malaria, another cause of anemia, is widespread.

In those instances where a Complete Blood Count is prohibitive and/or unavailable, an instant hemoglobin analyzer (Hemocue) will measure hemoglobin only. Hemoglobin is a protein molecule within the RBC that carries oxygen from the lungs to the body's tissues and returns carbon dioxide from the tissues back to the lungs. A lower than normal hemoglobin level reflects a lower than normal number of RBC's.

Malaria

Malaria infects RBCs and causes them to break up, which results in anemia. Malaria is a treatable disease that can be assessed easily by a blood smear examined under a microscope or rapid blood testing via a finger stick.

Performing the malaria smear serves two purposes: (1) a negative result rules out malaria as a cause of anemia, and (2) a positive result exposes the disease and the need for treatment.

Results of Rapid Appraisal

Stool Analysis

Soil-transmitted helminthiasis

	NUMBER TESTED	NUMBER POSITIVE	PREVALENCE
Total	**210**	**127**	**60.5%**
Girls	**105**	**65**	**61.9%**
Below 12 years old	69	41	59.4%
12 years and older	36	24	66.7%
Boys	**103**	**60**	**58.3%**
Below 12 years old	58	30	51.7%
12 years and older	44	29	65.9%

- 60.5% represents an extremely high overall prevalence
- Only one slide per stool sample was examined. Thus, the prevalence of STH infections observed in this study might have been underestimated.
- Girls were measured at a slightly higher prevalence than boys.
- There is a higher prevalence among older girls compared to younger girls.
- Likewise, older boys have a higher prevalence than younger boys.
- Extraneous factors that likely play a role:
    - The regular use of contaminated water for activities of daily life
    - Improper preparation of food
    - Lack of adequate hand washing and personal hygiene practices
    - Walking and playing barefoot in contaminated soil
    - The common practice of open defecation

Four types of helminths were found: Hookworm, Pinworm, Roundworm, and *Strongyloides*. These types are described in detail starting on page 13. The distribution of each helminth among those testing positive is represented below.

TYPE OF HELMINTH	NUMBER POSITIVE	PREVALENCE
Hookworm	76	59.8%
Pinworm	16	12.6%
Roundworm	39	30.7%
Strongyloides	6	4.7%
More than one species	10	7.9%

- Hookworm is the most common (59.8%) helminth found among this community.
    - Open defecation and poor sanitary conditions are the main causes of high prevalence.
    - The larvae enter the body by penetrating the skin usually through the bottom of the feet.
    - Major manifestation of hookworm infection is anemia.
- Roundworm is the second most common (30.7%) helminth.
    - Associated with poor personal hygiene and hand washing practices.
    - Transmitted by the ingestion of eggs from contaminated soil, water, and raw fruits and vegetables.
    - The most important consequence of ascariasis is the impact on physical and intellectual development.
- Pinworm is third most common (12.6%)
    - There may be no symptoms other than itching in the anal and rectal area
    - Pinworm infections are spread from person to person. Children scratch the rectal area, get eggs on their fingers or under their fingernails, and transport the eggs to bedding, clothing, and other items and other people.
    - Good hand washing practices, especially under the fingernails, will reduce the spread.

- *Strongyloides* has the lowest prevalence (4.7%) within this community.
    - The primary mode of infection is through contact with soil that is contaminated with parasites.
    - Unlike other intestinal parasites, the eggs of *Strongyloides* hatch in the intestines and re-infect the host. This is called auto-infection.
    - The best preventative measure is to avoid contact with human feces by ending open defecation and wearing shoes.

Height and Weight

Height-for-age

		BOTTOM 10TH PERCENTILE		TOP 10TH PERCENTILE	
	NUMBER TESTED	NUMBER	PERCENTAGE	NUMBER	PERCENTAGE
Total	**210**	**52**	**24.7%**	**21**	**10.0%**
Girls	**106**	**25**	**23.6%**	**9**	**8.5%**
Below 12 years old	70	10	14.3%	9	12.9%
12 years and older	36	15	41.7%	0	0.0%
Boys	**104**	**27**	**25.9%**	**12**	**11.5%**
Below 12 years old	60	7	11.7%	12	20.0%
12 years and older	44	20	45.5%	0	0.0%

Weight-for-age

		BOTTOM 10TH PERCENTILE		TOP 10TH PERCENTILE	
	NUMBER TESTED	NUMBER	PERCENTAGE	NUMBER	PERCENTAGE
Total	**210**	**57**	**27.1%**	**7**	**3.3%**
Girls	**106**	**28**	**26.4%**	**2**	**1.9%**
Below 12 years old	70	14	20.0%	1	1.4%
12 years and older	36	14	38.9%	1	2.8%
Boys	**104**	**29**	**27.9%**	**5**	**4.8%**
Below 12 years old	60	9	15.0%	5	8.3%
12 years and older	44	20	45.5%	0	0.0%

- Among all groups, a higher percentage falls in the bottom 10th percentile for height-for-age and weight-for-age than in the top 10th percentile. This correlates well with the high prevalence of parasites.
- For both boys and girls, there is a significant increase in the percentage of those that fall in the bottom 10th percentile in the older age groups.
    - For example, 14.3% of the younger girls fall in the bottom 10th percentile of height-for-age. This increases to 41.7% among the older girls. The data is similar among the boys.
    - The same overall trend is seen in regards to weight-for-age among girls and boys.
- This suggests that these children are losing ground physically during critical developmental years – most likely due to undernourishment and malnutrition. This correlates directly to the high prevalence of intestinal parasites.

Stunted, Underweight, Wasting

	STUNTED	UNDERWEIGHT	WASTING
Total	**18.6%**	**18.6%**	**9.5%**
Girls	**17.9%**	**19.8%**	**9.4%**
Below 12 years old	11.4%	12.9%	7.1%
12 years and older	30.6%	33.3%	13.9%
Boys	**19.2%**	**17.3%**	**9.6%**
Below 12 years old	6.7%	1.7%	8.3%
12 years and older	36.3%	38.6%	11.4%

- Stunting is defined as children with height-for-age below the 5TH percentile.
- Underweight is defined as children with weight-for-age below the 5TH percentile.
- Wasting is defined as children with Body Mass Index below the 5TH percentile. Body Mass Index is an estimation of body fat percentage using height and weight.

Blood Analysis

Hemoglobin values are related to a person's age and gender. Normal values vary; however, the ranges are very close (varying by about 0.5 g/dl) for almost every group. An example of normal ranges that is widely accepted by physicians is as follows:

Age 2 – 6 years	11.5 – 13.5 g/dl
Age 7 – 12 years	11.5 – 15.5 g/dl
Female	
Age 12 – 18 years	12.0 – 16.0 g/dl
Age greater than 18 years	12.1 – 15.1 g/dl
Male	
Age 12 – 18 years	12.0 – 18.0 g/dl
Age greater than 18 years	13.6 – 17.7 g/dl

Anemia

	NUMBER TESTED	NUMBER ANEMIC	INCIDENCE
Total	**207**	**17**	**8.2%**
Girls	**101**	**8**	**7.8%**
Below 12 years old	69	7	10.1%
12 years and older	34	1	2.9%
Boys	**102**	**9**	**8.9%**
Below 12 years old	60	9	15.0%
12 years and older	42	0	0.0%

- 8.2% incidence overall is much lower than expected and does not correlate with the high prevalence of intestinal parasites.
- Even under normal conditions in which there are no parasite infections, older girls are more predisposed to anemia than younger girls. These results show the opposite even though the older girls have a higher prevalence of parasites.
- Since the older boys have a higher prevalence of parasites, it would be expected that the older boys would also be more anemic, yet there is 0% incidence of anemia in this group.
- These results show no correlation between the incidence of anemia and the clear evidence of malnutrition indicated by the low height-for-age and weight-for-age shown in both boys and girls.

  - For example, about 40% of the older girls are in the bottom 10th percentile for height-for-age and weight-for-age and two-thirds (66.67%) of the older girls are positive for the presence of parasites. Yet, according to these results, only 2.9% of these girls are anemic.
- The lack of consistency in the blood results is disturbing. While there is consistent correlation and support between the other data collected, the blood results show no relationship to either the stool analysis or the height and weight.
- The accuracy of the blood test results is therefore questionable.

Malaria

	NUMBER TESTED	NUMBER POSITIVE	PREVALENCE
Total	**-**	**-**	**-**
Girls	**-**	**-**	**-**
Below 12 years old	-	-	-
12 years and older	-	-	-
Boys	**-**	**-**	**-**
Below 12 years old	-	-	-
12 years and older	-	-	-

- Malaria smears were requested. Samples were collected, yet IMO did not receive the results.

Results by Venue

					HEIGHT-FOR-AGE		WEIGHT-FOR-AGE	
	NUMBER TESTED	PARASITE	ANEMIA	MALARIA	BOTTOM 10TH	TOP 10TH	BOTTOM 10TH	TOP 10TH
Chimsolo	8	37.5%	14.3%	-	62.5%	0.0%	75.0%	0.0%
Kanjira	17	64.7%	5.9%	-	17.7%	5.9%	17.7%	5.9%
Kanjira Nursery	2	0.0%	50.0%	-	0.0%	0.0%	50.0%	0.0%
Maliwa	11	54.6%	9.1%	-	27.3%	0.0%	27.3%	0.0%
Mawelo	33	69.7%	16.7%	-	25.8%	12.9%	25.8%	0.0%
Mdzobwe	79	50.6%	1.3%	-	17.1%	9.8%	18.3%	6.1%
Mkanda	24	58.3%	25.0%	-	45.8%	4.2%	50.0%	0.0%
Mkanga	27	77.8%	0.0%	-	22.2%	11.1%	29.6%	0.0%
Mwai Wathu Nursery	2	100%	0.0%	-	100%	0.0%	50.0%	0.0%
Umodzi Nursery	2	100%	0.0%	-	0.0%	50.0%	0.0%	0.0%
Yankho Nursery	4	100%	25.0%	-	0.0%	75.0%	0.0%	25.0%

Soil-transmitted Helminthiasis (STH) Explained

1.1 Causative Agents

Hookworm *(Necator americanus* and *Ancylostoma duodenale*):

Hookworms affect approximately 576 million people globally and is the leading cause of maternal and child morbidity in developing countries of the tropics and subtropics. Infective hookworm larvae penetrate human skin through hair follicles and small fissures within minutes of contact with contaminated soil. The larvae are carried by circulation to the lungs, penetrate the alveolar walls, and make their way up the trachea to be swallowed and carried to their final habitat in the small intestine.

Migration of larvae through the lungs may provoke the inflammation of lung tissue. Once in the intestine, hookworms may cause chronic abdominal pain and persistent eosinophilia. The major manifestations of hookworm infection, however, are iron-deficiency anemia and protein energy malnutrition resulting from blood loss. Features of hookworm-induced anemia include smaller than normal red blood cells that are poorly filled with hemoglobin, skin paleness, weakness, physical or mental weariness, lack of energy, difficulty or uncomfortable breathing, and swelling of the organs due to an abnormally low level of protein in the blood, especially in malnourished children. Moderate infections and anemia can impair physical, cognitive, and intellectual growth in children, diminish productivity of workers, and threaten the outcome of pregnancy for both mother and child. The development of anemia depends on the intensity and duration of the infection, yet in the most sever cases, anemia caused by hookworms can lead to congestive heart failure.

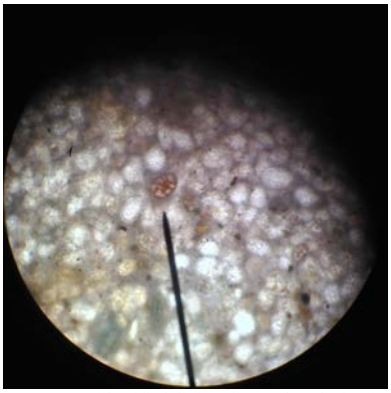
Pinworm *(Enterobius vermicularis*):

Pinworm, called *Enterobius vermicularis*, is highly prevalent throughout the world and is particularly common among children. Pinworms are small, thin, white roundworms that reside in the large intestine, appendix, and adjacent gut. Female worms, containing an average of 10,000 ova at a time, migrate to the perianal and pelvic regions where they deposit their eggs and die. The eggs become infective within six hours and are transferred to clothes, bedding, dust, and air. The most common mode of transmission, however, is via the hands of the host, particularly underneath the fingernails, through scratching or handling clothes and bed linen. On ingestion, the embryos hatch in the duodenum, molt twice, and develop within five or six weeks into adult worms that live for about a month.

Enterobiasis, or pinworm infection, is not associated with any particular social class, gender, race, or culture. The prevalence of enterobiasis is lowest in infants and reaches its maximum in schoolchildren from five to fourteen years old. Pinworm eggs are infective within six hours of the time that they are laid and may remain so for up to twenty days. Pinworm is primarily a familial or institutional infection associated with crowding. Because of the relatively brief life span of the worms, long-standing infections are due to continuous reinfection.

Most pinworm infections are asymptomatic; however, symptoms that do appear are largely related to perianal and pelvic itching and scratching. Painful urination, inability to control urine, vaginal infection, and vaginal discharge can also occur due to pinworm. The migration of the parasite may also lead to pelvic, cervical, vulvar, and kidney inflammation. Large numbers of larval pinworms have caused inflammation of the digestive tract in both adults and children.

Roundworm *(Ascaris lumbricoides)*:



Ascaris egg identified during the stool analysis of IMO's Rapid Appraisal in El Paraiso.

Ascaris is the most common form of STH, affecting about 800 million to 1.2 billion people globally. Ascariasis is transmitted by the ingestion of infective eggs from soil, water, or vegetables that have been contaminated with the feces of already infected persons. Once ingested, the eggs hatch in the intestines, burrow through the gut wall, and migrate via venous blood through the liver and heart to the lungs. There they break into the alveoli. Once mature, they pass up to the trachea where they are coughed up and swallowed. The larvae then pass through the stomach for a second time into the intestine where they become adult worms. A single worm has a life span of one to two years and may produce two hundred thousand eggs a day. The high prevalence of ascariasis worldwide is a consequence of the tremendous egg output from female worms and the remarkable ability of ova to resist unfavorable external environments.

As *Ascaris* travel through the body, they can cause visceral damage, peritonitis and inflammation, enlargement of the liver or spleen, and an inflammation of the lungs. They may also cause coughing or gagging, vomiting, wheezing, or shortness of breath. Once the worms make it to the intestine, they steal nutrients from the partially digested host food and cause malabsorption, contributing to malnutrition. They may also cause gastrointestinal discomfort, nausea, irregular stools, stomach or abdominal pain, weight loss, fatigue, and fever. Ascariasis has been shown to depress appetite and food intake by children and can interfere with absorption of proteins, fats, lactose, vitamin A, and iodine. The impact on nutrition, intellectual development, cognitive performance, and growth is likely the most important health related consequence of ascariasis worldwide. Treatment of heavily infected children with anthelmintics has been shown to improve nutritional status, but provision of micronutrients, protein, and energy is necessary for underweight or stunted children to achieve catch-up growth.

Ascariasis is associated with poor personal hygiene and poor sanitation, including places where there are no latrines or other sanitation infrastructure. Preventative measures taken against ascariasis include avoiding the ingestion of soil that may be contaminated with human feces; washing hands with soap and warm water before handling food; teaching children the importance of washing hands to prevent infection; and washing, peeling, or cooking all raw vegetables and fruits before eating, particularly those that have been grown in soil that has been fertilized with manure. Not defecating outdoors and establishing effective sewage disposal systems can also prevent the transmission of ascariasis.

Strongyloides (*Strongyloides fuelleborni* and *Strongyloides stercoralis*):

Strongyloides identified during the stool analysis of IMO's Rapid Appraisal in El Paraiso.

Estimates of the global prevalence of strongyloidiasis vary between 3 million and 100 million people infected, making it considerably less common than infections with other major intestinal nematodes. The semitransparent, colorless female worms measuring 2.2 mm in length embed themselves and deposit their eggs in the upper small intestine. Females lay eggs without the need for fertilization and hatch in the mucosa. Then, the noninfectious larvae work their way into the lumen of the bowel. If excreted with feces onto soil in a warm, humid environment, they develop into infective larvae that can penetrate human skin, migrate to the lungs, pass up to the trachea where they are swallowed, and eventually make their way back down into the GI tract. There they eventually mature into adult worms that produce eggs in the small intestine.

A crucial feature of *Strongyloides* that sets it apart from all other major parasitic worms is that non-infective larvae have the ability to develop into infective larvae within the bowel, reenter the host through the colonic mucosa or perianal skin, and complete their life cycle without ever leaving the host. This process of autoinfection explains how the parasite can increase without external reinfection, persist indefinitely in a single host, and be transmitted directly from one person to another during close physical contact. Its medical significance lies in its ability to produce overwhelming infection in immunocompromised hosts, a consequence of its unique ability to replicate and increase in numbers without leaving its host.

While more than half of chronically infected people are asymptomatic, acute infections of strongyloidiasis yield a

localized, itchy, red, raised rash soon after larval penetration. Diarrhea and abdominal pain may develop just before the appearance of larvae in the stool. Adult worms and larvae traversing the upper small bowel mucosa may produce abdominal pain, nausea, diarrhea, and blood loss. With hyperinfection, defined as repeated reinfection with larvae produced by worms already in the body due to their ability to complete the life cycle within a single host, increased numbers of larvae are found in the intestines, lungs, central nervous system (CNS), kidneys, liver, and almost any other organ. Gastrointestinal manifestations are common and include abdominal pain, nausea, vomiting, diarrhea, ileus, and edema of the bowel, which can lead to intestinal obstruction. Ulceration of the mucosa may produce massive hemorrhage, inflammation, or bacterial sepsis. Larvae migrating beyond the gastrointestinal tract produce pneumonitis with cough, hemoptysis, and respiratory failure. CNS invasion may cause meningitis and brain abscesses, with larvae in the cerebrospinal fluid and tissue. When Gram-negative bacteria gain access to the bloodstream via migrating larvae, bacterial sepsis, meningitis, and pneumonia occur frequently.

Strongyloides is primarily transmitted through contact with soil contaminated with infected feces. In ordinary hygienic conditions, human-to-human transmission does not appear to occur. Appropriate methods of human fecal sanitation and sewage disposal as well as the use of shoes are of paramount importance. Thus, the infection can be prevented by implementing public health measures aimed at ensuring proper disposal and treatment of excrement and by avoiding skin contact with contaminated soil.

1.2 Symptoms of Infection and Impact on Health

The symptoms of STH are nonspecific and only become evident when the infection is particularly severe. The nonspecific symptoms include nausea, fatigue, weakness, abdominal pain, and loss of appetite. STH causes morbidity through various different mechanisms. Three of particular significance are listed below.

- **Anemia**. All human cells depend on oxygen for survival; therefore, a decrease in the number of red blood cells can result in feelings of weakness, fatigue, malaise, and poor concentration. In severe cases of anemia, the body increases cardiac output in an attempt to compensate for the lack of oxygen. This may lead to palpitations, angina, and even heart failure.
- **Intestinal Obstruction**. In cases of massive infection, a bolus of parasites can cause intestinal obstruction. Obstruction is usually partial but overtime, it can become complete. Additionally, obstruction can occur where parasites excrete neurotoxins that cause contractions of the small bowel. A lingering obstruction gets complicated with the probability of intussusception, volvulus, necrotic bowel, or perforation, all of which are life threatening.
- **Malnutrition**. Malnutrition becomes life threatening in association with STH as STHs feed on host tissues, including blood, leading to a loss of iron and protein. Additionally, STH impairs the body's ability to absorb or assimilate food, decreasing the absorption of essential nutrients. In particular, STHs compete for already low levels of vitamin A in the intestine of the host. Because vitamin A maintains the integrity of the epithelium in the respiratory and gastrointestinal tracts, its deficiency increases the risk of developing respiratory disease and chronic diarrhea. Malnutrition weakens every part of the immune system, which increases the risk of infection and infectious disease. Infectious diseases like malaria, measles, persistent diarrhea, and pneumonia can also keep the body from absorbing adequate food.

The impact of STH on an infected person's life can be significant. Some examples include:

- **Stunting**. Chronic malnutrition occurring over time interferes with a child's ability to develop and grow. Malnutrition and recurrent infections in combination with STH are major contributors to growth stunting. A stunted child may appear normal, but is significantly smaller and shorter than children who are adequately nourished. Their immune system is weaker, leaving them more vulnerable to disease and they are five times more likely to die from diarrhea. Once established, stunting and its effects typically become permanent. Stunted children may never regain the height lost as a result of stunting, and most children will never gain the corresponding body weight. It also leads to premature death later in life because vital organs never fully develop during childhood. Height-for-age, weight-for-age, and weight-for-height are frequently used indicators of nutritional status of children. Because these represent the long-term effects of malnutrition and are not sensitive to recent, short-term changes in dietary intake, height and weight are measured as part of the Rapid Appraisal.
- **Need for surgery**. When their numbers in the body become extremely high, STHs build up in the child's intestines causing obstruction, hindering normal function, and eventually blocking the intestine entirely. The only solution in this situation is an emergent surgical intervention that in most cases is not possible in remote areas, causing the child's premature death.

- **Reduced ability to learn**. In an already malnourished child, STHs further rob the body of the nutrients required for physical and mental development. In the formative years of a child's growth, this chronic malnutrition results in a significant and irreversible drop in IQ. Children with STH are therefore less able to concentrate or process information, compromising their formal education that is, in most cases, already limited.

1.3 Who is most at risk?

According to the World Health Organization (WHO), children are at risk as soon as they stop breastfeeding and start crawling on the ground, frequently putting their hands in their mouths. Without treatment and prevention, children are infected and repeatedly re-infected, causing the number of STHs they harbor to steadily increase. By the time they reach school, they can be harboring hundreds of STHs or more.

Preschool and primary school-age children should be targeted for treatment and prevention of STH for the following reasons:

- They typically have the highest burden of STH.
- They are more susceptible to other infections.
- They are at a critical time of their physical and mental development.
- Primary school is foundational for secondary and higher levels of learning.
- Decreased STH prevalence among this group reduces the level of contaminate in the environment.

1.4 Treatment

IMO's preferred anthelmintic is Albendazole. Not only is Albendazole effective against each type of helminth found in Msundwe, it is also:

- Safe for young children and pregnant women
- Easy to administer due to its standard dose regardless of weight
- Chewable
- Relatively inexpensive.

The recommended dose is Albendazole 400mg, once, every six months.

1.5 Prevention

WHO advocates administering anthelmintic medication at regular intervals to populations at risk. This approach may lower the prevalence and intensity of STH but is unlikely to eliminate transmission in the absence of sanitation, clean water supplies, and overall economic development. The improvement of infrastructure, sanitation standards such as properly washing and cooking food and hand washing, and environmental factors such as housing conditions and access to clean water are broad steps toward prevention of STH.

Regular mass treatment is a commonly accepted remedy of STH because of the ease with which controlled doses of safe, effective, and relatively inexpensive anthelmintic medication can be administered. However, a disturbing aspect of this widespread practice of annual or semi-annual deworming of children and other groups is the concern about resistance developing to Albendazole and other anthelmintics. Prevention is, therefore, paramount.

General Recommendations for STH Prevention

Regular treatment will only result in a short-term reduction of infection. Re-infection is inevitable within a short period of time unless key preventive interventions are undertaken. The interventions outlined below are the basic requirements necessary to break the cycle of transmission and thus eliminate STH as a public health problem.

Use Safe Water

- Establish and utilize a safe water system.
    - Protected natural spring
    - Engineered method
        - Borehole
        - Dug well
        - Public standpipe
    - Filtration
        - Ceramic
        - Slow sand
    - Rainwater collection
    - Solar Disinfection
    - Boiled water
    - Chlorination
- Safe Water Storage
    - Container must only be used to transport/store clean water
    - Container must be kept closed with a properly fitted lid
    - Containers should have a small opening or a tap for access to water
    - Do not insert hands or objects into the container
- Use safe water for all activities of life
    - Drinking
    - Cooking
    - Hand-washing
    - Bathing/personal hygiene
- Hydrate the body adequately to receive full health benefits
    - Drink only safe water
    - Drink water everyday
    - Recommended daily amount of water is as follows:
        - 5-8 years old—1 liter
        - 9-12 years old—1.5 liter
        - 13+ years old—2 liters
        - Women—2 liters
        - Men—3 liters
- Practice proper food preparation
    - Clean food preparation areas and allow to dry thoroughly
    - Wash vegetables and fruits thoroughly, especially when eating them raw
    - Cook food and vegetables properly

Practice Proper Hygiene

- Wash hands
    - When the hands are dirty
    - After using the toilet
    - Before meals/snacks
    - Before taking medication
    - Before and after feeding and caring for children
- Bathe and take care of the body
- Always use soap—it causes sticky particles to loosen from the skin
- Exercise oral hygiene
- Wear shoes when outside the home
    - Protective shoes when walking distances
    - Slipper-type shoe around the homestead

Manage Human Waste

- Discourage open defecation
- Properly dispose of human waste, especially children's stools
- Use toilets or latrines—one of the most effective measures to break the cycle of transmission
    - Train and encourage all family members to use toilets
    - Proper construction must include barrier between user and excreta
    - Keep toilets clean and well maintained
- Composting toilet
    - Safe and sanitary management of human feces
    - Decomposes the germs and recycles the nutrients from human waste
    - Does not require power or water
- Pit latrine
    - Creates breeding ground for flies
    - Can be dangerous if not properly constructed, maintained or protected
    - Difficult to clean
- Designate a special field for defecation away from homesteads, water source, and food storage
- Only when absolutely necessary:
    - Dig a hole in the ground for defecation
    - Cover the hole with soil afterward to avoid exposed excreta

Abide by a Treatment Schedule

- Take medication at regular intervals
- Go to health services to provide treatment of symptomatic illness

Distribute Health Education

- Anatomy and physiology
    - Teach general information about the body
    - Teach proper care and disease prevention
- Biology of the body — teach how the body functions in general
- Helminthiasis and its physiology within the body
    - How helminths enter the body
    - How helminths migrate throughout the body and eventually reside in the intestines
    - The effect of helminthiasis on the body
- Nutrition
    - Define and discuss a balanced, nutritional diet
    - Incorporate a nutritional diet within the cultural context
        - Identify available foods
        - Explore options to meet nutritional requirements

Adopt Healthful Habits

- Education and practice are the most important activities to motivate children to change their behavior.
- Children can be effective agents to convince parents, family members, and community members to change their behaviors.
- Schools are important in the training process
    - Lead by example—administrators and teachers should wash their hands at the appropriate times
    - Be consistent
        - Enforce healthy behavior all the time
        - Consistency causes habits to form
        - Habits become a way of life
    - Make it easy and practical for the children and teachers to wash
        - Set up a hand-washing area at the school
        - Have clean water and soap always available at the station
- Present teaching in a positive rather than a negative context.
    - “Clean hands feel good” instead of saying “Dirty hands cause disease”
    - Encourage the children to try new ways of doing things
    - Rewards good habits
- Encourage self-respect—mind, body, and spirit. Self-respect is evidenced by the following:
    - Proper care of your body
    - Maintain privacy
    - Practice modesty