Schistosomiasis


Introduction

Schistosomiasis, also known as bilharzia or “snail fever”, is a parasitic disease carried by fresh water snails infected with one of the five varieties of the parasite Schistosoma. Found predominantly in tropical and sub-tropical climates, schistosomiasis infects 240 million people in as many as 78 countries, with a vast majority of the burden occuring in Africa. Schistosomiasis ranks second only to malaria as the most common parasitic disease.

Schistosomiasis is transmitted by contact with contaminated fresh water (lakes and ponds, rivers, dams) inhabited by snails carrying the parasite. Swimming, bathing, fishing and even domestic chores such as laundry and herding livestock can put people at risk of contracting the disease. Larvae emerge from the snails and swim in the water until they come into contact with an individual and penetrate the skin. Once inside the body, the larvae develop into male and female worms which pair up and live together in the blood vessels for years. Female worms release thousands of eggs which are passed out of the body in the urine and feces. If people urinate or defecate in bodies of freshwater, the eggs migrate to snails where they eventually hatch and begin the cycle again.

Some Schistosoma eggs, however, remain trapped in the body and migrate to specific organs (depending on the type of parasite) where they can inflict major damage. Urinary schistosomiasis causes scarring and tearing of the bladder and kidneys, and can lead to bladder cancer. Intestinal schistosomiasis develops slowly, causing abdominal bleeding; enlargement of the liver, lungs and spleen; and damage to the intestines. A major indicator of the disease is blood in the urine and/or feces.

Disease Overview

Risks

- Contact with freshwater sources where infected snails carrying the disease live
- Prevalent in as many as 78 countries with over half of all documented cases residing in Africa
- Children under age 14
- Individuals with labor or domestic chores centered around freshwater areas

Symptoms

- Symptoms for the disease vary depending on the type of worm involved and the location of the parasite inside the body, and can include initial itching and rash at infection site (“swimmer’s itch”)

- Frequent, painful or bloody urine
- Abdominal pain and bloody diarrhea
- Anemia
- Fever, chills and muscle aches
- Inflammation and scarring of the bladder
- Lymph node enlargement
- Enlargement of the liver or spleen
- Secondary blood disorders in cases of colon damage
- If infection persists, bladder cancer may eventually develop in some cases
- Children with repeated infection can develop anemia, malnutrition and learning disabilities

Transmission

- Parasites penetrate the skin during contact with freshwater containing contaminated snails. The larvae migrate to the blood vessels where they mate and produce eggs. Some eggs travel to the bladder or intestines and are passed into the urine or stool. Others remain trapped in the body and cause damage to internal organs.

Treatments

- Education campaigns about risks of getting infected by bathing in fresh water lakes and ponds
- Praziquantel is the primary form of treatment
- A single dose of praziquantel has been shown to reduce the severity of symptoms in cases of subsequent re-infection
- 250 million tablets are donated by Merck KGaA for as long as there is need
- Praziquantel is also available for purchase for 8¢ per tablet
- A schistosomiasis vaccine is currently in the early stages of development by Sabin's vaccine development team

Disease Burden

Prevalence

- 240 million people worldwide
- A majority of the burden occurs in Africa

Disease Impact

- Schistosomiasis is the most deadly NTD, killing an estimated 280,000 people each year
- Twenty million schistosomiasis sufferers develop severe and sometimes disfiguring disabilities from complications from the disease, including kidney disease, liver disease and bladder cancer
- Children with chronic disease can suffer from anemia and malnutrition, which can contribute to lost days at school and pervasive learning disabilities

Efforts at Control

Recent efforts have focused on targeted distribution of Praziquantel in specific areas thought to be disease-endemic. Schistosomiasis outbreaks can be identified by mapping the rates of blood in the urine of school-age children. If the rates are high, the drug is distributed to the entire community at risk. Annual dosing of Praziquantel is sometimes recommended for areas at high risk for re-infection with the disease, and has also been used to help reduce the severity of symptoms in chronic sufferers. Chronic disease contributes to

major organ damage, so reducing the severity of symptoms is critical to the management of schistosomiasis.

Pathophysiology

Life cycle

Schistosomes have a typical trematode vertebrate-invertebrate lifecycle, with humans being the definitive host. Infections by this parasitic worm is in a family of diseases known as helminthiases.

Snails

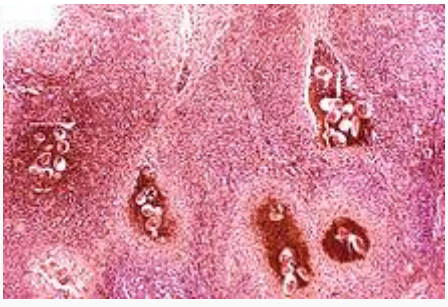
The life cycles of all five human schistosomes are broadly similar: parasite eggs are released into the environment from infected individuals, hatching on contact with fresh water to release the free-swimming miracidium. Miracidia infect freshwater snails by penetrating the snail's foot. After infection, close to the site of penetration, the miracidium transforms into a primary (mother) sporocyst. Germ cells within the primary sporocyst will then begin dividing to produce secondary (daughter) sporocysts, which migrate to the snail'shepatopancreas. Once at the hepatopancreas, germ cells within the secondary sporocyst begin to divide again, this time producing thousands of new parasites, known as cercariae, which are the larvae capable of infecting mammals.

Cercariae emerge daily from the snail host in a circadian rhythm, dependent on ambient temperature and light. Young cercariae are highly mobile, alternating between vigorous upward movement and sinking to maintain their position in the water. Cercarial activity is particularly stimulated by water turbulence, by shadows and by chemicals found on human skin.

The most common way of getting schistosomiasis in developing countries is by wading or swimming in lakes, ponds and other bodies of water that are infested with the snails(usually of the genera *Biomphalaria*, *Bulinus*, or *Oncomelania*) that are the natural reservoirs of the *Schistosoma* pathogen.

Humans

Penetration of the human skin occurs after the cercaria have attached to and explored the skin. The parasite secretes enzymes that break down the skin's protein to enable penetration of the cercarial head through the skin. As the cercaria penetrates the skin it transforms into a migrating schistosomulum stage.

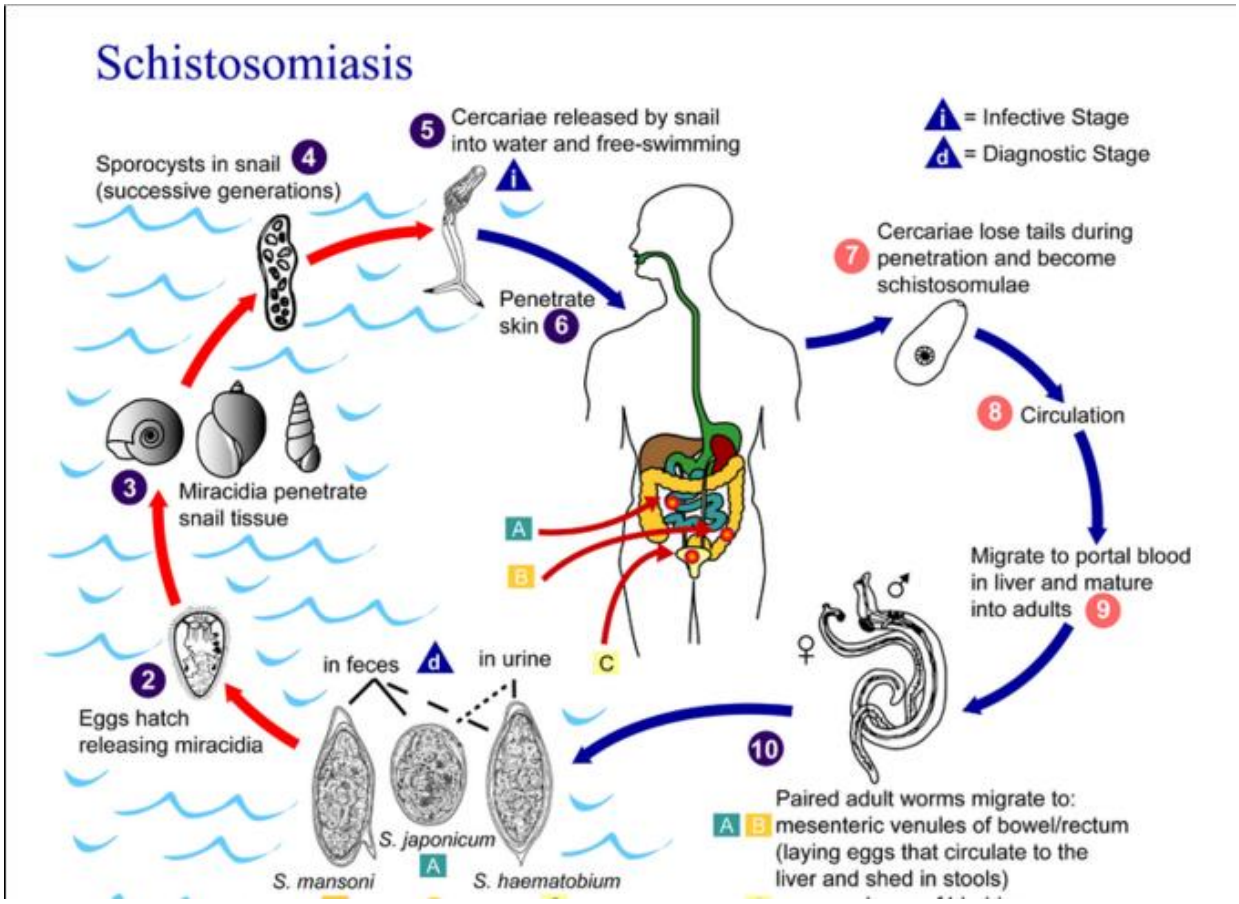


Photomicrography of bladder in*S. hematobium* infection, showing clusters of the parasite eggs with intense eosinophilia.

The newly transformed schistosomulum may remain in the skin for two days before locating a post-capillary venule; from here the schistosomulum travels to the lungs where it undergoes further developmental changes necessary for subsequent migration to the liver. Eight to ten days after penetration of the skin, the parasite migrates to the liver sinusoids. *S. japonicum* migrates more quickly than *S. mansoni*, and usually reaches the liver within eight days of penetration.
Juvenile *S. mansoni* and *S. japonicum* worms develop an oral sucker after arriving at the liver, and it is during this period that the parasite begins to feed on red blood cells. The nearly-mature worms pair, with the longer female worm residing in the gynaecophoric channel of the shorter male. Adult worms are about 10 mm long. Worm pairs of *S. mansoni* and *S. japonicum* relocate to the mesenteric or rectal veins. *S. haematobium* schistosomula ultimately migrate from the liver to the perivesical venous plexus of the bladder, ureters, and kidneys through the hemorrhoidal plexus.

Parasites reach maturity in six to eight weeks, at which time they begin to produce eggs.
Adult *S. mansoni* pairs residing in the mesenteric vessels may produce up to 300 eggs per day during their reproductive lives. *S. japonicum* may produce up to 3,000 eggs per day. Many of the eggs pass through the walls of the blood vessels, and through the intestinal wall, to be passed out of the body in feces.*S. haematobium* eggs pass through the ureteral or bladder wall and into the urine. Only mature eggs are capable of crossing into the digestive tract, possibly through the release of proteolytic enzymes, but also as a function of host immune response, which fosters local tissue ulceration. Up to half the eggs released by the worm pairs become trapped in the mesenteric veins, or will be washed back into the liver, where they will become lodged. Worm pairs can live in the body for an average of four and a half years, but may persist up to twenty years.

Trapped eggs mature normally, secreting antigens that elicit a vigorous immune response. The eggs themselves do not damage the body. Rather it is the cellular infiltration resultant from the immune response that causes the pathology classically associated with schistosomiasis.



Classification[

Species of *Schistosoma* that can infect humans:

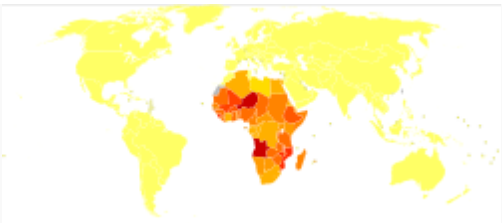
- *Schistosoma mansoni* and *Schistosoma intercalatum* cause intestinal schistosomiasis
- *Schistosoma haematobium* causes urinary schistosomiasis
- *Schistosoma japonicum* and *Schistosoma mekongi* cause Asian intestinal schistosomiasis

Avian schistosomiasis species cause swimmer's itch.

Species of *Schistosoma* that can infect other animals:

S. bovis — normally infects cattle, sheep and goats in Africa, parts of Southern Europe and the Middle East
S. mattheei — normally infects cattle, sheep and goats in Central and Southern Africa
S. margrebowiei — normally infects antelope, buffalo and waterbuck in Southern and Central Africa
S. curassoni — normally infects domestic ruminants in West Africa
S. rodhaini — normally infects rodents and carnivores in parts of Central Africa

Epidemiology[



The disease is found in tropical countries in Africa, the Caribbean, eastern South America, Southeast Asia and in the Middle East.*Schistosoma mansoni* is found in parts of South America and the Caribbean, Africa, and the Middle East; *Schistosoma haematobium*in Africa and the Middle East; and *Schistosoma japonicum* in the Far East. *Schistosoma mekongi* and *Schistosoma intercalatum* are found locally in Southeast Asia and central West Africa, respectively.

The disease is common in about 75 developing countries and mainly affects people living in rural agricultural and peri-urban areas.

Prevention

A few countries have eradicated the disease, and many more are working toward it. The World Health Organization is promoting these efforts. In some cases, urbanization, pollution, and/or consequent destruction of snail habitat has reduced exposure, with a subsequent decrease in new infections. Furthermore, the drug praziquantel is used for prevention in high-risk populations living in areas were the disease is common.

A 2014 review found tentative evidence that increasing access to clean water and sanitation reduces schistosome infection.

Snails

Prevention is best accomplished by eliminating the water-dwelling snails that are the natural reservoir of the disease. Acrolein, copper sulfate, and niclosamide can be used for this purpose. Recent studies have suggested that snail populations can be controlled by the introduction of, or augmentation of existing, crayfish populations.

For many years from the 1950s onwards, vast dams and irrigation schemes were constructed, causing a massive rise in water-borne infections from schistosomiasis. The detailed specifications laid out in various UN documents since the 1950s could have minimized this problem. Irrigation schemes can be designed to make it hard for the snails to colonize the water, and to reduce the contact with the local population.

While guidelines on how to design these schemes to minimise the spread of the disease had been published years before, but the designers were unaware of them.