

# Helminth infections – a review

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## Abstract

Parasitic worms are among the most common human infections in the world. Most patients are unaware of the infection. Adherence to good hygiene practices and provision of adequate sanitation play an important role in decreasing the burden of worm infestations. Some of the most common worms affecting humans are reviewed in this article.

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## Introduction

Medically important worms or helminths are considered to be parasites, as they require the invasion of a suitable host to complete all or part of their lifecycle.<sup>1</sup> Most helminths live in the gastrointestinal tract, but they may also infect the bloodstream or tissues.<sup>2</sup> The parasites have different stages in their lifecycles: egg, larva and adult worm. Humans may become infected by eating or inhaling eggs or larva, or larvae may enter the body through the skin.<sup>3</sup> Helminth lifecycles may include a stage outside of the human host, either in animal or free-living in the soil.<sup>2</sup>

Two phyla of worms that parasitologists concern themselves with are:

1. **Nematodes – roundworms**
2. **Platyhelminths – flatworms**

Flatworms may be further divided into trematodes (flukes) and cestodes (tapeworms).<sup>3,4</sup>

### 1. Nematodes

Nematodes or roundworms are among the simplest of multicellular animals. They have a simple digestive system that consists of a tube with two openings – a mouth and an anus. Food enters through the mouth and any undigested food exits via the anus. Roundworms vary in size from microscopic up to a metre in length. Most roundworms are free-living. However, there are many parasitic roundworms that affect plants and animals.

Roundworms that are parasites on animals may have complex lifecycles. Some roundworms require two or three hosts to complete a lifecycle, while others, such as *Ascaris*, use different organs of one host.<sup>4</sup> Roundworms may live in the gastrointestinal system or may infect the bloodstream or tissues.

### Intestinal Roundworms

#### • Roundworm – *Ascaris lumbricoides*

Roundworm is the most common worm infection in the world, with over one billion people thought to be infected. It is most common in warm areas with poor sanitation.

The parasite is transmitted when water or soil contaminated with *Ascaris* eggs is ingested. This occurs frequently when children play in soil contaminated with infected faeces. The eggs hatch in the small intestine and larvae are released. The larvae penetrate the mucosa and are carried via hepatic circulation to the heart and lungs. Once in the lungs the larvae are coughed up and swallowed, re-entering the stomach via the oesophagus. Adult worms produce eggs in the intestines and these are passed out in the faeces. Adult worms do not multiply in the human host. In places lacking in adequate sanitation, the eggs remain in the soil until ingested by another host. Mature female worms may reach up to 30 cm in length and can produce up to 250 000 eggs per day.

Symptoms may be mild and include abdominal pain, nausea, weight loss and diarrhoea. When the larvae move through

the lungs some people may develop fever, wheezing and cough. In cases of heavy infestation, the gut may be obstructed and may rupture.

Diagnosis is made by identifying eggs in a stool sample. Larvae may be identified in the sputum, and x-rays may reveal signs of migration.<sup>1,2,3,4,5,6</sup>

- **Whipworm – *Trichuris trichuria***

Whipworm occurs mainly in the subtropics and tropics, especially in areas where the sanitation is poor. Mainly children are infected. Moderate infestation may cause symptoms such as abdominal pain, nausea, vomiting, diarrhoea and loss of appetite. Heavy infestations may cause bleeding from the intestine, severe abdominal cramps, anaemia, appendicitis and rectal prolapse. The barrel-shaped eggs are usually visible in stool samples when viewed under a microscope.<sup>1,2,5,7</sup>

The life cycle for trichuriasis begins with passage of unembryonated eggs in the stool. In the soil, the eggs embryonate and become infective in 15 to 30 days. After ingestion via food or hands contaminated with soil, the eggs hatch in the small intestine and release larvae that mature into adult worms, which become established in the caecum and ascending colon after two to three months.<sup>7</sup>

- **Hookworm – *Ancylostoma duodenale*, *Necator americanus***

Hookworm is a serious intestinal parasite that infects approximately one billion people worldwide. People are usually infected when they walk barefoot on soil contaminated with human faeces.

Hookworm eggs hatch outside the body of the host and develop in the soil. The eggs require warm, moist, shaded soil to hatch into larvae. When the larvae come into contact with unprotected skin (usually the soles of the feet), they penetrate the skin using sharp hooks, enter the bloodstream and are carried to the lungs. The larvae travel up the trachea and are swallowed. Approximately a week after entering the skin they reach the intestine. Adult worms attach to the walls of the jejunum and suck blood.

The first signs of infection may be itching and a rash at the point of skin penetration. Heavy infections may cause anaemia, abdominal pain, weight loss and poor growth. Heavy chronic infections may cause stunted growth and mental retardation in children. It can be fatal in infants.<sup>1,2,4,5</sup>

- **Threadworm – *Strongyloides stercoralis***

Threadworms occur mainly in moist tropical regions,

especially in rural areas, in areas with poor sanitation and in institutional settings.

Threadworms live in the mucosal glands of the small intestine. Female worms lay eggs that hatch to become larvae. The larvae are excreted in faeces and contaminate soil. The larvae develop into infective filariform larvae that are able to penetrate human skin, usually the feet. They travel to the lungs via the bloodstream, and from the lungs to the small intestine where they become adult worms. Some larvae develop into filariform larvae while still in the intestine, and are capable of re-infecting the same person by migrating through the mucosa to the bloodstream. This "autoinfection" can lead to massive larval invasion, and is often found in patients with immune defects such as leukaemia, lymphoma and HIV infection.

Threadworm infection may be asymptomatic. Symptoms include itching, rashes in the buttock and waist areas, abdominal pain, alternating diarrhoea and constipation, nausea, vomiting and cough with bloodstained sputum. Massive larval invasion may lead to associated bacterial infections with shock, and severe sepsis that may be fatal. Larvae in the stools and duodenum are indicative of threadworm infection.<sup>2,5</sup>

- **Pinworm – *Enterobius vermicularis***

Pinworms occur worldwide and are often seen in children. They occur most frequently in school children aged 5 to 10 years. Pinworms are small white worms that live in the large intestine and rectum of humans.

At night, or in the early morning the female worms leave the intestines through the anus and lay up to 15 000 eggs on the surrounding skin before dying. In the process they cause severe itching. The eggs can survive up to two weeks on clothing, bedding and other objects.

People become infected when they touch contaminated surfaces and then swallow the eggs. Because of the itching, children often re-infect themselves from eggs under their fingernails. Bedding, clothing and toys are a source of infection and a means of spreading the eggs in families and in institutions such as boarding schools. The eggs are infectious on ingestion and hatch in the duodenum. The larvae pass to the large intestine where they mature into adult worms.

Symptoms of pinworm infection include itching around the anus, irritability, restlessness, insomnia, weight loss and poor appetite, nail biting and grinding of teeth. Vaginal itching and irritation may occur in girls.

Diagnosis can be made by seeing the worms as they move out of the anus to lay eggs, however, they are often mistaken for bits of thread. Sticky tape may be pressed to the anal area and examined for eggs.<sup>1,2,5,7</sup>

- **Trichinella – *Trichinella spiralis***

*Trichinella spiralis* is the main cause of trichinosis in humans. The two most common hosts for *Trichinella* are rats and pigs. Rats eat any meat they can find, even eating each other, and pigs regularly catch and eat rats.

When raw or inadequately cooked pork or pork products are eaten, encysted larvae in the meat hatch in the intestine and develop into worms in the mucosa. These mature, and female worms deposit larvae in the intestinal wall. Larvae travel through the bloodstream to organs and tissues. Only larvae that reach skeletal tissue survive. They penetrate the muscles, causing inflammation. By the end of the third month, they form cysts. The only way these encysted worms can complete their life cycle is if infected tissue is eaten. Certain muscles, such as the tongue, the muscles of the eye, and the muscles between the ribs are particularly likely to be infected.

Swelling of the eyelids is often one of the earliest and most typical symptoms. Muscle soreness and pain may develop, being especially pronounced in the muscles used to breathe, speak, chew and swallow. Difficulty in breathing may develop. Other symptoms may include fever, oedema, myalgia and eosinophilia. In extreme cases, infection can be fatal through myocarditis or encephalitis.<sup>1,4,5</sup>

- **Toxocara – *Toxocara canis*, *Toxocara cati***

Toxocariasis is caused by infection with worms that more commonly infect dogs and cats. Infection of humans with *T. canis* is more common than infection with *T. cati*. Infected dogs and cats shed the ova of these worms in soil. The ova are very hardy and can remain in the soil for weeks. Children are commonly infected if they eat or play in sand. Infection is most common where sanitation is poor, and where access to clean drinking water is limited.

Infection with *Toxocara* can cause a syndrome called visceral larva migrans. After ingestion, the eggs hatch to release larvae in the small intestine. The larvae burrow through the intestinal wall, and migrate to various organs and tissues, causing inflammation around them.

Most infections are asymptomatic, but symptoms may include cough, fever, wheezing, skin nodules and itching, seizures, enlarged liver or spleen, or involvement of the eye if larvae become trapped in the eye. Diagnosis is made with blood tests, as antibodies to the larvae may be present in the blood.<sup>2,5</sup>

### Tissue Roundworms

- **Filariases – *Wuchereria bancrofti*, *Loa loa*, *Onchocerca volvulus***

Filariases are insect-borne infections caused by filarial worms. These worms are found primarily in the tropical

regions of Asia, West and Central Africa, and are threadlike worms that live in the blood and lymph vessels of birds and mammals, such as humans. They are transmitted from one primary host to another through biting insects, especially mosquitoes.

When bitten, the larvae pass through the lymph and mature into thread-like adults in the lymphatic glands. After mating, the females develop eggs and larvae are released as microfilariae into the peripheral circulation.

*W. bancrofti* causes elephantiasis, a condition in which the affected part of the body swells enormously.

*Loa loa* causes Loiasis, which is transmitted by the mango fly. This disease is characterised by fugitive swellings that may arise anywhere in the body during the course of the worm's migration. This worm is often found in the eye, giving it the name – "eye worm".

*Onchocerca volvulus* causes onchocerciasis or "river blindness". This disease is spread by gnats. Characteristic features of this disease include an itchy rash and nodules in different parts of the body. The worm often invades the optic nerve and cause blindness.<sup>1,8</sup>

- **Cutaneous larva migrans – *Ancylostoma braziliense***

Cutaneous larva migrans is typically caused by the infective larva stage of the dog or cat hookworm, *Ancylostoma braziliense*. Infection occurs when skin comes into contact with contaminated soil and usually occurs in tropical or subtropical countries. Larvae are found on sandy beaches, in sand boxes or under dwellings. The larvae hatch in the soil after eggs are passed in canine or feline faeces. This disease may also be known as "sandworm".

Infective larvae penetrate and migrate in the skin producing an inflammatory reaction along the cutaneous tract of their migration. An itchy papule erupts at the site of larval entry. Two to three days later, and up to weeks later, very itchy, raised, reddish-brown lesions appear as the larvae migrate at the rate of several millimetres per day. As humans are not a natural host to these worms, the larvae eventually die and become absorbed. The cutaneous symptoms may last a few weeks, and may recur days to months after disappearing.<sup>3,9</sup>

## 2. Platyhelminths

Parasitic flatworms feed on blood, tissue and pieces of cells inside the bodies of their hosts. Flatworms lack any specialized circulatory and respiratory system. They depend on diffusion to transport oxygen and nutrients to their tissues. Metabolic waste products diffuse out of their body walls.<sup>4</sup>

### Trematodes

The members of the class Trematoda are known as flukes.

Some flukes live on the skin, mouth and gills of a host, but most flukes, including the ones that affect humans are internal parasites that infect the blood and organs.

These flukes have complicated life cycles involving at least two different host animals. Most flukes are hermaphrodites and produce large quantities of eggs. Blood flukes may lay so many eggs that the tiny blood vessels of the host's intestine break open, leaking blood and eggs into the intestine. The eggs are not digested by the host and are passed in faeces.

When the fluke eggs enter water they hatch into swimming larvae or miracidia, and when they find a snail of the correct species they burrow into it and digest its tissues. In this intermediate host the miracidia develop into cercariae, which break out of the snail and swim in the water. On contact with human skin, the worms burrow through the skin, and eat their way to the blood vessels. Blood carries the flukes via the heart and lung to the intestine, where they live as adults.<sup>1,4</sup>

- **Bilharzia – *Schistosoma haematobium*, *S. mansoni*, *S. japonicum***

In schistosomiasis, the cercarial stage of the fluke enters via the skin and matures in the portal circulation. The female lays eggs, which ascend into the gut or bladder and are excreted in the faeces or urine. *S. mansoni* is usually found in the gut, while *S. haematobium* is found in the bladder.

Symptoms may be due to the cercariae entering the skin ("swimmers' itch"), or due to the effect of the adult worms and eggs. Katayama fever is a syndrome that develops a few weeks after first exposure to the parasite, most commonly with *S. japonicum*. Symptoms include cough, loss of appetite, abdominal pain, chills, fever, diarrhoea and enlargement of the spleen, liver and lymph nodes.

*S. mansoni* causes symptoms of fatigue, nausea, and diarrhoea. This parasite may cause a bloody diarrhoea.

In *S. haematobium* infection, symptoms often include burning urine and blood in the urine. The ureters may become obstructed giving rise to kidney damage.

The infection may be diagnosed by the presence of eggs in the faeces or urine.<sup>1,2,8</sup>

- **Fasciola – *Fasciola hepatica***

Fasciola hepatica is found in most herbivores, (primarily sheep) that graze in wet pastures where the intermediate host, snails of the genus *Lymnaea*, are found. Eggs are released in faeces, and hatch to release a motile miracidia that penetrate the tissue of the intermediate host. Cercariae are produced in the snail, and when released into the environment, encyst to produce metacercariae. Humans may be infected by eating wild watercress infected with metacercariae. Once ingested, the metacercariae pass through the duodenal wall and penetrate the liver. After maturation of young flukes, the adults lie in the bile ducts or in adjacent liver tissue. Eggs are passed with the bile into the faeces.

Fascioliasis is characterised by fever, dyspepsia, sweating, loss of appetite, abdominal pain, and cough. Severe infestation may result in liver damage with or without jaundice.<sup>1,8</sup>

## Cestodes

- **Tapeworms – *Taenia solium*, *Taenia saginata*, *Diphyllobothrium latum***

Members of this class of worms are long, flat, parasitic worms. They have a head or scolex, with several suckers and a ring of hooks. These allow for attachment to the intestinal walls of hosts. The worms absorb food through their body walls.

**Table 1:** Anthelmintics and worm infections<sup>2,3,5,9,10</sup>

Medication	Examples of Trade names	Indications	Comment
<b>Albendazole</b>	Bendex-400® Zentel®	Single and mixed intestinal parasites Larva migrans Tape worm	Well tolerated Not well studied in children under one year Contra-indicated in pregnancy
<b>Ivermectin</b>	Not available in SA	Onchocerciasis Filarial infections	Safety not established in children less than five years
<b>Mebendazole</b>	Cipex® D-Worm® Vermox® Wormgo®	Single and mixed worm infestations, including Toxocariasis	Contra-indicated in children under one year, pregnancy and lactation
<b>Niclosamide</b>	Yomesan®	Tapeworm infections	No alcohol during treatment
<b>Piperazine</b>	Padax®	Round and threadworm infections	Contra-indicated in epilepsy, renal failure and liver disease
<b>Praziquantel</b>	Biltricide® Cysticide®	Bilharzia Schistosomiasis Tapeworm	Contra-indicated in 1 <sup>st</sup> trimester of pregnancy and ocular cysticercosis
<b>Thiabendazole</b>	Not available in SA	Trichinosis	

Behind the scolex is a narrow neck region that is constantly dividing to form the many proglottids or sections of the body of the worm.

Tapeworms are hermaphroditic, containing both male and female organs, and one worm can reproduce independently. Fertilised tapeworm eggs are released when mature proglottids break off the posterior end of the worm and burst open. Mature proglottids may rupture in the host's intestine or after being passed out the body with faeces. If an intermediate host (cow, pig or fish) ingests plants or water contaminated with tapeworm eggs, the eggs enter the host and hatch into larvae. The larvae grow and burrow into the muscle tissue of the host and form a dormant stage called a cysticercus. If a human eats raw or undercooked meat containing these cysts, the larvae become active within the human host. They migrate to the intestine, attach to the intestinal wall and grow into adult worms.

*Taenia saginata* (beef tapeworm) infects man through cattle. *Taenia solium* (pork tapeworm) uses pigs as an intermediate host.

The lifecycles are similar, but there is an important variation with *Taenia solium*. If the eggs of pork tapeworm are eaten by another human or are regurgitated by the original host, the eggs can hatch in the human host's gut and larvae can reach the intestines and form cysticerci. Cysticercosis may cause a variety of problems such as epilepsy and fluid on the brain.

*D. latum* (fish tapeworm) is passed to humans when they eat raw or undercooked freshwater fish.

People with tapeworm infections are often asymptomatic. If symptoms are present they may include abdominal pain, diarrhoea, weight loss, weakness and nausea.

Diagnosis usually is made when a piece of the worm is found in the stool.<sup>1,2,3,4,5</sup>

## Treatment

People with worm infections should seek medical help for diagnosis and treatment. Anthelmintics are medications to treat and to deworm patients. (See Table I)

## Prevention

Most worm infections may be prevented with strict adherence to hygiene. Avoidance of contaminated water, and thorough washing of hands and foods is important. Contaminated water should not be used for drinking, bathing or cleaning food.

Regular de-worming reduces transmission of worms, and reduces the possibility of severe infections and symptoms.<sup>3</sup>

## Conclusion

Worm infections affect millions of people worldwide. The breakdown of sanitation and lack of clean water aids the transmission of these diseases. Education and adherence to good hygiene procedures can minimise these problems.

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