



Taeniasis infections

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Taeniasis is a parasitic infection caused by tapeworms. In humans, three parasitic species can cause taeniasis: *Taenia solium* (pork tapeworm), *Taenia asiatica* (Asian tapeworm) and *Taenia saginata* (beef tapeworm). These three metazoan species have similar life cycles where *Taenia solium* and *Taenia asiatica* have pigs as intermediate hosts and cattle for *Taenia saginata* 1.

Of all three species, *Taenia solium* has the most adverse effects on human health. This article will be focusing on *Taenia solium*, which is a white coloured, flattened ribbon-like tapeworm 2.

Cysticercosis transmission

Humans can become infected with *T. solium* by the consumption of *Taenia solium*'s larval cysts in infected and undercooked pork or through the oral-faecal route due to unsanitary conditions such as open defecation. Once the *Taenia solium*'s eggs infiltrate the human body, they can further develop into cysticerci (larval tapeworm) in various organs 2. The cysticerci can develop in the central nervous system, skin, eyes, and muscles. The cysticercus matures into an adult tapeworm in the human intestine (upper jejunum) over the course of two months and can grow from 2-7m in length. These tapeworms use their scolex to adhere to the intestinal mucosa and reside there. Adult tapeworms then produce proglottids which become gravid at maturation and are released out of the human body via the anus. *Taenia solium* eggs are released as the gravid proglottids are passed with the faeces, adult *Taenia solium* has an average of 1000 proglottids and can produce up to 50,000 eggs per proglottid 3.

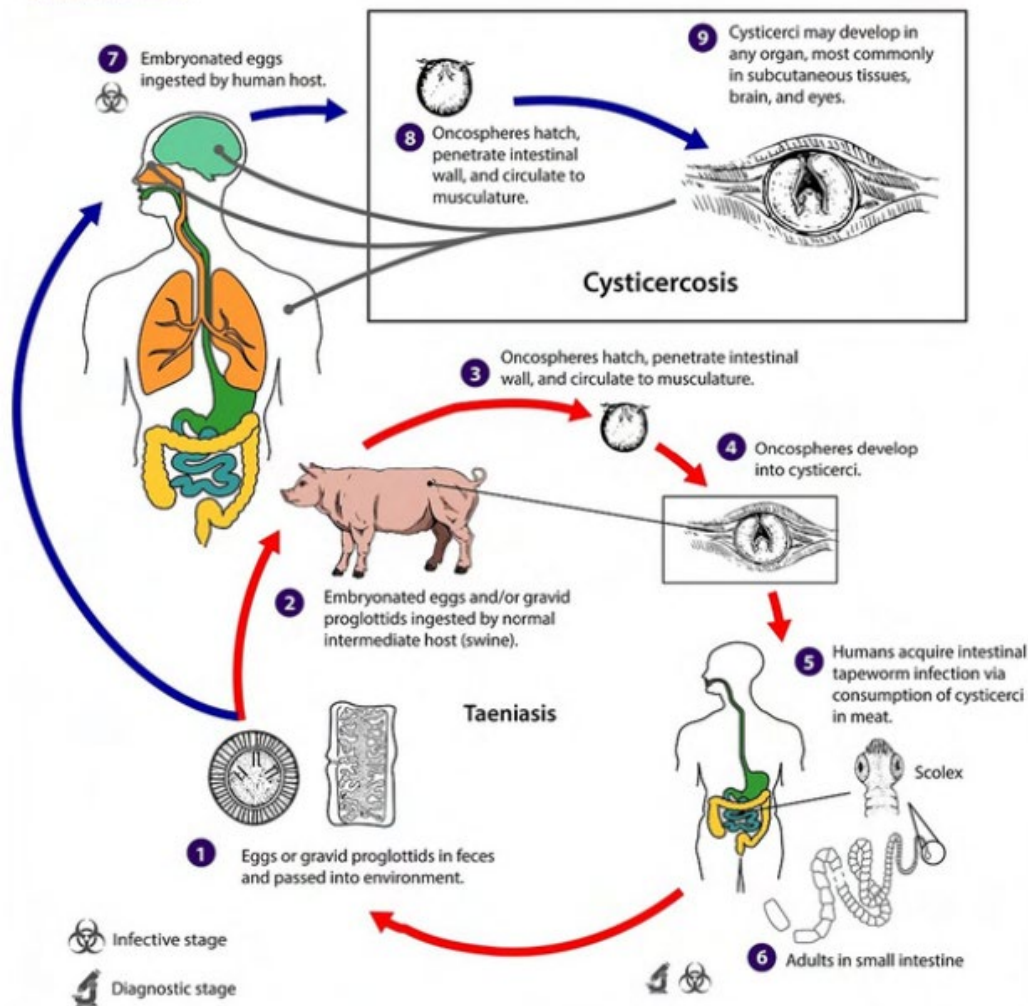


Figure 1: Life cycle of the *Taenia solium* tapeworm during taeniasis infection and cysticercosis 4.

Neurocysticercosis and epilepsy

When *Taenia solium*'s larval cysts are found in the central nervous system, the condition is known as neurocysticercosis. Neurocysticercosis is a neurological symptom of taeniasis which causes epileptic seizures. There are two mechanisms which are involved in neurocysticercosis pathogenesis; parasites located in the cerebral parenchyma or the extraparenchymal compartment. The parenchyma is the most common form of neurocysticercosis which results in seizures and chronic headache (occurs in 90% of symptomatic patients) and may lead to epilepsy 5. While, in the extraparenchymal compartment, *Taenia solium* tapeworms are located in the cerebrospinal fluid (CSF) causing hydrocephalus and intracranial hypertension 1.

Worldwide, approximately 2.56 – 8.30 million people are suffering from neurocysticercosis. In many endemic regions, *Taenia solium* causes 30% of epilepsy cases where humans and roaming pigs share proximity. However, in high-risk communities, a staggering 70% of epilepsy cases are associated with *Taenia solium* infection 2. In isolated communities, the inadequate health infrastructure and poverty leave 75% of people suffering without any treatment. The lack of knowledge and ignorance of the disease becomes a reason for many women and girls to suffer discrimination and stigmatisation, where episodes of

epileptic seizures are generally associated with witchcraft. These patients are also denied their basic rights such as education and marriage 6.

Who is affected?

Taenia solium infections are found worldwide but are much more prevalent in developing nations with low socio-economic conditions and poor sanitation. *Taenia solium* infections are endemic in India, Asia, Eastern Europe, Latin America, and sub-Saharan Africa 7. Farming communities of these developing countries are also affected by cysticercosis. In 2015, the Foodborne Disease Burden Epidemiology Reference Group (FERG) recognised *Taenia solium* as the main cause of deaths from food-borne diseases, contributing to about 2.8 million DALYs (Disability-adjusted life years) 2.

Symptoms

The active passage of proglottids (tapeworm segments) via the anus and into the faeces is the most obvious indication of taeniasis 7. Tapeworms take approximately 8 weeks to fully develop in the intestine after cysticerci ingestion. At this point, a person may experience symptoms such as diarrhoea, loss of appetite, abdominal pain, and nausea. People infected with *Taenia solium* can remain asymptomatic for several years and if left untreated infections can normally persist for 2-3 years 2. *Taenia solium* infections can lead to cysticercosis which can induce seizures when a parasite is localised in the brain, in the eye it can prompt atrophy and blindness, and can also cause muscle damage where people can develop visible or palpable nodules – a small solid bump in subcutaneous tissues 8.

Diagnosis and treatment

Taeniasis diagnosis includes microscopic examination of proglottids and eggs in the stool samples, specimens are obtained on three different days and are examined for *Taenia solium*'s eggs in the lab. These eggs can be found in the stool samples even after 2-3 months of getting infected 7.

The right treatment is essential in controlling the parasite transmission cycle and preventing the further development of conditions such as neurocysticercosis. Treatment can be provided individually or by implementing preventive chemotherapy (mass drug administration). Currently, drugs used to treat taeniasis include single doses of Praziquantel (10 mg/kg), Niclosamide (children aged 2-6: 1g, 6+ years: 2g) and Albendazole (400mg for 3 consecutive days) 2.

Neurocysticercosis is diagnosed through neuroimaging - computed tomography (CT) or magnetic resonance imaging (MRI) scans, these are excellent at evaluating degenerative stages, number, and location of the parasites. As neurocysticercosis can lead to an inflammatory response much more localised treatment is required. Currently, longer courses with higher doses of cestocidal drugs (Praziquantel and Albendazole) are used alongside corticosteroids and anti-epileptic drugs to treat neurocysticercosis. The treatment is adapted to each patient after the clinical presentation 1.

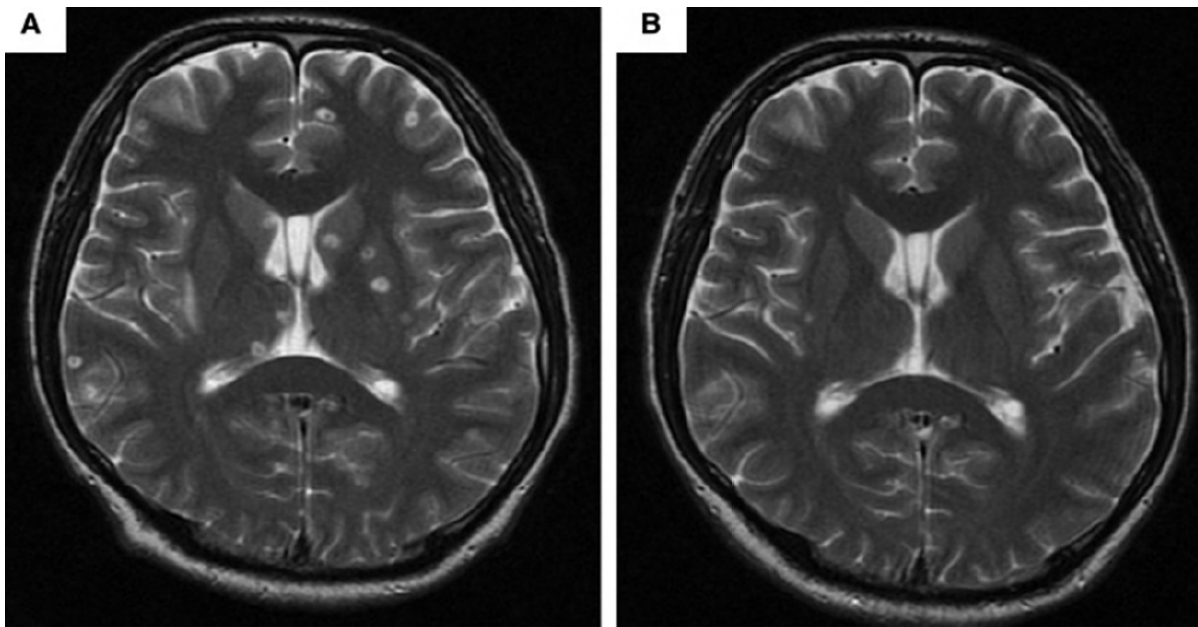


Figure 2: Brain MRI images were taken before (A) and after (B) treatment. Multiple cysts can be seen within the parenchyma (A) before albendazole (15mg for 28 days) cleared all the lesions (B) 9.

Prevention and control

Appropriate public health interventions are crucial to control and prevent the spread of *Taenia solium*. Firstly, suitable surveillance mechanisms are needed to keep abreast with new cases and to identify higher-risk communities 10. Also, point-of-care testing is required for cysticercosis diagnosis- early diagnosis would mean better management of viable cysts. Finally, identification of porcine cysticercosis would be invaluable to help reduce the prevalence of the disease.

There are several interventions set in place for *Taenia solium* obliteration, these include: ensuring effective treatments of human taeniasis, vaccinations in pigs, improved meat inspection and pig husbandry, helping communities improve sanitation and providing education on health, hygiene, and food safety 2.

What can you do?

Taeniasis is largely under-reported due to the lack of resources available in under-developed communities therefore any research in the area would be highly beneficial. More fundings are needed to research these neglected zoonotic diseases and you can help fight against parasitic infections by donating to organisations such as the SCI Foundation. Check their website: <https://schistosomiasiscontrolinitiative.org/>

In 2020, a German pharmaceutical company called Bayer and the World Health Organization (WHO) had an agreement to provide medicines for the infections caused by *Taenia solium*. Both Praziquantel and Niclosamide can now be requested through the WHO website: Steps to requesting donated medicines for treatment of epilepsy-associated tapeworm infection 11.

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