

## HUMAN TANNIASIS IN LATIN AMERICA: A LOOK AT ECUADOR

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***Andrés Dennys Castillo Pedreros***

Universidad Técnica de Machala

Doctor

Ecuador

<https://orcid.org/0009-0003-8964-5576>

***Xiomara Jacqueline Fernández Lima***

Universidad Técnica de Machala

Doctor

Ecuador

<https://orcid.org/0009-0007-2050-5515>

***Karen Vanessa Nuñez Ibarra***

Universidad de Guayaquil

Doctor

Ecuador

<https://orcid.org/0009-0001-8066-4389>

***Ana Solange Vallejo Orozco***

Universidad de Guayaquil

Doctor

Ecuador

<https://orcid.org/0000-0001-8956-7764>

***Angélica María Valarezo Ríos***

Universidad Técnica de Machala

Doctor

Ecuador

<https://orcid.org/0009-0005-6686-7138>

***Cristopher Noé Camacho Vásquez***

Universidad Técnica de Machala

Doctor

Ecuador

<https://orcid.org/0009-0001-1783-8040>

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***María del Cisne Cruz Cruz***

Universidad Técnica de Machala  
Médica  
Ecuador  
<https://orcid.org/0009-0009-5601-3605>

***Gianella Esthefania Quezada Labanda***

Universidad Católica de Cuenca  
Doctor  
Ecuador  
<https://orcid.org/0009-0006-8172-7675>

***Juri Irania Rogel Villegas***

Universidad Técnica de Machala  
Doctor  
Ecuador  
<https://orcid.org/0009-0000-0739-4186>

***Marjorie Alexandra Ramón Ramón***

Universidad Técnica de Machala  
Doctor  
Ecuador  
<https://orcid.org/0009-0005-3816-4734>

***Luis Alexander Guarnizo Orellana***

Universidad Católica de Cuenca  
Doctor  
Ecuador  
<https://orcid.org/0009-0001-6174-2070>

***Candy Cindy Coca Cruz***

Universidad Católica de Santiago de Guayaquil  
Doctor  
Ecuador  
<https://orcid.org/0009-0009-3122-086x>

**Abstract: Introduction:** Intestinal taeniasis is a disease transmitted by 2 parasitic organisms, Taenia Solium and Taenia Saginata, which causes symptoms such as abdominal pain, hyporexia, asthenia and weight loss. It is often asymptomatic, making its diagnosis difficult. In the country there are very little data about this disease, its diagnosis is overlooked, and it is generally detected when it is complicated by neurocysticercosis, thus increasing its morbidity and mortality. Taeniasis is an endemic disease in developing countries, occurring due to a lack of health infrastructure and poor health education. This infection frequently affects the child population, affecting their development and growth, triggering pathologies such as anemia, diarrhea, and malnutrition, among others. **Objective:** Describe the updates in the diagnosis and clinical management of Taeniasis, through scientific review, to provide a better understanding for its control in the country. **Materials and methods:** An exhaustive search was carried out in the databases of Pubmed, Scielo, Google Scholar academic search engines and medical journals such as the New England Journal of Medicine, based on scientific articles indexed in scientific journals, within the Q1-Q2 quartile. **Conclusion:** Because taeniasis is an asymptomatic disease, there are not many studies or statistical data in the country, mostly there are studies of its complication, neurocysticercosis. Ecuador is a developing country with low percentages of basic infrastructure, especially in rural areas, and few prevention programs necessary to control taeniasis and its complications.

**Keywords:** Taeniasis, Cysticercosis, Taenia Solium, Taenia Saginata, neurocysticercosis.

## INTRODUCTION

Intestinal taeniasis is a disease transmitted by 2 parasitic organisms, *Taenia Solium* and *Taenia Saginata*, which is caused by the adult form of this parasite, causing symptoms such as abdominal pain, hyporexia, asthenia and weight loss. It is often asymptomatic, making it difficult to treat. diagnosis, in the country there is very little data about this disease, its diagnosis is overlooked and it is detected only when it is complicated by neurocysticercosis, thus increasing its morbidity and mortality (1).

Taeniasis is an endemic disease in developing countries, occurring due to lack of health infrastructure and poor education. This infection greatly affects the child population, affecting their development and growth, triggering pathologies such as anemia, diarrhea, and malnutrition, among others. (1).

The life cycle of *Taenia Solium* and *Saginata* is the same, only the intermediate host changes, in one it is pigs and in the other it is cattle respectively (2). The tapeworm has two hosts, first we have the definitive host which is the human being and secondly the pigs and cattle which is the intermediate host, in the intermediate host we find cysticerci in the tissues of the animal in the skeletal muscle, these are ingested by the human being at the time of feeding, these when swallowed are located in the small intestine of the human, developing to their adult phase in months, the adult form releases distal proglottids that contain eggs in the feces, the feces contaminate the food and drink of Pigs and cows are ingested together with the mature tapeworm eggs. The eggs hatch in the intestine of these animals, passing through the intestinal mucosa, reaching the blood circulation where they are located in the tissues (1).

Taeniasis is a parasitic infection caused by helminths, cestodes of the genus Tapeworm

that occurs when the parasite invades the human intestine (2).

Cysticercosis is an infection of the same parasite in its larval form called the *Taenia Solium* cyst or cysticercus. It is an endemic disease in developing countries, related to poverty and poor health services (3).

## RISK FACTOR'S

Parasitic diseases are linked to poverty, poor health education and lack of infrastructure for wastewater disposal (4). The rural population is the most affected by having these risk factors; if you want to eradicate taeniasis, you must eliminate these factors that are an obstacle to prevention and health promotion programs (5).

It is linked to poverty due to the precarious lifestyle they lead, as they do not have sanitary facilities, drinking water, or adequate wastewater management. UNICEF estimated that 18 million people defecate in the open air and 17% do not. has basic services, these studies were carried out in regions endemic for parasitosis (4). In many rural areas it is observed that they use human feces as fertilizer, thus being a source of contamination for livestock fulfilling the life cycle of the parasite (5).

The feces of the human infected by the Tapeworm are contaminated with eggs of this parasite, the Tapeworm eggs in the intestine of the cow and the pig hatch and enter the blood circulation, locating themselves in the skeletal muscle and skin of the cattle, in Loja province. In Ecuador there are dietary customs such as eating semi-cooked pork skin, which is a risk factor for infection by *Taenia Solium*. The popular meat ceviche is also made with raw beef, facilitating infection by *Taenia Saginata*.

In Ecuador, Argentine barbecue is very popular, but due to the poor control of the slaughterhouses in the country, it is a risk factor for becoming infected with taeniasis,

because the meat is semi-cooked and in some cases raw, not cooking the meat at a temperature internal temperature of more than 63 degrees Celsius predisposes a risk factor for infection (4).

Ecuador has high risk factors in the consumption of contaminated meat because only 48% of pigs have the necessary veterinary control for human consumption (1).

Poor health education and not having drinking water increase the risk of infection, many rural inhabitants do not wash their hands before eating, nor do they wash food before consuming it, for this reason it is good to prioritize programs aimed at this population, educating and promoting hygiene standards, to prevent parasitic intestinal diseases (5).

## **EPIDEMIOLOGY**

Intestinal taeniasis infection is distributed between 0.5 to 2% of the population in endemic countries, allowing its survival and complications (2).

In endemic areas such as the Caribbean and Latin America, 14.9 million cases of neurocysticercosis have been reported, being responsible for 30% of all epilepsies in these areas (3). 10 to 20% of these inhabitants will present healed calcifications in the brain CT or MRI, giving a diagnosis of cerebral cysticercosis, about 1% will not present symptoms (2).

Studies have shown that 10 to 25% of inhabitants in endemic areas will present anti-Taenia Solium antibodies; this was performed using the electroimmunoblotting method or Western Blot for taeniasis (6).

In our country, 10 to 25% of epilepsies are caused by neurocysticercosis, the rural population is the most affected, this represents 38% of the inhabitants of Ecuador, 25 to 40% of rural inhabitants are exposed to this parasite, this population is distributed on the coast and in the mountains (3).

Previous studies from 1978 to 1984 demonstrated a prevalence of neurocysticercosis of 1.3% in Cuenca, Ecuador (4). In Ecuador, the raising of pigs for consumption is not optimal for the most part; studies report that 61% of the pig population is raised outdoors and only 48% were evaluated by veterinary doctors. (7)

In 2013, Ecuador reported 67 new cases of neurocysticercosis, giving a total of 0.42 cases per 100,000 inhabitants, with the most affected provinces being Loja and Pichincha. There is no current data on Taeniasis in Ecuador. (1)

The program for the prevention of intestinal parasitosis in schoolchildren in Centinela del C ndor Ecuador demonstrated that parasitic diseases in the country are neglected, putting the preschool population at risk with 66.8% and schoolchildren with 67.4% to contract parasitic infections caused by helminths (5).

The prevalence of intestinal parasitosis from 2014 to 2017 was 84.56%, there are no current epidemiological studies on Taeniasis in Ecuador, due to the few data updates carried out in the country on this pathology, the approximate number of infected is unknown(5).

## **PATHOGENESIS OF TAENIASIS**

Taenia Solium measures approximately 2 to 4 meters in length and T. Saginata measures 4 to 12 meters, even regardless of their size, they are usually asymptomatic when they enter humans and develop the intestinal taeniasis infection (7). When this pathology presents symptoms, the most common thing is to find clinical symptoms characterized by stomach upset, abdominal distention, abdominal pain (6).

In Chile, a study was carried out with 35 patients diagnosed with taeniasis, of which 91.4% presented alterations in appetite, 48.8% had abdominal pain, 42.9% had a normal appetite, 34.3% had an increase in appetite

and 14.3% had a decrease in appetite. (7).



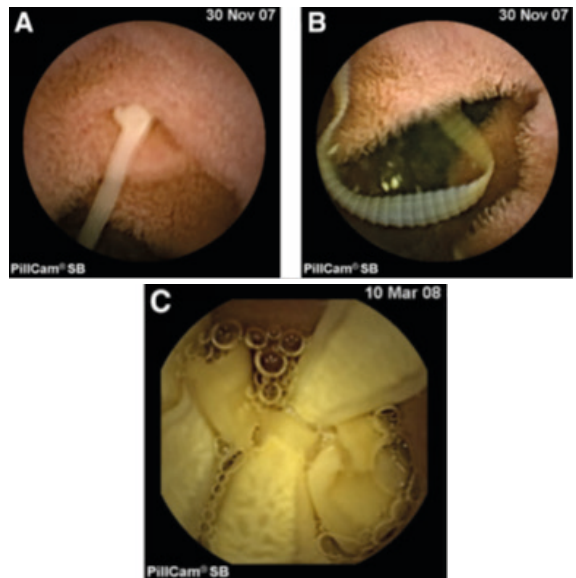
**Figure 1:** Removal of taeniasis in a person.

**Source:** 8. Philips, C. A., & Sahney, A. *Taenia solium*. India 2017. *New England Journal of Medicine*, [Internet] 376(4), e4. doi:10.1056/nejmicm1606747. Available in: <https://www.nejm.org/doi/full/10.1056/NEJMicm1606747> (8)

## INTERACTION OF THE TAPEWORM WITH THE HOST

When the Tapeworm is located in the intestine and adheres its scolex to the intestinal mucosa through hooks or suction cups, it causes local damage, provoking the response of the immune system, involving mast cells, plasma cells, eosinophils and neutrophils (8).

They are doing studies to develop a possible vaccine against *Taenia Solium*, the calreticulin protein of the T.S present in the rostellum and the suckers is being used to increase the immunological response of the intestinal mucosa to taeniasis infection, they have had good results in mice and dogs immunized with these proteins, but the test in humans is still being studied (9).



**Figure 2:** Taeniasis seen by endoscopy.

**Source:** Carretero, C., Borda, A., & Muñoz-Navas, M. Face to Face with Teniasis. Spain 2010. *Clinical Gastroenterology and Hepatology*, [Internet] 8(1), A36. doi:10.1016/j.cgh.2009.03.003. Available in: [https://www.cghjournal.org/article/S1542-3565\(09\)00218-3/fulltext](https://www.cghjournal.org/article/S1542-3565(09)00218-3/fulltext) (9)

## COMPLICATIONS

Intestinal taeniasis is a disease that in most people does not present symptoms. These larvae from the intestine can enter the circulatory system, thus locating themselves in other areas of the body, producing symptoms depending on where they are located, causing complications, such as neurocysticercosis, ocular cysticercosis, subcutaneous and visceral cysticercosis, the visceral form commonly affects the heart, but is asymptomatic (8).

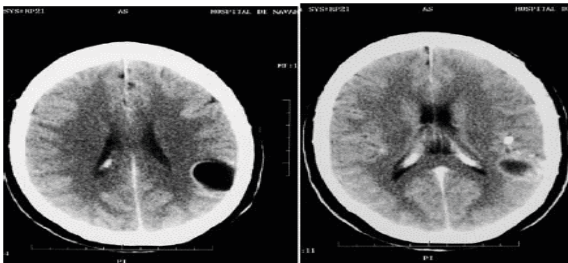
Subcutaneous cysticercosis usually presents pain at the site where the cyst is located (2).

In its ophthalmic form, the symptoms depend on the place that the cyst affects. If it is located in the ocular muscles, they can trigger strabismus. They can float in the vitreous humor and obstruct the visual field. Their most serious effect is when they invade the retina, deteriorating visual acuity, when it invades the retina it enters the classification of

neurocysticercosis. (6)

Neurocysticercosis is the infection of the cysticercus in the nervous system, it is associated with greater morbidity and mortality (7). The clinical manifestations of neurocysticercosis depend greatly on its location, number of cysticerci, the evolutionary stage of the parasite and the response of the host's immune system (9).

The larvae found in the brain parenchyma produce seizures in the majority of diagnosed cases. These can remain in the brain for decades until they calcify through an involuting process in response to host infection. These larval cysts are vesicles filled with clear liquid that After the immune response they become fibrotic, reducing their size (10). In addition to the brain parenchyma, they can invade the subarachnoid area and, as a mass, can obstruct the circulation of cerebrospinal fluid, producing cases of hydrocephalus. (5)



**Figure 3:** Cranial CT scan showing a cystic lesion measuring 3 cm in diameter with nodular calcifications in its periphery, which corresponds to neurocysticercosis.

**Source:** 1. Navarro, D. Huarte, I. Santesteban, R. Bidarte, M. Ayechu, A. Clinical-radiological diagnosis of neurocysticercosis: a case report. Spain 2009. Scielo [Internet]. 2020 [cited 2020 Sep 8]. Available in: [http://scielo.isciii.es/scielo.php?script=sci\\_arttext&pid=S1137-66272009000300013](http://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S1137-66272009000300013) (10).

Individuals seropositive for *Taenia Solium* (T.S) with subcutaneous cysticercosis present subcutaneous nodules which may appear months or years before manifesting

neurological symptoms. For this reason, a physical examination of the patient is important, since if detected in time, can prevent neurological complications (11).

Extraparenchymal neurocysticercosis is caused by cysts that obstruct the ventricles or the subarachnoid space. In these individuals, high levels of anti-TS antigens are found due to the host's immune reaction. Mononuclear pleocytosis and proteinorrachia can also be found in the cerebrospinal fluid (12).

In patients with intraparenchymal neurocysticercosis with a single involuting cyst, undetectable levels of anti-TS antigen can be found in up to 40% of patients. This depends greatly on the number of cysts found in the host, thus relating to the number of parasites. for its detection by T. S. immunoelectrophoresis. Neurocysticercosis can trigger cerebrovascular accidents due to its mass effect by occluding circulation, but there are no statistical data to support this because there is no significant increase in cerebrovascular accidents in areas endemic for taeniasis (12).

## DEPRESSION

36 to 85% of patients diagnosed with neurocysticercosis present depression, associated with seizures, affecting quality of life, it is believed to be due to the proinflammatory cytokines IFN $\gamma$ , IFN- $\alpha$ , IL-1 $\beta$  and TNF- $\alpha$  that they block. serotonin reuptake, and other mechanisms that participate in reducing the size of the hippocampus. (6)

## **IMMUNOPATHOLOGY OF TAENIA SOLIUM**

T. S uses various mechanisms to evade the immune system. We find that it blocks the complement system, emits cytokines that confuse the cellular response and camouflage itself with the host's own immunoglobulins. In asymptomatic patients, production of TH2 lymphocytes has been demonstrated, which in Coordination with cytokines produces an anti-inflammatory response wherever the cysticercus is located. At the same time, the action of osteopontin as an inflammatory regulator is also studied due to the low Th1 response that it produces in parasite infection (7).

As the infection continues, the immune system detects this pathogen and fights it through the response triggered by TH1 lymphocytes, causing lesions in the area where the parasite is found, producing symptoms such as seizures. The pro-inflammatory activity is mediated by the MyD88 that regulates cytokines and secretion of TNF, IL-1B and IL 6 by monocytes such as microglia, demonstrating that the response to parasitic antigens depends on the transcription of the NF-KB factor. (9)

The pro-inflammatory response produces damage to the brain parenchyma observed in CT scans, there is also an increase in permeability in the blood-brain barrier, this barrier is formed with collagen type 4, which is a substrate of matrix metalloproteinase (MMP-9). MMP are zinc-containing enzymes whose action can degrade the extracellular matrix, they are present in monocytes, their regulation and blockade is given by tissue inhibitors of metalloproteinases. In studies in mice with neurocysticercosis, MMPs were associated with breaking the blood-brain barrier. Thanks to this discovery, doxycycline is associated with neurocysticercosis to control damage to brain tissue due to its action as an

MMP inhibitor (10).

It was discovered that the parasitic cyst contains an anti-inflammatory mediator similar to IL-10, this mediator loses its action with antiparasitics, causing the immune system to respond to the parasite antigens (14).

## **DIAGNOSIS AND TREATMENT OF TAENIASIS**

The diagnosis of taeniasis is made directly by observing the proglottids in the feces; these are usually present 2 to 3 months after the parasitic infection (13).

## **PROMOTION AND PREVENTION**

The current prevalence of taeniasis in the country is unknown, more emphasis is placed on neurocysticercosis due to its high morbidity, so to prevent this complication the Taenia must be eliminated in its intestinal cycle, for this we must go to the cause of the infection, one of the causes is the consumption of contaminated meat, this meat is contaminated because the food of pigs and cows is in contact with human feces carrying tapeworm eggs, this commonly occurs in rural areas where they do not have good management to wastewater disposal (9).

In Ecuador, pork and beef to be sold must meet certain norms and standards that are evaluated in the country's Municipal Chambers; only by complying with this certification is the meat suitable for human consumption (7). We must eliminate the sale of meat that does not have health control and raise awareness in the population so that they do not buy this meat, in order to reduce cases of taeniasis and its complications (10).

Among other measures, hand washing is recommended before handling food, after defecating and before eating food, thus avoiding oral fecal contamination. This is achieved by promoting good standards of

PARASITE	DRUG	DOSE	TREATMENT DURATION
T. SOLIUM	PRAZICUANTEL NICLOSAMIDA	5-10mg/kg/day PO 50mg/kg/day PO	1 DAY
T. SAGINATA	PRAZICUANTEL NICLOSAMIDA	5-10mg/kg/day PO 50mg/kg/day PO	1 DAY

**Table 1:** Pharmacological treatment of human taeniasis.

**Source:** 5. Torres, F. Program for the prevention of intestinal parasitosis in schoolchildren in Centinela del C6ndor, Ecuador. Spain 2018. ``Universidad Publica de Navarra`` [Internet]. 2020 [cited 2020 Sep 8]. Available in: <https://hdl.handle.net/2454/29090> (5).

personal hygiene in the population through hand washing campaigns. and food (11).

The government must provide deworming programs to the general population, and reinforce its administration in rural areas. We must normalize antiparasitic prophylaxis every 6 months or at least once a year, with antiparasitics such as albendazole in doses of 400 milligrams once a day. 3 days in a row, or praziquantel in a dose of 10 milligrams per kilogram of weight in a single dose (5).

Another measure is to implement improvements in the raising of livestock for human consumption, treating them with the antiparasitic drug oxfendazole at a dose of 30 milligrams per kilogram of weight. This is recommended 2 to 4 times per year, and at the same time vaccinating pigs with the TSOL18 vaccine that offers immune protection against *T. Solium* infection. With these two measures we can reduce contagion to humans by reducing infection in the intermediate host. For this there must be better control by the Ecuadorian Agency for Quality Assurance of AGRO-AGROCALIDAD (3).

A study in Mexico demonstrated positive results by reducing cases of cysticercosis in humans through education programs for farmers and families, and swine immunization through the S3Pvac-phage vaccine, reporting a decrease in the prevalence of cysticerci in pigs. from 7 to 0.5% by physical examination of the tongue, from 3.6 to 0.3% by ultrasound of tissues, and from 17.7 to 13.3% by seroprevalence in blood due to the presence of

anticysticercus antibodies through the ELISA technique (11).

The constitution of Ecuador tells us that "Health is a right guaranteed by the State, the realization of which is linked to the exercise of other rights, including the right to water, food, education, physical culture, work, security social, healthy environments and others that support good living...The State will guarantee this right through economic, social, cultural, educational and environmental policies; and permanent, timely and non-exclusionary access to programs, actions and services for the promotion and comprehensive care of health, sexual health and reproductive health" (12).

It is our right to health to have programs for the eradication of pathologies that affect our daily lives and even cause repercussions in us that put our lives at risk, which is why it is important that the government finance studies and programs for the eradication of taeniasis and its complications, since it is an endemic disease in our country with few studies carried out, not even knowing an approximate number of people who suffer from this parasitosis (14).

Well, it is the duty of the state to offer prevention and health promotion programs, as indicated in the National Plan for Good Living, which aims to "Increase the hope and quality of life of the population, through policies aimed at the care and promotion of health" (12).



## CONCLUSION

In Ecuador there are no current studies of taeniasis infection, they focus more on studies of neurocysticercosis given its high morbidity and mortality, and to prevent this complication, the consumption of meat that does not pass the controls of the Municipal Camales must be controlled, and the adequate cooking of foods derived from meat; Cleaning of hands and food before ingesting them must be recommended through educational campaigns, providing prophylactic antiparasites to prevent complications, and having better control in the raising of livestock by Ecuadorian ranchers, who meet the standards of the

Ecuadorian Agency for Quality Assurance of AGRO- AGROCALIDAD.

To keep Taeniasis infection under control, both the medical side and those in charge of food quality control must work together, together with the government and its health programs, educating the population and respecting the standards of consumption of Taeniasis. meat, the government must facilitate the disposal of sewage in rural populations. We must learn from the studies and programs carried out worldwide, trying to adapt them to the most affected population, all aimed at the well-being of a country and its inhabitants. Taking all these measures can reduce infection by taeniasis and cysticercosis in the long term in Ecuador.

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