Intestinal parasites: Self-medication and public health risks

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ABSTRACT
Helminthiases are diseases caused by soil-transmitted parasites, such as nematodes and flatworms. Geohelminths are part of the soil cycle, affecting around 1.5 billion people, mainly in Africa, China, South America and Asia, while water-related parasitic diseases, caused by ingestion of contaminated water, are responsible for approximately 2 billion cases of diarrheal diseases and 842,000 deaths annually. Therefore, the present work aims to evaluate the general characteristics of intestinal parasites, the inherent risks to public health and the practice of self-medication in the treatment of parasites. To this end, an integrative review of the literature was carried out, using a wide variety of databases, such as: Scielo, Medline, Lilacs and Google Scholar, applying the following inclusion criteria: original articles; Portuguese and English published in the last 10 years, and as exclusion criteria: articles without a direct relationship with the topic and repeated articles. With the results obtained, it can be highlighted that most parasites can develop serious complications for their hosts, such as invasion to other organs, destroying the host's cells and the ability to multiply quickly, leading to death. Therefore, albendazole is a medicine widely used for various parasites such as Giardia lamblia, Cryptosporidium parvum, Enterobius vermicularis, Ascaris lumbricoides, Trichuris trichiura, Ancylostoma duodenale and Necator americanus. Albendazole has larvicidal, ovicidal and vermicidal activity, with the aim of eliminating parasites, contributing to the inhibition of tubulin polymerization, preventing replication. Health education, with an emphasis on hygiene and basic sanitation practices, is crucial in prevention. We can conclude that parasites contribute to an increase in morbidities, as they trigger a wide variety of diseases. Therefore, it is necessary to adopt sanitary measures, such as water treatment, correct food handling and hygiene.

Keywords: Geohelminths, Self-medication, Protozoa, Drugs.

1 INTRODUCTION

Helminthiases are soil-borne diseases caused by multicellular parasites, such as roundworms and flatworms. These organisms have cylindrical or flattened bodies, bilateral symmetry, and thrive in warm, humid conditions. Infection occurs when hosts meet eggs or larvae. Common examples in human infections include *Ascaris lumbricoides, Trichuris trichiura, Ancylostoma duodenale, and Necator americanus* (Peixoto, 2017).

Geohelminths are parasites that have part of their biological cycle in the soil, and in this way, they are transmitted. Geohelminths are related to social, economic and cultural factors that facilitate their expansion, especially in regions where environmental factors are appropriate. These infections are among the most common infections worldwide, with an estimated 1.5 billion people infected, being most prevalent in sub-Saharan Africa, China, South America, and Asia (WHO, 2022).

Water-bound parasitic diseases usually occur through a few ways: ingestion of contaminated drinking water; hot tubs; water playgrounds; Pools; Sewers; faeces-infected rivers; grounds. These are examples of places that can corroborate the emergence of parasitic outbreaks. Thus, these water-associated infections are the leading causes of death in the world, with approximately 2 billion diarrheal pathologies and 842,000 deaths annually. In which these water parasites trigger several clinical aspects, such as diarrhea (Bourli *et al.*, 2023).

Health education, as well as raising awareness among the population about hygiene practices and effective basic sanitation, are forms of prevention for various types of parasitosis. In Brazil, the treatment of geohelminthiasis can be done with albendazole or mebendazole, both of which are used orally. Albendazole has a low toxicity and few adverse reactions, since it is quickly eliminated from the body, in addition to being low-cost, it has the advantage of being a single dose (Belloti, 2019).

Generally, anthelmintics have two mechanisms of action: they act on the ion channels of parasites, such as levamisole, or they block the formation of microtubules of parasites, which are part of their cytoskeleton, preventing their cell division, such as thiabendazole (Katzung, 2017).

Anthelmintics and benzimidazole anti-protozoa are the classes of drugs most involved in self-medication, the main drugs are: metronidazole; albendazole. According to the World Health Organization (WHO), self-medication is a very common practice among individuals and is related to an individual's conduct when using medications without the instructions of a professional, with the aim of treating their illnesses or symptoms (Ge *et al.,* 2022).

The present study aims to evaluate the general characteristics of intestinal parasites, the risks inherent to public health and the practice of self-medication in the treatment of parasitic diseases.

2 METHODOLOGY

This is an integrative review of the literature. In which a bibliographic research was carried out in journal articles, books, e-books, monographs, master's dissertations and theses. The initial research was crucial to carry out the qualitative verification and detailed analysis on the topic chosen for the study. The study was divided into stages, which began with a sample in the literature, in which some key terms were selected, following the instructions of the Health Sciences Descriptors (DeCS), used in the VHL (Virtual Health Library) search engine.

The descriptors used in the initial research were: "Intestinal parasitosis", "Geohelminths" and "Treatment", with Boolean operator AND. The following databases were selected: Scielo (Scientific Electronic Library Online), Medline (Medical Literature Analysis and Retrievel System Online), Lilacs (Latin American and Caribbean Health Sciences Literature), PubMed (U.S. National Library of Medicine) and Google Scholar.

In the in-depth research on parasitosis, it was divided into parts, and more specific descriptors were used for each one. In the research on schistosomiasis, the descriptors "*Schistosoma mansoni*" were used; " Clinical aspects" and "Morphology", with the Boolean operators AND and OR. It generated 19,098 results, of which 7,533 were full-texts. As inclusion criteria, English and Portuguese were selected, as well as articles that explained the biological cycle, morphology, symptomatology and treatment. Duplicate articles, and those that do not match the theme, were excluded, in which 6 articles were used for the study, as well as 2 theses, 2 e-books and the Ministry of Health website were added to the research to complement them.

In the study on giardiasis, the same descriptors above were used, replacing only the name of the parasite with "*Giardia lamblia*", and with the same Boolean operators. It resulted in 11,152 papers, 5,124 of which were full texts. Only those who were in Portuguese and English were selected and followed the same inclusion and exclusion criteria used previously, choosing 6 articles for the final research. The descriptors used on Hookworm and Tricuriasis were "Hookworm infection"; "*Necator americanus"*; " Intestinal helminth" and "*Trichuris trichiura*". The following inclusion and exclusion criteria, applied in the search phase, remained the same as those described in the other parasites, in which 2,584 articles were found after the survey, and 16 of them were used.

To carry out the study on the treatment, the descriptors "Intestinal parasitosis" and "Treatment" were chosen, with the Boolean operator AND, searching for articles only in English and Portuguese, generating 102 full-text articles. As inclusion criteria, we used only articles that report on drug therapies in the treatment of the main intestinal parasites. Repeated articles that escaped the theme sought were excluded, in which 3 articles were chosen for theoretical deepening and 1 monograph. Additional information was also searched on the Ministry of Health website about some contraindications for anthelmintics. In addition, for the research on self-medication in the database, 1,620 articles were found, with the descriptors: "self-medication", "antiparasitics", using 4 articles. Thus, the total number of articles used to compose the research was: 35 articles.

In order to improve the content of the review, in addition to the articles used, a research was conducted based on dissertations, theses and monographs available in the collections of educational institutions. The research was focused on the themes of parasitic diseases: Ascariasis, Enterobiasis, Amebiasis, Schistosomiasis and Cryptosporidiosis. A total of 18 studies aligned with the theme of the study were identified. It was decided to select academic papers due to the depth of these materials,

which contributed significantly to a more relevant review. In addition, in the elaboration of the article, some current e-books on parasitosis were used, as well as the help of the academic book entitled "Human Parasitology", whose main author is David Pereira Neves. The book explores innovative themes, with emphasis on general concepts of protozoa, helminths, arthropods and emerging parasites.

3 RESULTS AND DISCUSSION

3.1 GEOHELMINTURES

Geohelminth infection is common in developing countries due to contact with contaminated soil that contains eggs or larvae of these parasites. This situation is compounded by the lack of access to safe drinking water and adequate sanitation, especially among disadvantaged communities. Estimates from the Pan American Health Organization indicate that approximately 820 million people worldwide are currently infected by *Ascaris lumbricoides, 460 million by* Trichuris trichiura *and 440 million by hookworms (Brasil, 2018).*

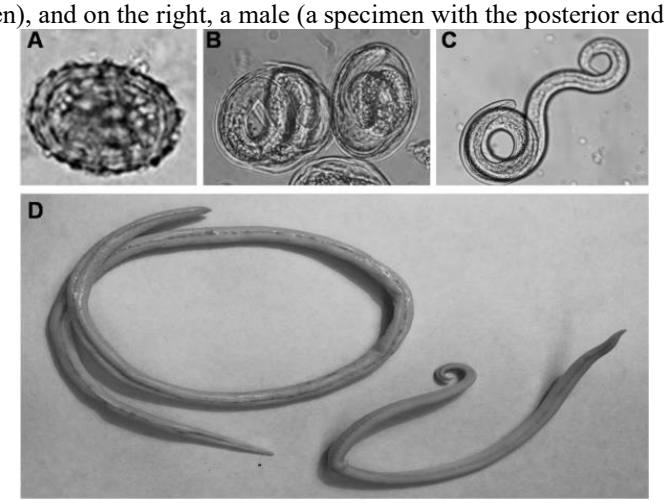
All of these geohelminths are affected, to varying degrees, by changes in soil and climate characteristics in a specific region. Experimental research and field studies demonstrate that the survival and development of the free life stages of these parasites, and therefore their ability to be transmitted to humans, are directly linked to environmental temperature and humidity conditions. Soil evolution involves the formation of larvae protected by eggshells, which hatch only after being ingested by a new host (Chieffi, 2015).

3.1.1 Ascaridia

Ascariasis is one of the most common and widespread intestinal infections, prevalent mainly in places with a hot and humid climate, with a higher incidence in rural areas. The parasite, exclusive to humans, is *Ascaris lumbricoides*, popularly known as roundworm, belonging to the phylum Nemathelminthes, of the class Nematoda, and being part of the Ascarididae family (Pêgo, 2013).

Thus, with regard to developmental phases, members of the genus *Ascaris* have three distinct stages in their life cycle: egg, larva, and adult worm (Figure 2). This cycle is monoxenic, meaning that it is completed in only one host, with the eggs going through an incubation period in the environment. Transmission of the parasite occurs through fecal-oral ingestion, since embryonated eggs, which contain the infective form of the parasite, need to be ingested by susceptible hosts to initiate infection (Amorim, 2021).

Figure 01: Images depicting the growth phases of *Ascaris spp*. A) Non-embryonated fertile egg with a nipple membrane, observed by microscopy at a 40X magnification. B) Decorticated larval egg, microscopic visualized at a 40X magnification. C) L3/L4 larva removed from the lungs, examined by microscopy at a 40X magnification. D) On the left, a female adult worm (a more robust specimen), and on the right, a male (a specimen with the posterior end curved ventrally).



Font: Amorim, (2021).

The adult stages of *Ascaris lumbricoides* are long, cylindrical, white-colored organisms of dioecious nature that preferentially inhabit the small intestine, mainly the jejunum and ileum, causing the condition known as ascariasis. These worms have a long, robust morphology, with a cylindrical shape and tapered ends, especially in the anterior region. It is important to highlight that this parasite does not have a circulatory system, and all the viscera of the adult stages, encompassing the digestive, excretory, nervous, and reproductive systems, are suspended in the body cavity, also known as pseudocoelom (Lopes, 2018; Amorim, 2021).

Helminths exhibit sexual dimorphism, with males having ventrally curved hind end and females generally larger (20 to 49 cm in length and 3 to 6 mm in diameter, compared to males 15 to 30 cm and 2 to 4 mm). Proportions may vary due to host nutritional status and intraspecific competition. After about 60 days in the small intestine, both males and females reach sexual maturity and reproduce. Fertilized females release about 200,000 eggs daily, eliminated in the host's feces, while, in the absence of males, they release infertile eggs (Lopes, 2018).

The eggs have a distinct morphology, with an outer nipple membrane produced by the uterine wall. When extracted from the uterus, they are colorless, but take on a yellowish-brown hue when they come into contact with fecal material. Fertile eggs have a thick, oval-shaped or nearly spherical shell, averaging 60 x 45 µm, ranging from 45 to 70 µm in the largest diameter. Infertile eggs, on the other hand, are more elongated (80-90 µm), with a thin shell and a reduced or absent albuminous layer. These characteristics are crucial in differentiation and influence the evolution of the parasite (Godinho, 2003).

Infection with *Ascaris spp.* begins with the ingestion of embryonated eggs from contaminated food and water. After hatching in the small intestine, the L3 larvae migrate to the cecum and colon, penetrating the mucosa, with the cecum as the main site of penetration. After reaching the lungs and passing through the molt to the L4 stage, the larvae, by perforating the alveolar endothelium, reach the

trachea, and can be expectorated or swallowed. They return to the small intestine, mature into adult worms, reaching sexual maturity in 2 to 3 months. After copulation, females lay eggs in their feces, and the larvae undergo two molts during the embryonic process in the environment. (Melo, 2017).

Ascaris infection is usually asymptomatic, but in symptomatic cases, symptoms include abdominal pain, diarrhea, vomiting, and anorexia. More intense infestations can cause toxic reactions, liver and lung damage, as well as intestinal complications such as obstruction and irritation. The mechanical action of the worms in the intestine, coiling together, can result in fatal complications. After maturity, the worms do not penetrate the intestinal mucosa, but migrate to other organs, causing obstructions and complications that can lead to death (Pêgo, 2013).

3.1.2 Ancilostomy

Hookworms are helminths that were possibly inherited by the human species during evolution, adapting when hominid ancestors left forests to live in environments conducive to the transmission of these parasites. To this day, there is a risk of infection by helminths from canids and felids, such as *Ancylostoma ceylanicum* and *A. caninum.* At the end of the nineteenth century, a laboratory accident involving *Ancylostoma larvae* caused pruritus and dermatitis on contact with the skin (Rey, 2001).

The rhabditoid larvae of hookworms move through the liquid film that surrounds the soil particles, feeding on bacteria and organic material until they become second and third stage larvae after five to seven days. Third-instar larvae are the only ones infecting humans. At this stage, they no longer feed, but remain active on the surface of the soil or vegetables for weeks or months until their nutrient reserves are exhausted (Valente, 2013).

Penetration occurs mainly through the skin of the lower extremities through direct contact of the host with the environment. After penetration, they reach the subcutaneous venules and lymphatic vessels, reaching the afferent circulation of the host until they reach the pulmonary capillaries where they lodge. In this phase, they cross the alveolar wall and, interspersed with mucous secretions, ascend the bronchial tree, gaining the larynx and pharynx where they are swallowed and reaching the small intestine (Lenzi, 2008).

In the intestine, the last ecdysis occurs with growth of the larvae to the stage of adult worms, both male and female, and an interval of five to nine weeks is required between the cutaneous penetration of the larvae and the development of the adult worms. A. *duodenale* larvae can also be orally infectious. An itchy irritation on any part of the body, often on the feet, may progress to a maculopapular rash that persists for up to two weeks, this being the main manifestation due to the entry of larvae through the skin (Chieffi; Ferreira, 2008).

About 10 days after infestation, the larvae in the lungs can cause a pneumonia similar to Löeffler's syndrome, although less intense than in *Ascaris lumbricoides infection*, unless it is a massive

infestation. Complete removal of the larvae from the lungs to the gastrointestinal tract can take more than a month. Gastrointestinal symptoms, such as abdominal pain and vomiting, usually emerge four to six weeks after exposure, preceding the detection of eggs in the stool (Yamada, 2021).

3.1.3 Tricuriase

Trichuriasis, caused by the parasite *Trichuris trichiura*, is common in developing nations, with a higher incidence in the North and Northeast regions of Brazil. This parasitic disease is often associated with other infestations in people with polyparasitism, and is transmitted by ingesting contaminated water and food. *T. trichiura infection* is linked to helminthiases such as *Ascaris lumbricoides* and *Ancylostoma spp*, which are prevalent in underdeveloped countries (Andrade *et al.*, 2010).

It is estimated that about a quarter of the global population is a carrier of this parasite. In communities where trichuriasis is endemic, the infection can affect more than 90% of individuals. Approximately 800 million people worldwide are believed to have this disease (Silva, 2021).

The prevalence of trichuriasis is more evident in regions with high rates of protein-calorie malnutrition and nutrient deficiency anemia, where infection rates can exceed 90%. In Brazil, the precarious living conditions of certain populations, exacerbated by uncontrolled urban growth and lack of basic sanitation, contribute to the spread of various geohelminthiases (Pereira *et al.,* 2021).

The human being is the only host of this worm and contracts the disease through the ingestion of water, dust or contaminated food with eggs enveloping the infecting larva inside, thus characterizing the form of fecal-oral contagion. *T. trichiura* is an exception to the rule because, unlike other geohelminths, it does not have a pulmonary cycle, thus remaining restricted to the intestinal lumen (Pereira *et al.,* 2021)

After the elimination of the eggs of T. *trichiura* in the feces, they mature for about 2-3 weeks under adequate conditions of humidity and temperature, thus originating eggs containing the worm larva inside, which, when ingested by humans, will suffer the action of the liquids produced by the gastrointestinal tract, promoting the release of the larva. close to the cecum region (Silva, 2021).

The larvae, now free, enter and remain in the crypts of the glands of the cecum for about 2 days and then undergo further transformations until they culminate in the adult worm, which happens about 1-2 weeks from the ingestion of the embryonated egg. This cycle usually lasts about three months in its entirety, but the adult worm can remain alive in the host for several years. The clinical aspects of the disease are nonspecific, and are also found in other diseases caused by helminths (Nichols; Bridgewater; Wagner, 2021).

The degree of clinical manifestation will be proportional to the parasite load and nutritional status of the patient. Individuals with good general/nutritional status will present mild symptoms, with

nonspecific symptoms such as hyporexia, mood irritability, altered sleep patterns, and mucocutaneous pallor (Lustosa *et al.*, 2016).

In infections that are a little more expressive, the symptoms of the digestive system become more prominent, and abdominal pain, diarrhea with meteorism and gastric discomfort may appear. In pediatric patients, diarrhea may be dysenteric or chronic, with the presence of enterorrhagia, weight loss, and hypochromic anemia (Almeida; Chehter, 2020).

One of the possible consequences of intense parasitism is rectal prolapse, which is the most characteristic sign of the disease. Rectal prolapse occurs due to continuous exertion due to tenesmus, in which case it is common to see worms adhered to the exteriorized rectum mucosa. Rectal prolapse can be reversed by surgical methods. It is worth mentioning that sanitary conditions are closely related to the transmission of trichuriasis, since it occurs through the fecal-oral route, and the prophylaxis of the disease is closely related to health education and basic sanitation (Gondim, 2022).

3.1.4 Enterobíase

Enterobiosis, caused by the nematode *Enterobius vermicularis,* presents symptoms such as nocturnal itching in the anal region, leading to irritability, sleep disturbances, and discomfort. The presence of the parasite on the skin can result in abrasions, increasing the risk of secondary infections such as anal congestion and inflammation with bleeding spots. In girls, vulvar itching and larval invasion into the vulva or vagina can also lead to vulvovaginitis (Santos, 2010).

Enterobius vermicularis is a small, white spindle nematode found in the large intestine, cecum, and cecal appendage in humans. It may be adhered to the mucosa or free in the intestinal cavity. Their diet includes waste cells accumulated on the surface of the epithelium, as well as bacteria and other substances present in the intestinal lumen. It has a small mouth and lateral expansions called "cephalic wings." The esophagus has a club-like shape and ends in a heart bulb. The female is approximately 1 cm long by 0.4 mm in diameter. Its tail is long and pointed, and the vulva opens in the anterior middle part, followed by a vagina that connects to two uteruses (Souza, 2017; Fernandes, 2017).

There is a remarkable sexual dimorphism, with a length of 0.8 to 1.3 cm, with a tapered posterior end, while males, with 0.3 to 0.6 cm, have a ventrally curved and truncated end. Males have a hind end that facilitates copulation by attaching to the female's genital orifice. Both have cephalic wings, lateral cuticular projections, mouth surrounded by three retractile lips, muscular esophagus with a more developed esophageal bulb, and rectilinear intestine, opening externally through an anal opening in the posterior third (Souza, 2017).

Females have a didelphic and amphidelphic tubular reproductive system, with two ovaries (one anterior to the vulva and one posterior), two uteruses that converge in the vagina and communicate with the outside through the vulva. The eggs produced accumulate in the uterus, as there is no

oviposition during the period in the host's intestine. The egg is about 50 µm long by 20 µm wide, featuring a characteristic double-membrane "D" shape, smooth and transparent. The eggs are embryonated from the moment of oviposition. Each female can lay 4,600 to 16,000 eggs (Souza, 2017; Fernandes, 2017).

It is a monoxene parasite, it has a cycle in which males disintegrate after copulation, while pregnant females migrate to the rectum, causing itching by releasing eggs at night. After laying, the females die, releasing infective eggs in about 6 hours, rich in protein, promoting self-infection. The host spreads the infection in the environment, favoring transmission to other individuals, including through the air. After ingestion, the larvae reach the large intestine as young adults, completing the cycle in 30 to 53 days. Females can store 5,000 to 16,000 eggs, with a pinworm survival of 45 to 60 days (Santos, 2010).

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3.2 WATERBORNE PARASITES

There is a wide variety of water-binding parasites, which can cause numerous problems to hosts. These parasites cause several symptoms, but the most common is dysentery. Thus, approximately 700,000 children die each year because of diarrhea caused by these water parasites. Most cases of infection are related to lack of basic sanitation, lack of drinking water or incorrect water treatment and lack of hygiene (Collins; Duffy, 2021).

However, the main diseases are: Giardiasis; Schistosomiasis; Amoebiasis; *Cryptosporidium*. Presenting common symptoms such as: abdominal pain; chronic acute diarrhoea; malnutrition, anemia, nausea and vomiting. In addition to water contamination, poorly sanitized food can occur through the fecal-oral route. Therefore, it is important to have a correct management of basic sanitation and effective water treatment. These are actions that can radically reduce the growing number of these diseases, aiming at the well-being of the population and eliminating the risks caused by these pathogens (Casimiro *et al.*, 2022).

However, there are many difficulties in statistically demonstrating outbreaks of water-related infections, because although infections are asymptomatic, a broad class of pathogens can cause parasite-like symptoms. Therefore, further research is needed to achieve the outcome (Egorov, 2018).

3.2.1 Schistosomiasis

Schistosomiasis is a parasitosis caused by the trematode flatworm *Schistosoma,* of the species *mansoni*, commonly known as "snail disease" or "water belly". It is transmitted by the snail of the genus *Biomphalaria*, which is the intermediate host, through contact with water contaminated by cercariae, which is the larval form of the parasite (Silva *et al.,* 2020).

It is a disease directly related to poor sanitation, and in Brazil it is estimated that about 1.5 million people live in areas at risk of contracting the disease. And the most affected states are the Northeast and Southeast regions, due to the presence of transmitting mollusks, and because the existence of poor communities without access to drinking water and adequate sanitation is prevalent (Brasil, 2018).

Schistosoma mansoni has 6 evolutionary forms, which are: adult worms, egg, myracicide, sporocyst, cercariae, and schistosomula. Among them, the most studied is schistosomula, for the development of new drugs. Schistosomula go through six phases before evolving into adult worms. In the first phase, when they reach the lungs, the formation of the cecum begins, which has a dark color, due to the presence of partially digested blood of man, in which it has a brief duration, until the next phases (Jeremias, 2015).

The eggs are large and have a double, transparent shell. They measure approximately 150 µm and have a spicule that assists in their transit through the intestine. They can be identified in formed human feces (2 to 5 days) and diarrheal feces (Santos *et al.,* 2022).

The cercariae has a forked tail to move in the water and is formed by the cercarian body, with the presence of an oral suction cup and penetration glands. The head with two suction cups is rich in digestion enzymes for fixation and to generate microlesions in the skin, to penetrate the host (Souza, 2011).

The worms have several tubercles with spines on their dorsal surface, and a mouth located at the bottom of the oral suction cup for food intake, with bifurcation in the digestive system (Queiroz, 2012).

Miracidians are larvae that have cilia, with a cylindrical shape, facilitating their locomotion and have a very primitive nervous system. It has an apical papilla at the anterior end, a penetration gland and an adhesive gland, as well as an excretory tract. Sporocysts, on the other hand, have many tubular branches and germ cells. During its transformations up to the sporocyst III phase, its size and cercarisal formation increase (Coelho *et al.,* 2008).

The biological cycle is heteroxenic, in which the snail of the type Biomphalaria glabrata is the intermediate host, in which the asexual cycle occurs, and the man is the main definitive host, in which the sexual cycle occurs. Schistosomiasis is acquired by approaching and/or bathing in the waters of

ponds, streams, dams or any collection of fresh water that is contaminated by cercariae (Carvalho, 2020).

The eggs that are eliminated through the feces, interact with the water, rupture and release the miracidia. These follow to the snail, and penetrate it, proliferating and turning into larvae. The infective larvae are the cercariae, which are released by the mollusks into the water. Then, these cercariae penetrate people by going through the skin. Inside the body, they change into schistosomulae, and in the liver they differentiate sexually. After growing, they migrate to the veins of the intestine, reach the adult form and mate. After mating, they begin to release eggs, and the cycle begins again (Nation *et al.,* 2020).

In most cases, it is an asymptomatic disease, but if it is symptomatic, it has two phases, one acute and one chronic. In the acute phase, it indicates a recent infection, and may be noticed depending on the amount of infective cercariae in the patient, with pruritus and erythema initially appearing at the site where the cercariae penetrates. The patient may manifest pyrexia, cold sweating, headache, myalgia, fatigue, absence of hunger, weight loss, cough and abdominal pain. Some may report nausea and vomiting. The liver becomes slightly enlarged and tender to palpation (France *et al.,* 2019).

If it has a high parasite load, the infection can become invasive, spreading eggs in the lungs, and triggering an intense inflammatory reaction, with the formation of granulomas. After four months, the acute phase ceases and the chronic phase can settle in the patient (Queiroz, 2012).

In the chronic phase, diarrhea becomes more constant, and blood may appear in the stool. In more severe cases, the patient loses weight, feels marked weakness, and there is an increase in the volume of the abdomen, enlargement of the spleen and liver, digestive bleeding, and even death (Brasil, 2018).

The ectopic form of the disease can also occur, in which adult eggs or worms can be found in the central nervous system, generating neurological manifestations that affect the thoracolumbar region of the spinal cord, presenting an inflammatory picture in this region (Souza *et al.,* 2011).

3.2.2 Girdy

Giardiasis is a disease that causes infection in the small intestine, and is caused by the parasite *Giardia lamblia*, which is a flagellated protozoan. It mainly affects preschool environments, such as daycare centers and schools, and has a global distribution. It is a parasitosis that affects the poorest populations, and that has very poor sanitation conditions. It is considered the most prevalent parasite in the world (4 to 8%) even in families with medium or high family income, and in Brazil its prevalence ranges from 12.4% to 50%, being more prevalent in children between zero and six years of age (Santana, 2014).

Giardia has two active forms, which are trophozoite and cysts. Cysts are the resistant and infective forms of the disease, and are found in the environment for dissemination. They measure about 12 µm long by 8 µm wide. It has an oval shape and can contain up to four nuclei (Heller *et al.,* 2004).

Figure 02: Cyst of Giardia lamblia.

Source: Chamber, (2014).

The most common form of transmission is by fecal-oral route, in which the cysts that are present in the feces of the sick patient are ingested, directly or indirectly. The biological cycle is monoxene, since it has only one host, which is the human being, although the parasite can infect other types of species (Hooshyar *et al.,* 2018).

Cysts and trophozoites can be found in human feces, but only cysts are responsible for transmission. Infection occurs through ingestion of cysts in water, contaminated food (indirect form) or fecal-oral route (direct form). After ingestion of these cysts, they rupture inside the intestine of man, forming trophozoites (de-cysting), in which they multiply intensively. After a while, an encysting occurs again, forming a new cyst, which does not adhere to the wall of the small intestine. Therefore, this cyst ends up detaching from the intestinal mucosa, and comes out along with the feces, ready to infect other people (Vitorino *et al.,* 2014).

The infected person may have irritation of the intestinal mucosa due to high parasite load, as well as the production of excessive digestive mucus and difficulties in absorbing nutrients. Lesions caused by trophozoites that are adhered to the intestinal epithelium may also occur. In most infected people, this disease is asymptomatic, and can occur in both adults and children. The most frequent symptom is diarrhea accompanied by abdominal cramps, with pasty stools containing mucus. Due to malabsorption, it causes weight loss in the patient, malnutrition, anemia, nausea and vomiting (Cotton *et al.,* 2011).

As a treatment, some oral medications can be used, which are: tinidazole, metronidazole or nitazoxanide. Tinidazole, as a single dose, and metronidazole three times a day for five days.

Nitazoxanide, on the other hand, is more suitable for children, since it has a liquid form, in addition to tablets, and is indicated to be taken twice a day, for three days (Marie *et al.,* 2022).

3.2.3 Amoebia

Approximately 50 million people worldwide are affected by intestinal amebiasis, which is responsible for 55,000 deaths. It is an infection caused by a parasite of the genus *Entamoeba histolytica (E. histolytica) of the* protist kingdom, considered an anaerobic parasite that parasitizes the large intestine of hosts. Another worrying factor is that *Entamoeba histolytica* can enter the bloodstream and invade other organs. The host presents with severe diarrhea, most hosts do not have symptoms (Verma *et al.,* 2022).

Entamoeba histolytica (E. histolytica) has 4 forms of presentation, cyst form, precyst, metacyst and trophozoite. Thus, cysts are spherical structures with a diameter of about 10 to 16 µm, with one to four nuclei. It contains the wall of cysts that are highly rigid due to the presence of chitin. It also has glycogen vacuoles and chromatoid bodies that participate in the protein synthesis process, in the maturation phase these structures tend to disappear (Belfort, 2012).

The trophozoites of *Entamoeba histolytica* have only one nucleus, with chromatin and spherical chromosome, located in a central position. The sizes of trophozoites vary between 20 and 40 µm in diameter, and may also contain chromatoid bodies. In addition, vesicles and vacuoles are important structures that participate in the process of enzyme production, aiding in phagocytosis. Organelles such as mitochondria, golgi complex, rough and smooth endoplasmic reticulum, centrioles are not found in trophozoites (Belfort, 2012).

The biological cycle is considered monoxenic, it needs only one host to carry out the cycle, it presents a cycle without complexity. In this way, the cycle is divided into four parts: cysts; meta-cysts; pre-cysts and trophozoites. It begins after the ingestion of mature cysts, the cysts lodge in the large intestine initiating the process of decystation, with the formation of meta-cysts. After this step, a series of nuclear divisions occurs, transformed into four to eight trophozoites. Normally, trophozoites multiply in the large intestine and stay in the intestinal mucosa feeding on bacteria and dendrites (Silva; Gomes, 2022).

However, they can invade the bloodstream and invade other organs, such as the liver and brain. In the lumen of the colon, the formation of pre-cysts occurs, through a process of dehydration and excretion of nutritive substances. After this phase, tetranucleated cysts are formed, which are eliminated by the host's feces, while those eliminated to the external environment are highly resistant due to the internal wall of the cyst (Silva; Gomes, 2022).

Entamoeba histolytica is able to aggregate to the intestinal epithelium, causing a degradation of the proteins present in the extracellular matrix. This situation ends up generating tissue lesions,

leading to the induction of rapidly evolving inflammatory responses. Infected hosts may present asymptomatically or symptomatically, but in most cases they are asymptomatic. As a result, intestinal amebiasis can present the following manifestations: abdominal cramps; non-dysenteric colitis; diarrhoea in the acute stages of the infection, interspersed with improvements in bowel function (Leite, 2015).

3.2.4 Cryptosporidiosis

Cryptosporidiosis is considered an emerging parasitosis in Brazil, caused by a parasite of the genus *Cryptosporidium spp*, has a range of species that infect a wide variety of hosts such as birds, cattle, birds, dogs, fish, felines and rodents (chart 01). In addition, contamination with this parasite can occur in several ways, such as: direct contact through the fecal-oral route; food; drinking water; air; seawater; zoonotic transmission; Rivers; Streams; spas and estuaries (Bonsere, 2020).

Table 01: Species of the genus *Cryptosporidium* and their main hosts.

Cryptosporidium *species*	Host	Authors
Cryptosporidium parvum	Humans and rodents	Macedo (2018)
Cryptosporidium hominis	Human	Macedo (2018)
Cryptosporidium Andersoni	Humans and cattle	Macedo (2018)
Cryptosporidium felis	Humans and felines	Macedo (2018)
Cryptosporidium canis	Humans and canids	Macedo (2018)
Cryptosporidium switch	Humans and pigs	Macedo (2018); Nakashima (2021)
Cryptosporidium muris	Humans and rodents	Nakashima (2021)
Cryptosporidium viatorum	Human	Nakashima (2021)

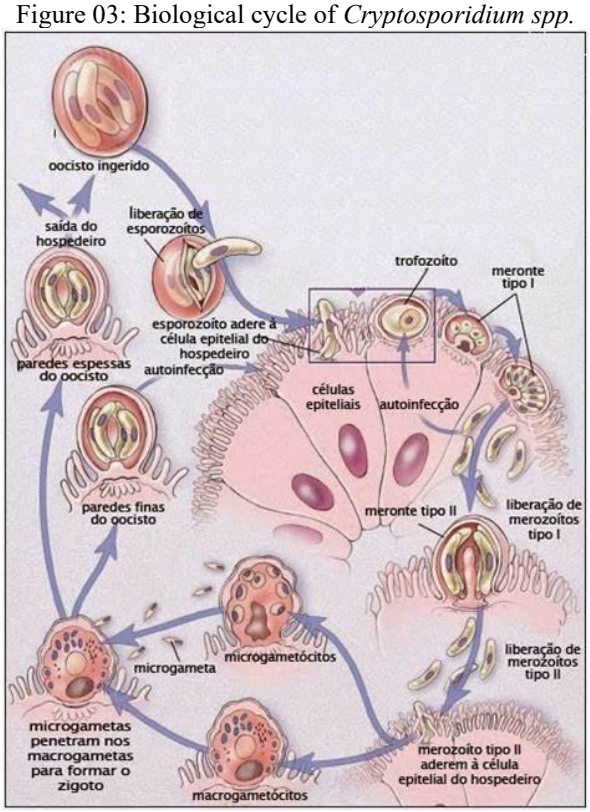
Source: adapted from Macedo (2018) and Nakashima (2021).

The genus *Cryptosporidium* has the capacity for self-infection, has resistance to many antiparasitic agents, and is classified as belonging to the phylum Apicomplexa due to its apical complex. Thus, exclusively the only Coccidium of the family *Cryptosporidiidae,* Kingdom Protozoa due to heterotrophic and unicellular (Pinto, 2016; Purple, 2014).

Thus, these parasites of the genus *Cryptosporidium* have a monoxenic cycle, involving two stages of reproduction: sexual and asexual. The infective form occurs through sporulated oocysts, the cycle begins when the oocysts are eliminated through the host's feces. These oocysts can survive several months in the environment due to the thick layer. After the host ingests or inhales the oocysts, they lodge in the epithelial cells of the small intestine, and the excision process occurs, releasing the sporozoites (Cossa, 2017).

After this phase, trophozoites are formed and released into the extracytoplasmic medium, in an asexual process originating type I meronts, later forming four to eight merozoites. As a result, merozoites propagate into other epithelial cells, developing into other new type II merontes or can multiply again in the type I meron phase. The microgamonte fertilizes the macrogamonte, resulting in the origin of the zygotes, transforming into two types of oocysts: thin membrane and others with thick membrane, as described in figure 3 (Cossa, 2017).

Figure 03: Biological cycle of *Cryptosporidium spp.*



Source: Macedo, (2017).

Pathogenesis begins when sporozoites adhere to the host cell. The process begins with the interaction between enterocytes and the superficial proteins of sporozoites. There is an alteration in intestinal absorption, generating increased secretions that contribute to diarrhea. These events occur because enterocytes are parasitized, initiate the production of pro-inflammatory cytokines and chemokines that end up inducing the inflammatory response that will act on the innate and adaptive immune response (Nakashima, 2021).

Symptoms are classified as: acute, chronic and asymptomatic. The incubation period varies between 3 and 12 days, the severity and clinical manifestations can appear in different ways, which depends on factors such as: species; site of infection; nutritional status; previous exposure; health of the individual. Thus, cryptosporidiosis manifests itself through gastrointestinal symptoms, mainly diarrhea, nausea and vomiting, lasting approximately two weeks, and may last longer. The individual may also experience hypothermia, anorexia, weight loss, and pancreatitis (Roxo, 2014).

3.3 TREATMENT OF INTESTINAL PARASITOSIS

There are several options for drug therapies, depending on the disease and the parasite in question. Most often, benzimidazole derivatives, such as mebendazole and albendazole, are used due to their ease of administration and proven efficacy. According to the World Health Organization (WHO), it is not recommended for use in children under 12 months, due to the lack of research that ensures its safety in this specific population (Fernandes *et al.,* 2011).

All these medicines are made available by the Unified Health System (SUS) free of charge. Albendazole is indicated in the treatment of *Ascaris lumbricoides*, *Enterobius vermicularis,* Necator americanus*, Ancylostoma Trichuris trichiura*, Giardia lamblia *in children* , among other parasites. It has anthelmintic activity, as it destroys larvae, eggs, and even adult worms, decreasing the energy level of the helminth, immobilizing it until its death (Belloti, 2019).

Mebendazole has a broad spectrum and can be used as a therapeutic resource in numerous pathogens, such as *Trichuris trichiura,* Ancylostoma duodenale*, Necator americanus, Taenia solium* and *Taenia saginata*. Its main mechanism of action is to inhibit the synthesis of microtubules (cytoskeleton), preventing the formation of cellular tubulin in the intestine of worms, interrupting cell replication, culminating in their death (Kogien *et al.,* 2011).

Table 02: Anti-protozoal and anthelmintic therapy.

Parasite	Medicament	Dosage
Giardia lamblia	Metronidazole	15 mg/kg/day (max. 750 mg), 3 doses daily, 5-7 days
	Albendazole	15 mg/kg/day (max. 400mg), single daily dose, 5 days
Entamoeba histolytica	Metronidazole	35-50 mg/kg/day (max. 750 mg), 3 servings daily, 7-10 days
	Tinidazole	50 mg/kg/day (max. 2 g), single daily dose, 3 days
Cryptosporidium parvum	Nitazoxanide	100 mg (1-3 years), 200 mg (4-11 years), or 500 mg (> 11 years), 2 daily doses, 3 days
	Albendazole	400 mg, 2 servings daily, 7-10 days
SchistosomaSoni	Praziquantel	40 mg/kg/day, 2 doses in one day
	Oxamniquine	20 mg/kg as a single dose or as two doses
Enterobius vermicularis (pinworms)	Mebendazole /flubendazole	100 mg, single dose
	Albendazole	400 mg, single dose
Ascaris lumbricoides	Albendazole	400 mg, single dose

	Mebendazole/ Flubendazole	100 mg, 12/12h, 3 days
Trichuris trichiura	Mebendazole/ Flubendazole	100 mg, 12/12h, 3 days or 500 mg, single dose
	Albendazole	400 mg, single dose (3 days if abundant infestation)
Ancylostoma duodenale, Necator americanus	Albendazole	400 mg, single dose
	Mebendazole/ Flubendazole	100 mg, 12/12h, 3 days

Cast iron: Fernandes *et al.*, (2011).

It is essential to seek the standardization of drug therapy with the selection of drugs that are easy to administer, with minimal risk, and affordable for the population, so that there is success in the treatment. Nitazoxanide is considered a very effective drug for several parasitic diseases, being the first and only drug approved by the FDA (Food and Drug Administration) for the intervention of cryptosporidiasis. It acts effectively against nitroimidazole-resistant organisms, such as the one that causes trichomoniasis, by directly inhibiting the enzyme essential for energy metabolism. In addition, it does not induce mutations in DNA during its specific mechanism of action (Andrade *et al.,* 2010).

Nitazoxanide is marketed in the drug ANNITA, and has a pharmaceutical form in powder (suspension) and in coated tablet form, both of which are administered orally. It is contraindicated in the treatment of infection by *Cryptosporidium species* in immunocompromised patients, and as an option, the Unified Health System (SUS) suggests albendazole, oxamniquine, and ivermectin (Brasil, 2012).

3.4 SELF-MEDICATION IN PARASITIC INFECTIONS: A CULTURAL ISSUE

Antiparasitics are one of the drugs most involved in self-medication, they can be easily purchased in commercial pharmacies without a prescription, leading to irrational use. In addition, the self-medication of antiparasitic drugs among the population is related to several factors, such as: culture; Socioeconomic; public policies. Antiparasitic drugs are divided into two classes: anthelmintics and antiprotozoa, especially albendazole and metronidazole. They are used for infections caused by parasites and helminths, acting in the elimination of parasites (Santos; Pavanelli, 2016; Silva, 2023).

However, incorrect use can cause undesirable effects such as nausea, vomiting, dry mouth, and abdominal pain. As is the case with the drug metronidazole, these adverse reactions are potentiated when incorrect use occurs. Therefore, it is extremely important to have the guidance of a health professional in the treatment of enteroparasitosis. For the pharmacological treatment to be successful, reducing the appearance of adverse reactions (Santos; Pavanelli, 2016).

The most used drugs in self-medication are albendazole and metronidazole. Although they seem harmless, they can cause serious problems if used without professional guidance. They can have toxic effects at high pharmaceutical doses and interactions with other drugs (Demarchi, 2006).

In an observational and qualitative study, conducted by Berber and Zampieron (2019) in a drugstore located in Mato Grosso. The study was carried out with 100 people, observed that self-medication was more likely to come from children from 1 to 10 years of age than adults. We can point out that children are more susceptible to ingestion of food or water contaminated by helminths and protozoa, which explains the reason for self-medication in children. The interviewees highlighted the reasons for self-medication of antiparasitic drugs: prevention; gastrointestinal pain; anal puridus; inappetence or eating disorders and skin blemishes. The largest acquisition was related to prevention (Fatore; Berber; Zampieron, 2019).

Therefore, it is necessary to raise awareness among individuals about the indiscriminate use of antiparasitic drugs. To warn about the risks associated with this practice, reducing the emergence of adverse reactions, intoxication, and parasitic resistance, in order to increase therapeutic adherence. The professional plays a crucial role at the time of orientation, guiding in the correct way, solving the users' doubts. Promoting health promotion, preventing possible complications (Silva, 2023).

4 CONCLUSION

From the results found in this research, we conclude that there is a great concern regarding the increasing number of cases of infections caused by parasites. Thus, this public health concern is justified by its ability to trigger a wide variety of diseases and aggravate morbidity rates.

These parasites pose an ongoing challenge, requiring comprehensive approaches that include improvements in sanitation, prevention education programs, and facilitated access to appropriate treatments. By proactively recognizing and addressing this concern, communities can aim not only to reduce infection rates, but also to promote a healthier and more resilient environment.

To mitigate this impact, it is crucial to adopt comprehensive measures that include significant improvements in basic sanitation, promoting proper hygienic conditions. Basic sanitation emerges as a crucial pillar in the control of parasitic diseases, evidencing its undeniable importance. Improving sanitary conditions not only reduces the incidence of parasites but also acts as an effective preventive measure.

It can also be observed that self-medication is another factor that can considerably influence parasitic resistance to drugs that are available on the market. There are highly effective drugs for the treatment of helminths and protozoa, however, through *in vitro studies*, it was possible to observe a greater resistance of the parasites to the drugs albendazole and metronidazole.

Thus, to reduce self-medication among the population, it is necessary to recognize the importance of guidance from health professionals, such as physicians and pharmacists. And to promote awareness of the risks of self-medication, highlighting the potential harms that can compromise the efficacy of pharmacological treatment and the emergence of parasitic resistance. This approach can contribute significantly to public health, suggesting appropriate treatments and minimizing complications in clinical cases, as well as encouraging prophylactic measures. It can also serve as an aid to students and health professionals, as it provides relevant information about parasitosis and drug therapies.

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