

Review Article
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Pathophysiology and Gastrointestinal Impacts of Parasitic Helminths in Human Beings

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ABSTRACT

This study mainly focus on the major pathologic manifestations of human gastrointestinal impacts of parasitic worms.

Background: Helminthes and protozoan are human parasites that can infect gastrointestinal tract of humans beings and reside in intestinal wall. Protozoans are one celled microscopic, able to multiply in humans, contributes to their survival, permits serious infections, use one of the four main modes of transmission (direct, fecal-oral, vector-borne, and predator-prey) and also helminthes are necked multicellular organisms, referred as intestinal worms even though not all helminthes reside in intestines. However, in their adult form, helminthes cannot multiply in humans and able to survive in mammalian host for many years due to their ability to manipulate immune response.

Objectives: The objective of this study is to assess the main pathophysiology and gastrointestinal impacts of parasitic worms in human being.

Methods: Both primary and secondary data were collected using direct observation, books and articles, and also analyzed quantitatively and qualitatively following standard scientific methods.

Results and conclusion: Parasites are organisms living temporarily in or on other organisms called host like human and other animals. Gastrointestinal parasitic helminthes have medical importance and live as endoparasites of human and other animals as host. Such pathogenic parasitic helminths are hookworms (*Ancylostoma duodenale* and *Necator americanus*), pinworm (*Enterobius vermicularis*), roundworm [(*Ascaris lumbricoides*) and lymphatic filariasis (*Wuchereria bancrofti* and *Brugia timori*)], whipworm (*Trichuris trichiura*), threadworm (*Strongyloides stercoralis*), heartworms (*Dirofilaria immitis*), and Guinea worm (*Dracunculus medinensis*). In addition, intestinal worms can transmit via fecal-oral route, direct contact with infected persons, zoonotic transmission, skin penetration, oral and anal sex, ingestion of contaminated food or water, etc and also factors that promote its transmission includes hot and humid climate, high population density, poor personal hygiene, presence of insects as vectors for carriers of parasites, limited economic resources and some social cultural habits. However, its prevention strategies include use of proper sewage disposal methods, consumption of clean and treated safe drinking water and food, proper hygiene, etc and the main treatment of antihelminthic medications include albendazole, metronidazole, diethylcarbamazine, etc as suggested by physician. Therefore, due to intestinal parasites can be easily transmit and cause great economic, health and social problems, and so prevention methods are greatly advisable.

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Introduction

According to zoological sciences, parasitic worms are the most successful invertebrate animals found as parasite (endoparasites and exoparasites of other animals) with varied shape of elongate, threadlike, roundworms, or eelworms. Many of parasitic worm species are extremely successful parasites, their biological process and food availability is largely depend on the appropriate host of animals. Gastrointestinal parasitic worms are multicellular organisms, vermiform invertebrate animal species, almost microscopic, of which are endoparasites of animals [1,2]. In addition, intestinal parasites infect gastro-intestinal tract of humans

such as helminthes and protozoan which live in intestinal wall [3]. Protozoans like *Entamoeba histolytica*, and *Giardia lamblia* are single celled microscopic, able to multiply in humans, which contributes to their survival, cause serious infection and transmit to another human through a fecal-oral route and also helminthes are necked multicellular organisms, referred as intestinal worms even though not all helminthes reside in intestines [4-6]. Similarly, in their adult form, helminthes cannot multiply in humans and they are able to survive in mammalian host for many years due to their ability to manipulate immune response [7].

Economic impact of human gastrointestinal parasites are varied and it depend on the development of the country and life style of the society. Based on American Psychopathological Society

(2019), gastrointestinal parasitic worms have great economic impacts on the host animals by causing diseases and feeding other microorganisms. Human intestinal parasitic infections have harmful effect on survival, appetite, growth, physical fitness, school attendance and cognitive performance and also poor sanitation, clean drinking water scarcity and poor personal hygiene practices may contribute to the rapid spread of intestinal parasite [8,9]. Furthermore, environmental factors also play a great role in the frequency of intestinal parasitic infection as hot and humid tropical climate favor increased parasite prevalence [10]. In addition, in developing countries, intestinal parasites are widely distributing due to low level of environmental sanitation, contaminated water and unaware of simple health promotion practices such as personal and food hygiene, altitudinal effect, urbanization, irrigation, and country resettlement [11].

Epidemiology of gastrointestinal parasites study in biological sciences indicates, intestinal parasitic infections are the major causes of human disease in most tropical region which estimates about 3.5 billion people in the world are infected, of which about 450 million school aged children's are at high risk [12]. The epidemiology of intestinal parasitic infections shows that, parasites are found in every age group and in both sexes but, the incidence is high in some areas and in some age groups [13,14]. World Health Organization (WHO), large number of people around worldwide infected with some type of intestinal parasite, and *amoebiasis*, *ascariasis*, *hookworm* and *trichiuriasis* infections are among most common infections of top ten global health problems and more than 980 million people are infected by *A. lumbricoides* [15,16]. Lymphatic filariasis (LF) are endemic in 72 tropics and sub-tropics countries where about 1.4 billion people are at risk of infection and about 120 million people infected with one or more types of the lymphatic filariae [17]. The most highly distributed intestinal parasites includes *Ascaris lumbricoides*, *Giardia lamblia*, *Necator americanus*, *Ancylostoma duodenale*, *Trichuris trichiura*, *Enterobius vermicularis*, *Wuchereria bancrofti* and *Brugia timori* with varying prevalence in different areas [18]. Therefore, collecting relevant information, organizing and brief scientific explanation on the above some example of human pathogenic gastrointestinal parasitic helminths invertebrate animals species is required.

Methods, Pathophysiology and Gastrointestinal Impacts of Helminthes

This article is mainly focus on the pathophysiology and gastrointestinal impacts of various helminthes including their symptoms, transmission, diagnosis, prevention and treatment of intestinal parasitic infections and also their economic impacts on human being. In addition, both primary and secondary data were collected using direct observation, books, articles and from key health personnel (i.e. doctors, health officers, nurses, and laboratory technician) and also the collected statistical data and information were analyzed and interpretation of quantitative data using table and figures, and the qualitative method represents by explanation.

Pathophysiology of Intestinal Parasitic Worms

In biological sciences, pathological information on the main causes and effects of the disease causing pathogens of some intestinal parasites of human being and some other mammals are explained as follows. Parasitic organisms can be endoparasites or ectoparasites living temporarily inside or on the body of other organisms as host [18]. The main routes of transmission of some helminthes, protozoa and microsporidia to humans is via the fecal-oral, direct contact with infected persons, zoonotic transmission, ingestion of

contaminated food or water and so cause gastrointestinal infections and also there are various ways of infecting and transmission of intestinal parasitic worms such as mosquito bites, ingesting organisms eggs, penetration of the body skin, when fecal matter get into the mouth via contaminated food or water, eating of raw meat containing encysted larvae of helminth species, swimming in contaminated water, oral and anal sex, non-sexual close contact like diaper changing [15,19,20]. In addition, eating of raw meat containing encysted larvae of a species can lead to a disease with two phases called gastrointestinal phase (occur after ingestion of infected meat by humans) and systemic (parenteral) phase (occur when the larvae enter the lymphatic circulation then into the blood, skeletal muscles, myocardium, and brain which are high in oxygen content) [20].

Intestinal parasites are one of the most important causal agents of gastrointestinal disorders like diarrhea, dysentery, vomiting, lack of appetite, hematuria, abdominal distension, loss of weight, abdominal pain, nausea, and Iron deficiency anemia and also causes itching and scratching around perianal area, swelling of the lower limbs, pharyngeal irritation, cough, dyspepsia, etc [21,22]. Therefore, spreading of intestinal parasitic infections can be controlled by family planning, protecting personal and environmental hygiene, health education and nutrition and also prevention strategies include use of proper sewage disposal methods, consumption of clean and treated safe drinking water and food, proper hygiene such as hand washing, cleaning fruits and vegetable before consumption [23].

According to the nature of gastrointestinal parasites, there are various methods of diagnosis and treatments suggested by physicians. These various diagnosis methods of intestinal parasitic infections can be done by morphological examination, host antibody detection, parasite antigen detection, parasite DNA detection, specific antigen detection in stool specimen, rapid diagnostic test, etc and also these infections are among the most widespread of all chronic human infections worldwide [22,24]. There are different methods of treatment modalities for various intestinal parasites, antihelminthic medications include *Albendazole*, *Mebendazole*, *Pyrantel Pamoate* [25,26]. The most common treatment for hookworm, pinworm, whipworm, roundworm and other worms are albendazole and/or mebendazol and Diethylcarbamazine is an effective microfilaricidal drug [28,29].

Human Gastrointestinal Impacts of Helminths (Worms)

In biological sciences, human parasitic infections are the major medical problem all over the world, especially in developing countries where they cause more morbidity and mortality than other infectious diseases and are the primary cause of death. The two main groups of parasitic organisms are protozoans include plasmodium species and helminths metazoan organisms, include the cestodes, trematodes and nematodes [30]. Parasitic organisms are organisms that can found internal or external body surface of other organisms, can live in a variety of ecological settings and some infections have zoonotic importance as disease producing agents resulting in potentially serious infections [31]. There are many pathogenic gastrointestinal parasitic species cause diseases to human being and other animals with various shapes such as elongated, threadlike, roundworms, eelworms active invertebrate animals and helminths species have greatest medical importance [32]. Therefore, some of the most medical importance of pathogenic gastrointestinal parasitic helminths invertebrate animals species such as hookworms (*Ancylostoma duodenale* and *Necator americanus*), pinworm (*Enterobius*

vermicularis), roundworm (*Ascaris lumbricoides*), *Lymphatic filariasis* (*Wuchereria bancrofti* and *Brugia timori*), whipworm (*Trichuris trichiura*), threadworm (*Strongyloides stercoralis*), heartworms (*Dirofilaria immitis*), Guinea worm (*Dracunculus medinensis*), *Entamoeba histolytica*, and *Giardia lamblia* are explained briefly as follows.

Hookworm

The hookworm infection is caused by the blood-feeding parasites of the two nematode species known as *Ancylostoma duodenale* and *Necator americanus*. Epidemiology of hookworm is estimated that 576-740 million individuals are infected today, of these about 80 million are severely affected and the morbidity associated with severe infection includes intestinal blood loss, anemia, and protein malnutrition [33]. Hookworms are named because the anterior end curves dorsally, suggesting a hook as indicated in figure 1. The major etiology of Hookworm infection is *Necator Americanus* which is found in Americas, sub-Saharan Africa, and Asian countries [34]. Both species of hook worms have their ways of transmission, meaning that *Necator americanus* transmitted only via penetration of skin and *Ancylostoma duodenale* transmitted in various ways like percutaneously, orally, and probably transplacentally, and early migrations of the larvae cause Wakana disease which characterized by nausea, vomiting, pharyngeal irritation, cough, and dyspepsia [34]. In this case, humans are definitive hosts for both *Necator americanus* and *Ancylostoma duodenale* and also primarily it infects dogs, but humans can be dead-end hosts that prevent the larvae from completing their life cycle [35].

In addition, the burden of infection that caused by hook worm is concentrated mostly among the world's most poorest people who are living on less than two dollars per day. Of this people, mainly children in low and middle income countries are most vulnerable population as infection with hookworm can inhibit their growth, physical fitness, impair, intellectual and cognitive development [36]. Based on report of disease information for Hookworm indicates that, hookworm infection has numerous synonyms including acanthocheilonemiasis, ancylostomiasis, necatoriasis, and uncinariasis and also statistics report indicate that, one third of all pregnant women in developing countries are infected with Hookworm, 56% of all pregnant women in developing countries are suffer from anemia, and 20% of all maternal deaths are either directly or indirectly related to anemia which caused by hook worms [37].



Figure 1. Hookworms structure of the anterior end curves dorsally and its physiological impacts [34,35,37].

Pinworm

The pinworm (*Enterobius vermicularis*) is known as threadworms, is a very common intestinal parasite, and one of the most common nematode infections in the world. The medical condition associated with pinworm infected known as enterobiasis and humans are the only natural host for this infection and the transmission occurs in people who are living in most crowded environments and usually within families [38]. In addition, the morphology of pinworm

are tiny, thread-like parasite that live in the colon and rectum of infected individuals, whitish and named after the characteristic pin-like tail present on the posterior part of female worms as indicated in figure 2 below [39-41]. Similarly, this infection most commonly occurs in children, but any individual is vulnerable and people from tropical climates and school-aged children are the most vulnerable to *E. vermicularis* infection. However, this infection is caused by ingestion of the pinworm eggs and route of infection spread by ingesting pinworm eggs that have contaminated fingers, bed lines, clothing, nightclothes and most commonly through the fecal-oral route and some of the symptoms includes diarrhea, skin irritation, intense, discomfort, and rash around anus and vagina and also a single tablet of mebendazole (Vermox) and albendazole (Albenze) is effective medication [42]. Therefore, protecting personal and environmental hygiene is the most important advisable prevention methods of pinworm infection.

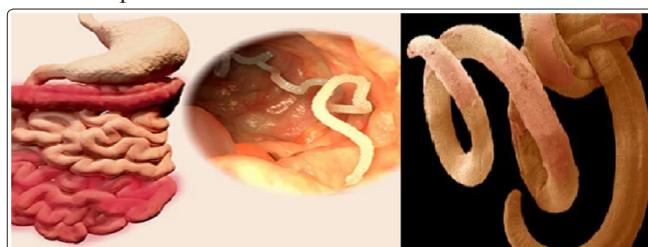


Figure 2: The morphology of pinworm and its living area of colon and rectum [40,41]

Roundworm

According to World Health Organization, the soil-transmitted helminths infection infect approximately 1.5 billion people in the worldwide, livestock, and wild animals [43-45]. Round worm species known as *Ascaris lumbricoides* is one of the most common parasitic helminths that infect humans, mainly children as indicated in figure 3 bellow, that caused by the intestinal roundworm *Ascaris lumbricoides* which infects approximately 800 million people [46]. The main transmission of this helminths begins as a female *Ascaris* can lay 200,000 eggs per day, passing out through the host's feces and in good soil, embryo nation is complete in two weeks. Viable eggs remain after signs of fecal matter have disappeared and the eggs can survive long periods in the soil. Infection begins with the ingestion of embryonated eggs containing L3-stage larvae which hatch in the small intestine before penetrating the intestinal wall of the cecum and colon to start their tissue migratory phase [47]. These L3-stage larvae then migrate through the liver before reaching the lungs by 6-8 days post-infection [48]. From the lungs, the larvae are coughed up and swallowed again, thereby reaching the small intestine where the nematodes will further develop into the L4 and adult stages and remain for approximately 1 year [49]. Therefore, protecting personal and environmental hygiene is the most important advisable prevention methods of *Ascaris lumbricoides* infection.



Figure 3: Morphological impacts of *Ascaris lumbricoides* [47-49].

Trichinellosis

The round worm nematodes known as Trichinellosis (trichinosis)

is a parasitic infection results from the genus and species name of *Trichinella spiralis* and caused by eating (consuming) of undercooked or improperly cooked or raw meat (usually pork), horse, or meat of other domestic animal and wild game like bear meat, humans can acquire the infection and it infect various organ such as human legs as indicated in figure 4. The *Trichinella spiralis* species is the most common cause of human disease by eating raw meat of pork. Although, other mammals like wild carnivores and horses can be reservoirs of infection. *Trichinella spiralis* can cause various symptoms from the most common fever, abdominal pain, diarrhea, nausea, vomiting, myalgia to the more severe like myocarditis and encephalitis. *T. spiralis* is a roundworm nematode intestinal parasite and possesses the capability of infecting a wide range of mammals including pigs, horses, reptiles, and birds but it causes disease only in humans [50]. Similarly, some reports have mentioned an occasional acquisition of the disease by ingestion of reptile meat, including lizards and turtles, however, there are no reports that indicates human to human transmission [51]. Therefore, in addition to protecting human personal and environmental hygiene, stop eating of undercooked meat of both domestic and wild game animal is the most important advisable prevention methods of *Trichinella spiralis* and other infection.



Figure 4: The morphology of *Trichinella spiralis* and its infection on human leg

Whipworm

The whip like worm of *Trichuris trichiura* also known as the human whipworm, is a roundworm that causes trichuriasis in humans. The morphology of *Trichuris trichiura* is referred as the whipworm due to it looks a whip like structure with a wide at the posterior end and a narrow anterior esophagus containing a thick posterior anus. In addition, these worms are usually pink in color and attach to their host via the slender anterior end and also the size of these worms are varies from 3 to 5 cm. Usually, the female is larger than the male and the females can lay from 2000 to 10,000 eggs per day anywhere which deposited in the soil from human feces [52]. The eggs become mature after 14 to 21 days and enter an infective stage. At this stage, if humans ingest the embryonated eggs, the eggs start to hatch in the human small intestine and utilize the intestinal microflora and nutrients to multiply and grow in the host as indicated in figure 5. The majority of larvae move to the cecum, penetrate the mucosa and mature to adulthood. Infections involving a high-worm burden will typically involve distal parts of the large intestine [52].

In addition, Like ascariasis and hookworm infection, Trichuriasis is also soil-transmitted helminthiasis infections; it considered a neglected tropical disease by the World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC). The most common cause of trichuriasis is ingestion of infected eggs that are found in soil. This is often due to poor sanitary conditions, including open defecation and using human feces as fertilizer. Some recent studies show that people with certain chromosome traits may be predisposed or have increased susceptibility to acquiring trichuriasis [53]. Therefore, in addition to protecting personal and environmental hygiene, stop ingesting any kind of

food before washing hands and uncooked vegetables is the most advisable prevention methods of *Trichuris trichiura* infection.

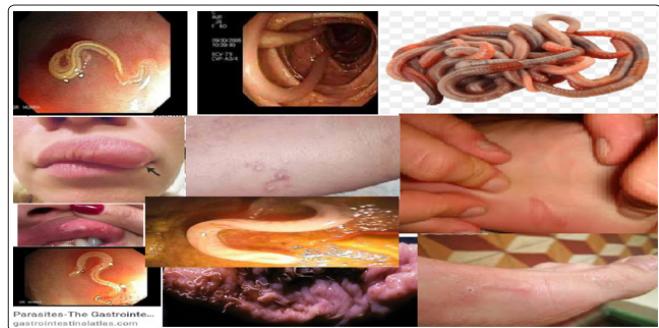


Figure 5: Morphological impacts of Whipworm (*Trichuris trichiura*) in human body

Lymphatic Filariasis

Lymphatic filariasis (LF) (elephantiasis) is a neglected tropical disease caused by the filarial nematode parasites. These worms are endemic in 72 countries in the tropics and sub-tropics where more than 1.4 billion people are at risk of infection and about 120 million people are infected with one or more types of lymphatic filariae. Filariasis is a parasitic helminthiasis disease caused by an infection with roundworms of the Filarioidea type, spread by blood-feeding diptera such as black flies and mosquitoes [54]. In addition, there are eight known filarial nematodes use humans as their definitive hosts and which divided into three groups based on their niche occupy in the host body such as Lymphatic filariasis, Subcutaneous filariasis, and Serous cavity filariasis. Meaning that, the Lymphatic filariasis is caused by *Wuchereria bancrofti*, *Brugia malayi*, and *Brugia timori* worms occupy in the lymphatic system, including lymph nodes and these worms lead to syndrome of elephantiasis. The Subcutaneous filariasis is caused by the eye worm known as *Loa loa*, *Mansonella streptocerca*, and *Onchocerca volvulus*. The *Loa loa* worms occupy the subcutaneous fat layer of the skin causes *Loa loa filariasis*, and *O. volvulus* causes river blindness. Serous cavity filariasis is caused by the worms *Mansonella perstans* and *Mansonella ozzardi*, occupy the serous abdominal cavity [54].

Morphological impacts of Lymphatic filariasis (elephantiasis) is a condition which characterized by swelling of the lower limbs (legs), male genitalia, arms, or breasts of human as indicated in the following figure 6. There are three causative agents of lymphatic filariasis in humans, such as *Brugia malayi*, *Wuchereria bancrofti* and *Brugia timori*, but both *Wuchereria bancrofti* and *Brugia timori* are differ from *B. malayi* in morphology, symptom, and geographical degree and *B. malayi* is transmitted by *Mansonia mosquitoes*. Lymphatic filariasis is caused by species of nematodes known as *Wuchereria bancrofti*, *Brugia malayi* and *Brugia timori* are transmitted by the bite of a number of mosquito species such as *Anopheles*, *Culex*, *Mansonia* and *Ochlerotatus* [43,56]. When biting infective third stage larvae break out of the mosquito proboscis and enter the skin through the puncture wound and parasite then develops over a period of 6-12 months in the human host. Adult filarial worms exist in the afferent lymphatics close to draining lymph glands and microfilariae of *W. bancrofti* and *B. malayi* show the nocturnal periodicity in most endemic areas but either non-periodic or semi-periodic in some others [56].

In addition to swelling of the lower limbs, Lymphatic filariasis also cause impairs the lymphatic system and can lead to the abnormal enlargement of body parts, causing pain, severe disability and social stigma. The major pathologic manifestations includes acute fever accompanied by tender swelling of the lymphatics

male genitalia leads to dysfunction and swelling of the legs, arms, or breasts of human [57,58]. Chronic swelling of the legs and compromised lymphatic drainage may result in secondary bacterial infections and sclerosis and verrucous changes of the overlying skin. The most severe cases are referred as elephantiasis and the male genital involvement includes hydrocele, funiculitis, epididymitis, and orchitis [57,58]. For example, filarial species can cause lymphatic filariasis in humans and most of the infections are caused by *Wuchereria bancrofti* and spreads from person to person by the bites of mosquito [17]. Therefore, a parasitic helminthiasis disease filariasis is caused by an infection with roundworms of the Filarioidea, transmitted by the bite of black flies, and a number of mosquito species like *Anopheles*, *Culex*, *Mansonia* and *Ochlerotatus* via blood-feeding with their proboscis, parasite enter via pierce wound skin and then develops in the host and so, prevention methods are highly advisable.



Figure 6: Various physiological impacts of Filarial worms on human being

Guinea worm

Adult Guinea worm (*Dracunculus medinensis*) in knee joint is occurs mainly in Asia and Africa. An adult Guinea worm in humans infection occurs from drinking water containing Cyclops which have been infected by the worm. The worm larvae in the Cyclops hatch out and penetrate the human intestine and the eggs are passed out of the human when a gravid female migrates to the skin and causes an ulcer as indicated in figure 7. Skin ulcer comes into contact with water the free-swimming larvae are released and this larvae then swim until they are eaten by a Cyclops or die [59]. Therefore, it is very important treating drinking water to protect health of people which caused by drinking contaminated water.



Figure 7: Physiological impacts of Guinea Worm on human

Heartworms

The heartworm (*Dirofilaria immitis*) is a type of parasitic filarial roundworm, also known as dog heartworm, a small tread-like worm that causes dirofilariasis, spread from host to host through the bites of mosquitoes and rarely infects humans [54,60]. There are four genus of mosquitoes that transmit dirofilariasis, such as *Ades*, *Culex*, *Anopheles* and *Mansonia* [60]. The main definitive host is the dog, but it can also infect cat, wolves, coyotes, jackals, foxes, and other animals such as ferrets, bears, seals, sea, lions and under rare circumstance humans [61]. However, opposing to

their name, adult heartworms often reside in the pulmonary arterial system of the lung and the heart as indicated in figure 8 and also damage those vessels and tissues of infected host animals and causes a serious complications for the infected host if untreated eventually leading to death, most often as a result of secondary cognitive heart failure [62].

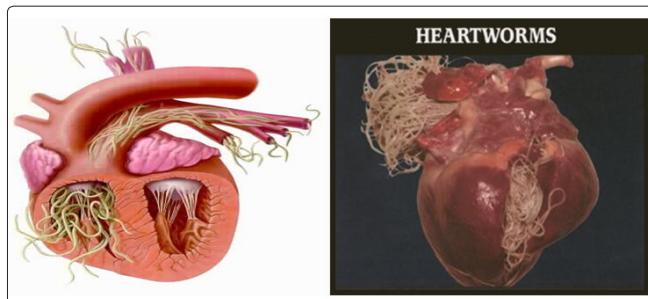


Figure 8: Physiological impacts of the heartworms

Tapeworms

Tapeworms or cestodes are ubiquitous among humans and animals worldwide. They are unique among all worms because they are perfectly specialized for the parasitic life and are incapable of living independently. Adult cestodiasis is far less pathogenic to human than other helminthic infections, and only heavy infections are able to cause physical damage of the gut wall, and possible blockage of the intestine. However, larval infections of few species of cestodes may cause serious clinical complications as in cysticercoids [63]. According to CDC, the tapeworms are parasites that live in the small intestines of many different animals species, including humans and its size is vary depending on the species, example, while *Echinococcus multilocularis* is less than 1 cm long, an adult *Taenia saginata* up to 10 metres long [64]. Except for the head, a tapeworm's body is made up entirely of small segments, called proglottids, which break off from the end of the worm's tail and both intact proglottids and the eggs may be passed in the feces. Of all the tapeworms in pets, *Echinococcus* spp. pose the greatest disease risk to people. Tapeworm infection in adult animals rarely causes illness, even with large numbers of worms, but the motile proglottids may cause irritation around the anus, causing the animal to chew or rub the area or "scoot" as indicated in figure 9. There are three main groups of tapeworms, each containing one or more species, that are a concern for most domestic animals and humans. Each group poses a different level of risk to people, and may be spread between animals and people in a different way [64].

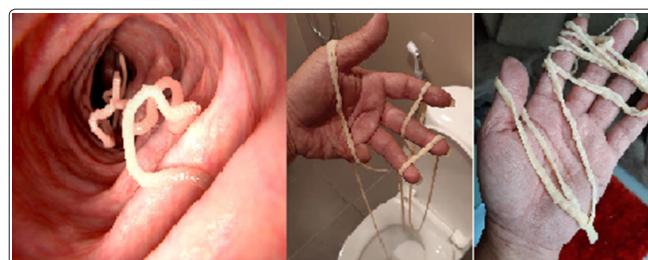


Figure 9: The morphology of tapeworm and its impact on host animals

The *Dipylidium caninum* is the most common type of tapeworm found in dogs and cats, and can be found in pets worldwide. The eggs of *D. caninum* are passed in an animal's feces, does not make animals or people sick, but it can be uncomfortable because the proglottids shed by the worms can move by themselves, and may get stuck around the anus, causing itching and this infection can

cause weight loss in pets but easily treated with oral anti-parasitic drugs. Similarly, human infections with tapeworm of *Taenia* species have a problem in some areas, come from livestock can cause infection of any kind in people. There are two kinds of *Taenia* species that can cause infection in humans, these are cysticercosis and taeniasis (intestinal tapeworm infection) as briefly found in table 1. The main causes of tapeworm in people is eating raw or undercooked beef or pork. The intermediate stage (cysticercosis) of a *Taenia* tapeworm that infects humans, they must have contact with feces from an infected person. Therefore, taeniasis is common where cattle and pigs meat for human consumption and around poor sanitation. Intestinal tapeworm infections can be easily treated using oral dewormers such as praziquantel and also can be prevented in people using the two major components are preventing intestinal infection in pets and preventing human exposure to the parasite eggs and cysts [64].

Table 1: Tapeworm species and its transmission between humans and domestic animals

Tapeworm group	Tapeworm species	Definitive host (intestinal worm)	Intermediate host (cyst stage)	Notes
<i>Dipylidium</i> spp.	<i>D. caninum</i>	Dogs Cats Humans (rare)	Fleas	Transmitted by swallowing infected adult flea
<i>Taenia</i> spp.*	<i>T. solium</i>	Humans	Cysticercosis Pigs Humans	Intestinal infection from eating undercooked pork, cysticercosis from contact with human sewage
	<i>T. saginata</i>	Humans	Cattle	Intestinal infection from eating undercooked beef
	<i>T. multiceps</i> <i>T. crassiceps</i> <i>T. serialis</i>	Dogs	Small prey Humans (rare)	RARE cause of cysticercosis
<i>Echinococcus</i> spp.	<i>E. granulosus</i>	Wild canids (especially foxes & wolves) Dogs	Cystic echinococcosis Humans Medium to large prey: Rabbits, sheep, moose	Eggs identical to <i>Taenia</i> spp. Infection in humans is uncommon or rare in some areas, but can be extremely serious
	<i>E. multilocularis</i>	Wild canids (especially foxes) Dogs Cats	Alveolar echinococcosis Humans Small prey: Voles, mice, lemmings	

Conclusions and Future Directions

Conclusions

This review article concluded that parasitic infections which caused by helminthes and protozoa are the major causes of human disease in most countries of tropical region and helminthic infections is highly predominant than protozoan infection. Intestinal parasitic infection can affect any individual of human being those who cannot protect their environment and personal hygiene including hand washing and shortening fingernails. Therefore, improvement of personal and environmental hygiene is very important to prevent from infecting by those intestinal parasites. Because both hook worms (*Ancylostoma duodenale* and *Necator americanus*) species can transmit via skin penetration, percutaneously, orally, probably transplacentally, etc. In addition, people who are living in most crowded environments from tropical climates are the most vulnerable to species of pinworm (*Enterobius vermicularis*), and round worm (*Ascaris lumbricoides*) infection which caused by ingestion of its eggs mostly through the fecal-oral route and so, protecting personal and environmental hygiene is important to prevent hook worms, pinworm and round worm infection. Similarly, the *Trichinella spiralis* species is the most common disease in human which caused by eating raw meat of pork and bear meat. Helminthiasis, like Ascariasis and hookworm infection, Trichuriasis is also soil-transmitted infections, which caused by ingestion of infected eggs due to poor sanitary environment. Therefore, personal and environmental hygiene, stop ingesting uncooked meat and vegetables is advisable prevention methods.

The pathogenic helminthiasis filarial parasites are affecting millions of people, especially those living in tropical countries, and may cause significant dermatologic manifestations and caused by an infection with roundworms of the Filarioidea, transmitted by the bite of black flies and mosquito species such as *Anopheles*, *Culex*, *Mansonia* and *Ochlerotatus* with their proboscis via blood-

feeding. Similarly, infection of Guinea worm occurs in humans while drinking Cyclops containing water which have larvae hatch out then penetrate the human intestine, the eggs passed out, migrates to the skin and causes an ulcer. Therefore, removing stagnant water to protect filarial reproduction habitat and to protect from drinking by human being and also health workers with government should focus on this regards and others prevention methods are advisable. Generally, helminthiasis in most instances associated with stunting of linear growth, physical fitness and low educational achievement due to their immune systems are not yet fully developed habitually play in fecally contaminated soil. Therefore, helminthiasis can cause gastrointestinal and other diseases in human and various economic impacts and so it can be prevented by protecting personal and environmental hygiene, stop eating of undercooked meat of both domestic and wild game animal, stop ingesting uncooked vegetables with unwashed hands, stop drinking of not treated or unclear water, etc are advisable prevention methods.

Future Directions

Most of intestinal parasitic infections are mainly cause from poor personal and environmental hygiene including ingesting parasitic eggs with unwashed hands, drinking unclear water, eating of raw meat, skin penetration, etc. Therefore, new research will require with multidisciplinary collaboration to enable the integration of traditional practices with new ideas created by the scientists and more research required on nematode biology and the environment, and nematologists must consider several possibilities regarding to how nematode life cycles can be interrupted, how microbial activity at the root soil interface nematode invasion can be promoted, identification of harmful nematodes, selection of resistant varieties, or tolerate nematode infestation, and that can produce acceptable yields and also developing biological control methods are some of the recommended information. In addition, the human pathogenic parasitic filarial helminths are affecting

millions of world people, especially those who are living in tropical countries. So, respective nongovernmental and governmental organizations should focus on health and environmental studies that required on creating awareness how to remove sluggish water to prevent filarial reproduction and how to treat drinking water to protect health of people which caused by drinking contaminated water and others best prevention methods are needed to control socio-economic impacts that caused by such gastrointestinal parasites.

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