Ascariasis: Public Health Importance and its Status in Ethiopia

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Abstract

Waterborne diseases are a major public health problem in many countries of the world including Ethiopia. Waterborne diseases are caused by viruses, bacteria, protozoa, helminthes, and fungi. Currently, about 1.1 billion people in the world drink unsafe water, which is responsible for millions of cases of waterborne diseases. Ascariasis is among the several parasites which is widely prevalent helminthic disease of public health significance. It is commonly found in warm tropical and sub-tropical climates in Sub-Saharan Africa and Southeast Asia. It flourishes in areas with poor sanitation and crop irrigation by improperly treated wastewater. Severe ascariasis infections cause approximately, 60,000 deaths annually, mainly in children. It is transmitted through accidental ingestion of Ascaris eggs from contaminated water, food or soil. Among the Ascaris species, Ascaris lumbricoides and Ascaris suum are the parasitic nematode infections of humans and pigs with serious outcomes, respectively. Ascariasis is found in association with low personal hygiene, poor sanitation, and in places where human faeces are used as fertilizer. Clinical spectrum of disease varies from asymptomatic to nausea, vomiting, abdominal pain, pneumonia, and intestinal obstruction. Laboratory help is imperative to assist the clinical diagnosis. Treatment of adult worms can be done with albendazole, mebendazole, and pyrantel pamoate. Public health department should improve the safety of the drinking water. Health education to the community, mainly the school children about the personal hygiene and environmental sanitation will be important in preventing the infection. Ascariasis caused by A. lumbricoides is found among children and adults in Ethiopia. Considering the importance of ascariasis from public health and economic perspective, further research on the development of safe, potent and cheap vaccine is emphasized. Moreover, comprehensive studies on zoonotic importance of A. suum should be planned particularly, in pig rearing countries.

Keywords: Ascariasis; Children; Ethiopia; Parasite; Pig; Public health; Water

Introduction

Waterborne disease can be defined as any illness caused by either drinking of contaminated water or by contact with polluted water. Waterborne diseases result in higher morbidity and mortality rates both in developing and developed countries of the world [1]. A number of waterborne diseases such as amoebiasis, ascariasis, balantidiosis, campylobacteriosis, cholera, colibacillosis, cyclospiriasis, cryptosporidiosis, echinococcosis, enterobiasis, fascioliopsisis, giardiasis, hymenolepiasis, infectious hepatitis, legionellosis, leptospirosis, microsporidiosis, poliomyelitis, schistosomiasis, shigellosis, taeniiasis, toxoplasmosis, typhoid fever, and yersiniosis are reported all over the world [1,2-7] According to different reports, waterborne diseases cause about 1.7 million human deaths annually, and 88% is attributed to unsafe water supply, poor sanitation, and lack of hygiene. It is described that approximately, 10% of the population in the developing countries are infected with various intestinal worms [2]. The use of faecal contaminated water is the main source of intestinal parasites. Among these diseases, ascariasis (round worm infection) is a chronic and potent fatal parasitic disease, caused principally by Ascaris lumbricoides. The disease is important with enormous health and social implications for school going children in many developing countries of Africa, Asia, and Latin America. Due to this condition, one fourth of the population of world is infected with A. lumbricoides.

Ascariasis is a roundworm, which is most commonly found in warm tropical and sub-tropical regions of the world including Ethiopia and India. Disease may be acquired through accidental ingestion of Ascaris by eggs contaminated water, food, or soil [4,8]. After the eggs are swallowed, they will be hatched into larvae after passed into the intestine. The larvae can cause severe coughing and wheezing after migrating into the bloodstream. Eventually, the larvae are swallowed and lay eggs sometimes up to 240,000 per day after returning to the small intestine where they mature. Before the cycle begins again, ascaris eggs are passed into the feces and incubate in the soil for a minimum of two weeks. Adult roundworms can grow as long as twelve inches and as wide as a pencil and can live in the body for one to two years. Ascariasis can be detected by observing the presence of worms in the stool as initially as can be asymptomatic [9]. Ascariasis particularly in children can cause intestinal blockage and obstruction in severe cases.

Ascaris lumbricoides and Ascaris suum are nematodes belonging to Family Ascarididae, and cause infections in humans and pigs, respectively. Ascaris lumbricoides is one of the most common human roundworm in the world, infecting 1.4 million population globally. There are reports of Infections which are most commonly documented in sub-Saharan Africa, Latin America, China, and East Asia. The spectrum of disease associated with A. lumbricoides infection in human is known as ascariasis, and is the major cause of disease burden, especially in developing countries, with an estimated loss of 1.2 to 10.5 disability-adjusted life years. Moreover, significant morbidity rate with serious health consequences is observed in 122 million cases per year. However, ascariasis being a neglected tropical parasitic disease, could not receive much attention.

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Ascaris in pigs is caused by *Ascaris suum* which is a widespread parasitic nematode that causes infection with high prevalence rates in host populations. Transmission occurs through oral-faecal route [10]. The prevalence of *A. suum* infection can vary due to differences in geographical regions, and farm management practices. Swine ascariasis can interfere with health and productivity of pigs resulting in reduced feed to gain ratios, and liver condemnation incurring economic losses [9,11]. Moreover, pig serves as reservoir of *A. suum*, and pig handlers can acquire *A. suum* infection from pigs [4,12]. The zoonotic implications of *A. suum* is not well established in many countries. Hence, the prime objective of this paper is to present an overview on ascariasis as a common helminthic disease of developing nations with more emphasis on Ethiopia.

**Etiology**

Ascariasis is caused by *A. lumbricoides* and *A. suum*, which are nematode parasites of public health significance. The later species is of zoonotic importance as pig serves as reservoir of the infection [4,10,13]. Human and pig Ascaris are morphologically indistinguishable that have showed a difference by only six (1.3%) nucleotides in the first internal transcribed spacer (ITS-1) and by 3-4% in the mitochondrial genome (mtDNA) sequence, which indicates the species are closely related at a phylogenetic level. Experimental cross-transmission studies have demonstrated that *A. lumbricooides* can infect pigs and vice versa however, both parasitic nematodes display strong affinity for their conventional hosts. In North America and Denmark which are non-endemic areas for *A. lumbricooides*, infected humans were found to harbour worms of pig origin. This showed that pigs are a potential reservoir of the infection for the human host population. However, in Ascaris endemic regions of Guatemala and China, molecular epidemiological studies revealed that the level of cross-infection between host species is low or absent and that gene flow is limited between/among different genotypes [9,11,14].

**Life Cycle of Parasite**

The faecal-oral route is the most important means of ascars infection in both human and pig. When infective eggs are ingested and hatched, *Ascaris* larvae develop in host parenteral tissues [9]. A similar migratory route is observed in human and pig hosts. After ingestion of the infective ova, L3 larvae covered by the L2 cuticle, hatch in the small intestine and migrate to the cecum and proximal colon where they penetrate the mucosa. The larvae reach the liver after migrating via the portal blood, where the L2 cuticle is shed. Following migration in the liver, the larvae advance to the lungs on day 6-8 post ingestion. The larvae move to the pharynx after penetrating the alveolar space and they are swallowed, resulting in returning to the small intestine on days 8-10. *A. suum* moults again to L4 stage larvae in the small intestine on day 10 [9,10,13,15]. In the small intestine, larvae grow and reach sexual maturity and moults again (L5 stage larvae) on day 24. After the uptake of eggs in pigs and humans, the hepatop-tractal migration takes place over a 10 to 14 day period, respectively. Majority of worms are expelled after 23 weeks of infection in pigs but adult worms may reside in the intestines for approximately one year. Male and female adult worms measure 15-25 cm and 20-35 cm, respectively. Even though, the number of eggs a female produces decreases with worm load, the daily *Ascaris* female egg production generally are in the range of 200,000 eggs. Unembryonated ova can remain viable in the soil for many years after entering to the environment via the faeces. The larvae may undergo two moults in the egg during embryonation [9,11,13,15].

**Epidemiology**

Parasitic diseases, caused by cestodes, nematodes, trematodes, and protozoa, are the cause of morbidity and mortality in many regions of the world [4]. These diseases are more prevalent in countries with poor socioeconomic status, where living conditions are unhygienic, and supply of safe drinking water is scarce or limited [1,8]. Ascariasis is mainly a disease of people exposed to untreated waste water. It is one of the most commonly occurring helminthic human diseases of worldwide distribution. Globally, more than 1.4 million people are infected with *A. lumbricooides*. Ascaris of both human and pig origin showed an over dispersed distribution, which results in the worms aggregating in few heavily infected hosts. Moreover, provision of anti-helminthic treatment and subsequent observation of intensity of re-infection have occurred, which showed that individuals tend to re-acquire similar worm burdens to those harbored before treatment [11,15].

Ascaris infection is caused by consuming drink or food contaminated with roundworm eggs. Ascariasis is highly prevalent intestinal worm infection in many countries of the world with poor socioeconomic conditions. It is estimated that 25% of world population is infected with *A. lumbricooides*. In India, over half of adolescents are infected with roundworms. Transmission of infection is facilitated when asymptotically infected persons shed the eggs for years. It is found in association with poor personal hygiene, poor sanitation, and in places where human faeces are used as fertilizer. Significant prevalence of *A. lumbricooides* infection among children in Senegal was associated with severe malaria attack [9]. Both species of Ascaris are found throughout the world. The zoonotic species *A. suum*, is widely present on pig farms. Therefore, it can be considered as zoonotic occupational disease of pig handler [10]. The parasite is most common in warm, humid climates, and swine are the normal reservoir [13]. The prevalence in swine varies with the level of care and ranges from 20-70%. Infection is most common among children and persons working with swine. A related organism, *Lagochilascaris minor*, normally found in clouded leopards, has been reported as the cause of subcutaneous abscesses in humans.

*Parascaris equorum* and *Neoscaris vitulorum* can cause visceral larva migrans in humans. It is transmitted by ingestion of ova in drinking water, contaminated soil or on fresh vegetables [11]. *Ascaris* may exist as a zoonotic infection associated with pig and use of pig manure [13]. Zhou [14] and co-workers (2012) have reported that pig *Ascaris* is an important source of human disease in China. Sporadic zoonotic infections with *A. suum*, a pig nematode, have been described in industrialized nations but not yet fully quantified [16]. It is emphasized that further comprehensive studies to elucidate the zoonotic role of animal Ascaris should be conducted.

**Clinical Signs in Humans**

The incubation period of the parasite is commonly 2 weeks until the respiratory phase begins; 2 months until the intestinal phase develops. However, the clinical signs both in humans and in pigs are not obviously manifested. People infected with *Ascaris* often show no clinical signs symptoms. If symptoms do occur, they can be light and include abdominal discomfort. Heavy infections can cause intestinal blockage and impair growth in children. Other symptoms such as cough are due to migration of the worms through the body. The major clinical signs in humans include worms in stool, coughing (sometimes coughing up of worms), wheezing, fever, nausea, vomiting, loss of appetite, shortness of breath, swelling of abdomen and severe abdominal pain, intestinal blockage or bowel obstruction (in severe cases), pneumonia (in rare cases), malnutrition, anemia and impaired physical growth, particularly in children. Severe cases involve Loffer’s syndrome in the lungs. The obstruction to gall bladder can result in cholangitis, cholecystitis, biliary colic, liver abscess, and pancreatitis.
In warm, and humid climates. Hence, measures such as drinking of boiled water, avoiding contact with soil contaminated with human faeces, proper washing of hands with soap and warm water before handling the food, proper washing, peeling, or cooking of all raw vegetables and fruits before eating, particularly those that have been grown in the soil that has been fertilized with manure, will be helpful in preventing the infection. Moreover, implementing effective sewage disposal systems, avoiding open defecation, sanitary disposal of swine faeces, seasonal deworming of pigs, periodic treatment of pig shed with sodium hypochlorite, and health education of children about the source of infection, mode of transmission, nature of disease, and personal hygiene are some of the prevention strategies [4,9,10,13,17]. It is advised that periodic deworming of school going children and others living in endemic areas may prove useful in the prevention of disease.

**Disease Status in Ethiopia**

Ascariasis caused by *A. lumbricoides* is found among all segments of the Ethiopian society. It is the most commonly occurring parasitic illness infecting children as well as adults in Ethiopia, especially in the malaria-free highlands [18]. The most comprehensive study on ascariasis in Ethiopia was conducted between 1979-1982 involving over 32,000 persons with a high prevalence rate of 44% among the study participants, two-thirds of whom were children. The infection rates as high as 59% percent were calculated for some highland study sites above 2500 meters with low laying elevations (below 1000 meters) burdened to a much lesser degree (7.8%). Arid climates are unfavorable for the survival of the parasite's eggs. Re-infection after de-worming is also very common in Ethiopia.

A study in the late 1970's sought to show the link, if any, between ascariasis and malnutrition among Ethiopian children living in urban areas. It assumed a prevalence rate of about 10% in infants, 28% in children 1-2 years old, and 62% in children over 3 years [19]. Surprisingly, this double-blind study found no effect of Ascariasis on the nutritional status of children. The biotic contamination of the living environment particularly from improper disposal of human waste and integration of the lives of humans and animals in rural Ethiopia accounts for the epidemic nature of parasitic infection in the country. In addition, a study conducted in rural areas close to Lake Langano, Southeast Ethiopia reported a prevalence of 6.2% (17 out of 259) among school children [20]. Another study conducted on Southwest Ethiopia recorded a prevalence of 4.3% among the urban dwellers in the study area [21]. Moreover, a study conducted in Jimma town detected 37.3% *A. lumbricoides* ova from a soil sample, and an overall proportion of helminth ovas recovered was 41.5% [22].

**Conclusion**

Ascariasis is a widely prevalent helminthic disease, which is frequently reported from warm tropical and sub-tropical regions affecting children more commonly and seriously. Ingestion of Ascaris eggs due to contaminated food, water or soil can result in an infection. Disease is observed more commonly in poor socio-economic groups, and economy, ascariasis still remains a neglected tropical disease. Moreover, the parasite's persistence and prevalence presents difficulties in controlling the worm itself and concurrent infectious diseases. Therefore, use of boiled drinking water, avoiding contact with soil that may be contaminated with human faeces and awareness creation,
especially of the children in schools on personal hygiene and sanitation of the environment will certainly help in reducing the prevalence of ascariasis. Moreover, further research on the prevalence, distribution and mechanism of infection is required in order to facilitate future initiatives in control and prevention.

References

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