

LITERATURE REVIEW

Pneumoascariasis: *Ascaris* Worm Infestation in the Lungs

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ABSTRACT

Pneumoascariasis is an infestation from one of the most common worms or helminths found on earth in the respiratory system. The worm is called *Ascaris lumbricoides*, which penetrates and infests the human body through the fecal-oral process. The fertilized *Ascaris* ova, or simply egg, would develop into larvae, which then move to the liver and lungs through the portal vein system. These larvae will soon develop into mature worms in the human respiratory system, inside the lungs, particularly in the bronchioles. These *Ascaris* larvae trigger common symptoms such as persistent cough, shortness of breath, and wheezing. To diagnose this condition, supplementary examinations are necessary since it is difficult to diagnose only by history taking and some physical exams. Additional exams include chest X-rays that, at one point, display lung infiltration. The chest computed tomography (CT) scan shows ground-glass opacity and a classic inflammation marker called Charcot-Leyden crystals that are most likely present. Pneumoascariasis is often misinterpreted and misdiagnosed. Therefore, this literature review was made to further understand about pneumoascariasis.

INTRODUCTION

Ascariasis is a worm infestation disease caused by *Ascaris lumbricoides*, which, together with hookworms and whipworms, form the Soil Transmitted Helminths (STH) group.¹ Geographically, ascariasis infestation is spread across the tropical and subtropical regions, with the prevalent numbers found in sub-Saharan Africa, America, China, and East Asia. *Ascaris* worms are more likely found in places with favorable climatic and environmental conditions, including limited access to drinking water supplies, sanitation, and hygiene resources.^{2,3}

Based on epidemiology, *Ascaris* infestations were found in areas with the highest estimated prevalence rate, Central & South Asia (12.91%), Latin America and

the Caribbean (12.75%), and Sub-Saharan Africa (11.66%), while North Africa & West Asia (2.04%) had the lowest prevalence rate.⁴ A systematic review and meta-analysis study conducted using data from 2010 to 2021 revealed that Indonesia has a prevalence of around 32.02% of *Ascaris* infestations.⁴

Before settling in the small intestine as adult worms, *Ascaris* migrate as larvae through the liver and lungs, where clinical effects could be involved in these organs.^{4,5} When *Ascaris* larvae and adult worms enter the human lungs, there are several problems, such as respiratory obstruction, bronchospasm, and pneumonitis.⁶

Pneumoascariasis is a self-limiting disease and is basically not risky. The migration phase of *Ascaris* larvae or adult worms inside human lungs causes acute pneumonitis or picture-like pneumonia in

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chest X-ray. Its clinical symptoms usually include fever, cough, wheezing due to hypersensitivity, and mostly no significant eosinophilia is obtained from the patient's complete blood count.⁶ Pneumoascariasis may cause Loeffler's syndrome if *Ascaris* infestation produces hypereosinophilia in blood count examination. Loeffler's syndrome is a transient respiratory illness associated with blood eosinophilia and radiographic shadowing. Infection with *Ascaris lumbricoides* is mostly caused by this syndrome. However, other parasitic infection and acute hypersensitivity reaction due to drugs are also included as etiologies Loeffler's syndrome.

Subsequently, treatment could be in the form of corticosteroids for systemic problems and inhaled bronchodilators for symptom reliever. In-patients with pulmonary symptoms, anti-worm medications are usually not advised as a dead larvae found in the lungs may be more dangerous than the migrating one.⁶

An Overview of Pneumoascariasis and Loeffler's Syndrome

Ascariasis is one of the most common human intestinal worm infestations caused by the parasitic helminth worm *Ascaris lumbricoides*, a family of parasites known as the soil-transmitted helminths.^{7,8} Depending on which part of the body is afflicted by ascariasis, different signs or symptoms may be present. As worm eggs penetrate the human body, they become larvae and have the ability to migrate toward the target organs. The migrating larvae of *Ascaris* in the lungs is able to cause signs and symptoms of pneumonia, including a persistent cough, shortness of breath, and wheezing.⁹ Thus, pneumoascariasis is defined as the aforementioned symptoms with a pulmonary infiltration found in chest radiographic examination. In addition, if peripheral eosinophilia is found, it is very likely that pneumoascariasis has caused a complication and caused Loeffler's syndrome.

Loeffler's syndrome was first defined by Wilhelm Loeffler as a clinical disorder characterized by transient

respiratory illness associated with blood eosinophilia and radiographic shadowing.¹⁰ Loeffler's syndrome typically is present as a triad of respiratory symptoms (persistent cough, shortness of breath, and wheezing), an abnormal chest radiograph with the constellation of ephemeral and migratory pulmonary infiltrates, and peripheral blood eosinophilia. Loeffler's syndrome is a rare eosinophilic pneumonia which is commonly transient and self-limiting. Loeffler's syndrome listed *Ascaris lumbricoides* as the most common etiology, but other acute hypersensitivity reactions to medications and infections of protozoa, fungus, bacterial, and helminth were included as causes for this disease. Loeffler's syndrome is considered a benign, self-limiting disease without significant morbidity. Symptoms usually subside within three to four weeks.¹¹

The Life Cycle of *Ascaris lumbricoides*

The life cycle of *Ascaris lumbricoides* consists of environments around and human being as its definitive host (Figure 1). The lumen of the small intestine is home to the adult *Ascaris lumbricoides* worm. A single female worm may lay up to 200,000 eggs daily, which is about 3.40 eggs per gram of feces.^{12,13} Eggs that are excreted with feces will be discarded on the ground where their development depends on environmental conditions. The eggs develop at 36-40°C within two to four months to become second-stage infective larvae (L2) when they are ingested and infect the small intestine of the existing host.^{12,14}

Ingested second-stage (L2) larvae hatch in the host's small intestine, penetrate the intestinal wall, and are transported to the liver by the portal vascular system.^{12,14} The blood carries the L2 larvae from the liver to the lung parenchyma, where they alternate to develop into L3 larvae. L3 larvae move up through the bronchial-tracheal tubes and epiglottis before being swallowed back into the lumen of the small intestine via the esophagus, where they would grow into adult worms.¹²⁻¹⁴

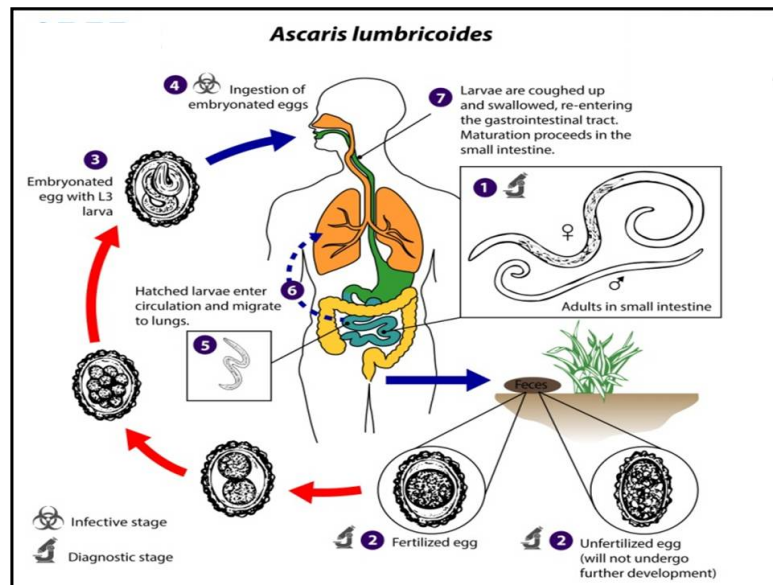


Figure 1. The life cycle of *Ascaris lumbricoides*⁷

Epidemiology of Ascariasis Pneumonia and Investment *Ascaris*

The prevalence of ascariasis infestation is primarily observed to be high in tropical and subtropical countries where warm, wet climates bring favor to the transmission throughout the year.⁹ The majority of people with ascariasis live in Asia, Africa, South America, and North America. The disease is very common helminthic infection in the world, especially in places with poor people. Socio-economic conditions, habit of open defecation, sewage system, and cultural variations relating to personal and food hygiene are also major factors associated with the high prevalence rate of infestation with roundworms.¹⁵

More than one billion people worldwide have been infected with helminthic parasites.¹ According to the World Health Organization (WHO) assessment from 2017, more than 1.5 billion people globally, or 24% of the world's population, are estimated to be infected with worms. These individuals are mainly found in sub-Saharan Africa, America, China, and East Asia.¹⁶

The highest risk prevalence of morbidity of *Ascaris lumbricoides* infestation are primary school children ranging between the ages of 4 and 9 for the reason that their immunity to parasite infestation has not been completely developed at that age.¹⁷ It is a major health concern among children living in rural areas where prevailing predisposing factors to infections exist, especially the habit of children playing on the ground and sand.¹⁸ This indicates that children are vulnerably exposed to contaminated soil and playing with dirty hands and putting them in their mouths.^{19,20} More than 270 million pre-school children and more than 600 million school-aged children living in endemic areas need preventive therapy and interventions.^{16,21}

In addition to children, pregnant women are another group who are susceptible to parasite infestations, where pregnancy has been shown to be an independent risk factor for this kind of helminthic infestation. Among pregnant women, the most common parasitic infestation is ascariasis followed by hookworm infection. Risk factors for parasitic infestations for populations in general also apply to pregnant women. Pregnancy is associated with complex immunological changes which are known to increase susceptibility to infestations. Cell-mediated immunity, which is required for the first response to helminth invasion, is known to be decreased during pregnancy.¹⁸

According to the Ministry of Health of the Republic of Indonesia, in 2011, there were around 195 million Indonesians, including 13 million pre-school children and 37 million school-aged children, living in worm infestation endemic locations.^{21,22} Worms such as *Ascaris lumbricoides*, *Trichuris trichiura*, *Ancylostoma duodenale*, and *Necator americanus* are the most common causes of soil-borne helminthiasis.^{16,21,23}

The worm infestation of *Ascaris lumbricoides* in human lungs causes pneumoascariasis, which if there are additional symptoms like eosinophilia, Loeffler's syndrome occurs. In the United States (US), epidemiology discovered that a number of children living in southern rural areas have a prevalence of pneumoascariasis, including Loeffler's syndrome, of 20-67%.¹⁹ The incidents of pneumoascariasis, including Loeffler's syndrome, is increasing in the US. Therefore, doctors in the US are currently more likely to encounter imported tropical diseases due to increasing globalization, immigration, and travel from other countries.¹⁹

Clinical Diagnosis of Pneumoascariasis

Pneumoascariasis or simply ascariasis pneumonia was a term proposed by a scientist named Koino in 1922.²⁴ In order to make a pneumoascariasis diagnosis, one must first find out whether or not *Ascaris* worms are manifesting in the patient's body by finding the egg or the adult worm in the stools and sputum macroscopically and microscopically.^{14,25}

Additional symptoms mostly occur in the digestive system. However, as the life cycle of *Ascaris lumbricoides* suggests, symptoms possibly occur in the respiratory system as well. The digestive system, which is affected by *Ascaris lumbricoides* infestation, affects food intake, digestion, absorption, and metabolism of the food. Ascariasis can cause cumulative nutritional loss, including protein and calorie deficiencies and blood loss.²⁶ Ascariasis may interfere with a person's ability to develop physically, intellectually, and professionally.²⁶⁻²⁹ This disease may also weaken the body's defenses, making it more susceptible to other diseases.²⁶ In severe ascariasis infestations, patients may also be found experiencing very severe abdominal pain and obstruction in the intestine due to the large size of the adult *Ascaris lumbricoides* worms.²⁵

Symptoms of ascariasis infestation in the respiratory system may vary ranging from fever, dry cough or with sputum, wheezing similar to asthma, increased eosinophil cells (indicates Loeffler's syndrome), and pulmonary infiltration on radiological examination.^{6,14} Aside from those symptoms, there are some other symptoms associated with *Ascaris* infestation, but are very rare to be found. Some of them

might be found to worsen the respiratory symptom such as hemobilia, or the bleeding from the biliary tract, hematemesis, the vomit that could mix up with blood, hemoptysis, coughing with blood which is possible to lead into severe respiratory distress, general rashes similar to urticaria ones, due to *Ascaris* larvae entrance in the blood, and causes hypersensitivity reaction to extremely allergenic components.^{11,30,31}

To detect ascariasis infestation outside the intestine is difficult. For pneumoascariasis, it is an important extraintestinal symptom. An important issue in tropical medicine is that Loeffler's syndrome causes eosinophils to accumulate in the lungs in reaction to parasite infestation.³² If the patient has peripheral eosinophilia and lives in an endemic area of parasitic diseases, it is very difficult in differentiating between pneumoascariasis, pneumonia, asthma, and Loeffler's syndrome with other etiologies.³²

Diagnosing pneumoascariasis basically comprises of the life cycle of the *Ascaris* worm, which is when the larvae move into the liver and lungs or adult worms that live in the digestive tract then migrate to the liver and lungs, causing pathology.¹⁴ Fourth-stage larval segments (L4) may be detected in the bronchioles along with polymorphonuclear eosinophil infiltration and scattered Charcot-Leyden crystals (CLC) (Figure 2), which are usually associated with eosinophil lysis. CLC is known as a classic marker of eosinophilic inflammation in tissues and body fluids. As a result, CLC is usually found in the patient's sputum during microscopic examination in cases of pneumoascariasis.^{33,34}

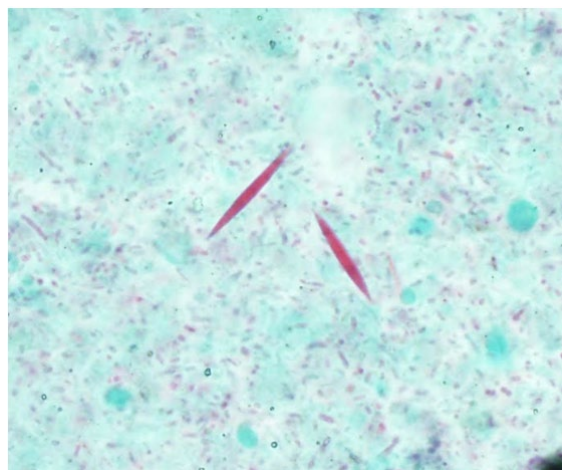


Figure 2. Charcot-Leyden crystals with Trichrome stain, x400 magnification¹⁸



Figure 3. Infiltrate in the right middle lobe of the lung¹¹

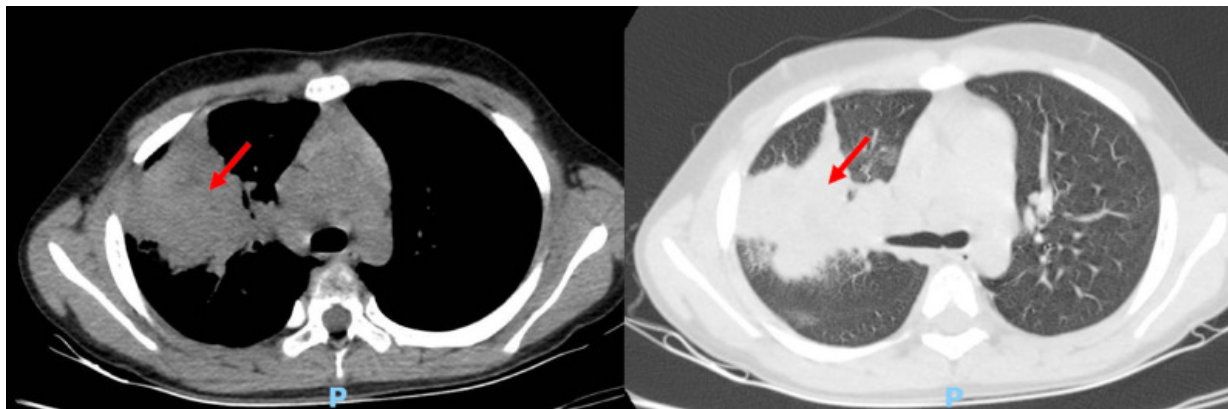


Figure 4. The top margin of the right lung hilum found a consolidation (red arrow), as well as a right pleural effusion and surrounding ground-glass opacity¹⁰

Additional examinations include radiological ones such as chest X-ray to see if there is an image of infiltrates in the lungs (Figure 3), as well as it is possible to have a chest computed tomography (CT) scan to see any image of ground-glass opacity (Figure 4).^{10,11} Currently, there is no gold standard on diagnosing pneumoascariasis, the presumptive diagnosis is based on ascariasis risk factors, respiratory symptoms, laboratory and radiologic finding.

Differential Diagnosis and Management of Pneumoascariasis

Based on the similarity of distinctiveness found in the case of pneumoascariasis, several differential diagnosis are possible to present same clinical sign and symptom with pneumoascariasis, like community-

acquired pneumonia (CAP), bronchial asthma, and Loeffler's syndrome caused by other parasitic infections and acute hypersensitivity reactions to drugs,¹⁹ such as beta-lactams and the third generation of cephalosporins.^{35,36}

Corticosteroids for systemic issues and inhaled bronchodilators for localized symptoms may then be used as treatments. Anti-worm drugs are typically not advised in people with lung symptoms because a dead larvae found in the lungs can be more dangerous than the migrating one.⁶ Nevertheless, in some cases, there are probability of using antibiotics in order to relieve the respiratory symptoms.^{10,11} Patients with ascariasis pneumonia regularly recover in three to four weeks with a good treatment. Moreover, this disease is not severe with no significant morbidity and mortality.¹¹

SUMMARY

Pneumoascariasis is a disease caused by the worm *Ascaris lumbricoides* infestation in the lung. The worm infests the human body through the fecal-oral process. The fertilized *Ascaris* eggs turn to larvae and then migrate to the liver and lungs through the portal vein system. In the bronchioles, they turn into adult worms, which cause systemic and local symptoms.

Once the complete blood count is performed, it would reveal whether there is any significant eosinophilia or not. Chest X-ray is also recommended to show signs of infiltration in the lungs. In prevalence, pneumoascariasis is very limited in identifying cases due to the similarity to CAP, bronchial asthma, and Loeffler's syndrome with other causes. Therefore, to identify and further the research, case reports of *Ascaris* infection in the lungs are required to raise and gain the awareness and to decrease the underdiagnosed cases within the population.

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Conflict of Interest

The authors declared there is no conflict of interest.

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Authors' Contributions

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