Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.8, No.11, 2018

Review on Lungworm Infection in Sheep and Goats in Ethiopia

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Summary
The objective of the paper was to summarize the overview of available research evidence and to assess the scope of the study in the country and to real the gap that need to be addressed in the future. Lungworms are parasites of small ruminants which have round shaped formation in the order *Strongylidea. Dictyocaulus filaria* belongs to the super family *Trichostrongyloidea* while the latter *P.rufescens* and *Muellerius capillaries* belong to *Metastrongyloidea,* which have direct (the way in which the parasite lives and reproduce inside the host cells while some can do this outside the host cells and may live entire life) and indirect (the parasite can't survive inside the host and need multiple hosts so that they can reproduce more) life cycles respectively. Among species of shoats, goats are more susceptible than sheep to lungworm infection. Depending on the severity of infection, age and immunological status of the animal, the clinical sign ranges from moderate coughing with slightly increased respiratory rates to sever persistent coughing, persistent respiratory distress and failure. Diagnosis of the disease is by examination of the feces with Baermann techniques of faecal detection to obtain the L_1 larvae in the laboratory, and postmortem examination of the lungs of infected animals for adult worms' isolation. Treatments of infection necessitate the use of effective and appropriate anthelmintic (includes Benzimidazoles, Levamisols and Ivermectin). The prevention and control of lung worm infection can be achieved by integration of administration of effective anthelmintic drugs, immunization and improved management practices.
Keywords: Anthelmintic, Control, Ethiopia, Lungworm, Small ruminant

INTRODUCTION

Ethiopia is one of the countries with the largest numbers of livestock in Africa (Muktar *et al.* 2015) and livestock production plays major role in the overall development of Ethiopian Agriculture. The numbers of livestock in Ethiopia are approximately 44.3 million cattle, 46.9 million small ruminants, more than 4 million camels and 4.5 million equine a1nd 40 million poultry (Yacob 2008). Small ruminants reared under intensive and extensive production systems are extremely susceptible to the effects of wide range of endo-parasites which were reported to equivalent to the combined effects of other ill health problems (Getachew *et al.* 2016).

Helminthes parasites of ruminants are ubiquitous and prevalent with many tropical and sub-tropical environments of the world providing nearly perfect conditions for their survival and development. However, the clinical signs they cause in infected animals can be less obvious than signs of other livestock diseases. Partly for this reason, infections with gastro-intestinal and other helminthes parasites are among the most neglected areas of veterinary care in much of the developing world. It has however been established that high prevalence of the infection withless obvious signs associate with poor production and unthriftness (Zeryehun and Degefaw 2017: Woldesenbet and Mohammed 2012: Asaye and Alemneh 2015).

Up to half of all sheep deaths and morbidity on farms in Ethiopian highlands are caused by pneumonia and endoparasites. Endoparasites, including *Dictyocaulusfilaria,* are major causes of death and morbidity (Kadi *et al.* 2017; Asaye and Alemneh 2015). Prevention and control of these parasites are, therefore, critical to enhance the economic benefit from these species of livestock. However, the incidence of parasitic diseases including respiratory helminthosis varies greatly from place to place depending on the relative importance of factors (Alemu 2006). Limited numbers of studies were done so far in concern to respiratory helminthes of goats and sheep (Asaye and Alemneh 2015).

Therefore, the objectives of this paper:

- To summarize the overview of available research evidence of lung worm infection in small ruminants in Ethiopia
- To assess the scope of the study in the country and reveal the gap noted that need to be addressed in the future.

Biology and Veterinary Importance

Case definition and Etiology

Verminous pneumonia is a chronic and prolonged infection of sheep and goats caused by any of several parasitic nematodes, characterized clinically by respiratory distress and pathologically by bronchitis and bronchopneumonia (Mekuria and Tefera 2016). It is infection of the lower respiratory tract, resulting in bronchitis or pneumonia, or both (Mihret and Firesbhat 2015; Kebede *et al.* 2014).

Lungworms of domestic ruminants are nematodes that belongs to the *phylum Nemathelmenthes* commonly named as round worms; classified under the super family Trichostrongyloidea and *Metastrongyloidea* (Tewodros 2015). Of which, *Dictyocaulus* and *Protostrongylus* are causes of lungworm infection in ruminants. The common causes of verminous pneumonia in sheep and goats are *D. filaria, P. rufescens and M. capillaris. D. filaria* belongs to the super family *Trichostrongyloidea* while the latter two belong to *Metastrongyloidea*, which have direct and indirect life cycles respectively (Adem 2016; Tewodros *et al.* 2015).

Epidemiology

The epidemiology of lungworm is similar to that of gastrointestinal nematodes. A damp and cool environment is very suitable for the development of *D.filaria* and the third stage of larvae (L_3) is resistant to cold (Kusiluku and Kambarage 1996). *Muelleius and Protostronglus* species have indirect life cycles, with land snails and slugs acting as an intermediate hosts. Moisture is considered to be an important factor determining the survival and availability of land snails and slugs (Kusiluku and Kambarage 1996).

Lung Worms in Sub-Saharan Africa

Gastrointestinal parasite infections are a world-wide problem for both small and large scale farmers, but their impact is greater in sub-Saharan Africa in general and Ethiopia in particular due to the availability of a wide range of agro-ecological factors suitable for diversified hosts and parasite species. Economic losses are caused by gastrointestinal parasites in a variety of ways: they cause losses through lowered fertility, reduced work capacity, involuntary culling, a reduction in food intake and lower weight gains, lower milk production, treatment costs, and mortality in heavily parasitized animals (Gizaw *et al.* 2014).

And also *helminthosis* is a widespread infection of small ruminants in the sub-Saharan region. Nematodes, *trematodes* and *cestodes* are the three major classes of parasitic helminthes affecting goats and sheep in this region which cause major mortality and sub-optimal productivity in shoats in traditional farming practices sub-Saharan countries (Kusiluka and Kambarage 1996).

Prevalence and Distribution of Small Ruminants Lung Worm Infection in Ethiopia

Data showing the prevalence and distribution of lungworm infections in different parts of Ethiopia is summarized and presented in table 1 below.

Authors	**Year**	**Study area**	**Prevalence**			**Species**	
			D.F %	M.C %	P.R %	Sheep (%)	Goats (%)
Dinka *et al*	2011	Ambo town	23.1	15.15	-	91.7	27.1
Terefe *et al*	2013	North Gondar zone	20.4	51	28.6	39.8	62.7
Fantahun *et al*	2012	Jimma town	11.4	8.77	8.77	24.26	26.49
Muktar *et al*	2013	Ambo town	-	-	-	41.9	42
Alemu *et al*	2006	Debresina	23.3	49.7	9.8	24.4	50.7
Addis *et al*	2011	Gondar	15.86	11.07	4.79	32.67	37.35
Abebe *et al*	2016	Wolaita Sodo town	-	-	-	22.1	19.2

NB: - D.F➔*Dictyocaulusfilaria,* **M.C➔***Metastrongyloidus capillaris*, **P.R➔***Protostrongylus rufescens*

Clinical relevance

Parasitic nematode is characterized clinically by respiratory distress and pathologically by bronchitis and bronchopneumonia. It is infection of the lower respiratory tract, resulting in bronchitis or pneumonia, or both (Mihret and Firesbhat 2015). Studies in the central highland of Ethiopia have shown that lungworm parasites are a major problem in small ruminants and cause disease, increase mortality and production losses.

Available prevention and control practice

The control of *helminthosis* is designed to eliminate or reduce the prevalence of helminthes and improve the productivity of the livestock industry. The eradication of helminthosis in animals is difficult and the aim of control is therefore to limit the infection by minimizing the challenge to an economically justifiable level. Effective control of helminthosis can be achieved by use of anthelmintic and good management (Kusiluka & Kambarage 1996).

Pathogenesis

The pathogenic effect of lungworms depend on their location within the respiratory tract, the number of infective larvae ingested, the animal immune state, and on the nutritional status and age of the host (Mitiku *et al.* 2017; Tesfaye *et al.* 2015). *D. filarial lives* in the trachea and bronchi so aspirated eggs, larvae and debris affect a large volume of lung tissue. It is therefore the most pathogenic species (Tewodros 2015). Adult *P. rufescens* are found in smaller bronchioles, so associated lesions are much smaller. *M. capillaris* is found in the lung parenchyma

where it becomes encysted in fibrous nodules; lesions are therefore confined to its immediate surroundings. Consequently, this worm is generally considered to involve heavy mixed *protostrongyloid* infection and impair pulmonary gaseous exchange (Bekele and Shibiru 2017).

Severe infection with lungworm can cause vasculitis and perivasculitis with infiltration of inflammatory cells in and around the vascular wall and thickening of interalveolar walls and mononuclear cell infiltration due to inflammation response in lung (Bekele and Shibiru 2017). Migrating *D. viviparous* larvae provoke little damage until they reach the lungs. Thereafter, passage of larvae up the bronchioles causes them to become blocked by mucus, eosinophils and other inflammatory cells, leading to collapse of the alveoli that they supply. Coughing and dyspnea occur if a sufficiently large volume of lung tissue is affected (Nashiruddullah *et al.* 2007).

Life Cycle

The life cycle of small ruminant Lungworms have two forms, direct and indirect. Direct form of life cycle is accompanied by Dictyocaulidae (D*ictyocaulus filaria)* in which the free living larvae undergo two moults after hatching and infection are by ingestion of the free L_3. The other form is indirect life cycle (Protostronglidae) whereby the first two moults usually take place in an intermediate host (snails or slugs) and infection of the final host is by ingestion of intermediate host (Tewodros 2015; Adem 2016).

Adult Dictyocaulus species found in the trachea or bronchi where eggs are produced. The eggs are coughed up and swallowed. Hatching of eggs occur in their air passages or in the intestines and it is the L_1 which is found in host faeces (Anmaw, *et al*. 2015). Under suitable conditions of temperature and moisture, the L_1 hatches into L_2 and L_3. Infection is acquired through ingestion and the L_3 migrate through the intestinal wall and enter the mesenteric lymph nodes where they moult into L_4. The L_4 passes through lymphatic and venous circulation to the heart and then through pulmonary circulation to the lungs where they enter the alveoli. Maturation occurs in the bronchi or tachea and the mature worms start to produce eggs (Kasiluka and Kambarage 1996).

Clinical Finding

The clinical course of lungworm infection depends on severity of infection, age and immunological status of the animal (Adem 2016). Signs of lungworm infection can range in many cases from moderate coughing with slightly increased respiratory rates to severe persistent coughing and respiratory distress and even failure (Tamire and Mohammed 2013). Reduced weight gains, reduced milk yields, and weight loss accompany many infections in cattle, sheep, and goats, and patent subclinical infections can occur in all species (Adem, 2016). The most common sign in sheep and goats are pyrexia, coughing, rapid shallow breathing, nasal discharge, and emaciation with retarded growth (Adem 2016; Chakraborty *et al.* 2014). Initially,the animals experience the sign of rapid, shallow breathing which accompanied by a cough that is exacerbated by exercise

Differential diagnosis

Lung worm infection can be mistaken for pneumonia or pasteurella infection, and as a result, lung worms go untreated. Coughing without any fever usually indicates lung worm infection (ESGPIP 2008).

Diagnosis

The factors that suggest lungworm infection are a history of exposure to previously grazed pasture by animals of the same species, the presence of the disease in the area and failure to respond to standard treatments to bacterial or viral pneumonia (Soulsby 1986; Adem 2016).

Diagnosis can be based on the clinical signs and grazing history. The disease occurs typically in young at the grass for the first time when all members of a group may be affected to some degree that leads to pasture contamination. Usually, the clinical signs, the time of the year and a history of grazing on permanent or semi-permanent pastures are sufficient to enable a diagnosis to be made (COWS 2014).

In laboratory, 25 gram of fresh faeces will be weighed from each sample for the extraction of L_1 larvae using modified Baermann technique. The paste enclosed in gauze fixed on string rod and submerged in clean glass tube filled with fresh water. The whole apparatus will be left for 24 hours. The larvae leave the faeces and migrate through the gauzes and settle at the bottom of the glass. After siphoning of the supernatant, the sediment is examined under the lower power of the microscope (Alemu 2006).

Examination of sputum for eggs and larvae is rapid and sensitive, and the presence of patent infections can often be detected one or two days earlier than with fecal examination (COWS 2014).

The larval identification of small ruminant lungworm takes place based on their morphological characteristics. The diagnosis of *Protostrongylus rufescens* is confirmed by larvae found in the feces which elongate 300 to 400 micrometers with a characteristic tapering tail and a wavy outline but without dorsal spine, and that of *M. capillaries* (250 to 300 micrometers long) is also confirmed in the feces with its characteristic tapering and a wavy ouline tail and a dorsal spine and larva of *D. flarie* (550-585 µm in length) could be identified by having head with protruding knob, bluntly pointed tail and brownish intestinal granules (Adem

2016).

Postmortem Examination

Lungs from selected animals were palpated for the presence of *Protostrongylidea* nodule. If the nodule present they were trimmed off and worms extracted from the tissue by gentile comprising a small non-calcified nodule or part of large nodule between two glass slides and then carefully testing the worm away from the tissue (Kadi *et al.* 2017). Air passages were opened starting from the trachea to the small bronchi with fine blunt pointed scissors to detect the presence of adult *Dictyocaulidae* (Wolde and Mersha 2016). At necropsy, most lesions are found in the respiratory system. With infection by *D. filaria*, the bronchi, especially those of the diaphragmatic lobes, contain tangled masses of worms mixed with frothy exudates. Infestation of goats by *M. capillaris* leads to a diffuse infection quite different to the nodular reaction in sheep and to the production of an interstitial pneumonia (Adem 2016)

Veterinary Importance

Lung worm infection causes one of the significant losses in productivity of ruminants and up to half of all sheep deaths and morbidity on farms in Ethiopian highlands are caused by pneumonia and endoparasites (Mekuria and Tefera 2016).

Lungworms are parasitic nematodes known for infection of the lower respiratory tract, characterized by respiratory distress, trachitis, bronchitis and pneumonia (Kadi *et al.* 2017). The lungworm have a pathogenic effect based up on their location within the respiratory tract, the number of infective larvae ingested, the animals immune state, and on the nutritional status and age of the host (Fraser 1991). Inflammatory processes spreads to the surrounding per bronchial tissues and the exudates passes back into bronchioles and alveoli causing atelectasis and catarrhal pneumonia (Soulsby 1986). The young larvae passing through the intestine may irritate the mucosal and cause diarrhea. *D.filaria* is the most pathogenic of sheep and goats lungworm (Kimberling 1988).

Treatment

There are only a few drugs approved to treat parasites in sheep and goats. According to Adem (2016) effective drugs currently approved for use in sheep and goats for treatment of lung worm are *Albendazole, Ivermectin* and *Levamisole. Levamisole* hydrochloride and ivermectin is active against gastrointestinal and lungworm (Adem 2016; Janquera,2014).

Control and Prevention

The objective of prevention and control can be achieved most effectively by integration of three interrelated approaches of anthelmintic drugs, immunization and improved management practice (Howard 1993; Tewodros 2015). The management system and keeping the animal good body conditioned are also very important to control lungworm infection (Adem 2016).

Extinction of the snail intermediate host is an additional measure important for the control of *Metastrongyloidea*. The snails creep up plants in the early morning and evening and rainy weather, the animals should, therefore, not be allowed to graze at such times, particularly in the autumn when the infection most frequently occur (Soulsby 1986; Regassa 2004).

In Ethiopia, relatively best method to control and prevention is to graze young stock in advance of older stock especially in the rainy season since the susceptibility of animals varies with age and using cut and carry feeding systems can significantly limit worm infestation (Adem 2016).

Conclusion and Recommendations

Small ruminant is economically very important animal which sometimes considered as immediate source of cash for smallholder family. Lungworm of small ruminant is widely distributed in Ethiopia and affecting this economically most important animal. Diseases of small ruminants were mainly caused by nematodes of round worm which belong to the phylum Nemathelmenthes. They have two classifications: Trichostrongyloideas and Metastrongyloideas. Among these, *Dictyocaulus* and *Protostrongylus* are causes of lungworm infection in ruminants. The respiratory nematodes, *Dictyocaulus filaria, Muellerius capillaris* and *Protostrongylus rufescens,* are the species of lungworms most commonly affecting small ruminants. Dictyocaulus filarial has a direct life cycle while the Muellerius and Protostrongylus have indirect life cycle. Lungworm distribution is mainly based on climate of an area, rain fall or marsh and intermediate host snail and slug, so the infection is more common during rainy season. Goat is more susceptible than sheep for lungworm because it is less infected due to its grazing behavior. Commonly, female animals, young animals of less than one year of age, poorly conditioned animals, and those managed under extensive system of production are more prone to lungworm infection. It highly damage lung, bronchi and bronchioles and mostly present clinical sign like pyrexia, coughing, rapid

shallow breathing, nasal discharge, and emaciation with retarded growth, may be up to sever respiratory distress and failure. Diagnosing methods is carried out by history and clinical signs manifested followed by examination of fecal exam for the presence of larvae. The available antihelmintics for treatment of lungworm are *Albendazole*, Ivermectin and Levamisole. Treatment is not sufficient for control and prevention but treatment with grazing management and its usage as prophylactic treatment before the onset of infective season is the most important method to control lungworm infection. Grazing young stock in advance of older stock, rotational grazing, decreasing overcrowding, separating sheep and goat stock and regular deworming before and after rainy season are best management practice to control and prevention of lungworm in Ethiopia. Based on the above conclusion the following points are forwarded:

- Proper diagnosis and treatment should be given for sick animal
- Awareness creation must be put forward to small ruminant keepers to keep their animals
- Awareness should be given for farmers about lung worm effect by veterinarian.

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