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Prevalence, Circulating Species and the Associated Risk Factors of Ovine Lungworm Infection and Financial Loss In and Around Assela Town, Southeast Oromia, Ethiopia

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Abstract

A cross-sectional study was conducted from November 2021 to April 2022 with the objectives of determining the prevalence of lungworm infection by coproscopic and postmortem examination, associated risk factors, and identification of the species parasite in fecal examination and financial losses due to ovine lungworm in and around Assela town. The number of investigated animals were 380 for coprology and 170 for post-mortem examination. The overall prevalence was 45.52% and 49.41% were found by coprological and post-mortem examinations respectively. Age, sex, and body condition were taken as risk factors for the occurrence of lungworm infection. There was a significant difference ($p<0.05$) in the infection among the sex group, respiratory signs and body condition of sheep. However, the rest risk factors like age and management system of animals were not found to have a significant statistical association with the occurrence of lungworm infection ($P > 0.05$). *Dictyocaulus filaria, Muellerius capillaries* and *Protostrongylus rufescens* were identified as single and mixed infections. The prevalence of infection by *D. filarial* was high and *Protostrongylus rufescens* has the lowest one. The direct and indirect annual financial loss incurred due to lungworm infection in Assela municipal abattoir was estimated at 7,650,373 Ethiopian Birr (US$ 148,263). In conclusion, our work revealed that ovine lungworm is a common problem that affect the health and productivity of sheep in the study area; hence an appropriate control and prevention intervention should be carried out to reduce the losses associated with the parasite.

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Cross-Sectional Study, Lungworm, Prevalence, Risk factor, Ovine, Assela.

Introduction

Small ruminants in Africa are noted for their ability to convert low-cost feed into high-value products, namely: meat, milk, fiber, manure, and hides (31). In the Horn of Africa and especially in Ethiopia where the economy is predominantly agriculture-based, sheep and their products play a critical role in the livelihood of millions of farmers and pastoralists (45). Lungworms are parasitic nematode worms of the order Strongylida that infest the lungs of vertebrates. The most common lungworms belong to one of two groups, the super family Trichostrongyloidea or the super family Metastrongyloidea (25). Among ovine lung worm parasites *Dictyocaulus filarial* is the most predominant lungworm species, followed by *mulleries capillaries* and *Protostrongylus refescens* is the least prevalent (24). The life cycle of ovine Lungworms have two forms, direct and indirect type. Direct form of life cycle is accompanied by *dictyocaulidae* and the indirect form of

life cycle is accompanied by *metastrongiloidae* (38). The signs of lung worm infection (verminous pneumonia), range from moderate coughing with slightly increased respiratory rates to sever persistent coughing (12). The three respiratory parasites that cause significant damage in sheep production are *D.filaria, P.rufescens,* and *M.capillaries* but the disease caused by the genus Dictyocalus has more economic importance (44).

The pathogenesis of lungworms depends on their location within the respiratory tract, the number of infective larvae ingested, the animal immune state, the nutritional status, and the age of the host (12). 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 inflammatory response in the lung, the effect is known as verminous pneumonia (10).

The signs of lungworm infection (verminous pneumonia), range from moderate coughing with slightly increased respiratory rates to sever persistent coughing, Unthrifitness, dyspnea, nasal discharge, weight loss, in case of associated bronchopneumonia, also fever, and death are important clinical signs. Usually, the clinical signs, epidemiology, and the history of grazing are sufficient to make the diagnosis (8). The common anthelmintics available for the treatment of lungworms arealbendazole, levamisole, and ivermectin (38).

The production loss is a direct result of clinical and subclinical helminths infections resulting in low productivity due to stunted growth, insufficient weight gain, poor feed utilization, and mortality and indirect losses associated with treatment and control costs (4); (34)). Ethiopia has huge sheep population, estimated at 30.70 million heads, is found widely distributed across the diverse agro-ecological zones of the country (9). Unlike the large population and the importance of sheep in the country, their productivity is low. This low productivity is reflection of animal diseases, poor nutrition, poor animal production system, and a general lack of veterinary care (35).

The livestock sector in Ethiopia plays a significant role in the national economy. It contributes 15-17% and 35-49% of the total and agricultural Gross Domestic Product (GDP), respectively, and provides a livelihood for 37-87% of the population (9). The morbidity of animals generally estimated to be in the range of 8-10% of national cattle herd per annum and 14-16% and 11-13% of national sheep and goat flock respectively with average live weight loss of 70kg for cattle and 6kg for sheep and goat (14). About half of all sheep mortality and morbidity on farms in Ethiopian highlands are caused by pneumonia and endoparasitism including lungworms (22); (3).

The prevalence of lungworm infection of small ruminants depends on different factors like the climate of an area, altitude, intermediate hosts and favourable ecological conditions such as rainfall, humidity, temperature, and marshy area for grazing, sheep, and goat management system for the development of lungworm species (24). Lungworm parasites are host specific and common in areas of mild high rainfall and abundant grass (29). They are an important problem for sheep breeders throughout the world (17).

The previous finding of lungworm infections reported in different parts of Ethiopia by (27) 57.1% in Tiyo; (32) 55.2% in Assela; (32) 54.16% in DebreBirhan; (50) 43% in Eteya. Although the disease seems important, there is a shortage of information on current status and magnitude of the disease on the study area.

Therefore, this research aimed to determine the current prevalence of lungworm infection and identify the circulating lung worm species and associated risk factors of lungworm in the study areas with determining financial loss.

Materials and Methods

Study Area

This study was conducted in and around Assela town which is the capital of the Arsi zone in Oromia region, Ethiopia. Asella town is located 175 km southeast of Addis Ababa. The town is characterized by mild subtropical weather with the maximum and minimum temperature of 18 and 5 °C, respectively.

The annual rainfall ranges from 1300 to 1500 mm (23). Assela is situated at 6◦ 59' to 8◦ 49' N latitudes and 38◦ 41' to 40◦ 44' E longitude in Central Ethiopia. The area covers 23674.72km² presenting only 2% of the total land surface of the country. Topographically, Asella province has high land escarpment and lowland areas. Vegetation of the area changes with altitude and rainfall ranging from scattered trees and bushes to dense shrubs and bushes. Livestock are the major agricultural resources in the area and has livestock population of 74,141 cattle,

43,306 sheep, 11,864 goats, 2, 849 horses, 13,262 donkey, 160 mule and 63,265 poultry (9). Assela town have 8 kebeles called as kombolcha, hundegudina, welkessa, halila, chilalo, burqitu, hanqu, and busseta. From these 5 kebeles (kombolcha, welkessa, halila, chilalo, and burqitu,) were included in to study and also those kebeles (Lalocheka, konicha, and Dosha) around the town were included.

Study population

The study was conducted on local breed ovine species. The study population comprised of sheep at different sex, age, and body condition category. Age (<1 year (young), between 1 and 3 years (adult), and >3 years (old)), body condition score (poor, medium, and good) of sheep will a determination based on the method used by Gaten (16).

The data collection was achieved through discussion with the animal owners in each kebeles or sites and with the assistance of district Agricultural offices, animal health professionals, and other concerned bodies.

Study Design

Cross-sectional study was conducted from November 2021 to April 2022 to establish the prevalence and associated risk factors of lungworm infection in ovine species and its financial loss in sheep farming.

Sample Size and Sampling Methods

Simple random sampling technique was used for coproscopical examination and systemic simple random for abattoir survey. The minimum sample size required for the study was determined using a formula recommended by (42). Accordingly, 95% confidence level, 5% desired absolute precision and an expected prevalence of 55.1% from the study conducted by (26) and 60.5% from the study conducted for fecal and postmortem examination taken, respectively. To calculate the sample size the following single proportion formula was used.

$n = 1.96^2 x Pexp (1-Pexp)/d^2$

Where n=required sample size, Pexp=expected prevalence, d^2=desired absolute precision. Hence, with a 55.1% and 60.5% expected prevalence, 95% confidence level and 5 % precision, the sample size calculated to be 380 and 367, respectively. However, due to the limitation of time and low number of slaughtering sheep due to fasting time only 170 samples was collected from the abattoir survey.

Study methodology

Faecal sample collection

Fresh fecal samples was aseptically collected per rectum from individual sheep and stored in a sampling bottle and immediately transferred to Assela regional veterinary laboratory. At the time of sample collection, necessary data was recorded including age, sex, body condition, site, owner name and management system to avoid bias, particularly re-sampling. In the laboratory, isolation of lungworm from feces of sheep was performed by using the modified Baerman technique as described by (7).

Modified Berman technique

In the laboratory, faecal sample examination for the presence of L1 larvae was conducted using modified Baermann technique. Briefly, 5gm to 10gm of fresh fecal material was wrapped in double-layered gauze and suspended in a beaker containing warm water using a clip wire (a graph). The feces were partially immersed in the warm water and allowed to stand for 24 hours. Then after 24 hours the wrapped feces were removed and the supernatant discarded from the beaker, the sediment was transferred to watching glass or Petridish of L1 larva under a microscope.

The sediment was examined under a microscope with low power of magnification to identify the species of lungworms (7). Difference in morphological features of larvae (L1) is important for identification of the parasite. The larvae (L1) of *Dictyocaulus filarial* is differentiated from the other two lungworms by having a characteristic cuticular knob at an anterior extremity, large size, and blunt tail and intestinal inclusions on larvae (L1).

While the larvae of *Protostrongylus rufescens* and *Muellerius capillaries* were differentiated by their characteristic features at the tip of their tails. The L1 of *P. rufescens* and *M. capillaries* had a small size, absence of anterior cuticular knob; additionally, L1 of *M. Capillaries* possesses dorsal spine at pointed wave tail, but L1 of *P. rufescens* has no dorsal spine (18)

Abattoir survey

A pre-slaughter examination of study animals was conducted with recording age, sex, body condition of

each animal and their identification number. Soon after slaughter, the lungs along with the trachea were removed and put on a clean metallic tray. Each lung from study animals was inspected by incising it starting from trachea down to bronchi and bronchioles and then making multiple deep incisions of the lobes with several small sub cuts.

They were first inflated with running water during which time the minute alveoli broke down and liberated the maximum possible number of worms in cases of positive samples. In the presence of the nodules, it were trimmed off and worms extracted from the tissue by gentle compression of small non-calcified nodules or part of large nodules between two glass slides and then the adult lungworm were drawn away from lung tissues with a thumb forceps.

Financial Loss Assessment

The financial losses due to lungworm infection in slaughter sheep was determined by taking the average number of condemned lungs and carcass weight loss.

The mean price of one lung and one kilogram of meat in town was taken and used to calculate annual financial loss. The average carcass weight loss in the individual animal due to lungworm infection is 6kg. Therefore, the total annual financial loss due to lung condemnation and carcass weight loss was estimated by using the following formula.

AFLLI = (ANCL *ACL) + (NSSLW * AMPM *Z)

Where,

AFLLI = Annual Financial Loss due to Lungworm Infection

ANCL = Average number of condemned sheep lungs at Assela municipal abattoir

NSSLW = No of slaughter sheep identified with lung worm infection

ACL = Average cost of one sheep lung Assela town

AMPM = Average market price (cost) of 1 kg meat in Assela town

Z = carcass weight loss in individual animal because of lungworm infection (6 kg)

Using the above formula, the direct (lung condemnation) and indirect (carcass weight reduction) financial loss due to lungworms estimated by summation of average annual condemned lung and carcass weight reduction by average cost for each items.

Data management and analysis

All data collected at different stage was entered into a Microsoft Excel spread sheet, checked and coded and then analysed using STATA statistical software. Descriptive statistics like mean, standard deviation, count and percentage will be used to express the findings.

Association between various risk factors (such as sex, age, origin, body condition score…etc) and the prevalence of the different disease conditions/lesions will be determined using a chi-square independent test. In all the analyses significance was set at $p < 0.05$.

Results and Discussion

Coprological examination result

Overall prevalence

From 380 randomly selected sheep using a modified Baerman technique revealed an overall lungworm prevalence of 173 (45.52%). The most common species in this study was *D. filarial* 80 (21.05%), followed by *M. capillerius* 67 (17.63%), Mixed infection 17 (4.47%), and *P. rufescens* was found the least prevalent with 9(2.36%).

Prevalence of lung worm species with sex

Sex was considered as risk factor of ovine lungworm infection and encountered result reveal lungworm infection was much less common among males than females as there were 125/255 (49.1%) and 48/125 (38.4%) positive for L1 larva in their feces of lungworm infection in females and males respectively. Statistically, there was significant difference between the occurrence of disease and sex ($P < 0.05$).

Prevalence of lungworm species with different age groups

Regarding age, among the studied sheep, 64 of them were young as they were all less than one year of age, 262were adults age between one and three years while

remaining 54 sheep with greater than or equal to three years were considered in the old category. The majority of the infections occurred in the old age group 57.38% (31/54) than adult and young 44.26% (116/262) and 40.61% (26/64) respectively. Age with lungworm infection was not statistically significant (P>0.05).

Prevalence of lungworm species with different body condition groups

Sheep with poor body condition were more frequently positive for lungworm infection than the corresponding sheep with medium and good body condition, 57.15% (64/112), 50.6% (38/75) and 31.61% (61/193) respectively and the difference was statistically significant (p<0.05).

Prevalence of lungworm species in relation to respiratory signs

Presence or absence of clinical respiratory signs was evaluated for prevalence of lungworm infection, 136 animals were clinically positive for respiratory sign from them 82.5% were positive for lungworm infection.

And the animals that hadn't respiratory sign apparently healthy animals but positive for lungworm infection were 25% (61/244). The statistical analysis showed that, there is significant difference in lungworm infection rate between animals with respiratory signs and the apparently healthy animals.

Prevalence of lungworm species with management system

The management system was assessed for occurrence of ovine lungworm infection and higher prevalence rate (83.2%) was recorded in extensive management practice, however, there was no statistically significant difference between occurrence of the disease and management system.

Postmortem result

In the current study, a total of 170 slaughtered sheep in the Assela municipal abattoir were examined 84(49.41%) were found positive for lungworm infection, of which 53/109(48.62%) were female and 31/61 (50.81%) were male. The observed proportion between the sex was not statistically significant (P > 0.05). Also, the majority of the infections occurred in the young age group 62.79% (27/43) than old and adult 47.36% (9/19) and 44.44% (48/108) respectively.

Age with lungworm infection was statistically significant (P<0.05). Although body condition of sheep was considered as risk factor and encountered as poor body condition were more frequently positive for adult lungworm parasite than the corresponding sheep with medium and good body condition, 62.90% (39/62), 47.72%(21/44) and 37.5%(24/64) respectively and the difference was statistically significant (p<0.05)

Prevalence of lungworm species

Prevalence of different species of lungworms of sheep in Coprology examination technique

The most common species in this study was*D.filarial*80 (21.05%), followed by *M. capillerius* 67(17.63%), Mixed infection 17 (4.47%), and *P. rufescens* was found the least prevalent with 9(2.36%)

Compression of prevalence in Coprology and Post-mortem examination techniques

In this study, the prevalence of lungworm was found to be higher in the postmortem examination (49.1%) when compared to the coprology examination (45.52%).

Financial loss analysis

The total financial loss due to lungworm infection was calculated using the following formula:

• Direct annual estimated value of condemned lung = NAL x CL x Prev. in the abattoir,

Where NAL= Average number of sheep slaughtered at Assela municipal abattoir; CL = Mean cost of one lung in Assela town; Prev. = Prevalence of lungworm in the abattoir.

= 5682 x 25 Birr x 49.41%

= 70,187 Ethiopian Birr (US$ 1,360)

• Indirect annual due to number of slaughter sheep identified with lungworm infection = NAL x Zx PA x Prev. in meat production, where: NAL = Average number of sheep slaughtered in the Assela municipal abattoir per year; Z= Carcass weight loss in individual animals due to lungworm; PA =Average market price of

one kilogram of sheep meat in Assela town; Prev. = Prevalence of lungworm in the abattoir

= 5682 x 6 x 450 Birr x 49.41%

= 7,580,186 Ethiopian Birr (US$ 146,903)

The total annual financial loss due to lungworm in the Assela municipal abattoir of the study area is therefore; 7,650,373 Ethiopian Birr (US$ 148,263).

The present study revealed the prevalence of lungworm with an overall infection rate of 45.52% by coproscopic examination in sheep. This finding agrees with the previous study was done by (6) reported 45.7% in South Wollo and (49) in North Ethiopia (46.6%). It was higher than the finding of (5) who reported a prevalence of 18.3% from in and around DebreBirhan town, (41) who reported a prevalence of 15.5% in MinijarShenkoraWoreda, North Shoa, Ethiopia, (48) who reported a prevalence of 17.5 in around Bahir-Dar Town, Northern Ethiopia.

However, current finding was lower than the results of other surveys in sheep carried out by (40) who reported prevalence of 54.88% in Assela, by (13) who reported prevalence of 72.44% in Assela province and by (21) who reported a rate of 56.5% in Goba district. This difference could be due to the establishment of an open-air clinic in rural kebeles, increase the number of the private veterinary pharmacy, increase farm awareness to de-worm their sheep, differences in the methods followed in the detection of larvae of lungworm, the difference in the study areas which favours the survival of the larvae of the lungworm or the snail intermediate host in case of *P. rufescens* and the different sample sizes used by the researchers. It might also be associated with nutritional status, level of immunity, management practice of the animal, rainfall, humidity and temperature differences, and season of examination on the respective study area.

Regarding age, higher prevalence of lungworm infection was observed in the groups of old (57.38%) as compared to age groups of adult (44.26%) and young (40.61%). The difference was not statistically significant ($p > 0.05$) result agrees with that of previous studies by (2), (30) and (40) where the infection tended to increase with increasing of age. This may be due to more number of samples taken from adult small ruminants and due to the nature of the parasite which was most prevalent in the present study that it needs an intermediate host. Also, this variation could be related to the adult animals moving long distance for searching for feed which leads to exhaustion and loss of immunity /body condition that potentially increase the susceptibility of animals. Disagree to these reports (27), (3), and (51) reported that susceptibility to lungworm infection decreases when the age of animals increases. Prevalence of 49.1% and 38.4% was recorded in female and male animals respectively. There was also statistically significance difference ($P<0.05$) between the two sexes indicating female animals are more susceptible to lungworm infection than males. Similar results that support the present finding were reported by (47), (36), (33) and (2). However, some workers found that there was no sex variation (2), (27) and (40). In this work most males are kept for fattening to be sold later, thus, males receive more attention by farmers. The high prevalence in females could be due to the fact that resistance to infection is decrease at the time of parturition and during early lactation in the female animals. This pre parturient relaxation of resistance results in the female's inability to expel adult worms which causes a higher level of larvae detection (29). The other possible reason could be the dominance of the numbers of females over males. This variation in sample size between females and males might have caused such a difference in prevalence.

Regarding species of lungworm, a higher prevalence of *D. filarial* infection was recorded in sheep followed by *M. capillaries* and mixed infections. Whereas; *P. rufescens* was the least prevalent in Coprological examination. This result in line with the previous reports of (32) in Debra Birhan; (48) around Bahir-Dar and (41) in MinijarShenkoraWoreda, North Shoa, Ethiopia. In contrast, *M. capillaries* were prevalent in different parts of the country in a different period as reported by (40) in Assela Municipal Abattoir; (50) in and around Eteya Town and (2) in northeastern Ethiopia. This might be associated with the difference in the life cycles. *D. filarial* has a direct life cycle and takes less time to reach the infective stage and after ingestion, larvae can appear in the feces within 5 weeks (37). While *M. capillaries* and *P. rufescens* have indirect life cycles with land snails and slugs acting as intermediate hosts. Therefore, their geographical distribution and prevalence are mainly determined by the distribution of the intermediate hosts, which in turn is affected by the availability of suitable environmental conditions (29). Concerning body condition, variation among body condition was statistically significant among different body condition scores of those animals ($P<0.05$) in both Coprological and post-mortem examinations.

Table.1 Prevalence of lungworm species with sex

Risk factor	Lungworm species				
Sex	*D. filarial*	*M. capillaries*	*P. rufescens*	Mixed	Negative
Female	51(20.01%)	51(20%)	9(3.52%)	14(5.49%)	130(50.98%)
Male	29(23.2%)	16(12.8%)	0	3(2.4%)	77(61.6%)
Total	80(21.05%)	67(17.63%)	9(2.36%)	17(4.47%)	207(54.47%)

Pearson chi2=10.8131 p-value=0.029

Table.2 Prevalence of lungworm species with different age groups

Risk factor	Lungworm species				
Age	*D.filaria*	*M.capillaries*	*P.rufescens*	Mixed	Negative
Old	8(14.81%)	16(29.62%)	2(3.7%)	5(9.52%)	23(42.59%)
Adult	57(21.75%)	45(17.17%)	6(2.29%)	8(3.05%)	146(55.72%)
Young	15(23.43%)	6(9.37%)	1(1.56%)	4(6.25%)	38(59.37%)
Total	80(21.05%)	67(17.63%)	9(2.36%)	17(4.47%)	207(54.47%)

Pearson chi2=14.88295 p-value=0.061

Table.3 Prevalence of lungworm species with different body condition groups

Risk factor	Lungworm species				
Body conditions	*D.filaria*	*M.capillaries*	*P.rufescens*	Mixed	Negative
Good	27(13.98%)	26(13.47%)	4 (20.72%)	4(20.72%)	132(68.39%)
Medium	22(29.3%)	10(13.3%)	3(4%)	3(4%)	37(49.3%)
Poor	26(23.21%)	26(23.21%)	2(1.78%)	10(8.92%)	48(42.85%)
Total	80(21.05%)	67(17.63%)	9(2.36%)	17(4.47%)	207(54.47%)

Pearson chi2=38.8009 p-value=0.000

Table.4 Prevalence of Lung Worm Infection in Relation to Respiratory Signs

Risk factor	Lungworm species				
Clinical respiratory signs	*D.filaria*	*M.capillaries*	*P.rufescens*	Mixed	Negative
Detected	55(40.44%)	40(29.41%)	2(1.47%)	15(11.02%)	24(17.64%)
Not detected	25(10.24%)	27(11.06%)	7(2.86%)	2(0.81%)	183(75%)
Total	80(54.47%)	67(17.63%)	9(2.36%)	17(4.47%)	207(54.47%)

Pearson chi2=128.2897 p-value=0.000

Table.5 Prevalence of Lung Worm Infection in Relation with management system

Risk factor	Lungworm species				
Management system	*D.filaria*	*M.capillaries*	*P.rufescens*	Mixed	Negative
Extensive	67(22.11%)	55(18.15%)	6(1.98%)	16(5.28%)	159(52.47%)
Semi intensive	13(16.88%)	12(15.58%)	3(3.89%)	1(1.29%)	48(62.33%)
Total	80(21.05%)	67(17.63%)	9(2.36%)	17(4.47%)	207(54.47%)

Pearson chi2=5.2508 p-value=0.263

Table.6 Prevalence of lungworms based on major host related risk factors of sheep in PM examination techniques

Risk factor	Result of intact lung incision for lungworm during PMI				
		No .examined sheep	Positive	X^2	P-value
Age	Young	43	27(62.79%)	4.1770	0.124
	Adult	108	48(44.44%)		
	Old	19	9(47.36%)		
Sex	Female	109	53(48.62%)	0.0754	0.784
	Male	61	31(50.81%)		
Body condition	Poor	62	39(62.90%)	8.1975	0.017
	Medium	44	21 (47.72%)		
	Good	64	84(49.41%)		

Table.7 Prevalence of different species of lungworms of sheep in Coprology examination technique

Lungworm species	Number of positive animals	Prevalence%
D.filaria	80	21.05
M.capillerius	67	17.63
P.rufescens	9	2.36
Mixed	17	4.47
Total	173	45.52

Table.8 Compression of prevalence in Coprology and PM examination techniques.

Examination techniques	Number of examined	Number of positive	Prevalence %
Coprology	380	173	45.52
Post-mortem	170	84	49.41

The parasites were more common in poor body condition than in medium and good body conditions. This finding agrees with the reports of (41), (49) and (1), they all reported higher prevalence rate in animals with poor body condition but the study disagrees with the findings of (11) who reported higher prevalence rate in animals with good body condition. The possible explanation for this difference could be due to poor body conditioned animals are easily exposed to infectious and non-infectious diseases than medium and good body conditioned animals.

Because of these and other related reasons, their immune system becomes suppressed and less competent on feeding than medium and good body conditioned animals and hence they faced to a problem in tolerating and getting rid of the lungworm larvae this may be followed by malnutrition and concurrent infections like other gastrointestinal nematodes or infectious diseases like bacterial infections. Poorly nourished sheep appear to be less competent in getting rid of lungworm infection and the infestation with a parasite by itself might result in progressive emaciation of the animals (39).

In the present study, the prevalence of lungworm infection in sheep obtained by coproscopic and postmortem examination was 45.52% and 49.41%, respectively. This higher prevalence in postmortem examination agrees with the finding of Asaye and Alemneh, in and around Bahirdar city, Tigist in North and South Gondar, Teketel and Alemu in Assela Municipal Abattoir who reported a higher prevalence in postmortem than Coprological (43), (3) and (40). However, the current result disagrees from that of Sissay A in Bahir Dar and Paulos A in Arsi (Chilalo) who reported as higher prevalence in fecal than post mortem examination (36), (28). One of the probable reasons attributed for such difference in the present finding could be related to the worm nodules of the *Protostronglidae.* In *Muellerius capillaris,* those larvae which reach the

lungs of small ruminant remain in the parenchyma and become encysted in fibrous nodules and because such nodules might not contain adults of both sexes, fertile eggs could not be deposited in the air passages. For this reason, the number of larvae in the feces is often not indicative of the degree of infestation; however, these nodules could be detected during postmortem examination (29). Again as stated in (15), the prepatent, post-patent phase or hypobiosis might also affect the detection of larvae by fecal examination. The slightly higher infection rate observed on postmortem examination as compared with coprological examination might be related to these worm nodules detected in investigated lungs. In addition to the above reason, it was impossible to detect the parasite of *Protostronglidae* by fecal examination in prepatent, post-patent phase, or during hypobiosis. Furthermore, egg-laying adult female parasites might be inhibited by the immune reaction of the host. The result was in total agreement with those described by (19) and (15).

Lungworm infection in sheep results in huge economic losses as it increases mortality increases farm inputs via increased treatment expenses and cause a reduction in growth rate and possibly weight loss during and after the period of parasitic disease outbreaks. In doing so a sum of money amounting 70,187 Ethiopian Birr (US$ 1,360) was lost due to lung condemnation and7, 580,186 Ethiopian Birr (US$ 146,903) as a result of a reduction in meat production with a total loss of 7, 650,373 Ethiopian Birr (US$ 148,263). annually due to lungworm infection. Financial loss analysis reported from other parts of the country by (6) in south wollo 7445549.96ETB (402462.16, USD (1USD=18.50 ETB) who reported the total annual financial loss due to lungworm, (46) and (20) at Addis Ababa abattoir enterprise who reported the total annual financial loss 8760 and 5438USD per annum in small ruminants due to different major parasitic diseases, respectively. These results showed that lungworm cause significant loss in different parts of Ethiopia. Considering the prevalence of the disease and its economic significance in different parts of the country, one can strongly conclude that lungworm is one of the most important sheep parasitic diseases which impose huge carcass condemnation.

Conclusion and Recommendations

The result of this study showed that lungworm is one of the major helminthiasis of sheep in and around Assela town, which is affecting the health and production performance of sheep in this area. The Coproscopic and postmortem examination of the present study revealed that 45.52% and 49.41% of the examined sheep were infected respectively with *D. filaria*, *M. capillaries*, and *P. rufescens* as or mixed infection of the three species of lungworms. The prevalence of lungworm infection is higher in females, in animals with poor body condition but males and animals with good body condition were less infected with lungworm. Though this disease affects all age group animals it was found more prevalent in old age animals. This also indicated that *D. flaria* is the dominant lungworm species present in this study area. The probable reason for this is *D. filaria* has a direct life cycle compared with the transmission of *P. rufescens* and *M. capillaries* are epidemiologically complex events involving host, parasite, and intermediate host. The postmortem study demonstrated the significant economic impact of the disease, directly and indirectly, affecting sheep productivity.

Based on the above conclusion, the following recommendations are forwarded:

- ✓ Regular strategic deworming (at the end of dry season before the rain starts and after the long heavy rainy season) with effective anthelmintic of the whole flock rather than treating individual animals should be performed to decrease the occurrence of disease.
- ✓ The animal health extension service should also be launched to make the sheep owners aware of the disease for improvement of the economic benefits and productivity of their animals.
- ✓ Due to its impact on production, emphasis should be given for the control and prevention of lungworm infections.
- ✓ Further studies are needed to clarify issues regarding seasonal variations of lungworms in all domestic animals.

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