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The Prevalence and Associated Risk Factors of Small Ruminant Lungworm Infection in and Around Shashemene, Oromia, Ethiopia

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Abstract: A cross-sectional study were carried out from November 2018 to March 2019 in and around Shashemene, West Arsi, Oromia Regional States, Ethiopia to estimate the prevalence of lungworm infection in small ruminants, to assess associated risk factors in study area and to identify species of parasites involved by coprological examination. A total of 384 fecal samples were collected from randomly selected small ruminant (270 sheep and 114 goats) and examined for lungworm parasites. The modified Baerman techniques were implemented for the extraction of first stage larvae of lungworm. Out of 384 small ruminant examined 36 (9.4%) were found to be positive for one or more species of lungworm parasite. Lungworm species identified in small ruminant of the study area were *Dictyocaulus filaria* (5.5%), *Protostrongylus rufescens* (2.3%) and *Mullerius capillaries* (1.6%). Overall, 23(8.5%) sheep and 13(11.4%) goats were found infected with lungworms. Statistical significant difference was not observed in the prevalence of lungworm infection between sheep and goats (χ^2=0.785, p>0.05). Highest prevalence of lungworm was recorded in young animals (10.83%) than adult (8.71%). However, age wise prevalence was not statistically significant (χ^2 = 0.437, p > 0.05). Sex related lungworm infection did not have significant difference (χ^2=1.756, p>0.05) with 6.5% and 10.73% prevalence in male and female respectively. Significant difference on the prevalence between different body conditioned animal were recorded; in which higher value observed in poor body conditioned small ruminant (χ^2 = 6.015, P < 0.05). Generally, lungworm infection of the study area in small ruminant was low. However, lack of strategic seasonal deworming, poor management and husbandry practices may favors the increment of lungworm infection in the study area. Therefore, in order to increase profitability from small ruminants of the study area seasonal deworming, improved animal management and husbandry practice should be practiced.

Key words: Lungworm · Risk Factor · Prevalence · Shashamene and Small Ruminant

INTRODUCTION

Livestock production constitutes one of the principal means of achieving improved living standards in many regions of the developing world. In Sub-Saharan African countries, livestock plays a crucial role both in national economies and livelihood of rural communities [1]. It provides drought power, milk and meat, input for crop production and soil fertility and raw material for industry [2]. Ethiopia is a country of huge livestock resources of which small stock is an integral part of the system. The country owns an estimated population of 28.29 million sheep and 29.7 million goats which play an important role in the rural economy and enable the country to earn substantial amounts of foreign currency through export of skins and other byproducts [3].

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Agriculture is the mainstay of the Ethiopian economy. It employs over 80% of the adult population and account for 45% of the GDP and 85% of the export earnings. Livestock production performs several functions primarily as source of household incomes, food and animal drought power for livestock producers [4]. Small ruminant provide 33% of meat and 14% of milk consumption in Ethiopia [5]. In the central high lands where mixed crop-livestock production system is practiced, small ruminant account for 40% of cash income and 19% of the house hold meat consumption [6]. Yet these species have received much less attention from research and development agencies [7]. And the economic benefits to the farmers remain marginal due to prevailing disease, poor nutrition, poor animal production systems and general lack of veterinary care [2]. Among the diseases impairing small ruminant production and productivity parasitic infection is the most important of which lungworm infection is vital. Lungworms are widely distributed throughout the world but they are particularly common in countries with temperate climates and in the highlands of tropical and subtropical countries and it is common in Ethiopia [8].

Lungworm infection is also called Verminous Bronchitis or Verminous Pneumonia which caused by the three economically important species of lungworm of sheep and goats namely, *D. filaria, P. rufescens* and *M. capillaries* [8, 9]. The parasites are round worms (nematodes) belonging to the phylum Nemathelminthes and grouped under Metastrongyloidea or Trichostrongyloidea super families [10]. The larvae of *D. filaria* diffentiated form *P. rufescens* and *M. capillaris* by having characteristic cuticular knob at the anterior extremity, brownish intestinal granules, large size and blunted pointed tail [11, 12, 13]. The larvae of *P. rufescens* and *M. capillaris* differentiated from *D. filaria* by their small size and absence of anterior cuticuar knob, while *P. rufescens* and *M. capillaris* are differentiated from each other by their characteristic features, at the tip of their tail. *P. rufescens* has a wavey out line at the tip of its tail, but devoid of dorsal spine, on the other hand *M. capillaris* has an undulating tip and a dorsal spine [12, 14].

Prevalence of small ruminant lungworm is different based on geographical and climatic factors of spatial area. It is host specific and common in areas of mild high rain fall and abundant grass [13]. The prevalence of infection is low in spring and summer and rises rapidly in the autumn and winter [15]. According to Gelagay [16] lungworms particularly *D. filaria* can suppress the immunity of the respiratory tract. The pathogenic effect of lungworms depends on their location within the respiratory tract, the number of infective larvae ingested and the immune system of the animals [17].

In many cases, the clinical sign in infected animals can be less obvious than signs of other livestock diseases. However, in naturally affected animals clinical signs like reduced growth, loss of appetite, increase respiratory rate and coughing are usually observable [18]. The incidence of parasitic disease including respiratory helminthosis varies greatly from place to place depending on the relative importance of factors in Ethiopia and proper diagnosis, treatment, control and prevention of these parasites, therefore, critical to enhance the economic benefit from these species of livestock [19].

Helminth 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 with less obvious sign associate with poor production and unthriftness [10].

The production loss due to helminths is associated with direct consequences of clinical and subclinical infections resulting in low productivity due to stunted growth, reduced weight gain, poor feed utilization or loss due to mortality or indirect loss associated with cost of treatment and control measures [20].

In Ethiopia, the prevalence of lungworm infection in sheep and goats and the species of the parasite involved have been reported by many researchers such as [6, 8, 10, 19, 21-25]. According to these studies, the prevalence of lungworm infection in Ethiopia ranges from 13.4-73.25% in sheep and 26.5-62.7% in goats. Several studies have been done concerning the prevalence and economic significance of lungworm infection of small ruminants in Ethiopia. However, information on the status of lungworms of small ruminant in and surrounding of Shashemene was lacking.

Therefore the objectives of this study were;

- To estimate the prevalence of lungworm infection in the study area.
- To identify the species of the lungworms infecting small ruminant of the study area.
- To identify the associated risk factors of lungworms in small ruminant in the study area.

MATERIALS AND METHODS

Study Area: The study was carried out in and around Shashemene town. Shashemene is a town and separate woreda in West Arsi zone, Oromia Regional States, Ethiopia. It was about 250km from capital city, Addis Ababa and has latitude of 7°12' North and a longitude 38°36' East.Climatically, Shashemene district falls into three climatic zones known as Dega, Woinadega and kolla. Its altitude ranges from 1, 672 to 2, 722 meters above sea level. The temperature level ranges from 12-28°C and yearly rainfall varies from 1, 500-2, 000mm [26].

Study Animals: The study populations were small ruminant in and around Shashemene town. Small ruminant in the study area are kept under extensive traditional and semi-intensive management system. The age was categorized in to two groups (young and adult) based on the farmers' response and cross checked by teeth inspection and those sheep and goats with age less than two years were considered as young and greater or equal to two years adult according to Cringol*, et al.* [27]. Regarding to body condition, the animals categorized in to three groups (good, medium and poor) body condition according to ESGPIP [28]. All the study animals were local breeds. These animals are maintained in small house hold flocks of mixed age for subsistence and small scale private farms for sale. In the study area the number of goats is low compared to sheep population.

Study Design: Cross-sectional study design was implemented from November 2018 to March 2019 to addresses the objectives of the study obtained from four sites in and surroundings of Shashemene and animals were selected proportionally by using simple random sampling technique from these areas. The four sites were Faji, BishanGuracha, MelkaOda and Sole were selected from the study area. The variable of interest considered as an output variable versus risk factors during the study was fecal status for larvae for small ruminant lungworms.

Sampling Method and Sample Size Determination: The study area was selected purposively based on the information obtained about small ruminant lungworm studies conducted before, ecology of the study area, animal population and farmer's willingness. Likewise the study sites (Faji, Bishan Guracha, MelkaOda and Sole) and villages/kebeles from each site were purposively selected based on the willingness of the owner; but, households/flocks were selected randomly. Simple random sampling technique was employed to include sampling unit (each animal) from each flock.

The sample size required for this study was determined based on sample size determination using expected prevalence rate of50%, absolute desired precision of 5 % at confidence level of 95%. The sample size was calculated according to the following formula Thrusfield [29].

$$n = \frac{1.96^2 P_{exp}(1 - P_{\exp})}{d^2}$$

where:
n= required sample size
pexp = expected prevalence
d = desired absolute precision = 5%

Therefore, based on the above formula a total of 384 (270 sheep and 114 goats)were included in the current study.

Data Collection and Laboratory Examination: Fecal samples (n = 384) were collected from small ruminants in the field. Fecal samples were collected directly from the rectum of randomly selected small ruminant using plastic gloves, put in labeled sampling bottles, while collecting fecal samples, the species of the animal and date of sampling, sites, sex, age, management system, body condition and code of sampling were properly recorded and transported to laboratory for analysis in the same day.

In the laboratory, feces were subjected to coprological examination for the detection of larvae (L1) using Modified Baermann Technique [24]. About 10grams of feces were enclosed in double layered gauze suspended and fixed in a beaker containing warm water by using a string rod. The whole apparatus was stayed for 24 hours and then the sediment was examined under lower power microscope after siphoning off the supernatant. All larvae were identified based on morphological characteristics described by Taylor *et al.* [30]. When positive, a drop of 1% iodine solution was used to immobilize the larvae and use (40x) magnification power for identification of species of the parasites [31, 32] and otherwise it was registered negative for lungworm infection [10] and in both cases, the result was recorded corresponding to the specific animal.

Data Analysis: The collected data was recorded and the MS-excel spread sheet program was employed to create dataset. Before subjected to statistical analysis, the data were thoroughly screened for errors and properly coded; finally statistical data analyses were performed using Stata version 13 statistical software. Descriptive statistical analysis such as tables and figures were used to summarize and present the output from the data collected. The prevalence of lungworm infection was calculated as percentage by dividing total number of small ruminant positive for lungworm infection to the total number of small ruminant examined. Pearson chi square (χ^2) test and logistic regression were used to assess the existence of association between the lungworm infections with different risk factors and to evaluate degree of association. For (χ^2) test, p-value<0.05 were considered as significant while p-value >0.05 considered as non-significant.

RESULTS

From the total 384 small ruminant examined for lungworm infection 36 (9.4%) were harbored the parasite.

Out of 270 sheep and 114 goats examined, 23(8.5%) sheep and 13(11.4%)goats were found to be infected with lungworms with higher prevalence in goats than sheep. No significant difference was observed in the prevalence of infection between sheep and goats ($\chi^2 = 0.785$, $p > 0.05$) (Table 1).

Different level of prevalence, 10.73% (28 of 261) and 6.5% (8 of 123) observed in female and male animals, respectively (Table 2). There was no significant difference ($\chi^2 = 1.756$, $p > 0.05$) between the prevalence of lungworms in female and male animals.

The highest prevalence of lungworms (13.3%) was detected in poor body conditioned small ruminant when lungworm infection were compared between the different body conditioned animal and there was statistically significant difference between the prevalence of lungworms in small ruminant of different body condition ($\chi^2 = 6.015$, $P < 0.05$) (Table 3).

The highest prevalence (10.92%) was observed in young animals and lowest prevalence (8.68%) was observed in adult animals. The prevalence between the age groups was not statistically significant ($\chi^2 = 0.437$, $p > 0.05$). With regard to management system the prevalence of lungworm infection was numerically higher in extensive (10.69%) than in the semi intensive (5.32%) management system, but the prevalence was not statistically significant ($p>0.05$) (Table 2). Lungworm infection was observed in the four study sites Melka Oda, Faji, Sole and Bishan Guracha; the highest (11.36%) and the lowest (5.06%) prevalence were observed in Faji and Melka Oda, respectively. There wasno statistically significant difference between the prevalence of lungworms in small ruminant of the different study sites ($\chi^2 = 2.387$, $P > 0.05$) (Table 2).

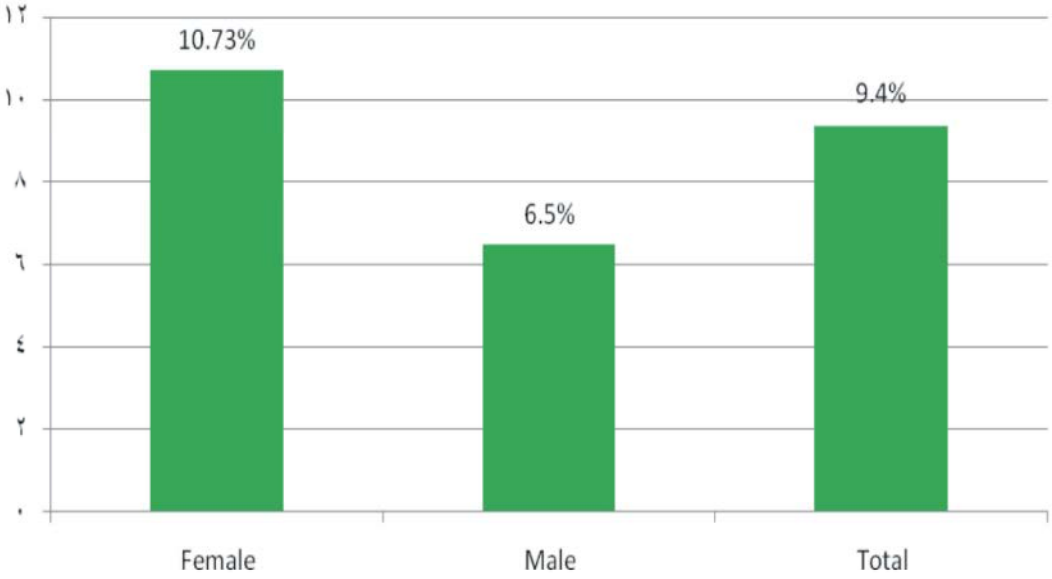

Fig. 1: Sex wise prevalence of lungworm infection in small ruminant

Table 1: Prevalence of lungworm infection in sheep and goats in study area

Host species	No. Animals examined	No. animals positive	Prevalence%	Chi square (χ^2)	95% CI for OR	OR (95% CI)	p-value
Sheep	270	23	8.5	0.785	0.615-2.731	1.296	0.376
Goats	114	13	11.4			1	
Total	384	36	9.4				

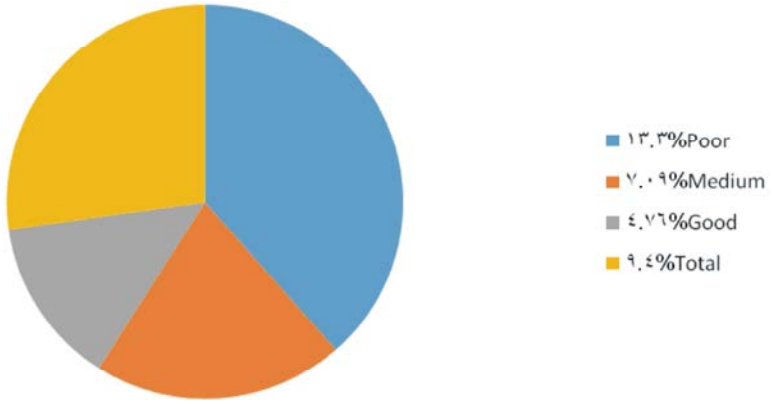

Fig. 2: Prevalence of lungworm infection in small ruminant with body condition

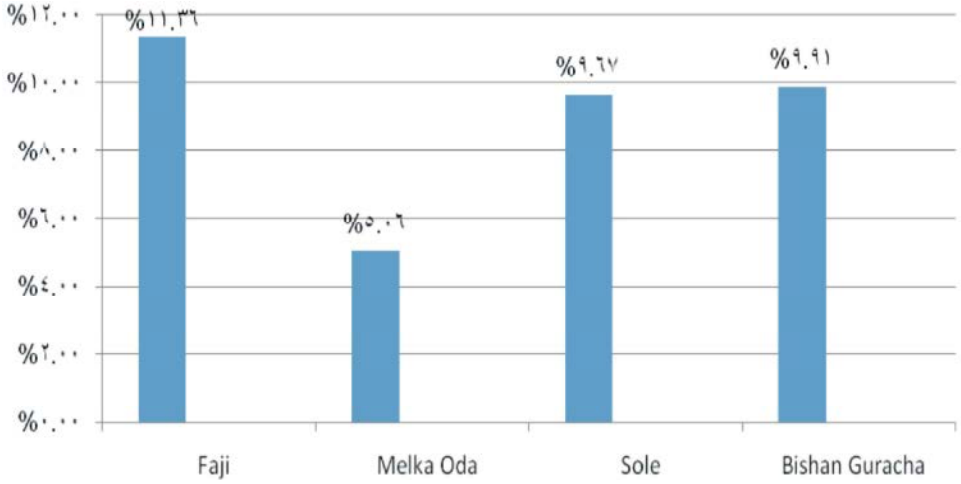

Fig. 2: Prevalence of lungworm infection with sites wise

Table 2: Summary of statistical result on small ruminant lungworm in study area

Variable	No.animals examined	Positive	Prevalence%	OR (95% CI)	χ^2	p-value
Age						
Young	120	13	10.83	0.679	0.437	0.509
Adult	264	23	8.71	1		
Sex						
Male	123	8	6.5	0.650	1.756	0.185
Female	261	28	10.73	1		
Origin						
Faji	132	15	11.36	0.835	2.387	0.496
MelkaOda	79	4	5.06	2.041		
Sole	62	6	9.67	0.866		
Bishanguracha	111	11	9.91	1		
Bcs						
Good	84	4	4.76	1	6.015	0.049
Medium	127	9	7.09	2.086		
Poor	173	23	13.3	3.218		
Management						
Extensive	290	31	10.69	0.519	2.410	0.121
Semi-intensive	94	5	5.32	1		

Table 3: Prevalence of different species of lungworm with species, age, sex, body condition and sites wise

Variable	No. of animals examined	Spp of parasites			Total%	χ^2	p-value
		D. filaria%	*M. capillaris*%	*P. rufences*%			
Spp of animals							
Sheep	270	15(5.60)	3(1.10)	5(1.90)	23(8.50)	2.211	0.530
Goat	114	6(5.30)	3(2.60)	4(3.50)	13(11.40)		
Age							
Young	120	6(5.00)	3(2.50)	4(3.33)	13(10.83)	1.822	0.620
Adult	264	15(5.68)	3(1.14)	5(1.90)	23(8.71)		
Sex							
Male	123	5(4.10)	2(1.62)	1(0.81)	8(6.50)	2.632	0.452
Female	261	16(6.13)	4(1.53)	8(3.07)	28(10.73)		
BCs							
Good	84	4(4.76)	0(0.00)	0(0.00)	4(4.76)	9.201	0.163
Medium	127	6(4.72)	1(0.79)	2(1.57)	9(7.09)		
Poor	173	11(6.36)	5(2.89)	7(4.05)	23(13.29)		
Sites							
Faji	132	9(6.82)	3(2.27)	3(2.27)	15(11.36)	5.757	0.764
MelkaOda	79	2(2.53)	1(1.26)	1(1.26)	4(5.06)		
Sole	62	3(4.83)	0(0.00)	3(4.83)	6(9.68)		
BishanGuracha	111	7(6.31)	2(1.80)	2(1.80)	11(9.91)		
Management							
Extensive	290	18(6.21)	6(2.10)	7(2.41)	31(10.69)	3.376	0.337
Sem-intensive	94	3(3.20)	0(0.00)	2(2.13)	5(5.32)		
Total	384	21(5.50)	6(1.60)	9(2.30)	36(9.40)		

The identified species of lungworms were *D. filaria* 21(5.5%), *M. capillaris* 6(1.6%) and *P. rufescens* 9(2.3%) from the small ruminant of the study area. Of the identified species, *D. filaria* was obtained more frequently from sampled fecal, followed by *P. rufescens* and *M. capillaries*. *D. filaria* was more prevalent in sheep than goats while the left two lungworm species are more prevalent in goatswithno significant variation ($\chi^2 = 2.211$, $p>0.05$) between sheep and goats and the prevalence of *D. filaria* were highest in adult while the other species were higher in young animals. There was no statistically significant difference ($\chi^2 = 7.790$, $P>0.05$) among different lung worm species identified from different age groups of small ruminant. The prevalence of *D. filaria* and *P. rufescens* are higher in female while, *M. capillaries* are high in male with no significant variation ($\chi^2 = 2.632$, $p>0.05$) and regarding to body conditions lungworm species are high prevalent in poor body conditioned animals with no statistically significant difference ($\chi^2 = 9.201$, $p>0.05$). The prevalence of *D. filarial* and *M. capillaris* was high in Fajikebele while *P. rufences* was high in Sole than other sites with statistically insignificant variation ($\chi^2 = 5.575$, $p>0.05$) and the prevalence of lungworm species was more prevalent in extensive management systems than semi intensive with insignificant differences as indicated in (Table 3).

DISCUSSION

In this study, an overall prevalence of 9.4% was observed. This level of prevalence was in line with previous study reported by Ibrahim and Godefa [22] in and around Mekelle, Frewengel [33] in Tigray and Sissay [34] in Bahirdar who conducted 13.4%, 11.24% and13% respectively. However, the current studywas lower than the studies conducted by Weldesenebet and Mohammed [35] in Jimma, Desta *et al*. [36] in Ambo, Mekonnen *et al.* [37] in Gondar, Regessa *et al*. [21] inDessie and kombolcha, Aseye and Alemneh [10] in Bahirdar, Mengestom [38] in Tigray and Muluken [39] in Bahirdar who reported prevalence of 26.7%, 34.9%, 37.74% 40%, 22.7%, 21.5% and 18.16% respectively. The difference in prevalence of small ruminant lungworm might be due to the difference in methods followed in the detection of the larvae and/or the study area which favors the survival of the larvae of the lungworms or it might be associated with the nutritional status of the animals, management practice of animals, rain fall, level of immunity of animals, humidity, temperature difference, seasonal deworming of animals and difference in season of examination in the respective study areas. The topography of the area might also highly influence the prevalence by harboring the intermediate host.

In the present study, the specific prevalence of 8.5% in sheep and 11.4% in goats were recorded with no statistically significant variation. This relatively high prevalence in goats than sheep was in agreement with Terefa *et al.* [24] in North Gondar, Weldesenebet and Mohammed [35] in Jimma, Fentahun *et al*. [6] in and around Jimma and Zeryehun and Degefaw [40] in and around Mekelle. This might be due to the difference in grazing behavior of these species of ruminant. Goats appear to be more susceptible to helminthes than sheep as they appear to develop less immunity. Sheep predominantly graze; pick up more parasites. So, sheep have higher acquired resistance than goats which mostly consume browse. Goats with their browsing behavior consume uncontaminated matter with parasite larvae, so being less exposed to infective larvae and therefore have lower acquired resistance than sheep [41]. However, this study disagreement with the prevalence conducted by Mihret and Firesbhat [5] who studied in Gondar and Abebe *et al*. [8] in Wolaita Sodo.

Age wise study revealed relatively higher prevalence was observed in young small ruminant (10.83%) than adult one (8.71%). Though, this difference was not statistically significant ($p>0.05$). This finding was in line with Kebede [25] in Dale, Muluken [39] in Bahirdar, Asaye and Alemneh [10] in Bahirdar and Tigist [42] in North and South Gondar. This were due to apparent developed immunity of the adult animals. However, this observation disagreement with prevalence conducted by Bekele and Shibbiru [32] in DebreBerhan.

In the present study higher level of prevalence was detected in female (10.73%) compared to the level of prevalence observed in male (6.5%) small ruminant with no statistically significant variation ($p>0.05$). This high prevalence in females agrees with the prevalence studied by Leben *et al.* [31] in North Shoa, Denbarga *et al.* [43] in Bahir Dar, Zeryehun and Degefaw [40] in and around Mekelle, Negash *et al.* [44] in Gedeb Asasaand Shenba *et al.* [45] in Debra Berhan. This result contradicts with the previous study of Weldesenebet and Mohammed [35] who observed high prevalence in male (29.7%) than female (24.7%) in Jimma. This difference in prevalence between female and male small ruminant was probably due to the fact that resistance to infection is decreased at the time of parturition and during early lactation which results in the females' inability to resist adult worms which cause higher level of larval detection Asaye and Alemneh [10] and may be due to the fact that improper distribution of sample selection between the two sexes as observed by Addis *et al*. [46]. The way that males and females treated in terms of nutrition may also attribute for such differences. Males are kept for fattening to be sold later, except some which are kept for breeding and receive more attention by small ruminant producers. Crop leftovers and remnants after human consumption, for instance, are provided primarily for males [19].

In this study *D. filaria* was the most predominant lungworm species with the prevalence rate of (5.5%) followed by *P. rufescens* (2.3%) and *M. capillaries* (1.6%). This finding was in line with Weldesenebet and Mohammed [35], Alemu *et al.* [19], Asaye and Alemneh [10], Addis *et al.* [46] and Abebe *et al.* [8]. In contrast to this findings, Mihret and Firesbhat [5] in Gondar reported that *M. capilaris* was the most prevalent species and Bekele and Shibbiru [32] reported that *M.cappilaris* was the second most prevalent species. This difference in the prevalence of the different species of lungworms might be associated with difference in their lifecycle. Thus, *D. filaria* has a direct life cycle and requires shorter time to develop to an infective stage while, the transmission of *P. rufescens* and *M. capillaris* is complex involving host, parasite, intermediate host and appropriate environmental climatic condition. Furthermore, development from first stage to infective stage larvae in the snail takes 12 to 14 days and the prepatent period can take 30 to 60 days. Therefore, the probability of infection, transmission and re-infection take longer time compared with *D. filaria* [5].

In the current study body condition based prevalence of lungworm infection indicated statistical significant differences ($p<0.05$). The highest prevalence was recorded in poor body conditioned animal (13.3%) than medium body conditioned (7.09%) and good body conditioned (4.76%). This finding agrees with the other studies Hussein *et al.* [20] in and around Assela, Kassa and Abdu [47] around Bahir Dar and Mihret and Firesbhat [5] in Gondar. However, the current study was disagrees with the findings of Fentahun *et al*. [6] in and around Jimma. This might be associated with the nutritional management of animals. Poor body condition occurred as a result of lack of feed or nutritional management. This may lead to lack of resistance to infection and contribute for increased prevalence rate in poorly conditioned animals [31].

With regard to management system the prevalence of lungworm infection was numerically higher in extensive (10.69%) than the semi intensive (5.32%) management system, but the prevalence was not statistically significant ($p>0.05$). This finding coincides with the previous studies of Zeryehun and Degefaw [40] in and

around Mekelle and Gebrekidan [48] in and around Jimma. However, it contradicts with the finding of Weldesenebet and Mohammed [35] in Jimma. The reason for this could be the degree of pasture contamination in the extensive system of production increases the degree of exposure that could result in high prevalence Soulsby [49] and the communal grazing pasture highly contaminated by the continuously and/or visiting infected animals. This increased degree of pasture contamination in turn leading to higher prevalence of lungworm and other parasites [43].

CONCLUSION AND RECOMMENDATIONS

A cross-sectional study on lungworm infection in small ruminant were conducted in and surrounding of Shashemene by preforming fecal examinations revealed overall prevalence of 9.4% of which (8.5%) in sheep and (11.4%) in goat. Higher prevalence was recorded in goats than sheep. Female animals, young animals and those managed under extensive system of production were more prone to lungworm infection but statistically not significant. However, significant variation was recorded on body condition based prevalence of the disease with highest prevalence obtained from poor body conditioned small ruminants. The species of lungworm identified were *D. filaria, M. capillaris* and *P. rufescens* and; *D. filaria* was detected more frequently followed by *P. rufescens* and *M. capillaris*. Despite, lower prevalence of lungworm infection obtained in the present study with in the specified period of study, it is still risk of lungworm infection in the study area which may leads to loss of production and productivity of small ruminant.

Based on the above conclusion, the following recommendations are forwarded

- To control the infection with lungworm, regular and strategic deworming programs with efficacious anthelminthic should be carried out regularly.
- Improved housing, feeding and management system should be implemented to decrease the risk of lungworm infection in small ruminant.
- Owners should be awarded about husbandry practice and regular deworming of small ruminant in the study area.
- The government should formulate and implement policies regarding to management and health aspect of small ruminant.

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