Journal of Veterinary Science & Technology

Abebe, et al., J Veterinar Sci Technol 2016, 7:2
DOI: 10.4172/2157-7579.1000302

Research Article Open Access

Lungworm Infection in Small Ruminants in and Around Wolaita Soddo Town, Southern Ethiopia

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Received date: December 17, 2015; **Accepted date:** February 10, 2016; **Published date:** February 12, 2016

Abstract

This study was conducted between November 2010 to April 2011 to estimate the prevalence of lungworm infection in small ruminants, determine the parasite species and identify the potential risk factors in and around Wolaita Soddo town, Southern Ethiopia. Faecal samples were collected from 360 randomly selected small ruminants (204 sheep and 156 goats) and processed with the modified Baerman technique for the extraction of first stage larvae. Overall, 45 (22.1%) sheep and 30 (19.2%) goats were found infected with lungworms. No significant difference was observed in the prevalence of lungworm infection between sheep and goats ($p>0.05$). *Dictyocaulus filaria* was the single lungworm species identified in both sheep and goats. The risk factors analyzed were sex, age, management system (zero-grazing or free-ranging), deworming history and body condition score (BCS). Management system, deworming history and BCS were significantly associated with the prevalence of *D. filaria* infection in sheep and goats ($p<0.05$ for each factor). It was observed that the prevalence was significantly higher in extensively managed/free-ranging (OR=4.6 in goats), poorly conditioned (OR=5.3 in sheep; 6.1 in goats) and non-dewormed (OR=4.8 in sheep; 6.1 in goats) animals. Sex and age had no significant effect on the occurrence of *D. filaria* infection ($p>0.05$). In conclusion, the association of lungworm infections with the management system and deworming status of the animals in the present study are as expected. The association of infection with BCS requires further research to investigate if improving the nutritional status, thereby improving BCS, will result in lower prevalence of lungworm infection. Also, as the present sample size is thought to be small, further study with a larger sample size is required to determine the effect of age and host species difference in susceptibility to lungworm infection. One of the limitations of this study is that it is a one season survey and thus, a further year-round investigation is warranted to establish the association between seasonal variation and infection.

Keywords: *D. filaria*; Prevalence; Risk factors; Small ruminants; South Ethiopia

Introduction

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 24.2 million sheep and 22.6 million goats [1] 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. Despite the country has a huge potential of small ruminants, the country is unable to exploit these resources due to various reasons including endoparasitic infections.

Sheep and goats can be infected by many different kinds of endoparasites including lungworms. These lungworms are widely distributed throughout the world but are particularly common in countries with temperate climates, and in the highlands of tropical and sub-tropical countries [2]. The three economically important species of lungworms in sheep and goats are the nematode *Dictyocaulus filaria*, *Muellerius capillaris* and *Protostrongylus rufescens*. *D. filaria* is one of the most pathogenic lungworm of sheep and goats which lives in the lumen of the bronchial tree and commonly associated with chronic bronchitis and localized occlusion of the bronchial tree with atelectasis [3]. *P. rufescens* and *M. capillaris* are located in the lung parenchyma [3] and infections with these parasites are mainly associated with respiratory disturbances, development of focal pneumonia, and secondary bacterial infections of the lungs [4]. Infections with lung worms are either clinical or sub clinical [3].

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 Alemu et al., Regassa et al., Ibrahim and Godefa, Fentahun et al., Eyob and Matios, Terefe et al., Kebede et al. [5-11]. According to these studies, the prevalence of lungworm infection in Ethiopia ranges from 13.4–72.4% in sheep and 26.5–62.7% in goats. Nonetheless, much of the available data are from the northern and western parts of the country and information on the subject from the southern part of the country is scarce. Furthermore, as Ethiopia is a country with diverse ecological and climatic conditions, occurrence, species diversity and risk factors may vary from area to area and thus, it is found important to study the parasite in all parts of the country.

Therefore the objective of this study was to estimate the prevalence of lung worm infections, to investigate the lungworm species involved and to identify the associated risk factors in small ruminants in selected areas of southern Ethiopia [12,13].

Materials and Methods

Study area

The study was conducted between November 2010 to April 2011 in Wolaita Soddo town and its surroundings. Wolaita Soddo is a town and separate district in south-central Ethiopia located 385 km from Addis Ababa, the capital of Ethiopia. The town is the administrative center of the Wolaita Zone of the Southern Nations, Nationalities, and Peoples Region. Geographically, the town is situated at 6°54′N 37°45′E and has an elevation between 1600 and 2100 m above sea level.

Study population

The study population consisted of 360 small ruminants (204 sheep and 156 goats) randomly selected from the sheep and goat populations in the study area. All the study animals were local breeds. Of the total sampled animals, 129 were female while 231 males. The age of the animals was determined based on the farmers' response and cross-checked by teeth inspection. Based on the response the animals were categorized in to three age groups: ≤ 1 yr, 1-3 year and >3 year old. The number of animals in each age category was 131, 197 and 32, respectively. Body condition scoring (BCS) was performed according to Ethiopia Sheep and Goat Productivity Improvement Program [14]. The assessment revealed that 178, 48 and 134 animals had good, moderate and poor BCS, respectively. With regard to the management system, 295 (81.9%) study animals were free-ranging on communal lands (extensively managed) whereas 65 (18.1%) kept under zero-grazing system (intensively managed). As to their deworming status, 218 animals were known to be treated with a broad spectrum anthelminthic (i.e albendazole) within 3 months prior to the onset of the study while 142 animals did not receive any treatment.

Study design and sample size determination

A cross-sectional study design was employed to address the objective of the study. The sampling procedure used was a simple random sampling technique which means that all the animals in the study area had equal chance of being part of the sample. The sample size was determined according to Thrusfield [15] taking in to account an expected prevalence of 16% for sheep and 11.5% for goats, 5% absolute precision and 95% confidence level. Accordingly, the sample size required for the study was computed to be 204 for sheep and 156 for goats.

Sample collection and larval identification

Faecal samples were collected directly from the rectum of the selected animals in a universal bottle. While collecting the faecal samples, data about the species of animal, sex, age, body condition score (BCS), management system (zero-grazing vs free-ranging), and date of sampling were recorded on the format prepared for this purpose. The samples collected were transported to Sodo Regional Veterinary Laboratory within six hours of collection. In the laboratory, the Baermann technique was employed for the extraction of lungworm larvae from the faecal samples as described by Foreyt [16]. Identification of the species of lungworm encountered was carried out based on the characteristic morphological features described in literature by Taylor et al. and Bowman [3,4].

Statistical analysis

Data obtained from questionnaire survey and faecal examination were entered into Microsoft excel spreadsheet after coding. All statistical analyses were performed on STATA 11.1 software (StataCorp 4905 Lakeway Drive, College Station, Texas 77845 USA). The prevalence of lung worm infection was calculated by dividing the number of animals affected by the total number of animals examined. The association between the prevalence of lung worm infection and the hypothesized risk factors (animal species, age, sex, deworming history, BCS and management system) was analyzed by univariable logistic regression test. A p value<0.05 was considered significant.

Results

Prevalence of lung worm infection

Out of 204 sheep and 156 goats examined, 45 sheep (22.1%) and 30 goats (19.2%) were found to be infected with lung worms. No significant difference was observed in the prevalence of infection between sheep and goats (p>0.05). *D. filaria* was the only species of lung worm identified in both sheep and goats (Table 1).

Host species	No. Animals examined	No. animals pos	Prevalence (%)	95% CI for prevalence	OR (95% CI)	p
Goats	156	30	19.2	13.5 - 26.4	1	
Sheep	204	45	22.1	16.7 - 28.5	1.2 (0.8 - 2.0)	0.513
Over all	360	75	20.8	16.8 - 25.4		

Table 1: Prevalence of *D. filaria* infection in sheep and goats in and around Wolaita Soddo. CI: Confidence Interval; OR: Odds Ratio.

Hypothesized risk factor analysis

In sheep, among the presumed risk factors, BCS and deworming history were found to be strongly associated with the prevalence of *D. filaria* infection (p<0.001) while sex and age of the animals didn't have significant effect (p>0.05). Furthermore, all the animals infected were extensively managed ones (Table 2).

Variable	No. animals examined	No. animals pos.	Prevalence (%)	OR (95% CI)	p
Sex					

Male	89	17	19.1	Ref	
Female	115	28	24.4	1.4 (0.7-2.7)	0.371
Age					
≤ 1 Year	79	23	29.1	Ref	
1-3 Year	109	20	18.4	0.5 (0.3-1.1)	0.085
>3 Year	16	2	12.5	0.3 (0.1-1.7)	0.184
Management system					
Intensive	32	0	0		
Extensive	172	45	26.2		
BCS					
Good	102	9	8.8	Ref	
Moderate	28	11	39.3	6.7 (2.4-18.6)	0
Poor	74	25	33.8	5.3 (2.3-12.2)	0
Deworming history					
Dewormed	118	13	11	Ref	
Non dewormed	86	32	37.2	4.8 (2.3-9.9)	0

Table 2: Logistic regression analysis of *D. filaria* infection in sheep with different risk factors. OR: Odds Ratio; CI: Confidence Interval; BCS: Body Condition Score; Ref: Reference Category.

In goats, the prevalence of lungworm infection was significantly associated with management system, BCS and deworming history ($p<0.05$ for each factor). As in sheep, sex and age of the animals were not significantly associated with infection ($p>0.05$) (Table 3).

Variable	No. animals examined	No. animals pos.	Prevalence (%)	OR (95% CI)	p
Sex					
Male	40	6	15	Ref	
Female	116	24	20.7	1.5 (0.6 -3.9)	0.433
Age					
≤1 Year	52	14	26.9	Ref	
1-3 Year	88	14	15.9	0.5 (0.2-1.2)	0.119
>3 Year	16	2	12.5	0.4 (0.1-1.9)	0.247
Management system					
Intensive	33	2	6.1	Ref	
Extensive	123	28	22.8	4.6 (1.0 -20.3)	0.046
BCS					
Good	76	5	6.6	Ref	
Moderate	20	7	35	7.6 (2.1-27.8)	0.002
Poor	60	18	30	6.1(2.1-17.6)	0.001
Deworming history					

Dewormed	100	9	9	Ref	
Non dewormed	56	21	37.5	6.1 (2.5-14.5)	0

Table 3: Logistic regression analysis of D. filaria infection in goats with different risk factors. Note: OR: Odds Ratio; CI: Confidence Interval; BCS: Body Condition Score; Ref: Reference Category.

Discussion

In this study, lungworm larvae were observed in 22.1% of sheep and 19.2% goats examined. The prevalence recorded in both sheep and goats is lower than reports of the previous studies in Ethiopia (24.3% –72.4% for sheep; 26.5%–62.7% for goats) [5,6,8-11,15-17]. The lower prevalence in the current study could be attributed to better awareness of farmers to deworm their small ruminants against lungworms and other helminthic infection, apart from geographic variation. This was evidenced by the fact that more than 60% of the small ruminants included in this study were dewormed with broad spectrum anthelminthics.

D. filaria was the only species of lungworm identified in both sheep and goats in the present study. The small lungworms, *P. rufescens* and *M. capillaris*, were not detected. The absence of small lungworms in the present study area could be associated with their life cycle and the season of the study. Unlike *D. filaria*, which has a direct life cycle, *P. rufescens* and *M. capillaris* have an indirect life cycle requiring a molluscan intermediate host to complete their development [3]. As this study was conducted in a dry season, the climatic conditions in the study area might not be conducive for the survival and breeding of the intermediate hosts. In agreement with this finding, many of the previous studies [8,11,15,16,] also reported *D. filaria* as the predominant species circulating in Ethiopian sheep and goats managed under traditional husbandry system although mixed infections with the small lungworms was stated in low proportions. In contrast, other studies reported the preponderance of the small lungworms over *D. filaria* [5,6,11,12]. Apart from year and season of the studies, this difference might be ascribed to the variations in ecological conditions required for the breeding of the intermediate host between the current and previous study areas [18-20]. The aforementioned studies were conducted in the west and northeast part of Ethiopia while the present study was carried out in the southern part. Outside Ethiopia, surveys in Turkey, India and Iran [21-25] also reported *D. filaria* as the sole or predominant lungworm while in Morocco, Czech Republic, Norway and Bulgaria the most prevalent species identified was *M. capillaris* [26-28].

The current study revealed lack of significant difference in the prevalence of *D. filaria* infection between sheep and goats ($p>0.05$). Consistent with the present finding, most of the previous studies in which *D. filaria* was the predominant lungworm, reported absence of significant variation between the two hosts [9,13,17,19]. In contrast, in two studies dominated by the small lungworms [5,12], a significantly higher prevalence was noted in goats than in sheep. Our finding is also contrary to what is generally stated that goats appear to be more susceptible to infection than sheep and are thought to play a prominent role in the dissemination of the infection where both are grazed together [3]. The present and most of the previous studies in Ethiopia suggest that variations between sheep and goats in susceptibility to lungworm infections depend on the species of the parasite involved. That is, when *D. filaria* is the sole or predominant species encountered, no significant difference is observed in prevalence between the two hosts but in infections where small lungworms are the most prevalent goats are more susceptible than sheep. Nonetheless, this fact needs to be substantiated in the future by experimental studies involving the two hosts. The use of adequate sample size computed for sheep and goats separately should also be considered in future studies. In agreement with the present study, lack of significant variation between sheep and goats for *D. filaria* infection was also reported by a study in Iran [24].

In the present study, although *D. filaria* prevalence tended to decrease with age, the variation among the three age categories of animals was not significant in both sheep and goats ($p>0.05$). The prevalence in the younger animals (≤ 1 Year) was higher than in older animals (>3 Years) but the difference was not significant. This finding is consistent with some of the previous studies [5,9,15-17]. In contrast to the current findings, other authors [6,8,10,11] reported a significantly higher infection of *D. filaria* in young than adult animals. The absence of significant variation between young and old animals in the present study might be due to failure of the older animals to develop strong immunity to reinfection associated with the dry season feed shortage. It could also be attributed to sampling of small and disproportionate number of animals between the two age categories. Nevertheless, further investigation using large and proportional sample size is warranted in a season where adequate feed is available to determine the effect of age on lungworm infection.

The analysis of lungworm infection with the management system in goats showed that the prevalence was significantly higher in extensively than intensively managed animals ($p<0.05$) while all the sheep infected were extensively managed ones. The odds ratio (OR) of infection in extensively managed goats was 4.6 times higher than that in intensively kept. This is as expected and attributed to differences in feeding system between the two groups of animals. The intensively managed animals were zero-grazed and consequently, less likely to be infected with lungworm larvae. Of the intensively managed ones, only two animals had lungworms probably through some contamination of hay or bedding material. Similarly, the prevalence of lungworm infection was significantly higher in non-dewormed sheep and goats than dewormed ones ($p<0.001$) and this finding is also as expected. The odds of infection were 4.8 and 6.1 times higher respectively in non-dewormed sheep and goats than dewormed animals.

In both sheep and goats, the prevalence of D. filaria infection was significantly associated with BCS ($p<0.05$). It was observed that sheep with moderate or poor condition were 6.7 or 5.3 times more likely to shed *D. filaria* larvae than those in good condition. Similarly, the odds of infection in goats with moderate or poor BCS were 7.6 or 6.1 higher than those with good BCS. This, partly, may be attributed to the nutritional status of the animals. This study was conducted in the dry season where feed shortage is a serious problem for small ruminants kept under extensive management system in Ethiopia. Therefore, in the dry season free-ranging animals are not able to meet their maintenance requirements, and lose a substantial amount of weight. It is well known that poor nutrition lowers both the resistance (ability to

resist the parasites) and resilience (ability to tolerate or ameliorate the effects of the parasite) of the animal thus enhancing the establishment of worms and increasing the prevalence in poorly conditioned animals [27]. In connection to lungworm, it is reported that poorly nourished animals appear to be less competent in getting rid-off lungworm infection although it is not unusual for well-fed animals to succumb to lungworm infection [28].

In conclusion, the overall prevalence of *D. filaria* infection in the current study was 22.1% in sheep and 19.2% in goats. As expected, management system (zerograzing or not) and deworming history in the last 3 months (yes/no) were significantly associated with presence of lungworm infection. BCS also was significantly associated with lungworm infection with animals with moderate or poor condition being at least 5.3 times more likely to be infected than animals in good condition. Further research is required to investigate if improving the nutritional status, thereby improving BCS, will result in lower prevalence of lungworm infection. Also, as the sample size in this study was thought to be small, a further study with a larger sample of sheep and goats is needed to determine the effect of age and host species difference in susceptibility to lungworm infection. Finally, one of the limitations of this study is that it is a one season observation and reflects the prevalence of the parasite only in the dry season. Thus, further year-round studies are warranted to establish the association between seasonal variation and lungworm infection.

Conflicts of Interest

Authors have none to declare.

Acknowledgments

The authors would like to thank Wolaita Soddo Regional Laboratory staff for their immense technical support during the laboratory work.

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