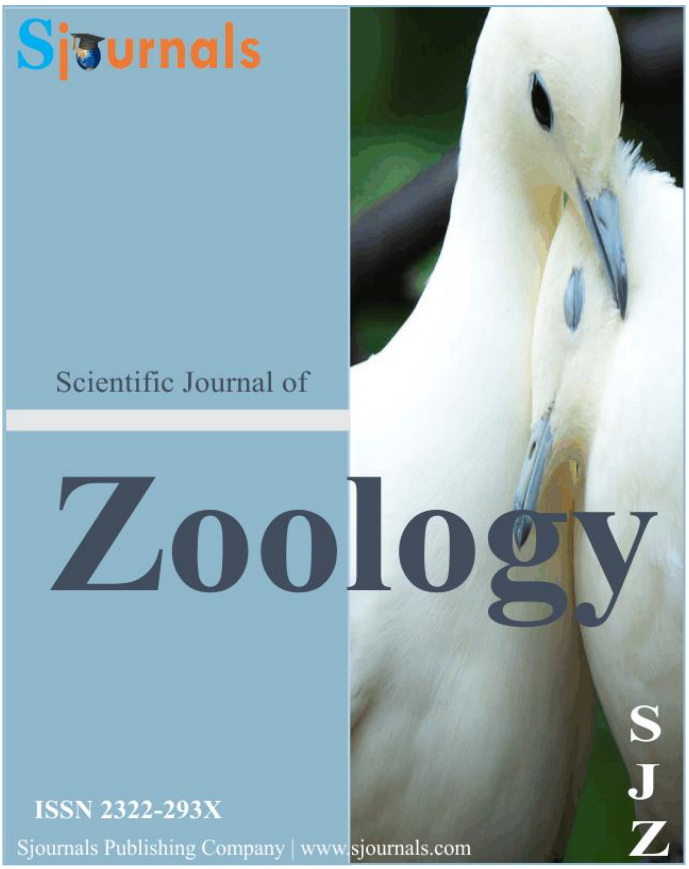

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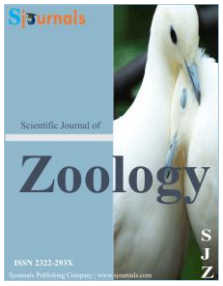

Original article

Epidemiology of small ruminants lungworm in Gedeb Asasa district, West Arsi zone, Ethiopia

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ABSTRACT

A cross-sectional study was carried out in Gedeb Asasa district of West Arsi zone, Ethiopia from November 2016 to April 2017 to identify and determine prevalence of small ruminant lungworm species and assess potential risk factors. A total of 400 fecal samples were randomly collected from 288 sheep and 112 goats in the study area and collected samples were cultured and first stage larvae (L1) were isolated using modified Baerman technique. Isolated first stage larvae (L1) were examined and identified morphologically using microscope. The present study recorded an overall prevalence of 44.8%. The prevalence of lungworm infection by animal species was determined to be (45.5%) and (42.9%) for sheep and goat, respectively. The study identified three lungworm nematode species of small ruminants: *Dictyocaulus filaria, Muelleris capillaris, Protostronylus rufescens* along with mixed infection by coprological larval morphology identification system with respective prevalence of 17%, 14.5%, 5.3% and 8% applying descriptive statistics. Statistically, higher lungworm infection rate in female (48.8%) recorded compared to male (37.5%), in young (53.3%) compared to adult (36.3%) in animals with poor body condition (66.9%) followed by medium (37.5%) and good body condition (31.9%) animals and non-dewormed animals (49.2%) compared to dewormed ones (37.2%). To determine the existence of association between the disease

and risk factors (sex, animal origin, animal species, age, body condition, anthelmintic treatment), Chi-Square statistics was employed and only four (sex, age, body condition, anthelmintic treatment) were found to have association with the disease. Multivariate logistic regression analysis confirmed the existence of statistically significant impact (P<0.005) of the four factors (sex, age, body condition, anthelmintic treatment) on small ruminants lungworm infection dynamics.

1. Introduction

As of 2013 central statistical agency's data, Ethiopia possesses dominant livestock population in Africa estimated at 54 million cattle, 25.5 million sheep and 24.06 million goats. Sheep and goats are typically important in extreme climates and noted for their ability to convert low opportunity cost feed into high value products like meat, milk, fiber, manure and skin (Asaye and Alemneh, 2015). In Ethiopia, they provide 33% meat and 14% milk consumption and accounts for 40% of cash income in the central highlands where mixed crop livestock production system is practiced (Asaye and Alemneh, 2015) though productivity is much less compared to their figure (Tewodros et al., 2012). The economic benefits to the farmers remain minimal due to prevailing disease, poor nutrition, poor animal production systems and general lack of veterinary care (Sisay et al., 2007). Parasitism impedes small ruminants' productivity resulting in serious economic loss (Teklye, 1991). The annual economic loss due to diseases, death, reduced reproduction and productivity estimated at 150 million USD (Berhanu, 2002). In Ethiopia, 5-7 million small ruminants die with an overall loss of 400 million in meat industry due to parasitic diseases annually (Sileshi and Lidetu, 2003). Helminthiasis of small ruminants is ubiquitous in tropical and subtropical environments of the world providing suited conditions for survival and development. Infection with helminth parasites are among the most established high prevalence rates of the infection with less obvious signs associated with poor production and unthriftiness (Hansen and Perry, 1994).

Verminous pneumonia is a chronic and prolonged infection of sheep and goats caused by parasitic nematodes with clinical feature of respiratory distress; bronchitis and bronchopneumonia as a result of lower respiratory tract infection (Tewodros, 2015). The prevalence of lungworm infection of small ruminants depends on different factors, including altitude, intermediate hosts and favorable ecological conditions such as rain fall, humidity, temperature, marshy grazing area and small ruminants' management system for the development of lungworm species (Serkalem et al., 2014). Moreover, pathogenic effect of lungworms depends on parasite location within the respiratory tract, the number of infective larvae ingested and the immune system of the animals. The three respiratory parasites that cause significant damage in small ruminant production are *Dictyocaulus filaria, Protostrongylus rufescence and Muellerius capillaris* (Gebreyohannes et al., 2013). In Ethiopia, farmers prefer to manage small ruminants due to low cost of production, prolificacy, adaptive capacity to various environmental factors through dynamic feeding behavior and fast reproduction cycle and growth rate despite parasitic challenges. Studies on lungworms of small ruminant are limited. Thus, the objective of this study was to identify and determine the prevalence of small ruminant lungworms in the study area.

2. Materials and methods

2.1. Study area and population

A cross-sectional study was done to address the objective of the study in Gedeb Asasa district, Oromia region, south-eastern Ethiopia, from November 2016 to April 2017. The administrative center of the district is Asasa. The altitude of the district ranges from 2200 to 4180 meters above sea level. Topographically, the district's 76.9% land is cultivable, 17.3% pasture, 0.4% forest and the remaining 5.4% is considered swampy, mountainous or otherwise unusable. Study population included both sex and all age groups of indigenous small ruminants managed in free grazing system. As of the statistical agency data, the estimated total human population of the district was estimated at of 169,940, of which 86,633 are men and 83,307 are women; 19,506 or 11.48% of its

population are urban dwellers. The community principally dependent on agriculture and livestock production economic income (CSAGAW, 2013).

2.2. Sampling method and sample size

The study district was selected purposively as no study conducted in the district previously and population number of small ruminants, whereas Kebeles/PAs and study units (sheep and goats) were selected randomly. Sample size was determined by setting 50% expected prevalence, 95% confidence internal and 5% absolute precision. The total number of animals to be included in the study were determined using the Thrufield (2005) formula.

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

Where

n= Required sample size
d= Desired absolute precision
P_{exp}= Expected prevalence (50%)

Accordingly, 384 animals have to be included in the study; however, 400 small ruminants were included in this study.

2.3. Sample collection and study methodology

2.3.1. Collection and transportation of sample

Of each animal selected, about 15 grams of fecal samples were collected from rectum of sampling units into labeled (species, sex, age, date and area name) sterile plastic bottles using disposable glove. Then, the samples were kept in ice box and transported to Parasitology laboratory, College of Veterinary Medicine and Agriculture, Addis Ababa University, Bishoftu. During sample collection, species of animals, sex, age groups, body condition and deworming status of the animals were considered as explanatory variables.

2.3.2. Coprological laboratory analysis

Screening of larvae (L1) of the lungworm was performed for each sample using modified Baermann technique (Conboy, 2006). About 10 grams of feces taken and wrapped with gauzes, fixed on a string-rod on the conical flask and submerged in a conical flask filled with warm water of about 45°C which covers about ¾ of the fecal samples. Next, the samples were kept undisturbed for about 24 hours. Then supernatants were discarded and samples left at the bottom were examined for moving lungworms larvae under stereomicroscope. Positive samples were subjected to further examination for species identification under low power objective microscope fixed by iodine solution (1%). Species identification of lungworms was performed using the methods described by Van et al. (2004). Accordingly, larvae (L1) of *Dictyocaulus filaria* were characterized by larger size, brown color due to food granules in their intestinal cells with cranial cuticular knob and blunt tail while L1 of *Muellerius capillaris* were found to be smaller in size, whitish in color with "S" shaped tip and dorsal spine while L1 of *Protostrongylus* were uniquely identified by whitish color and smaller size possessing similar "S" shaped tip that is similar with L1 of *Muellerius capillaris* but without dorsal spine.

2.3.3. Questionnaire survey and data collection

Based on the consent of each animal owner, structured questionnaire were administered to each interviewee aimed at gathering valuable data pertaining to the disease. Variables regarding each sampled species of animal included sex, age, deworming history, body condition, specific PA and date of sampling were properly recorded on the prepared paper format. Age of each animal was determined by dentition and categorized as young (less than 1 year old) and adult (greater than 1 year old) (Girma and Alemu, 2008). Body condition of each animal was determined based on the criteria set by Nicholson and Butterworth (1996). Animals were visually assessed, followed by palpation of the area around the lumbar vertebrae between the back of the ribs and the front of the pelvic bones. Body conditions of each sampled animal were conducted as of the method described and categorized into 3 scores as poor, medium and good.

2.3.4. Data management and analysis

Relevant data recorded during sample collection and laboratory processing were transferred to Microsoft Excel Spreadsheet and classified, entered, coded and finally filtered. Organized data were further analyzed using IBM SPSS version 20.0 tool. Descriptive statistics was computed to determine the overall prevalence of the disease in shoats and the prevalence of parasitic infection by animal species as well as the prevalence of each parasitic species. Chi-square statistic was computed to determine the association of risk factors with parasite positivity. Statistically significant risk factors were further computed using Odds ratio (OR) and 95% confidence interval (CI) to find out the strength of association between the statistically significant risk factors and the parasite positivity. Descriptive statistics was computed to determine the overall prevalence of the disease in shoats and the prevalence of parasitic infection by animal species as well as the prevalence of each parasitic species.

3. Results and discussion

A total of 400 fecal samples examined (288 sheep and 112 goats) of which 179 were positive for lungworms with overall prevalence of 44.8%. Statistical manipulation of parasitic positivity by animal species revealed prevalence record of 45.5% and 42.9% in sheep and goats, respectively. Similarly, the prevalence of each identified species of lungworm parasitic species was computed: D. *filarial* 68 (17%), *M. capillaris* 58(14.5%), *P. rufescens* 21(5.3%) as well as mixed infection (*D. filarial* and *M. capillaris*) 32(8%) (Table 1 and Fig. 1).

Table 1
Summary of prevalence of lungworm species based on species of parasite.

Species of lungworm	No Positive	Prevalence (%)
D. filarial	68	17
M. cappilaris	58	14.5
P. rufescens	21	5.3
Mixed infection	32	8
Total	179	44.8

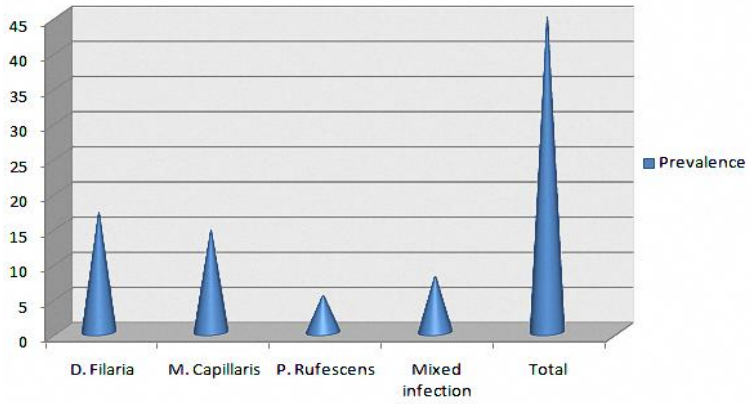

Fig. 1. Prevalence of lungworms in the study area.

In an attempt to determine the association of risk factors on the occurrence of the disease, Chi-Square statistics computation revealed statistically significant association factors including sex, age, body condition and deworming of parasite as summarized in Table 2. Chi-Square computation evinced the existence of statistically significant association between parasitic positivity and sex of the animals ($P<0.05$). Higher lungworm infection was recorded in female (48.8%) compared to male (37.5%). Chi-Square statistics showed significant association ($P<0.05$) between age of animals and lungworm infection. Higher prevalence of lungworm infection was recorded in young (53.3%) than adult (36.3%). Statistical operations showed a statistically significant association of animals' body condition with the disease ($P<0.05$). Higher prevalence of lungworm infection was recorded in animals with

poor body condition (66.9%) followed by medium (37.5%) and good body condition (31.9%) and was statistically significant. Similarly, Chi-Square computations evinced higher prevalence of lungworm infection in animals nondewormed with an anthelmintic (49.2%) compared to dewormed ones (37.2%) with statistically significant association (P<0.05).

Table 2
Summary of lungworm prevalence associated with risk factors.

Risk factor	Variables	No Examined	No Positive	Prevalence %	X^2	P-value
Species of animal	Caprine	112	48	42.9	0.225	0.635
	Ovine	288	131	45.5		
Sex	Female	256	125	48.8	4.78	0.029
	Male	144	54	37.5		
Age	Young	199	106	53.3	11.62	0.001
	Adult	201	73	36.3		
Body condition	Poor	121	81	66.9	35.4	0.00
	Med.	160	60	37.5		
	Good	119	38	31.9		
Deworming status	No	252	124	49.2	5.47	0.019
	Yes	148	55	37.2		

Chi-Square computations revealed a statistically nonsignificant association between the disease occurrence and locality or geographic distribution of animals or PA (P>0.05) as indicated in Table 3.

Table 3
Summary of prevalence of lungworms based on study area (PA).

Study area	No Examined	No Positive %	Prevalence %	X^2	(P-value)
Bonota dabara	90	39	43.3		
Dalati burkitu	62	34	54.8	5.12	0.275
Chofira shashe	74	32	43.2		
Huluko chakaso	90	43	47.8		
Luko titu	84	31	36.9		

Of the five variables considered, Chi-Square revealed four variables associated with the disease. Multivariate logistic regression was employed to compute Odds Ratio (OR) and 95% confidence interval (CI) in order to determine the strength of association of each statistically significant variable with parasitic positivity. Computation outputs are summarized in Table 4.

Table 4
The strength of association between lungworm and risk factors.

Risk factor	Variables	No Examined	No Positive	Prevalence %	OR (CI 95%)	X^2	P-value
Sex	Female	256	125	48.8	0.629	4.78	0.029
	Male	144	54	37.5	(0.414-0.954)		
Age	Young	199	106	53.3	0.500	11.6	0.001
	Adult	201	73	36.3	(0.335-0.747)		
Body condition	Poor	121	81	66.9			
	Med.	160	60	37.5	0.296	35.4	0.00
		119	38	31.9	(0.18-0.487)		
	Good				0.232		
					(0.135-0.398)		
Deworming status	No	252	124	49.2	0.610	5.47	0.019
	Yes	148	55	37.2	(0.403-0.924)		

The present study recorded an overall prevalence of 44.8% in small ruminants in the selected study area. Moreover, prevalence of 45.5% and 42.9% was recorded in sheep and goats, respectively. The present finding is almost in agreement with the reports of Sisay (1996) 44.7% in Bahir Dar, Alemayehu et al. (2010) 40.4% in Dessie and Kombolcha districts, Shumye et al. (2016) 43.76 % in and around Gondar Town and Muhammed et al. (2016) 45% in Hitosa Woreda. Comparatively, the present study recorded lower prevalence rate than the reports of (Alemu et al., 2006; Eyob and Matios, 2013; Serkalem et al., 2014; Abeje et al., 2016; Abdela et al., 2016; Hubado et al., 2017) who reported overall prevalence of lungworm infection in small ruminants: 53.60%, 72.44%, 55.20%, 57.6%, 66.67%, 59.9%, in Asella province, in North Gondar zone, in Dale district, Bale and Arsi zone, district, Munesa in Assela and its surroundings, respectively.

On the other hand, the present study recorded a relatively higher overall prevalence compared to reports of (Adugna et al., 2011; Addis et al., 2014; Gebreyohannes et al., 2013; Fentahun et al., 2012; Desta et al., 2013). Variation in overall prevalence of lungworm infections in small ruminants across the study sites might be attributed to the climate, altitude, intermediate hosts and favorable ecological conditions such as rainfall, humidity, temperature, and marshy area for grazing, sheep and goat management system of the respective study areas for the development of lungworm species, the methods used for the detection of the larvae, differences in the samples sizes used during the various investigations, seasonal variation during the investigation period, variation in the nutritional status of the animals and the degree of availability of animal health extension and veterinary services and appropriate drugs (Getachew et al., 2015).

Statistical computation indicated a higher prevalence (53.3%) in younger animals than adults (36.3%) with statistically significant difference ($P<0.05$). The present finding is also in agreement with (Wondwossen, 1992; Abdella et al., 2016; Dawit and Abdi, 2012; Gebreyohannes et al., 2013; Desta et al., 2013; Nibret et al., 2011) who reported as young sheep harbor more lungworms compared to adult sheep indicating the decrease of susceptibility to lungworm infection with concomitant increase in age of animals. This may be attributed to the apparent inability of the host to develop acquired immunity compelling young animals to have heavier parasitic infection burden and higher prevalence rate (Soulsby, 1982) while in adult sheep and goats after primary infection, rapid solid immunity is developed and sheep and goats continually exposed to infection at low rate resulting in the decrease of infection (Urquhart, 1994).

The present study revealed as *D. flaria* (17%) was the dominant species in the area followed by *M. capillaris* (14.5%) whereas *P. rufescens* (5.3%) was found to be the least prevalent. This finding is inline with (Netsanet, 1992; Nemat and Moghadam, 2010; Dawit and Abdua, 2012; Cabaret, 2009; Nuraddis and Yared, 2012). In contrast to this finding (Sissay, 1996) in Addis Ababa reported that *M. capillaris* was the most prevalent species. However, the dominance of *D. flaria* in the study area might be attributed to the difference in the life cycles of the parasites. *D. flaria* has a direct life cycle and requires shorter time to develop to an infective stage as described by Soulsby (1982), after ingestion, the larvae of these parasites can be shed with feces within 5 weeks. Compared to *D. flaria,* the transmission of *P. rufescens* and *M. capillaris* is epidemiologically complex event involving host, parasite and intermediate host. Moreover, the low prevalence of both *M. capillaris* and *P. rufescens* in the study are might be attributed to the fact that the study was done in dry season, which does not favor the development of the snail intermediate hosts of *M. capillaris* and *P. rufescens.* In sheep, slugs or snails are required as intermediate hosts, which must be eaten for infection to occur (Mark Vet Manual, 2011). Mixed infection was observed in the current study similar to previous studies by Abeje et al. (2016) and Hansen and Perry (1994).

The present study revealed the direct impact of sex on the disease occurrence indicating higher prevalence of 48.8% in females compared to 37.5%) in males. The association of lungworm infection in relation to sex of animals was found to be statistically significant ($P<0.05$). This finding agrees with the previous works done by Tewodros (2010) in and around Bahir Dar and Tigist (2009) in North and South Gondar, female 28.9%, male 13.4% and female 43.3% and male 33.57%, respectively. Similarly, Addis et al. (2011) reported the prevalence of lungworm infections 36.22% and 30.43% in female and male animals, respectively, in Gondar town. The sex wise difference may be due to resistance to infection abrogated at the time of parturition and during early lactation. This pre-parturient relaxation of resistance results in the female inability to expel adult worms which cause higher level of larvae detection (Crawing, 1998). In addition, it can also be associated with difference in the number of samples in both sexes during specific study duration.

The present study has confirmed as the selected sites have no statistically significant association ($P>0.05$) with lungworm infection in shoats. The present study finding agrees with the report of Desta et al. (2013) in Ambo and Wondwossen (1992), in and around Asella. Unlike the present study, significant association of study area on

lungworm infection was reported by Alemu et al. (2006). The significant association of the study area with the disease reported by these researchers could be attributed to the fact that they had collected their samples from highland, midland and lowland of differing agroecological zones which are supposed to influence disease occurrence unlike the current study where all samples were collected within the same agroecology of highland altitude area.

As of the present study, body condition of shoats was found to play a role on lungworm infection in the animals. The prevalence of lungworm infection was higher (69.9%) in animals of poor body condition than medium body condition (37.5%) and good body condition (31.9%) with concomitant statistically significant difference ($p<0.05$). The present finding is consistent with Alemu et al. (2006) who reported higher prevalence in animals with poor body condition. The association might be linked to nutritional management of animals which would result in lack of resistance to infection and contribute for increased prevalence rate in poorly body conditioned animals. Moreover, considerable weight loss was associated with infection as a result of *D. filaria* as reported by Thomson (2008). Poorly nourished sheep and goat appeared to be less competent in getting rid of lungworm infection. Obviously, the infection with a parasite by itself might results in progressive emaciation of the animals (Radostits et al., 2007).

The dissimilarity with anthelmintic treatment is clearly signifying as the non-dewormed (49.2%) have high infection prevalence than dewormed (37.2%) and it was statistically significant ($P<0.05$). This could be attributed to the fact that the drugs kill the lungworm parasites reducing their prevalence. The current assessment has also made out the absence of significant degree of association of lungworm infection between species of study animal (sheep and goat) ($P>0.05$).

Consistent with the present finding, most of the previous studies in which *D. filaria* remained the dominant lungworm, have reported absence of significant variation between the two hosts (Eyob and Matios, 2013; Thrusfield, 2005; Weldesenebet, 2012; Girisgin, 2008). In contrast, in studies dominated by the small lungworms (*M. capillaris*), significantly higher prevalence rates were noted in goats than in sheep (Alemu, 2006). The present and previous studies in Ethiopia suggested that variations between sheep and goats in susceptibility to lungworm infections depend on the species of the parasite involved. However, in infections dominated by *D. filaria*, had no significant difference in prevalence between the two hosts however in infections dominated by small lungworms, goats were found to be more susceptible than sheep.

4. Conclusion

The present study evinced an overall prevalence of lungworm in sheep and goats which falls with medium category in the study area. The study identified three small ruminants' nematode lungworms with the dominance of *Dictyocaulus filaria* followed by *M. capillaris* and *P. rufescens.* Chi-Square statistics and logistic regression analysis confirmed the existence of association and statistically significant association of sex, age, body condition of animals and anthelmintic treatments on the disease occurrence, respectively. It has been shown that sheep were found more susceptible than goats to lungworm infestation though association was nonsignificant. The combination of high prevalence together with the existence of all important lungworm species signals that the disease could be the possible threat to small ruminant industry. Therefore, public awareness should be made on regular basis so that parasitic economic impacts as well their control methods be understood more and season wise studies should be undertaken to establish the exact seasonal dynamics and epidemiology of the disease.

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