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Research Article

Prevalence and associated risk factors of Lungworm infection in cattle in and around Haramaya town, eastern Ethiopia

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Abstract

Lungworms are parasitic nematodes of the family Strongylidae that infect the lungs of cattle and other domestic animals, causing pneumonia and bronchitis. These illnesses are found all over the world, including Ethiopia. A cross-sectional study was conducted from December 2022 to May 2023 in and around Haramaya Town, Oromia Regional State, Ethiopia. The objectives of the present study were to estimate the prevalence of lungworm infection in cattle and identify associated risk factors in and around Haramaya Town. A total of 384 randomly selected cattle were examined using the modified Baermann technique to detect first-stage larvae (L1) larvae of lungworms. The overall prevalence of lungworm infection was 6% (23/384). Age group, body condition, and kebele were significantly associated with infection ($P < 0.05$), while sex and breed were not. The lungworm infection was higher in the young age group (11.1%) and poor body conditioned (9.47%) cattle. Lungworm infection remains an important parasitic disease of cattle in the study area. Routine and strategic deworming, coupled with improved management practices, are recommended to reduce its prevalence.

Key words: *Cattle, Haramaya*, *Lungworm, prevalence, risk factors*

1. INTRODUCTION

The livestock sector plays a vital role in the national economy of developing countries. It plays a great role in food supply, a source of income and foreign currency (CSA, 2023). Currently, Ethiopia holds the largest livestock population in Africa with approximately 59.5 million cattle, 30.7 million

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sheep, 30.2 million goats, 4.5 million donkeys, 1.7 million horses, 0.33 million mules, 56.53 million poultry, and 4.9 million beehives (CSA, 2023). Livestock suffers from different diseases and among them parasitic problem is important in hindering the development of livestock (Mahmood *et al.,* 2014). Dictyocaulus is a genus of very harmful parasitic roundworms that infects cattle, sheep, goats, horses and many other domestic and wild mammals (Taylor et al., 2007; Dima and Fikedu, 2021). Lungworm infection in cattle is caused by the nematode parasite *Dictyocaulus viviparous* (*D. viviparous*), the only lungworm found in first season grazing calves but also in adult cattle and is characterized by respiratory distress, bronchitis and pneumonia (May *et al.,* 2018). 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 age of the host (Alemayehu, 2020). Diagnosis is based on clinical signs, postmortem findings and laboratory testing to detecting lungworm larvae in feces (Fentaw *et al*., 2018).

Although there is a lot of evidence on bovine lungworm in temperate regions with pleasant weather and high to average rainfall, it is scarce and very infrequent in tropical regions (Lat-Lat *et al*., 2007). Lungworm are known to exist in east Africa (Ethiopia, Kenya, Tanzania and South Africa) and also it cause major mortality and morbidity in different part of Ethiopia (Wondmnew *et al*., 2016; Wodaje *et al*., 2021). However, there is a dearth of published information on the prevalence of bovine lungworm and its associated risk factors in the study area. Therefore, the objectives of this study were: To determine the prevalence of bovine lungworm infection and to assess its associated risk factors in the study area.

2. MATERIALS AND METHODS

2.1. Study area

The study was conducted in and around Haramaya town of Haramaya District (Figure 1), Oromia region, eastern Ethiopia. Haramaya district is one of the 24 districts in east Hararghe zone which is located at 520 km from Addis Ababa; capital city of Ethiopia, and 20 km from the historical city, Harar. Geographically the study site located at 41°59’58’’ North latitude and 90°24’10’’ South longitudes. The elevation of this area is about 2000 meters above sea level and its mean annual temperatures ranges from 10°C to 18°C with the relative humidity of 65%. The area receives an annual rain fall of 800 millimeters within a bimodal distribution of the season’s pattern peaking in mid- April and mid-August of the year. The district is home to roughly 116,089 cattle, 88,344 sheep,

134,520 goats, 33,466 donkeys, 570 camels, and 138,675 chicks, according to data from the Haramaya district agricultural statistics. The district uses a mixed type production system. The open acacia shrub land is dotted with native grasses and legumes, making up the majority of the vegetation that makes up the area's pasture lands (HWAO, 2023).

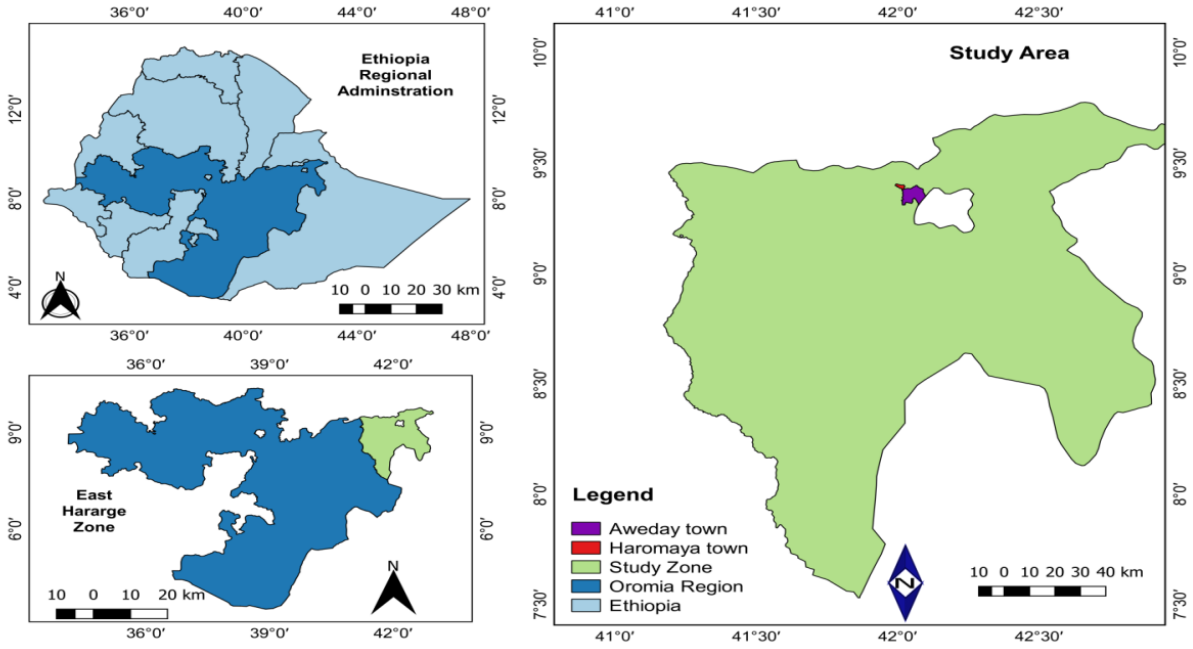


Figure 1. Map of the study area

2.2. Study population

Cattle were the study population in and around Haramaya town. For this study cattle of both sex (male and female), all age groups, body condition and both cross and local breeds were considered as the study animal characteristics. The age of cattle was estimated based on owner information and examining the dentition patterns according to the recommendation given by Dyce*et al*. (2009) and grouped into young (<2years), adult (≥2-5years) and old (above 5 years) age group. The body condition score of cattle were given according to (Bewley and Schutz, 2008.) with a scale of 1.0 to 9.0 and categorized into good (7, 8, 9 were as classified as good/fat), medium (4, 5, 6, were as medium), and poor (2, 3) were as categorized as poor/lean) body conditions.

2.3. Study design and period

Cross-sectional study was conducted from December 2022 to May 2023 to estimate the prevalence and identify associated risk factor of bovine lungworm in the study area.

2.4. Sample size and sampling method

Since there was a lack of available published previous data on lungworm infection report in cattle in the study area, an expected prevalence of 50% and 5% absolute precision were used to calculate the sample size using the formula provided by Thrusfield (2018) as follow (Equ. 1):

$$n = \frac{1.96^2 * Pexp(1-Pexp)}{d^2} \quad \text{..... Equ. 1}$$

Where, n= Sample size, Pexp = expected Prevalence, d = absolute desired precision (5%). Therefore, based on the above formula the total sample size was 384.

With the district the 4 kebeles were selected randomly from the list kebeles. Finally the study animals within the selected kebeles were sampled using simple random sampling (lottery) method. The number of local and cross breeds were sampled proportionally based on their population in the study kebeles.

2.5. Sample collection and laboratory procedure

Fecal sample was collected directly from the rectum of the cattle, after wearing disposable gloves and all samples were clearly labeled with the necessary identifier information of the animals such date of sampling, sex, age, breed, body condition score of the cattle and the site where sample was taken. The samples were transported promptly to the Veterinary Parasitology Laboratory, Haramaya. All fecal samples were processed within 24 hours.

Using modified Baermann technique 10 grams of fresh feces was weighted from each sample for the extraction of first stage larvae (L1). Briefly, each sample was enclosed with double layered gauze fixed on to a string rod and submersed in a clean glass beaker filled with Luke water. The whole apparatus was left in place for 24 hours during which time larvae actively move out of feces and ultimately collect by gravitation in the glass beaker and the supernatant was discarded. After that, a small amount of sediment was transferred to a microscopic glass slide using pipette for examination of L1 under low power (x10) of the microscope. L1 larvae were detected and identified following Bowman (2014).

2.6. Data management and analysis

The collected and generated data were entered and coded in Microsoft Excel (2010) and the data was analyzed by using STATA version14.2. Descriptive statistics such as percentages were used to describe the prevalence of lungworm infection. The relationships between the prevalence of lungworm infection with age (young and adult), sex (male and female), breed (local and cross), kebele (01, 02, Adele and Tuji gebisa) and body condition (poor, medium and good) were tested by using the Pearson Chi-Square test. The level of significance was tested at $P< 0.05$.

2.7. Ethical clearance

During sample collection, the best practice guidelines for veterinary care were followed in order not harm animals. The college of Veterinary Medicine and Animal Sciences, University of Gondar College Review and Ethical committee (CREC) approved the verbally informed consent process with reference number CVMASc: 75/2023 on date 7/01/2023. Animal owners were informed about the purpose of the study for the collection of fecal samples. After providing adequate information and clarification, verbal/informed consent was obtained from each owner before sample collection.

3. RESULTS

3.1.Prevalence and Risk Factors

The overall prevalence of lungworm infection in cattle was 6% (23/384) [95% CI: 3.9-8.6%). First-stage larvae (L1) of *Dictyocaulus viviparus* were successfully recovered from 23 positive fecal samples. The larvae exhibited the characteristic morphological features of *D. viviparus*, including a distinctively granular intestinal tract and a blunt, smoothly tapered tail—features that are consistent with established descriptions used for reliable species differentiation.

Variation across age groups, body condition scores, and kebeles is summarized in Table 1. Young animals and those with poor body condition showed higher infection rates, and prevalence also differed across kebeles, with Adele exhibiting relatively higher levels. The associated Chi-square tests indicated significant associations between these factors and lungworm infection status ($P <0.05$). Regarding kebeles, relatively higher prevalence was observed in Adele and Tuji Gebisa—both located around Haramaya Town—compared with the kebele situated within the town (Kebele 01 and 02). The prevalence of lungworm infection in crossbred animals was also higher than in local breeds; however, this difference was not statistically significant (Table 1).

Table 1. Association of the prevalence and risk factors of bovine lungworm infection in and around Haramaya town

Risk factor	Category	No.Examined	No.of positive N(%)	$\chi 2$	*P-value*
Sex	Male	127	6(4.7)	0.5394	0.463
	Female	257	17(6.6)		
Age	Young	108	12(11.1)		
	Adult	208	9(4.3)	7.1744	0.028
	Old	68	2(2.9)		
Body cond*	Poor	95	9(9.47)		
	Medium	155	13(8.38)	10.0884	0.006
	Good	134	1(0.7)		
Breed	Local	273	17(6.2)	0.0946	0.758
	Cross	111	6(5.4)		
kebele	Adele	82	11(13.4)		
	01	79	2(2.5)		
	02	76	1(1.3)	12.6592	0.005
	Tuji gebisa	147	9(6.1)		
Total		384	23(6)		

***Key**: body cond*=body condition, No. = number, $\chi 2$=Chi-square*

3.2. Limitation of the study

The Modified Baermann technique, while widely used for detecting first-stage lungworm larvae, has inherent limitations. Its sensitivity is influenced by the freshness of fecal samples, larval output variability, and the intermittent shedding pattern of infected animals. Consequently, this method may underestimate the true prevalence, particularly in early or low-grade infections. These methodological constraints should be considered when interpreting the findings of the present study. In addition, cross-sectional studies provide only a single time-point "snapshot," which makes it impossible to establish causality or determine the temporal sequence between exposure and outcome. They cannot measure incidence, may miss rare or short-duration diseases, and are prone to survival, confounding, and misclassification biases.

4. DISCUSSION

The overall prevalence of bovine lungworm infection in the study area was found to be 6% (23/384; 95%CI: 3.9-8.6%) in this study. This finding is in line with the previous studies reports by Mahmood *et al. (*2014) who reported the prevalence of (4.88%) from Faisalabad, in Pakistan; Höglund (2004) who reported the prevalence of (5%) in Sweden; Fesseha and Mathewos (2021) who reported the prevalence of 3.98% at Durame District, Southern Ethiopia.

However, the current prevalence report is not in line with various reports in Ethiopia and abroad. Therefore, the current study prevalence report is lower than the finding of Ashango *et al. (*2020) who reported the prevalence of (34.3%) in Tiyo District, Central Ethiopia; Yihenew and Temesgen, (2017) who reported a 10% prevalence in Kembibit District, Central Ethiopia; Mohammad *et al.,* 2015) who reported the prevalence of (47.5%) in Iran Tebriz city; Ergün (1961) who reported 70% prevalence in Turkey that the cattle was imported from other country, and Schunn *et al. (*2013) who reported the prevalence of (17.1%) in German dairy cattle herds. On the contrary, higher prevalence of lungworm infection in cattle was recorded in the current study than the report of Wodaje *et al. (*2021) at Gondar Elfora Abattoir, North West Ethiopia (3.75%); Fekadu (2008) who reported (0.5%) in Addis Ababa abattoir, Ethiopia; Wolde and Mersha, (2016) who reported (1.5%) at Addis Ababa abattoir, Ethiopia; Menzir and Dessie (2017) who reported in Gondar town, North Ethiopia (3.1%), and Yildiz (2006) who reported the prevalence of (70%) in bursa city in turkey.

This variation is might be attributable to a combination of socio-ecological characteristics of the Haramaya production environment, causal pathways associated with identified risk factors, and methodological or agro-ecological differences among studies. Studies employing highly sensitive diagnostic techniques such as the necropsy are expected to report higher prevalence estimates than those utilizing less sensitive approaches such as Baermann method. Agro-ecological factors—including temperature, humidity, and altitude—further shape the epidemiology of lungworm infection (Lat-Lat *et al.,* 2007). Moist, high-altitude regions provide favorable conditions for larval development and survival, explaining the relatively higher prevalence documented in such settings relative to the semi-arid environment of Haramaya.

The present study revealed that prevalence of lungworm infection based on age group was slightly higher in young cattle (11.1%) than adult (4.3%) and old (2.9%). The difference by age group was statistically significant ($P<0.05$). This finding in agreement with the previous reports conducted by (Mahmood *et al*., 2014) in Faisalabad, Pakistan, <1year,1-3 year and above 3 year with the prevalence of 6.42%, 2.91% and 3.73%, respectively. The variation of lungworm prevalence in the age groups might be explained by the fact that lungworm infection occurs in previously unexposed cattle such as in calves or moved cattle because during first grazing the animals highly susceptible to the parasites (Holzhauer *et al*., 2011). It could be due to the reason that the older animals may develop immunity and did not shed larvae of nematodes (Mahmood *et al*., 2014; Forbes, 2018).

In relation to the animals' body condition, there was a statistically significant difference in the prevalence rate of lungworm infection among cattle with poor (9.47%), medium (8.34%), and good body condition (0.7%) ($P<0.05$). This result was consistent with the findings of Juvenal *et al.* (2010), who indicated that the prevalence in medium, poor, and good body conditioned cattle categories was 8.7%, 8.9%, and 7.3%, respectively. In addition, the current finding is in line with the finding of Wolde and Mersha (2016) and Desa *et al. (*2019) who indicated that higher prevalence was observed in cattle with poor body condition against the infection. Their study indicated in medium (0.97%), poor (3.8%) and good body conditioned cattle (0.79%) at the Addis Ababa abattoir, and in medium (4.35%), poor (5.70%) and good body conditioned cattle (3.85%) in Bedele, south west Ethiopia, respectively.

The higher prevalence of lungworm infection in poor body condition animals is likely due to a combination of predisposition from nutritional and immune deficiencies**,** direct pathological effects of infection and behavioral or management factors that increase exposure. This represents a bidirectional relationship, where poor body condition increases susceptibility, and infection further exacerbates condition decline.

Regarding the kebele where fecal samples were taken from the cattle, higher prevalence was recorded from Adele kebele (13.4%) followed by Tuji gabisa kebele (6.1%), which is in turn followed by kebele 01 (2.5%) and kebele 02 (1.5%). The statistical analysis showed that there is a statistically significant difference in the prevalence rate of lungworm infection among the study kebeles. The observed variation in lungworm prevalence among the study kebeles, with Adele kebele exhibiting the highest prevalence (13.4%) and Kebele 02 the lowest (1.5%), can be attributed to differences in deworming practices, livestock management systems, and nutritional status**.** Irregular or infrequent anthelmintic treatment in some kebeles may allow the accumulation of infective larvae in grazing areas, sustaining transmission. In contrast, kebeles with more controlled grazing or improved herd management experience lower exposure. Nutritional status also plays a critical role; animals with inadequate or low-quality feed have compromised immunity, making them more susceptible to infection. The higher prevalence observed in Adele kebele likely reflects the combined effect of insufficient deworming, extensive grazing systems, and suboptimal nutrition, whereas kebeles with better herd management and nutritional conditions exhibit reduced prevalence.

In the current study higher level of prevalence was observed in female animals (6.6%) when compared to that of male animals (4.7%). However, the sex variation was not statistically significant associated (P>0.05). This result was in line with the finding of Mahmood *et al.* (2014) who reports 4.15 and, 6.11% prevalence rate in male and female, respectively from Faisalabad, in Pakistan. Hence this signifies that sex seems to have no impacts on infection rates and both sexes are believed to have almost equal susceptibility to infection with lungworms (Shapiro and Patricia, 2010). In addition, these may be due to the fact that improper distribution of sample selection between the two sexes (Bain and Fan, 2012).

Even though there is no statistical significant variation in the prevalence of lungworm infection in cross (5.4%) and local cattle breed (6.2%) (P >0.05), slightly higher prevalence rate was recorded in the latter. This finding is in line with report of Desa *et al. (*2019) who reported the prevalence of lungworm infection in local breeds was 4.70% and in cross breeds (4.62%). This difference in prevalence between cross and local breeds of cattle might be due to the reason that the management practice of the farmer such that local breeds do have low management practices than cross breeds.

5. CONCLUSION AND RECOMMENDATIONS

In this study an overall 6% prevalence of lungworm infection in cattle was determined. The prevalence was slightly higher in goats than in sheep. The risk factors identified were age group, body condition score, and study kebeles. Young animals, those with poor body condition and animals in Adele kebele showed higher infection rates and this variation was indicated to be significant associations between these factors and lungworm infection status.

Consequently, considering the chronic nature of the disease in cattle, single season and cross sectional study design, and low sensitivity of Baermann technique as a diagnostic approach, the current study came to the conclusion that lungworm infection in cattle is a problem.

It is recommended that strategic and periodic deworming programs against lungworm infection in cattle be regularly implemented. In addition, awareness creation programs should be organized for animal owners to enhance their knowledge of the transmission, prevention, and control of lungworm infections. Furthermore, further studies employing advanced diagnostic approaches are recommended to clarify issues related to the seasonal variation of lungworms in all domestic animals, while also considering different management systems within the study area.

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Conflict of Interest

The authors declare no conflict of interests.

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