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Cestode and Trematode Infections in Sheep: Epidemiology, Economic Impact, and Control Strategies in Gondar, Central Gondar zone, Northwestern Ethiopia

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Research Article

Keywords: Cestodes, Ethiopia, parasite control, prevalence, sheep, trematodes

Posted Date: July 21st, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10395696/v1

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Additional Declarations: The authors declare no competing interests.

Abstract

Cestode and trematode infections are among the major parasitic diseases limiting sheep production in Ethiopia, particularly in the study area. However, there is limited information on their combined epidemiology, economic impact, and control practices in the study area. Thus, a cross-sectional study was conducted from August 2024 to September 2025 to investigate the epidemiology, economic impact, and control strategies of cestode and trematode infections in sheep in Gondar, the Central Gondar zone, Northwestern Ethiopia. A total of 384 sheep were examined for cestode and trematode infections using flotation, sedimentation, and the McMaster method for egg count determination. In addition, a questionnaire survey was administered to 150 sheep owners to assess economic impact and parasite control practices. Data were analyzed using descriptive statistics and binary logistic regression, with odds ratios (OR) and 95% confidence intervals (CI) used to determine associations between risk factors and infection. The overall prevalence of cestode and trematode infections was 50.0% (95% CI: 45.0–55.0). Trematodes were more prevalent than cestodes, with *Fasciola spp.* (25.0%) being the most dominant parasite, followed by *Paramphistomum spp.* (14.06%), *Schistosoma spp.* (3.65%), and *Moniezia spp.* (7.29%). Logistic regression analysis showed that adult sheep (AOR = 1.80, 95% CI: 1.15–2.75), poor body condition (AOR = 3.50, 95% CI: 2.00–6.10), and extensive management systems (AOR = 2.90, 95% CI: 1.80–4.70) were significantly associated with infection ($p < 0.05$). The estimated total economic loss was 385,750 ETB, mainly due to mortality and reduced body weight. Although 73.3% of farmers were aware of parasitic infections, only 26.7% practiced regular deworming. In conclusion, cestode and trematode infections are highly prevalent and economically important in sheep production in the study area.

1. Introduction

Sheep production is a cornerstone of Ethiopia's agricultural economy, with an estimated 39.89 million sheep contributing to meat, income, manure, food security, rural livelihoods, and socio-cultural value (CSA, 2024). Ethiopia possesses one of the largest sheep populations in Africa; however, productivity remains low due to multiple constraints, among which parasitic diseases are of paramount importance (Mergers et al., 2024; Tesema et al., 2023). Among these, parasitic diseases caused by cestodes and trematodes are widely recognized as major health problems affecting sheep in tropical and subtropical regions.

Cestodes and trematodes are health parasites with complex life cycles involving intermediate hosts, which facilitate their persistence in diverse ecological settings (Megersa et al., 2024; Sara et al., 2024). Trematodes, particularly *Fasciola* spp., *paramphistomes*, and *Schistosoma* spp., are associated with aquatic environments and depend on snail intermediate hosts, making their distribution closely linked to agroecological and climatic conditions (Mergers et al., 2024). Similarly, cestodes such as *Echinococcus granulosus* and *Moniezia* spp. Infect sheep and contribute to both veterinary and public health burdens. For instance, cystic echinococcosis, a cestode infection, has been reported with a pooled prevalence of about 24.3% in sheep in Ethiopia, indicating its widespread occurrence (Samba et al., 2024).

In Ethiopia, parasitic helminthes, including cestodes and trematodes, are among the major factors limiting sheep productivity. These parasites commonly inhabit the gastrointestinal tract or associated organs such as the liver, leading to chronic infections (Terra et al., 2023). The impacts include reduced weight gain, poor feed conversion efficiency, decreased fertility, anemia, and increased susceptibility to other diseases (Terra et al., 2023). In addition, trematode infections like fasciolopsis condemn livers at slaughterhouses, causing direct economic losses, while cestode infections lead to carcass and organ rejection, further exacerbating financial losses for farmers and the meat industry (Sarba et al., 2024). In Ethiopia, these parasites are estimated to reduce sheep productivity by up to 30%, undermining household income and national livestock GDP (Win et al., 2020). Treatment costs, carcass condemnation, and reduced market value further compound the burden (Tamara, 2025).

Epidemiological studies conducted in different parts of Ethiopia have revealed considerable variation in the prevalence of health infections due to differences in climate, management practices, and animal husbandry systems. For example, a study conducted in and around Gondar reported an overall gastrointestinal health prevalence of 59.11% in sheep, with cestodes accounting for 4.18% and trematodes for 1.47% of infections (Multan et al., 2012). Similarly, other studies across Ethiopia have reported high levels of parasitic infections, emphasizing the widespread nature of the problem and its dependence on environmental and management-related risk factors (Tasmania et al., 2022; Sissy et al., 2007).

Despite the recognized significance of cestode and trematode infections, research in Ethiopia, particularly in Gondar, has predominantly addressed gastrointestinal helminths in general, without generating parasite-specific epidemiological insights. Moreover, there is a paucity of studies that integrate epidemiological findings with assessments of economic impact or evaluations of existing control strategies at the local level. This gap is especially pronounced in Gondar, Central Gender Zone, where sheep production constitutes a major livelihood activity, yet comprehensive and up-to-date data on these parasites remain scarce. The lack of such information limits the design and implementation of effective, evidence-based control measures tailored to the local production system. Thus, the present study aimed to investigate the epidemiology, economic impact, and control strategies of cestode and trematode infections in sheep in Gondar, the Central Gondar zone, Northwestern Ethiopia.

2. Materials and Methods

2.1. Study Area and Study Period

The study was conducted from August 2024 to September 2025, in Gondar, Central Gondar Zone of the Amhara Regional State, Northwestern Ethiopia (Fig. 1). The area is characterized by a mixed crop–livestock production system, where sheep play an important role in household income and food security. The zone includes diverse agro-ecological settings ranging from lowland to highland areas, with altitudes between approximately 1,500 and 3,200 meters above sea level. The climate is generally divided into a rainy season (June to September) and a dry season (October to May), with annual rainfall ranging from 700 to 1,200 mm and average temperatures between 15°C and 25°C. These environmental conditions are favorable for the survival and transmission of helminth parasites and their intermediate hosts.

2.2. Study Design and Study Animals

A cross-sectional study design was employed to investigate the epidemiology, economic impact, and control strategies of cestode and trematode infections in sheep in Gonadr, Central Gondar zone, Northwestern Ethiopia. Additionally, a questionnaire survey was conducted to assess farmers' perception regarding parasite control and economic impact. The study animals consisted of indigenous sheep managed under extensive and semi-intensive production systems. Sheep of different age groups, sexes, and management systems and body condition scores were included. Age was categorized as young (≤ 1 year) and adult (> 1 year), while body condition was classified as poor, medium, and good based on standard scoring systems (ESGPIP, 2008). Both clinically healthy and apparently diseased animals were included to obtain representative data.

2.3. Sample Size Determination

The sample size was determined using the formula for estimating sample size in prevalence studies described by Thrusfield (2018). Since there was no recent specific prevalence data for cestode and trematode infections in the study area, an expected prevalence of 50% was assumed to maximize sample size.

$$\mathrm{n} = \frac{1.96^2 Pexp(1 - Pexp)}{d^2}$$

Where n is the required sample size, Z is the value for 95% confidence level (1.96), *Pexp* is the expected prevalence, and *d* is the desired absolute precision (0.05). Thus, the calculated sample size was 384 sheep. The sample size for the questionnaire survey was determined using the formula (n $= \frac{0.25}{SE}$) proposed by Arsham (2002) at the standard error (SE) of 0.04 with a 95% confidence interval. Based on the formula, the total numbers respondent was 150.

2.4. Sampling Techniques

A multistage sampling technique was employed. First, Gondar city was selected purposively based on sheep population and accessibility. Then, kebeles within and around the city were selected by simple random sampling. Finally, individual sheep were selected using simple random sampling from flocks. For the questionnaire survey, sheep owners were selected purposively based on willingness to participate and experience in sheep rearing.

2.5. Data Collection Methods

2.5.1. Sample Collection and Processing

Fecal samples were collected directly from the rectum of selected sheep using clean disposable gloves. 10 grams of feces were placed into labeled universal bottles indicating animal ID, age, sex, body condition, management, and location. Samples were preserved in 10% formalin when immediate examination was not possible and transported to the University of Gondar, Veterinary Parasitology Laboratory, under appropriate conditions by using an icebox.

2.5.2. Fecal Sample Examination

The simple flotation method was used primarily for detecting cestode eggs. Three grams of feces were mixed with flotation solution (saturated sodium chloride), strained, and poured into a test tube. A coverslip was placed on top and left for 20 minutes, then examined under a microscope with 10x magnification. In addition to this, the sedimentation technique was employed for detecting trematode eggs, which are heavier and do not float easily. Fecal samples were mixed with water, strained, and allowed to sediment. The supernatant was discarded, and the sediment was examined microscopically at 10X. Furthermore, the McMaster technique was used to determine eggs per gram (EPG) of feces for estimating infection intensity. When only one chamber was examined, the number of eggs counted was multiplied by 100 to estimate the eggs per gram of feces (EPG), expressed as: $\mathrm{EPG} = (\text{eggs counted in one chamber} \times 100)$. When only one chamber was examined, the number of eggs counted was multiplied by 100 to estimate the eggs per gram of feces (EPG), expressed as: $\mathrm{EPG} = (\text{eggs counted in one chamber} \times 50)$. The intensity of infection was then categorized based on (Zajac and Conboy, 2012; Urquhart et al., 1996) as low infection (< 500 EPG), moderate infection (500–1000 EPG), and high (severe) infection (> 1000 EPG).

2.5.3. Questionnaire Survey

A structured questionnaire was administered to sheep owners to collect data on demographic characteristics, sheep management practices, awareness of parasitic diseases, deworming practices, anthelmintic drug usage, and perceived economic impacts of cestode and trematode infections. The interviews were conducted through face-to-face interaction to ensure clarity of questions, minimize misunderstanding, and improve the accuracy of responses. The questionnaire was initially prepared in English and then translated into the local language (Amharic) for ease of understanding by respondents. After data collection, the responses were retranslated back into English to ensure consistency and to maintain the original meaning of the information collected. The questionnaire was pre-tested in a non-sampled area, and necessary adjustments were made prior to the actual data collection.

2.6. Data Analysis and Management

All collected data were coded and entered into Microsoft Excel 16 and analyzed using SPSS version 20. Descriptive statistics were used to summarize prevalence and questionnaire data. The prevalence of infection was calculated as:

Prevalence (%) $= \frac{\text{Number of infected animals}}{\text{total number of animals examined}} \times 100$. The association between risk factors (age, sex, body condition, and management system) and infection status was analyzed using binary logistic regression (OR) tests. A p-value of less than 0.05 was considered statistically significant. Eggs per gram (EPG) counts obtained from the McMaster technique were categorized into light, moderate, and heavy infections based on standard thresholds. Data quality was ensured through proper sample labeling, standardized laboratory procedures, and careful data entry and validation.

3. Results

3.1. Overall prevalence of cestode and trematode infection

Out of 384 sheep examined, 192 were found positive for at least one cestode or trematode parasite Fig. 3, giving an overall prevalence of 50.0% (95% CI: 45.0–55.0) (Fig. 2). Trematode infections were more prevalent than cestodes. Among the identified parasites, *Fasciola* spp. had the highest prevalence (25.0%, 95% CI: 20.8–29.6), followed by *Paramphistomum* spp. (14.06%) and *Schistosoma* spp. (3.65%). The cestode *Moniezia* spp. showed a relatively lower prevalence (7.29%) in (Table 1).

Table 1
Overall prevalence of cestode and trematode infections (n = 384)

Parasite Type	Parasite Species	Positive (n)	Prevalence (%)	95% CI
Cestodes	*Moniezia* spp.	28	7.29	4.9–10.4
Total Cestodes		28	7.29	4.9–10.4
Trematodes	*Fasciola spp.*	96	25.00	20.8–29.6
	Paramphistomum spp.	54	14.06	10.7–18.0
	Schistosoma spp.	14	3.65	2.0–6.0
Total Trematodes		164	42.71	37.7–47.8
Overall		192	50.00	45.0–55.0
n=number, %=percent, CI=confidence interval				

3.2. Binary logistic regression analysis of associated risk factors

Binary logistic regression analysis revealed that age, body condition, and management system were significantly associated with infection (Table 2). Adult sheep were 1.8 times more likely to be infected than young animals (AOR = 1.80, 95% CI: 1.15–2.75, $p < 0.05$). Sheep with poor body condition had significantly higher odds of infection (AOR = 3.50, 95% CI: 2.00–6.10, $p < 0.001$), while those with medium body condition also showed increased risk (AOR = 1.85). Furthermore, sheep managed under extensive systems were 2.9 times more likely to be infected compared to those under semi-intensive systems (AOR = 2.90, 95% CI: 1.80–4.70, $p < 0.001$). Sex was not significantly associated with infection ($p > 0.05$). Multivariable analysis Table 2 confirmed that body condition and management system were the strongest predictors of infection. Sheep with poor body condition had 3.5 times higher odds of infection, and those under extensive management had 2.9 times higher odds. Age remained significant, while sex did not show a significant association.

Table 2
Univariate and multivariable logistic regression analysis of potential risk factors associated with cestode and trematode infections in sheep (n = 384)

Risk factor	Category	Number examined	No. positive (%)	Univariate analysis		Multivariable analysis	
				COR (95% CI)	p-value	AOR (95% CI)	p-value
Age	Young	150	60 (40.0)	1	—	1	—
	Adult	234	132 (56.4)	1.94 (1.28–2.93)	0.002*	1.80 (1.15–2.75)	0.010*
Sex	Male	220	105 (47.7)	1	—	1	—
	Female	164	87 (53.0)	1.24 (0.83–1.85)	0.290	1.20 (0.78–1.84)	0.390
Body condition	Good	114	36 (31.6)	1	—	1	—
	Medium	150	72 (48.0)	2.00 (1.22–3.27)	0.006*	1.85 (1.10–3.12)	0.020*
	Poor	120	84 (70.0)	5.03 (2.96–8.55)	0.000*	3.50 (2.00–6.10)	0.000*
Management system	Semi-intensive	124	36 (29.0)	1	—	1	—
	Extensive	260	156 (60.0)	3.68 (2.30–5.88)	0.000*	2.90 (1.80–4.70)	0.000*

COR = Crude odd ration, AOR = Adjust odd ration; No = Number; *statistical significance

3.3. Association of Risk Factors with Specific species of Parasites

Species-specific analysis (Table 3) indicated that *Fasciola spp.* infection was significantly associated with age, body condition, and management system. Sheep with poor body condition were nearly 5 times more likely to be infected. Adult sheep had higher prevalence of Fasciola spp., Paramphistomum spp., Moniezia spp., and Schistosoma spp. compared with young animals, with significant associations observed for Fasciola and Paramphistomum ($p < 0.05$). Body condition was strongly associated with parasite occurrence, where sheep with poor body condition showed the highest prevalence across all parasite species. Poorly conditioned sheep had significantly greater odds of infection with Fasciola and Paramphistomum compared with sheep in good body condition. Sheep managed under extensive systems had higher prevalence and odds of trematode infections than those managed under semi-intensive systems. Sex was not significantly associated with infection for any of the parasite species ($p > 0.05$).

Table 3
Association between risk factors and specific parasites

Risk factors	Category	Number examined	*Fasciola*		*Paramphistomum*		*Moniezia*		*Schistosoma*	
			N (%)	OR (95% CI), p-value	N (%)	OR (95% CI), p-value	N (%)	OR (95% CI), p-value	N (%)	OR (95% CI), p-value
Age	Young	150	27 (18.0)	Ref	15 (10.0)	Ref	9 (6.0)	Ref	3 (2.0)	Ref
	Adult	234	68 (29.0)	1.85 (1.10–3.10), 0.020*	40 (17.1),	1.85 (1.00–3.40), 0.040*	19 (8.1)	1.38 (0.60–3.10), 0.440	11 (4.7)	2.40 (0.70–7.90), 0.110
Sex	Male	220	53 (24.1)	Ref	29 (13.2)	Ref	15 (6.8)	Ref	7 (3.2)	Ref
	Female	164	43 (26.2)	1.12 (0.71–1.77), 0.620	25 (15.2)	1.18 (0.67–2.06), 0.560	13 (7.9),	1.18 (0.56–2.48), 0.660	7 (4.3)	1.36 (0.47–3.91), 0.570
Body condition	Good	114	14 (12.3)	Ref	7 (6.1)	Ref	5 (4.4)	Ref ex	2 (1.8)	Ref
	Medium	150	36 (24.0)	2.25 (1.16–4.34), 0.016*	20 (13.3)	2.35 (0.97–5.67), 0.058	11 (7.3)	1.72 (0.57–5.14), 0.330	5 (3.3)	1.93 (0.36–10.20), 0.440
	Poor	120	48 (40.0)	4.75 (2.35–9.61), 0.000*	26 (21.7)	4.23 (1.69–10.56), 0.002*	12 (10.0)	2.41 (0.78–7.46), 0.120	7 (5.8),	3.46 (0.68–17.60), 0.130
Management system	Semi-intensive	124	17 (13.7)	Ref	10 (8.1)	Ref	6 (4.8)	Ref	2 (1.6)	Ref
	Extensive	260	79 (30.4)	2.75 (1.50–5.03), 0.001*	44 (16.9)	2.31 (1.09–4.89), 0.028*	22 (8.5),	1.83 (0.71–4.74), 0.210	12 (4.6)	2.94 (0.65–13.28), 0.160

N: Number of positive; OR = odd ration; CI = confidence interval; Ref = reference (1); * = statistically significance

3.4. Intensity of cestode and trematode infection

The intensity of infection showed that most animals had light to moderate infections (Table 4). For cestodes, 64.3% of infections were light, while only 10.7% were heavy. In trematodes, infections were more evenly distributed, with 42.7% light, 41.5% moderate, and 15.8% heavy infections.

Table 4
Intensity of cestode and trematode infection

Parasite Type	Category	EPG Range	Number	Percentage (%)
Cestodes	Light	< 500	18	64.3
	Moderate	500–1000	7	25.0
	Heavy	> 1000	3	10.7
Trematodes	Light	< 200	70	42.7
	Moderate	200–800	68	41.5
	Heavy	> 800	26	15.8
%=percent				

3.5. Economic Impact of Cestode and Trematode Infections

The majority of respondents (80%) reported that parasitic infections affect their sheep, indicating a high economic burden. Weight loss (70%) and poor growth (65.3%) were the most commonly reported impacts. About 76.7% of respondents indicated a reduction in market price due to infection, while 30% reported mortality losses. Additionally, 86.7% incurred treatment costs, highlighting the financial implications of parasite management (Table 5).

Table 5
Economic impact of Cestode and Trematode infections on sheep (n = 150 respondents)

Parameter	Category	Frequency (n)	Percentage (%)
Sheep affected by parasites	Yes	120	80.0
	No	30	20.0
Major problems observed	Weight loss	105	70.0
	Poor growth	98	65.3
	Weakness	85	56.7
	Diarrhea	72	48.0
	Reduced fertility	40	26.7
Number of sheep affected/year	1–5	60	40.0
	6–10	55	36.7
	> 10	35	23.3
Weight loss observed	Yes	110	73.3
	No	40	26.7
Estimated weight loss	< 2 kg	30	20.0
	2–5 kg	60	40.0
	> 5 kg	20	13.3
Price reduction	Yes	115	76.7
	No	35	23.3
Estimated price loss (ETB)	< 200	40	26.7
	200–500	55	36.7
	> 500	20	13.3
Mortality observed	Yes	45	30.0
	No	105	70.0
Number of deaths	1–2	25	16.7
	3–5	15	10.0
	> 5	5	3.3
Treatment cost incurred	Yes	130	86.7
	No	20	13.3

The study revealed substantial economic losses associated with parasitic infections (Table 4). The largest loss was attributed to mortality (225,000 ETB), followed by severe weight loss (77,000 ETB) and price reduction (40,250 ETB). Treatment costs also contributed to the overall loss. The total estimated economic loss was 385,750 ETB, indicating a significant financial burden on sheep owners (Table 6).

Table 6
Estimated Economic Losses from Live Sheep and Associated Values

Parameter	Category	Number Affected	Loss/Animal (ETB)	Total Loss (ETB)
Reduced body weight	Mild	80	300	24,000
	Severe	110	700	77,000
Price reduction	—	115	350	40,250
Mortality	—	45 (×2 sheep avg)	2500	225,000
Treatment cost	Anthelmintics	130	150	19,500
Total Estimated Loss				385,750

3.6. Cestode and Trematode parasites Control Practices

A high proportion of sheep owners (86.7%) practiced deworming; however, only 26.7% followed a regular 3-month schedule. A considerable number (40%) administered drugs themselves, and 43.3% determined dosage by guessing, which may lead to improper treatment. Drug rotation was poorly practiced (23.3%), increasing the risk of anthelmintic resistance. Communal grazing (63.3%) was dominant, which may facilitate parasite transmission. Access to veterinary services was limited, with only 40% reporting regular access.

Table 7
Cestode and Trematode parasites control practices among sheep owners (n = 150)

Variable	Category	Frequency (n)	Percentage (%)
Deworming practice	Yes	130	86.7
	No	20	13.3
Frequency of deworming	Every 3 months	40	26.7
	Every 6 months	55	36.7
	Once/year	25	16.7
	Irregular	30	20.0
Drug administrator	Veterinarian	50	33.3
	Health worker	40	26.7
	Self	60	40.0
Drug type used	Albendazole	70	46.7
	Tetracosane / Tetracozash	40	26.7
	Triclabendazole	20	13.3
	Ivermectin	20	13.3
Dose determination	By weight	45	30.0
	Guessing	65	43.3
	Advice	40	26.7
Drug source	Veterinary clinic	60	40.0
	Private shop	70	46.7
	Market	20	13.3
Drug rotation	Yes	35	23.3
	No	115	76.7
Grazing system	Communal	95	63.3
	Private	35	23.3
	Cut-and-carry	20	13.3
Access to veterinary service	Regular	60	40.0
	Occasional	65	43.3
	None	25	16.7

4. Discussion

Cestode and trematode infections represent major parasitic constraints to sheep production, contributing to substantial economic losses through reduced productivity, mortality, and treatment costs. Despite their importance, limited information exists on the combined epidemiology, economic impact, and control practices of these parasites in Gondar town and surrounding areas. The present study revealed an overall prevalence of 50.0% for cestode and trematode

infections in sheep in Gondar, Central Gondar Zone. This finding indicates that cestode and trematode infections remain an important constraint to sheep production in the study area. This finding is consistent with reports from different parts of Ethiopia, where prevalence ranging from 40% to 60% has been documented (Mulatu et al., 2012; Tesema et al., 2022).

The prevalence observed in the present study is lower than the 59.11% previously reported in sheep around Gondar (Sisay et al., 2007). However, the present finding remains within the range of prevalence values reported from different parts of Ethiopia, demonstrating the continuing importance of parasitic infections in small-ruminant production systems (Tesema et al., 2023). The observed variation among studies may be attributed to differences in agroecology, season of sampling, grazing management, and diagnostic methods employed.

Trematodes were more prevalent than cestodes, with *Fasciola spp.* being the dominant parasites. This agrees with findings from Ethiopia and other tropical regions, where fasciolosis is a major constraint to livestock production due to the presence of suitable snail intermediate hosts (Megersa et al., 2024). Similar prevalence levels have been reported in countries such as Nigeria and India, emphasizing the global importance of fasciolosis. The relatively lower prevalence of *Moniezia spp.* compared to trematodes may be explained by their dependence on oribatid mites as intermediate hosts, which are less influenced by aquatic environments. Comparable findings have been reported in Ethiopian sheep populations (Tesema et al., 2022).

Among the trematode parasites identified in the study, *Fasciola spp*. emerged as the most prevalent, accounting for 25.0% of infections. This result is consistent with previous reports indicating the widespread distribution of trematode infections in Ethiopian ruminants. The high prevalence is largely attributed to favorable climatic and ecological conditions that support the development and survival of *Lymnaeid* snail intermediate hosts, which play a critical role in the transmission of fasciolosis (Megersa et al., 2024).

The relatively high occurrence of fasciolosis observed in the present study may further be explained by the presence of marshy grazing areas, irrigation practices, and seasonal water bodies, all of which create optimal habitats for snail multiplication and thereby facilitate parasite transmission. Similar findings have been reported in several Ethiopian studies, where fasciolosis was among the most frequently encountered trematode infections in ruminants (Megersa et al., 2024; Sissay et al., 2007). However, the prevalence observed in the present study is comparatively lower than that documented in high-rainfall areas of Ethiopia, where continuous moisture creates ideal habitats for *Lymnaeid* snails and thereby sustains higher transmission rates.

The prevalence of Paramphistomum spp. (14.06%) observed in the present study also support the growing evidence that paramphistomosis is an emerging trematode infection of economic significance in Ethiopian sheep. The occurrence of Schistosoma spp. (3.65%) was relatively low compared with other trematodes. This lower prevalence may be associated with the specific ecological requirements of schistosome intermediate hosts and the comparatively limited exposure of sheep to suitable aquatic habitats. Similar low prevalence has been reported in Ethiopian small-ruminant studies where schistosomosis occurred sporadically compared with fasciolosis and paramphistomosis (Sisay et al., 2007). The prevalence of Moniezia spp. (7.29%) recorded in this study was lower than the prevalence of trematode infections. This finding is consistent with previous reports from Gondar that documented relatively lower cestode prevalence compared with other gastrointestinal helminths (Mulatu et al., 2012). The comparatively lower occurrence of Moniezia infection may be related to its dependence on free-living oribatid mites as intermediate hosts, whose abundance is influenced by soil type, humidity, pasture management, and environmental conditions.

The logistic regression analysis demonstrated that age, body condition, and management system were significant predictors of infection. The present study identified age as a significant risk factor for cestode and trematode infection. This finding agrees with reports from Ethiopia indicating that older animals accumulate infections due to prolonged exposure to contaminated grazing fields and infective stages of parasites (Sissay et al., 2007; Mulatu et al., 2012). Although young animals are generally more susceptible immunologically, adults experience longer cumulative exposure,

which may explain the higher prevalence observed. Body condition score was strongly associated with infection. This result agrees with findings reported by Mulatu et al. (2012) and other Ethiopian studies where poorly conditioned animals consistently exhibited higher parasite burdens.

Poor nutritional status compromises immune competence, thereby increasing susceptibility to infection. Therefore, the association observed may reflect both increased susceptibility and the pathological consequences of infection. The management system also had a significant influence on infection occurrence. This finding is consistent with numerous Ethiopian studies showing that extensive grazing exposes animals to contaminated pastures, water sources, and intermediate hosts (Mulatu et al., 2012; Sissay et al., 2007). Under semi-intensive management, animals generally receive better nutrition, improved veterinary attention, and reduced exposure to infective stages

The economic analysis revealed substantial losses, mainly due to mortality and reduced productivity. These findings are consistent with previous studies in Ethiopia that have emphasized the economic importance of helminth infections (Sarba et al., 2024). The economic burden likely arises from reduced weight gain, treatment costs, mortality, and condemnation of infected organs. Previous studies have emphasized that helminth infections significantly reduce livestock productivity and household income in Ethiopia (Terfa et al., 2023; Win et al., 2020).

The questionnaire survey revealed that although 73.3% of sheep owners were aware of parasitic infections, only 26.7% practiced regular deworming. This finding suggests a substantial gap between awareness and effective control practices. Inadequate deworming schedules, improper drug selection, and limited veterinary consultation can facilitate continued parasite transmission and reduce treatment effectiveness. Similar challenges have been reported in Ethiopian livestock production systems where access to veterinary services and farmer training remains limited (Tamiru, 2025).

This study has some limitations. The cross-sectional design does not account for seasonal variations in parasite prevalence. Coprological techniques used for diagnosis may have limited sensitivity, particularly for low-intensity and early infections. Economic data were partly based on farmer recall, which may introduce recall bias and affect accuracy. The study did not include molecular diagnostic methods, which could have improved species confirmation. In addition, some potential confounding factors, such as pasture contamination level, intermediate host abundance, and detailed nutritional status, were not fully assessed. Therefore, the findings should be interpreted with these limitations in mind.

5. Conclusion

The present study demonstrated that cestode and trematode infections are widespread among sheep in the study area. Trematodes, particularly *Fasciola spp.* and *Paramphistomum spp.*, were the predominant parasites. The study identified body condition, age, and management system as the most important risk factors, with poorly conditioned and extensively managed sheep being significantly more affected. Although most infections were of light to moderate intensity, their cumulative effect resulted in considerable economic losses, estimated at 385,750 ETB, primarily due to mortality, reduced body weight, and treatment costs. The findings also revealed gaps in farmers' knowledge and parasite control practices, including irregular deworming and reliance on non-professional drug sources.

Based on the findings of this study, the following recommendations are forwarded

- Implement regular and strategic deworming programs based on epidemiological patterns rather than irregular treatment.
- Reduce reliance on communal grazing and encourage controlled grazing systems where feasible.
- Improve access to veterinary consultation and services for proper diagnosis and treatment.
- Conduct training and extension programs to improve farmers' knowledge of parasite transmission, prevention, and control.

- Conduct longitudinal studies to understand seasonal dynamics of parasite infections.
- Explore integrated control approaches combining chemotherapy, management, and environmental control

Declarations

Acknowledgments

Not applicable

Declaration of competing interests

The authors declare that there is no known competing financial interest or personal relationship that could have appeared to influence the work reported in this paper.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data Availability

The datasets generated during the current study are available from the corresponding author on reasonable request:

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Consent to publish

Not applicable

Ethics approval

This study was conducted in accordance with the ethical guidelines established by the University of Gondar (UoG), Ethiopia. The collection data during faecal sample examination were carried out with utmost care to minimize pain and risk to the dogs. All procedures adhered to animal welfare standards and followed established sample collection protocols. Ethical approval for the study was obtained from the Departmental Ethical Committee of the College of Veterinary Medicine and Animal Sciences, University of Gondar (in September 2024, Ref.No: CVMAS.Sc/ 1.28.2024).

Author Contributions

Seid Kassaw: Methodology, Investigation, Supervision, Conceptualization, Writing – Review and Editing, Writing – Original Draft. **Zenebe Jemere:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – Original Draft and Writing – Review and Editing.

References

1. Birara Ayalneh Tamiru. (2025). Review of Major Gastrointestinal Tract Parasites in Small Ruminants in Ethiopia. *Biomedicine and Nursing*, 11(4), 35–41.
2. Central Statistical Agency (CSA). (2024). *Livestock Population Estimates in Ethiopia*. Addis Ababa.
3. Ethiopia Sheep and Goat Productivity Improvement Program (ESGPIP). (2008). Body Condition Scoring of Sheep and Goats. Technical Bulletin No. 8. Addis Ababa, Ethiopia.

4. Fayisa WO, Sarba EJ, Borena BM, Gebremedhin EZ, Tola GK. Prevalence of Cystic Echinococcosis in Sheep and Goats of Ethiopia: A Systematic Review and Meta-Analysis. Vet Med Sci. 2025 Jan;11(1):e70189. doi: 10.1002/vms3.70189. PMID: 39740086; PMCID: PMC11683775.
5. Gemeda Tesema, Solomon Tesfaye, Damtew Bekele (2023) Helminth parasites prevalence and distribution among Sheep in Gudaya Bila District, East Wallaga, Ethiopia. Journal of Parasite Research – 1(3):23–38. https://doi.org/10.14302/issn.2690-6759.jpar-23-4764
6. Megersa, B., Hussein, B., Shemsu, J., Terefe, Y., Regassa, A., & Bekele, J. (2024). Trematode infection in ruminants and diversity of snail hosts across three agro-ecological zones in Ethiopia. BMC Veterinary Research, 20(1), 197. https://doi.org/10.xxxx/bmcvetres.xxxx
7. Mulatu, M., Fentahun, T., & Bogale, B. (2012). Gastrointestinal Helminths Parasites in Sheep: Prevalence and Associated Risk Factors, in and Around Gondar Town, Northwest Ethiopia. *Advances in Biological Research*, *6*(5), 191–195.
8. Sissay, M. M., Uggla, A., & Waller, P. J. (2007). Prevalence and seasonal incidence of nematode parasites and fluke infections of sheep and goats in eastern Ethiopia. Tropical Animal Health and Production, 39(7), 521–531. https://doi.org/10.1007/s11250-007-9035-z
9. Tamiru, B. A. (2025). Review on major gastrointestinal tract parasites in small ruminants in Ethiopia. Biomedicine and Nursing, 11(4), 35–41.
10. Terfa, W., Kumsa, B., Ayana, D., Maurizio, A., Tessarin, C., & Cassini, R. (2023). Epidemiology of Gastrointestinal Parasites of Cattle in Three Districts in Central Ethiopia. Animals, 13(2), 285. https://doi.org/10.3390/ani13020285
11. Tesema, G., Tesfaye, S., & Bekele, D. (2023). Helminth parasite prevalence and distribution among sheep in Gudaya Bila District, East Wollega, Ethiopia. Journal of Parasitology Research, 2023, 1–8.
12. Thrusfield, D. (2018). *Veterinary Epidemiology* (4th ed.). Wiley-Blackwell.
13. Urquhart, G. M., Armour, J., Duncan, J. L., Dunn, A. M., & Jennings, F. W. (1996). *Veterinary Parasitology* (2nd ed.). Blackwell Science.
14. Win, S. Y., Win, M., Thwin, E. P., Htun, L. L., & Bawm, S. (2020). Occurrence of gastrointestinal parasites in small ruminants in the central part of Myanmar. Journal of Parasitology Research, 2020, 8826327. https://doi.org/10.1155/2020/8826327
15. Zajac, A. M., & Conboy, G. A. (2012). *Veterinary Clinical Parasitology* (8th ed.). Wiley-Blackwell.

Figures

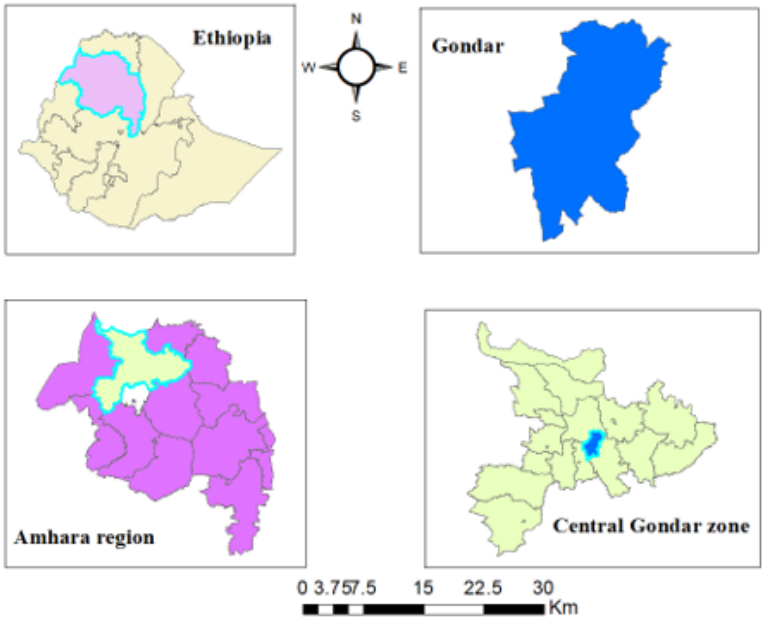


Figure 1

Study area map

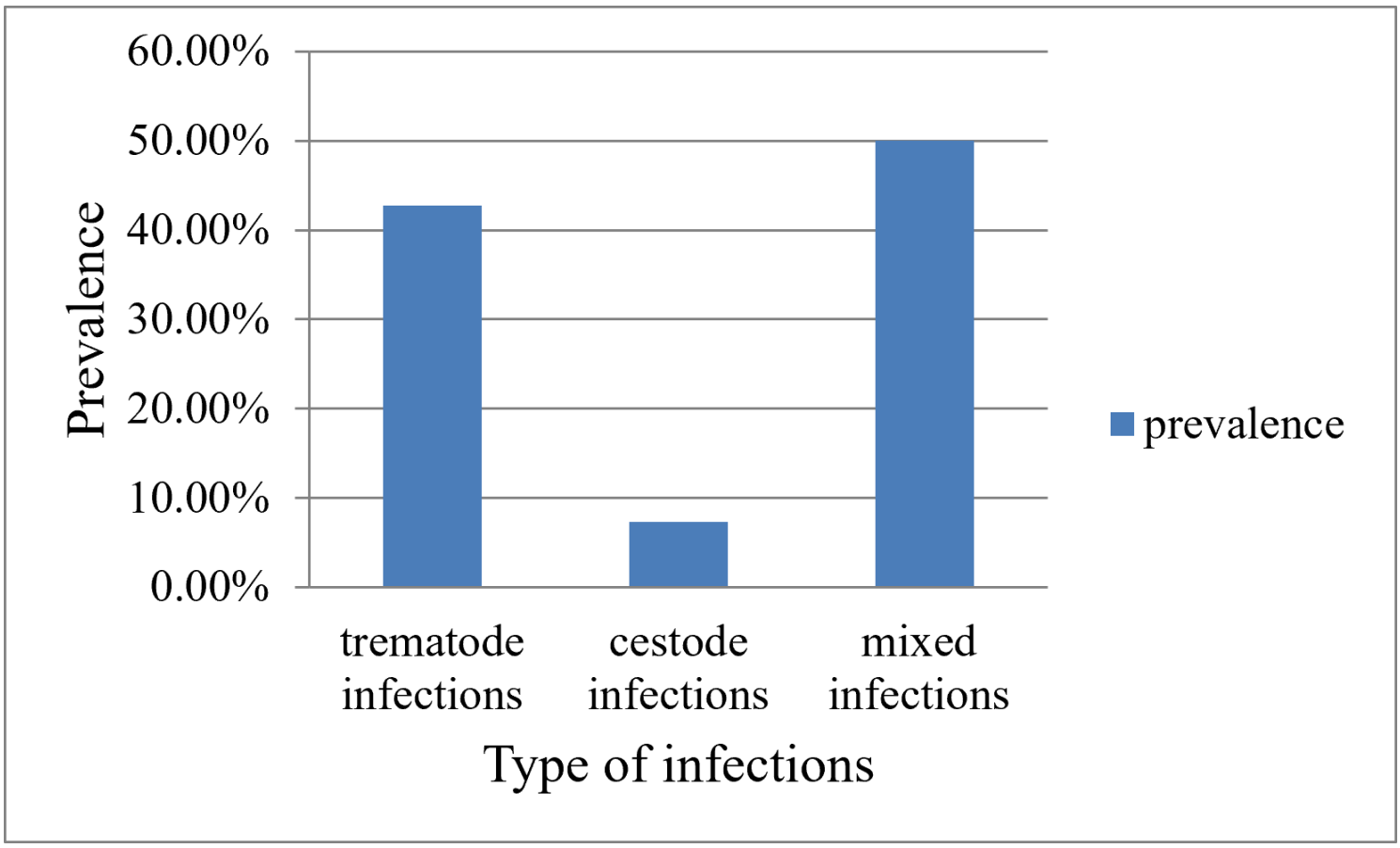


Figure 2

Overall prevalence of cestode and trematode infections (update the figure with pecents on the top part of the bar).

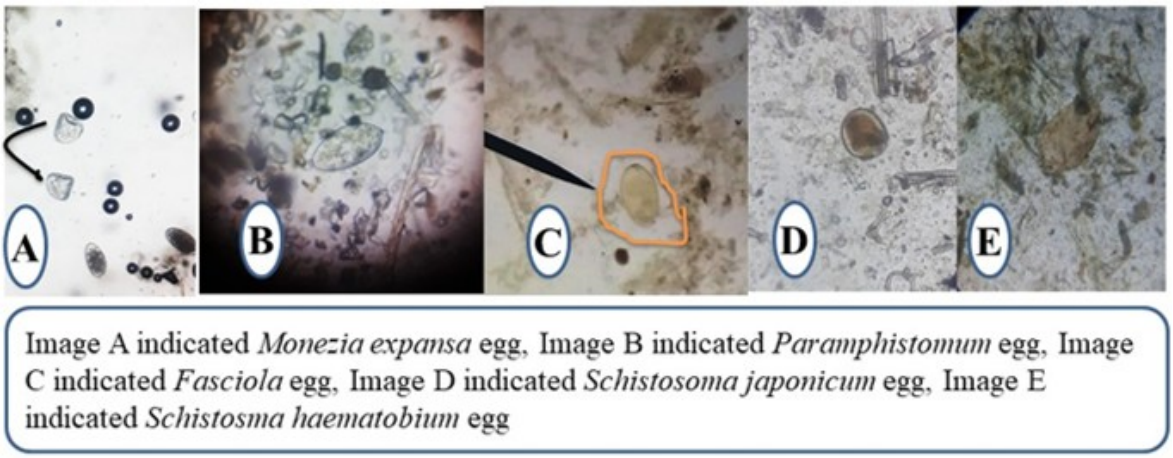


Figure 3

Eggs of ovine cestode and trematode

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- Supplementarymaterials.docx