DOI https://dx.doi.org/10.4314/evj.v28i2.4 Ethiopian Veterinary Journal

Prevalence of bovine schistosomiasis and associated risk factors in Bahir Dar, northwest Ethiopia

Yeshareg Gedifew[1], Tesfaheywet Zeryehun[1,] and Belayineh Tsegaye[2]*

[1]*College of Veterinary Medicine, Haramaya University, P.O Box 138, Dire Dawa, Ethiopia*

[2]*Gedeo Zone, Livestock and Fishery office, SNNPR, Ethiopia*

**Corresponding author. E-mail: tesfahiwotzerihun@yahoo.com*

Abstract

A cross-sectional study was conducted from December 2022 to March 2023 to estimate the prevalence of bovine schistosomiasis and associated risk factors in Bahir Dar town, northwest Ethiopia. A total of 298 cattle were selected randomly, and subsequent fecal samples were obtained for coprological examination. *Schistosoma* eggs were examined using sedimentation technique. A logistic regression model was employed to assess the association between risk factors and prevalence of schistosomiasis. Of the total of 298 fecal samples examined, 63 (21.1%) were found positive for *Schistosoma bovis* eggs. In the study, sex, breed, and management system were not significantly associated ($p > 0.05$) with the occurrence of bovine schistosomiasis. On the contrary, prevalence of bovine schistosomiasis showed significant variability ($p < 0.05$) amongst the different age and body condition groups. The study disclosed a significantly higher risk of bovine schistosomiasis in old cattle (AOR= 3.2; 95% CI: 1.4 - 7.0) and cattle with poor body condition (AOR=3.9; 95% CI: 1.5 - 10.2). The findings indicated a higher prevalence of *Schistosoma bovis* infection among older cattle and those with poor body condition. Therefore, it is recommended that husbandry-related risk factors be incorporated into disease control and prevention strategies.

Keywords: Bahir Dar; Bovine schistosomiasis; Coprology; Risk factors.

Introduction

Ethiopia has the largest livestock population in Africa, with an estimated 70 million cattle, about 42.9 million sheep, 52.5 million goats, 2.15 million horses, 10.80 million donkeys, 0.38 million mules, about 8.1 million camels, and 48.9 million poultry (CSA, 2020). Cattle play a vital role in the country's economy, providing traction power for crop cultivation, as export commodities, manure, food security, and wealth accumulation. However, the livestock sector is not fully exploited due to several constraints, including malnutrition, traditional husbandry practices, poor genetic makeup, and prevailing diseases (Jabbar *et al*., 2007; Negassa *et al*., 2011).

Parasitic diseases are one of the major constraints of animal health and production throughout tropical and sub-tropical countries (Juyal and Singal, 2011). Among the challenges of cattle production, trematode parasites, especially schistosomiasis, are one of the most prevalent infections of ruminants in different parts of the world, including Ethiopia (Urquhart *et al.,* 2003; Ali *et al.,* 2006; Yeneneh *et al*., 2012).

Cattle infected with *Schistosoma bovis* develop a syndrome characterized by liver damage, roughness of the hair coat, pale mucous membrane, severe emaciation, and inferior reproductive performance that results in a significant economic downturn and a threat to public health (Hambali *et al.,* 2016). Schistosomiasis is a significant economic burden for livestock farmers in Ethiopia. The parasite can cause mortality, retarded growth, poor productivity, low milk yield, and increased susceptibility to other parasitic or bacterial diseases (Marquardt *et al*., 2000; Lefevre *et al.,* 2010). Therefore, it is essential to control schistosomiasis to protect livestock health and productivity.

Schistosoma bovis, a parasitic trematode, is among the significant causes of parasitic infections in cattle in Ethiopia. The prevalence of the parasite has been reported to vary widely across the country, with studies in Kemissie (Ameni *et al*., 2001), Fogera (Chane *et al.,* 2012; Mengistu *et al*., 2012), Debre Tabor (Tsega and Samuel, 2015), Dangila (Alemayehu and Asrat, 2015), and around Bahir Dar (Samuel *et al.*, 2016). The absence of recent surveys on schistosomiasis in cattle within the current study area, coupled with the recognized economic significance of the disease, underscores the imperative to undertake an investigation aimed at elucidating the present status of this issue in the area. This information will be essential for developing effective control strategies. Therefore, the objectives of this study were to estimate the prevalence of bovine schistosomiasis in Bahir Dar town and assess the major risk factors for the occurrence of schistosomiasis in the study area.

Materials and methods

Study area

The study was conducted from December 2022 to March 2023 in Bahirdar town, northwest Ethiopia. Bahir Dar is found 570 km away from Addis Ababa. It is located at 11° 29'N latitude and 37°29'E longitude with an altitude of 1500-2300 m.a.s.l., annual rainfall of 1200-1600 mm, and mean annual temperature of 29.5° C. The landscape is marked by the presence of Lake Tana, which drains a watershed of about 3,000 $km^{2,}$ and areas adjacent to Lake Tana and Abay River have poor drainage and over flooding during the wet months.

Study population

In this study, cattle from different areas of three kebeles of Bahir Dar town were included. The major risk factors considered included breeds (local and cross), management systems (intensive, semi-intensive, and extensive), age, body condition, and sex. The animals were classified into three age categories: young (< 2 years old), adult (2- 5 years old), and old (> 5 years old) on the basis of dentition, as described by Pope (2008). The body condition of the animals was classified into three groups: poor, medium, and good based on visual assessment as described by Debont *et al.* (2005).

Study design

The study had a cross-sectional study design in which the study subjects were sampled once during the study period to assess the prevalence and associated risk factors of bovine schistosomiasis in Bahir Dar town, northwest Ethiopia.

Sample size determination and sampling of animals

The desired sample size was calculated according to Thrusfield (2005) with a 95% confidence level, a 5% desired absolute precision, and an expected prevalence of 26.3% (Samuel *et al.,* 2016).

n= (1.96)2 p (1-pexp)/d2

Where: n= required sample size, 1.96=the value at 95% confidence interval,
p= expected prevalence of schistosomiasis, and
d= desired absolute precision (0.05).

$$n = (1.96)2 *26.3\% (1- 26.3\%)/0.0025= 298$$

Hence, a total of 298 cattle were chosen through a simple random sampling technique for the purpose of estimating the prevalence of the disease.

Cattle of different breeds, sexes, and age groups in three kebeles were included in the study. Multi-stage sampling was employed to select cattle for the field survey. In the first stage, kebeles (Kebele Nine, Sebatamit, and Zenzelima) were selected based on practical logistic and demographic considerations. In the second stage, households encountered during the field survey were systematically selected, and then cattle were randomly selected for the study.

Sample collection and laboratory procedure

Fresh fecal samples were collected directly from the rectum of the animals in the field using gloves. The samples were filled into universal sampling bottles, preserved in 10% formalin to prevent the hatching of the eggs before examination and closed with screw tops. It was placed in ice box and transported to Bahir Dar University Parasitology laboratory. Subsequently, the samples underwent concentration through the standard sedimentation technique, as outlined by Urquhart *et al*. (2003). Briefly, approximately 3 grams of feces were placed into a centrifuge tube, to which 40 ml of water was added, and the mixture was thoroughly blended. The mixture was then passed through a tea strainer into another centrifuge tube and allowed to settle for 15 minutes. Following this, supernatant was poured off, and the sediment was mixed again. This process was repeated three times until the supernatant became clear. Finally, the sediment was transferred using a pipette onto a clean microscope slide for examination under a microscope at 10x magnification. A slide was considered positive if eggs that were oval to spindle-shaped, with a central bulge and a terminal spine on one side, were detected. The slides were considered positive when oval to spindle shaped centrally bulged eggs with terminal spine on one side of egg was identified (Urquhart *et al*., 2003).

Data analysis

The data was collected and entered into an Excel spreadsheet. The spreadsheet was then transferred to the Statistical Package for Social Sciences (SPSS) software version 20 for analysis. The data were then summarized using descriptive statistics. A univariable logistic regression analysis was used to assess the association of prevalence with individual risk factors for bovine schistosomiasis. Variables with p value ≤ 0.25 in the univariable logistic regression analysis with no multicollinearity were entered into the multivariable logistic regression model. Collinearity between variables was also checked by standard error and model fitness assured by Hosmer and Lemeshow test and Omnibus test (Dohoo *et al.,* 2003). In all analyses, statistical significance was set at $p <$ 0.05, with a confidence level of 95%.

Results

Overall prevalence of bovine schistosomiasis

The current study revealed that out of the total 298 faecal samples examined in the study area, 63 (21.1%) were found to be positive for *S. bovis* eggs (Table 1).

Prevalence of bovine schistosomiasis by risk factors

The outcomes of the univariate logistic regression analysis are detailed in Table 1. The model indicates a nearly equivalent prevalence of schistosomiasis in males (20.4%) and females (21.7%). Likewise, there was no statistically significant difference ($p > 0.05$) in the prevalence of bovine schistosomiasis between the local breed (23.9%) and cross-bred (15.5%) cattle. However, within this model, age, body condition score, and management system exhibited significant associations with the prevalence of the disease ($p < 0.05$).

A multivariable logistic regression model was applied to ascertain the association between the prevalence of schistosomiasis, as detailed in Table 2. The results indicated significant associations ($p < 0.05$) between the prevalence of bovine schistosomiasis and both age and body condition score. Specifically, the model revealed a significantly elevated risk of bovine schistosomiasis in older cattle (AOR = 3.2; 95% CI: 1.4 - 7.0; $p = 0.004$) and in cattle with poor body condition (AOR = 4.6, 95% CI: 1.8 - 11.7; $p = 0.005$) (Table 2).

Table 1. Univariable logistic regression analysis for potential risk factors associated with the prevalence of bovine schistosomiasis in cattle in the study area.

Variables		No. Examined	No. Infected	Prevalence (%)	COR (95% CI)	*p* value
Breed	Local	201	48	23.9	1[a]	
	Cross	97	15	15.5	0.6 (0.3 - 1.1)	0.098
Sex	Female	161	35	21.7	1[a]	
	Male	137	28	20.4	0.9 (0.5 - 1.6)	0.784
Age	Young	86	11	12.8	1[a]	
	Adult	121	23	19.0	1.6 (0.7 - 3.4)	0.237
	Old	91	29	31.9	3.2 (1.5 -6.9)	0.003
Body condition score	Good	70	6	8.6	1[a]	
	Medium	119	24	20.2	2.7 (1.1 - 6.9)	0.041
	Poor	109	33	30.3	4.6 (1.8 -11.7)	0.001
Management	Intensive	30	2	6.7	1[a]	
	Semi-intensive	54	10	18.5	3.2(0.6-15.6)	0.154
	Extensive	214	51	23.8	4.4 (1.1-19.0)	0.049

1[a]: Reference; COR: Crude odds ratio; CI: Confidence interval

Table 2. Multivariable analysis to identify the strengths of factors associated with the prevalence of bovine schistosomiasis in the study area (n=298).

Variables		No examined	No. positive	Prevalence (%)	AOR (95% CI)	*p* value
Age	Young	86	11	12.8	1[a]	
	Adult	121	23	19.0	1.6 (0.7 - 3.6)	0.242
	Old	91	29	31.9	3.2 (1.4 - 7.0)	0.004
Body condition score	Good	70	6	8.6	1[a]	
	Medium	119	24	20.2	2.3 (0.9 - 6.0)	0.097
	Poor	109	33	30.3	3.9 (1.5 - 10.2)	0.005
Management	Intensive	30	2	6.7	1[a]	
	Semi-intensive	54	10	18.5	3.3 (0.6 - 17.4)	0.152
	Extensive	214	51	23.8	4.1 (0.9 - 18.9)	0.067

1[a]: Reference; AOR: Adjusted odds ratio; CI: Confidence interval

Discussion

The study revealed a 21.1% overall prevalence of *Schistosoma bovis,* a figure comparatively lower than prevalence reported in some prior studies. For instance, the prevalence documented in this investigation was notably lower than the 37.3% reported by Habtamu and Mariam (2011) in Bahir Dar area, and the 27.13% reported by Gebre (2010) in Dembia district. However, it exceeds the prevalence reported in other studies, such as the 10.17% by Chanie *et al.* (2012) in South Gondar zone, the 4.59% by Abebe *et al.* (2011) in Agaro and the 10.11% in Jimma area, 11.5% by Alemayehu and Asrat (2015) in Dangila district, and 7.6% by Mihret and Samuael (2015) in Debre Tabor. Disparities in the prevalence could be attributed to various factors, such as irrigation practices, agroecology, types of animal management, climatic variations, and other geographical influences both on the parasite and its snail vector. Yihunie *et al.* (2019) mentioned that agro-ecological factors, such as temperature, moisture, humidity, availability of large permanent water bodies, and irrigation practices are crucial to sustain schistosome life cycle. Additionally, Hansen and Perry (1994) highlighted that a critical factor influencing the spread of bovine schistosomiasis is the prevalence of intermediate hosts and their capacity to thrive and reproduce in specific environmental conditions, particularly in proximity to substantial, permanent bodies of water. Marshlands and stagnant water sources, including creeks, ponds, and swamps situated near rivers, lakes, and irrigation areas, are identified as principal factors for transmission of bovine schistosomes. This emphasizes the importance of these aquatic environments in the life cycle of the disease, serving as critical hubs for the infection's propagation (Urqhart *et al*., 2003).

The prevalence of *S. bovis* infection exhibited no statistically significant difference ($p > 0.05$) among male (20.4%) and female (21.7%) cattle. This pattern aligns with the results reported by Mihret and Samuel (2015), who found a prevalence of 33.1% in females and 27.1% in males. This might be due to the absence of difference in grazing behavior, animal management and grazing land for the two sexes. Nonetheless, our findings diverge from the outcomes of studies conducted by Kebede *et al.* (2008) and Gebre (2010), where higher prevalence rates were recorded in male cattle. The present study suggests, in contrast, that both sexes face an equal risk of contracting bovine schistosomiasis.

In the present study, a markedly elevated prevalence of bovine schistosomiasis was observed in older cattle (31.9%), in comparison to adults (19.0%) and young cattle (12.8%). Multivariable logistic regression analysis revealed that older cattle exhibit a threefold higher likelihood of contracting bovine schistosomiasis (AOR = 3.2; 95% CI: 1.4 - 7.0; $p = 0.004$) when compared to their younger counterparts. These findings align closely with previous reports in the country (Mengistu *et al.,* 2012; Merawe *et al*., 2014; Yihunie *et al.,* 2019). The increased prevalence of bovine schistosomiasis in older cattle is postulated to be linked to husbandry practices that elevate the risk of environmental exposure. Moreover, older cattle, with potentially compromised immune systems, are more susceptible to infection. In contrast, a study by Gebre (2010) reported a higher prevalence of 17.6% in cattle below two years of age in Dembia district. The reasons for the discordance between these studies are not entirely clear, but potential contributing factors might include variations in parasite load in the environment and/or in the intermediate host, differences in animal management systems, or disparities in age definitions applied across studies.

The current study indicated that cattle with poor body condition exhibit a fivefold increased likelihood of schistosomiasis infection (AOR = 4.6, 95% CI: 1.8 - 11.7; $p = 0.005$) compared to those with a good body condition score. This finding aligns with the outcomes of previous studies that reported a notably higher prevalence of bovine schistosomiasis in cattle with poor body conditions (Abebe *et al*., 2011; Melkamu, 2016; Samuel *et al*., 2016; Shiferaw and Deressa, 2017). Marquardt and Greive (2000) and Mihret and Samuel (2015) indicated that acquired immune status of animals with poor body condition and that are weak become suppressed and prone to become more vulnerable to parasitic infestations. On the other hand, Urqhart *et al.* (2003) and Hansen and Perry (1994) have documented that bovine schistosomes exploit the nutrition of their hosts and undermine their immune capabilities that could lead to several adverse effects, such as anorexia, weight loss, and emaciation. On a similar report, Niaz *et al.* (2010) mentioned that *S. bovis* infection can result in weight loss, poor weight gain, and weak acquired immunity (Niaz *et al*., 2010). Hence, the poor body condition of animals might have resulted as a result of schistosomiasis and/or it might result in higher exposure to *S. bovis* infection.

The highest prevalence of bovine schistosomiasis was observed in animals under an extensive management system (23.8%) as opposed to those in semi-intensive and intensive management systems. This outcome aligns with findings from other studies conducted in the country (Gebre, 2010; Lulie and Guda, 2014; Samuel *et al*., 2016). Extensive management practices commonly involve allowing cattle to graze in open areas, thereby increasing their exposure to contaminated water sources. In contrast, animals maintained under intensive management systems are typically housed in pens or stalls, effectively reducing their likelihood of encountering contaminated water.

Conclusions

In conclusion, the study establishes prevalence of bovine schistosomiasis in the study area, with an overall prevalence of 21.1%. The findings underscore the influence of various factors including age and body condition. Specially, older cattle, and cattle with poor body condition were more likely to be infected with the parasite. The significance of these factors underscores the crucial importance of incorporating husbandry-related risk factors into disease control and prevention interventions.

Acknowledgments

The authors would like to extend their utmost gratitude to the technical staff of Bahir Dar Veterinary Laboratory for their support during the laboratory activities.

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