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ORIGINAL RESEARCH

Prevalence of Bovine Schistosomiasis and Associated Risk Factors in and Around Haramaya, Oromia Region, East Ethiopia

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Introduction: Schistosomiasis is caused by the *Schistosoma* genus and is transmitted through intermediate hosts, such as snails.
Methods: A cross-sectional investigation was conducted within and surrounding Haramaya town between December 2022 and May 2023 to estimate the prevalence of schistosomiasis in cattle and associated risk factors. The degree of prevalence was estimated using surveys carried out in slaughterhouses and coprological laboratories. For statistical estimation, chi-square tests and logistic regression were utilized. A total of 390 samples were obtained through simple random sampling. In the survey that was undertaken on abattoirs, a total of 384 samples were chosen through the utilization of a systematic random sampling approach. The recovery of *Schistosoma* eggs from fecal specimens was achieved by sedimentation.
Results: The overall rates of schistosomiasis in cattle were estimated to be 21.28% and 18.23% through coprological and postmortem examinations, respectively. The analysis conducted through multivariable logistic regression indicated that management system, body condition, and age were significant risk factors. Cattle under extensive management (OR = 5.9, 95% CI = 2–17) and those in the young age category (OR = 2.7, 95% CI = 1.0–7.00) were more susceptible to acquiring schistosomiasis than cattle under intensive management and those in the adult age category, respectively. According to the odds ratio, there was a positive association between the incidence rate of schistosomiasis in cattle and poor body condition (OR: 3.048, 95% CI = 1.07–8.68; P = 0.00). Schistosomiasis infection was 3.048 times more likely to manifest in animals in poor physical condition. This affliction has had a profound impact on the livestock industry, as substantiated by the elevated prevalence of schistosomiasis in cattle within the studied region.
Conclusion: Consequently, an integrated approach to prevention and control that targets the parasite is needed.
Keywords: schistosomiasis, cattle, Haramaya, prevalence, risk factors

Introduction

Ethiopia possesses an exceedingly diverse terrain, encompassing a wide range of climatic landscapes and an abundance of agricultural and ecological zones that are conducive to accommodating a substantial livestock population.[1] Ethiopia boasts an extensive livestock population and is positioned among the top ten nations globally, with an estimated count of 70 million cattle, 42.9 million goats, and 52.5 million sheep.[2] Despite the vastness of Ethiopia's livestock resources, the country faces various challenges that hinder its complete utilization, such as recurring droughts, infrastructure obstacles, outbreaks of animal diseases, inadequate nutrition, poor farming practices, a scarcity of skilled personnel, and shortages of government strategies for disease control and preventive measures.[3]

Worldwide, the prevalence and welfare of cattle are greatly impacted by parasitic diseases. The two most harmful ailments to cattle are gastrointestinal nematodes and liver flukes.[4] Economic losses caused by parasitic infections, specifically those caused by Helminths, protozoa, and arthropods, can surpass those caused by viruses and bacteria; however, the influence on livestock owners remains uncertain.[5] Noteworthy flukes documented in different areas of the

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globe include *Schistosoma, Fasciola*, and Paramphistomes.[6] Among these parasites, cattle schistosomiasis holds particular importance as a major economically significant animal disease due to its association with mortality, inhibited growth, reduced productivity, and diminished production of milk.[7]

In Africa, schistosomiasis in cattle is caused by *Schistosoma bovis, Schistosoma leiperican, and Schistosoma mattheei*. A high prevalence of the parasites commonly occurs in cattle abattoir, but clinical manifestations of the parasites are rare.[8] Conversely, an infection may result in severe clinical symptoms.[9] The presence of water bodies such as stagnant ponds, swampy areas, rivers, streams, channels for irrigation, wetlands, and canals are among the environmental variables that affect both people and animals suffering from schistosomiasis.[10] Using snails as an intermediary host, schistosomiasis is disseminated; the immature infectious form enters through the host's body and can potentially infect cattle by drinking water.[11]

It is frequently found in Ethiopia's central, southwestern, eastern, and northwestern regions.[12] In Ethiopia; distinct Bulinus species serve as intermediary hosts, as documented in various parts of Ethiopia, such as Gondar, Tigray, Gojjam, Shewa, Arsi, Harrarge, and Wollo.[13]

The diagnosis of schistosomiasis in cattle infection can be established during necropsy by identifying numerous mature worms visible within the mesenteric vessels. Due to the resemblance of symptoms caused by schistosomiasis in cattle to those induced by other trematode worms, reliance on this approach for confirming *S. bovis* infection in field conditions is unreliable.[14] During necropsy, the diagnosis of *S. bovis* infestation can be established by the identification of numerous mature worms visible within the mesenteric vessels. The identification of infected livers is made possible by the existence of visible lesions linked to schistosomiasis, which are characterized by white-gray patches inside and underneath the liver tissue. A confirmatory diagnosis of ongoing schistosomiasis in cattle can only be achieved through the detection of parasite eggs in fecal samples or biopsy specimens from the affected animal.[15]

The treatment of schistosomiasis not only facilitates the reversal of acute or early chronic disease but also serves to prevent complications associated with chronic infection and the development of neuro schistosomiasis.[16]

The most effective approach to controlling schistosomiasis in prevalent regions involves the implementation of measures such as the construction of barriers around perilous bodies of water and the provision of uncontaminated water sources to prevent contact between the parasite and the animals. Unfortunately, the nomadic management of animals prevails in the majority of regions worldwide, rendering the aforementioned methods unfeasible. Consequently, alternative control strategies are directed toward targeting populations of intermediate snail hosts. These methods encompass the use of chemical measures, including molluskicides such as Bayluscide (niclosamide) and copper sulfate, which are currently the preferred options. Furthermore, the use of a native Ethiopian plant known as "Endod" or Phytoplaccadodecandara has also been shown to be an efficacious molluskicide.[13]

The coprological prevalence of *Schistosoma bovis* has been examined by numerous authors at various time points and in different regions of Ethiopia. Cattle schistosomes occur sporadic in their habitat, based on the availability of intermediate snail hosts, the severity of their infestations, and the frequency of aquatic interactions. The prevalence of infections in cattle can reach 40–70% in regions with conducive circumstances, and often exceeds this threshold.[17] These epidemiological investigations provide evidence of the regular occurrence of diseases, particularly in areas with stagnant water and swampy open grazing zones. In Ethiopia, the occurrence of animal schistosomiasis caused by *S. bovis* has been documented, with prevalence rates ranging from 5.7% to 23% in ruminants according to studies conducted by[7,11,18] reported a high prevalence of schistosomiasis of 60% in the southern part of Ethiopia, while[13] reported a prevalence of 17% in the northwestern region.

The advancement of molecular techniques aimed at enhancing the diagnosis of parasitic infections has spurred significant research activity in recent times. The identification of *Schistosoma* DNA through PCR in feces and urine shows promise as a highly sensitive and specific method.[19] Particularly, the utilization of multiplex rapid diagnostic PCR represents a cost-efficient and reliable approach for distinguishing between larval forms of S. haematobium and *S. bovis*, prevalent across various regions in Africa. Numerous serological methods, including indirect immunofluorescent antibody tests (IFATs), indirect hemagglutination assays (IHAs), and enzyme-linked immunosorbent assays (ELISAs), have been developed in the last few decades for the detection of antibodies targeting *Schistosoma* antigens.[20,21] As far as we are aware, there have been no serological or molecular investigations of *S. bovis* in Ethiopia, but there have been some reports of it in Africa. By using an enzyme-linked immunosorbent assay (ELISA)[22] reported the seroprevalence of *S. bovis* in Nigeria. ELISA test results showed 20 cattle (10%) were positive while PCR test results showed 2% (4/200) of cattle were positive. Similarly, in Yola, Nigeria, 200 sera samples have been analyzed for Schistosoma antibodies using IgG Schistosoma ELISA. 6.5% (13/200) has been reported as the overall seroprevalence.[23] ELISA results for *S. mansoni* antibodies in humans from 345 serum samples revealed 177 (51.3%) positive samples in serological investigations also reported in Tanzania.[24]

These parasites inflict considerable economic losses, including mortality, a decrease in carcass weight, a decrease in milk production, diminished productivity, heightened susceptibility to other infectious pathogens, and the financial burden of disease treatment and diagnosis expenses. Furthermore, the public health implications of schistosomiasis have been documented in various regions worldwide, including Ethiopia. Humans become infected through the swallowing of cercariae that are fixed to specific vegetables and aquatic plants.[25] This investigation also offers valuable insights that can inform interventions aimed at addressing Schistosoma in Ethiopia, considering the global objective of eliminating schistosomiasis as a human health concern until 2030. Although the study area is characterized by Lake Haramaya, which provides a favorable environment for the proliferation and maturation of Schistosoma species' biological vectors (snails), there is a dearth of reports about the occurrence of schistosomiasis in cattle. Consequently, this study aimed to determine the occurrence rate of schistosomiasis in both coprological and abattoir surveys in cattle and to evaluate the possible risk factors within and surrounding Haramaya town.

Materials and Methods

Description of the Study Area

The investigation was carried out in the vicinity of Haramaya town, which is located in East Hararghe, Oromia Region, Eastern Ethiopia (Figure 1). The study area has a geographical position determined by a latitude and longitude of 9°24′N

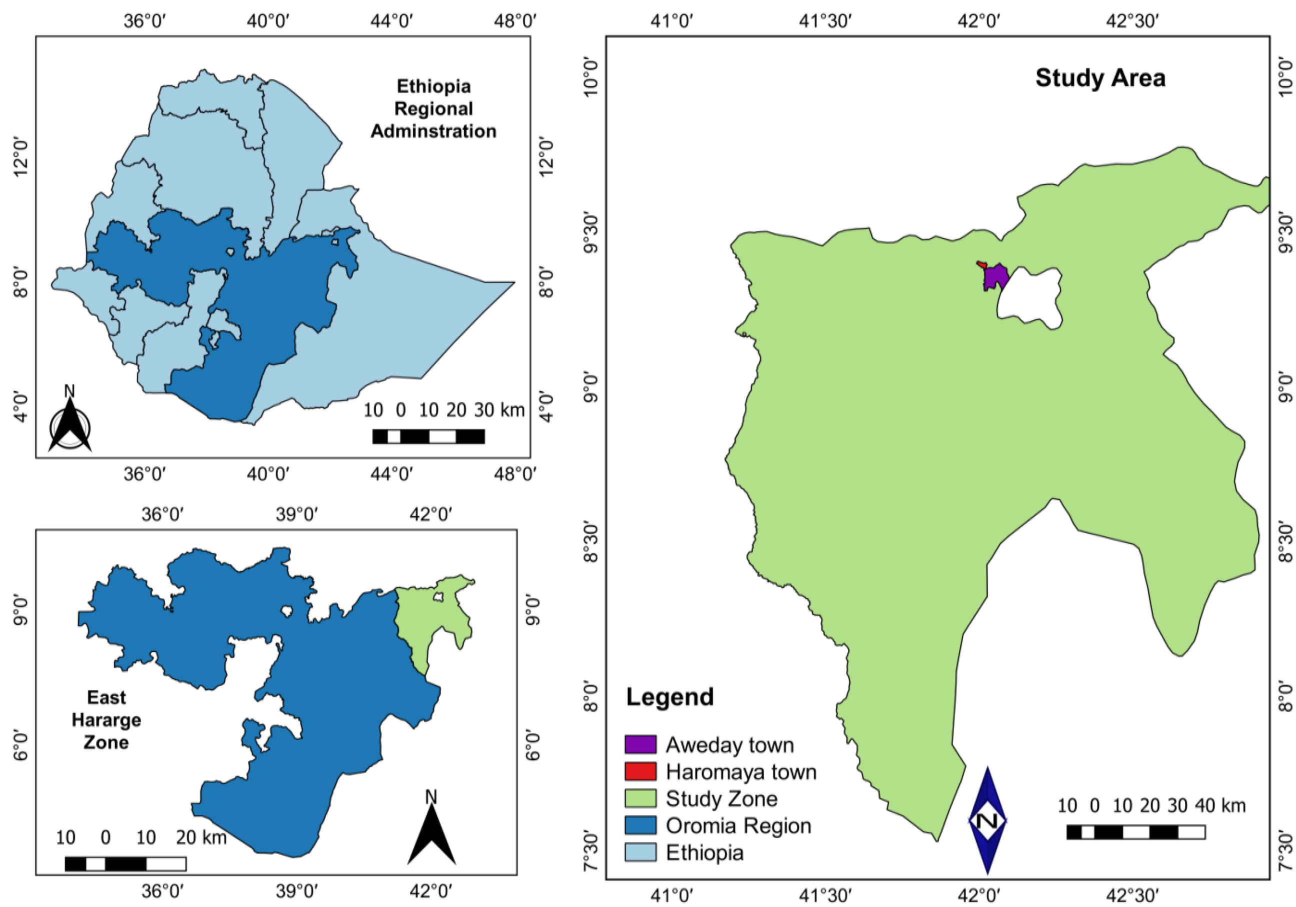

Figure 1 Map of the study area.

42°01′E. Additionally, the region experiences a relative humidity of 64.5% and is located approximately 511 kilometers away from Addis Ababa. In terms of climate, the district experiences rainfall, characterized by a condensed season that typically occurs in February, as well as an extended rainy season spanning from July to September. Similarly, the annual precipitation in the area ranges from 118 to 866 millimeters.2; the average monthly minimum and maximum temperatures recorded in the region are 9.4 and 24 degrees Celsius, respectively. Regarding agricultural practices, the predominant production system in rural areas consists of a combination of crop cultivation and livestock rearing. The primary livestock species maintained in the region include cattle, sheep, goats, camels, donkeys, and poultry. Notably, Haramaya town is situated alongside Lake Haramaya, which had previously experienced a period of desiccation two decades ago. However, the lake has currently experienced a resurgence, with the water level rising by 61%. In particular, the study location was very swampy, and there were many water bodies (Figure 2).

Study Population

The study population consisted of local breed cattle that were randomly selected from Haramaya, Addele, Awday, and Batte. The study included indigenous animals of all ages greater than six months, encompassing various management systems and both sexes. Data regarding the sex, age, and body condition of the animals were documented before sample collection. Tooth eruption and wear were employed to ascertain the age of the study animals.[26] Consequently, the animals were grouped into three categories according to their age: 6 months to 2 years, 2–5 years, and greater than 5 years. Body condition status was classified as good (greater than 6), medium (4–6), or poor (1–3), in accordance with the condition of anatomical structures such as spines, ribs, and vertebral column spines.[27]

Study Design, Period, and Sampling Methods

A cross-sectional study was carried out between December 2022 and May 2023 to estimate the prevalence of bovine schistosomiasis and associated risk factors. The selection of the study areas (both districts and kebeles) was performed purposely, taking into consideration the livestock population, easy access to transport, and the ecology of disease. However, the selection of the study unit/animal was based on a simple random sampling approach. Since there was no prior coprological investigation on bovine schistosomiasis infections in cattle within the study area, an estimated prevalence of 50% was considered, along with a 95% confidence interval and a 5% required absolute precision. The minimum sample size was calculated using the formula provided below.[28]

$$n = \frac{1.96^2 \times Pex(1 - P\exp)}{d^2}$$

Figure 2 Specific sample collection sites.

Then, n= 384 cattle. However, to increase the level of accuracy and consider cluster effects (herd sizes, different levels, districts), the sample size increased to 390.

Abattoir Surrey

Determination of the occurrence of the parasite in the slaughterhouse was also the second objective of the research. Since the abattoir and the sampling location for the coprological investigation were close to each other in this study area, we needed to confirm the presence of gross Schistosoma parasites. As a result, 384 animals were methodically sampled from the abattoir and examined after slaughter to identify the adult Schistosoma parasite.

Coprological Examination

The included animals were carefully restrained, and ten grams of feces were removed from the rectum with their hands gloved. The feces were then transported in an ice box. The eggs were subsequently examined under a microscope along with fecal sedimentation procedures at the veterinary parasitology laboratory of Haramaya University in Ethiopia.

Abattoir Survey

An investigation was conducted at the Haramaya University abattoir, a small-scale facility situated at Haramaya University. This conveniently accessible abattoir was chosen as the site for studying gross parasitic infestations. With a daily average capacity for slaughtering 14 animals, the abattoir was surveyed for *S. bovis* infection in 384 cattle. Cattle from various livestock markets were slaughtered and subsequently subjected to postmortem examination. The presence or absence of adult schistosomes in their mesenteric veins was determined, and the schistosomes were morphologically characterized using a stereomicroscope (Figure 3a and b). The study animals were chosen using a systematic random sampling technique, with the collection of samples taking place three times per week (eight samples per day) over four months.

Data Management and Analysis

In the process of collecting fecal samples from animals, the relevant information was documented in field notebooks using predetermined methods. Then, the data were entered into Microsoft spreadsheets and analyzed utilizing R software (version 4.1.3). To determine the percentage of schistosomiasis patients, descriptive statistics were computed. Furthermore, the relationships between independent factors such as animal district, management system, sex, age categories, and body condition and the prevalence of bovine schistosomiasis (*Schistosoma* positive/negative) were

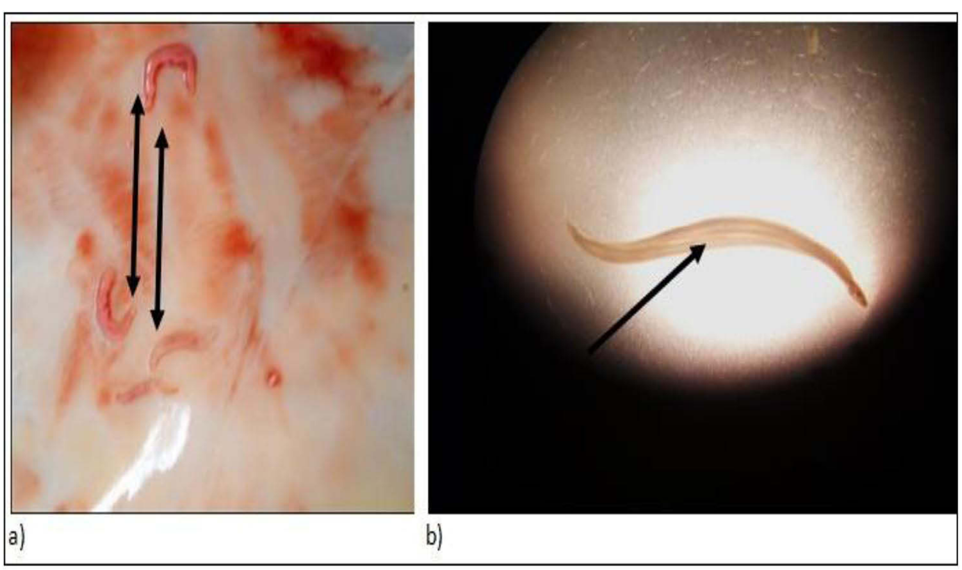

Figure 3 As shown the black arrows, the gross (a) and microscopic (b) structures of *Schistosoma* worms postmortem at abattoirs.

determined by the X^2test. The extent of these associations was calculated using 95% CIs and ORs with a binary logistic regression model (*Schistosoma* positive/negative).

A procedure utilizing a mixed-effect binary logistic regression model was employed to account for the random effect of districts. The fixed effects incorporated in the model consisted of risk factors such as age, sex, management system, and body condition. Subsequently, a mixed effects univariable logistic regression was utilized to ascertain the impact of each explanatory factor on the dependent variable. Following this, a multivariable mixed-effects binary logistic regression model was constructed, including only variables that exhibited a p-value of less than 0.25 and were not collinear.

Results

Coprological results

Among the entire population of 390 cattle, 83 (21.8%) animals tested positive for schistosomiasis. The microscopic examination of the schistosome's egg was demonstrated (Supplementary Figure 1-microscopic structure of schistosoma's egg). The results obtained from the current investigation demonstrated that certain factors, such as age ($\chi2$= 15.9798, P= 0.000), body condition ($\chi2$= 44.1599, P= 0.000), and management ($\chi2$=27.5019, p=0.000), exhibited a significant association with the presence of schistosomiasis in cattle. However, there was no statistically significant association between the occurrence of bovine schistosomiasis and factors such as sex and origin in the present study (Table 1).

Risk Factor Analysis

In the present study, body condition status, sex, age category, and management system were regarded as the primary risk factors (fixed effects), while the district was also regarded as a random factor in the logistic regression model. The dependent variable examined in this study was the presence or absence of schistosomiasis, a binary outcome. The multivariable mixed-effect logistic regression model included only those variables that demonstrated a p-value less than 0.25 in the univariable mixed-effect logistic regression model. Regrettably, all of the variables, namely, sex, age, body condition, and management system, fulfilled the inclusion criteria. The results of the univariate logistic regression analysis can be found in Table 2. Similarly, the incidence of schistosomiasis at the district level is presented in Table 3.

A multivariable logistic regression analysis was carried out utilizing variables that were found to be significant (p<0.25). Consequently, the final model included variables such as sex, age category, body condition, and management

Table 1 The Rate of Bovine Schistosomiasis in Relation to Various Risk Factors

Risk Factors	Category	No. Examined	Positive	Prevalence (%)	X^2	P-value
Sex	Male	171	43	25.15%	2.7142	0.099
	Female	219	40	18.26%		
Age	Young	69	26	37.68%	15.9798	0.000
	Adult	151	21	13.91%		
	Old	170	36	21.17%		
Body Condition	Poor	76	36	47.36%	44.1599	0.000
	Medium	237	43	18.14%		
	Good	77	4	5.19%		
Management	Extensive	192	58	30.21%	27.5019	0.000
	Intensive	102	4	4.08%		
	Semi-intensive	96	21	21.87%		
Origin	Adele	74	17	22.97%	1.2462	0.742

Table 2 Univariable Logistic Regression of Risk Factor with Prevalence of *S. bovis* (N=390)

Variables/Factors/	Category	Total Examined	No. Positive	95% CI (Percentage)	OR(95% CI)	p-value
Sex	Male	171	43	25.15	Ref.	
	Female	219	40	18.26	1.2(0.25, 1.66)	0.101
Age	Adult	151	21	13.91	Ref.	
	Young	69	26	37.68	3.7(1.31, 10.7)	0.000114
	Old	170	36	21.2	1.6(0.54,5.05)	0.090940
Body condition	Good	77	4	5.2%	Ref.	
	Medium	237	43	18.14	0.25(0.14,0.43)	0.00972
	Poor	76	36	47.4	4.1(1.3, 12.2)	8.75e-07
Management system	Intensive	98	4	4.08	Ref.	
	Extensive	192	58	30.2	10.6(9.7, 30.2)	9.70e-06
	Semi-intensive	96	21	21.9	6.8(5.3, 20.8)	0.000679

Table 3 The Prevalence of Bovine Schistosomiasis at the District Level

No	District	Total Number of Animals Examined	No Positive	Prevalence (%)
1	Adele	74	17	22.9
2	Away	24	3	12.5
3	Batte	51	11	21.6
4	Haramaya	241	52	21.6

system. Despite conducting a multivariable regression analysis, there was no significant difference in the occurrence of *S. bovis* between males and females (p=0.442632). Furthermore, there was no significant difference in the occurrence of schistosomiasis between animals with medium or good body condition (p=0.052175) (Table 4). Additionally, the prevalence of bovine schistosomiasis did not significantly differ (p=0.237266) between old and adult animals.

Table 4 Multivariable Logistic Regression of Risk Factor with Prevalence of *S. bovis* (N=390)

Variables/Factors/	Category	Total Examined	No. Positive	95% CI (Percentage)	OR(95% CI)	p-value
Sex	Male	171	43	25.15	Ref.	
	Female	219	40	18.26	1.23(0.40, 3.7)	0.442632
Age	Adult	151	21	13.91	Ref.	
	Young	69	26	37.68	2.7(1.0, 7.00)	0.008285
	Old	170	36	21.2	1.5(0.5, 4.5)	0.237266

(*Continued*)

Table 4 (Continued).

Variables/Factors/	Category	Total Examined	No. Positive	95% CI (Percentage)	OR(95% CI)	p-value
Body condition	Good	77	4	5.2	Ref.	
	Medium	237	43	18.14	0.34(0.11,1.0)	0.052175
	Poor	76	36	47.4	3.048(1.07,8.)	0.000177
Management system	Intensive	98	4	4.08	Ref.	
	Extensive	192	58	30.2	5.9(2,17)	0.001280
	Semi-intensive	96	21	21.9	4(1.6, 12)	0.010991

Abattoir Survey

During the necropsy of the 384 slaughtered cattle, 18.23% exhibited positivity for an adult parasite, which was detected in the mesenteric veins. Subsequently, the adult parasites were characterized using stereomicroscopy. All the slaughtered animals were male and possessed a body condition ranging from medium to good. However, they originated from diverse geographical locations. Consequently, due to the homogeneity of nearly all factors, conducting risk analysis and other statistical analyses was not feasible.

Discussion

Schistosomiasis is widely recognized as the primary helminth infection in domestic animals in Ethiopia. The primary objectives of this cross-sectional study were to determine the incidence of schistosomiasis in bovine animals and the associated risk factors contributing to its existence. The prevalence of schistosomiasis in cattle was 21.28% (83/390). According to the present investigation, bovine schistosomiasis is recognized as a significant livestock ailment in and around Haramaya Town. In terms of coprological examination, the overall prevalence in the current study was comparable to that in studies conducted by,[29] who reported a pooled prevalence (24%) through meta-analysis in Ethiopia. The prevalence rates reported by[16,30–36] are in line with the prevalence observed in our study.

The coprological investigation yielded better outcomes than prior discoveries by[11,] with a predominance of 5.7% in and around Nekemte,[10] with a pervasiveness of 13.02% in Tis Abay District,[15] with a predominance of 16.7% in chosen areas of the South Wollo and Oromia Zones of the Amhara Region, and[13] with a predominance of 16.28% in FogeraWoreda. These findings are lower than those of past reports[37] in and around Gozamen District,[38] in the Bahir Dar region,[39] in chosen locations of Bahir Dar, and[40] and associates, who generally reported a predominance of 26.3%, 29%, 37.3%, and 27.13%, respectively. The variety in pervasiveness can be attributed to contrasts in study design, methodology, epidemiology, ranch husbandry, and agroecological factors across the areas under scrutiny. The contamination rate of bovine schistosomiasis varied widely across various locations inside the investigation district. The availability of sizable permanent bodies of water, variations in temperature, wetness, and humidity, as well as irrigation techniques, are additional important elements that support the life cycle of schistosomes and increase their diversity.

The present discoveries also revealed the highest occurrence (47.36%) in animals in poor physical condition, followed by animals in moderate (18.14%) and good (5.19%) physical condition. The disparity in the occurrence of bovine schistosomiasis among animals with varying physical conditions was found to be significantly correlated. These findings are in agreement with the occurrence reported by[39,] who reported an occurrence rate of 29.3% in animals in poor physical condition, 14.0% in animals in moderate physical condition, and 13.3% in animals in good physical condition in the North Gulf of Lake Tana, Northwest Ethiopia. Similarly,[32] reported an occurrence of 32.46% in animals in poor physical condition, 21.42% in animals in moderate physical condition, and 11.86% in animals in good physical condition in and around Bako town. Furthermore,[36] reported an occurrence of 68.88% in animals in poor physical condition, 17.57% in animals in moderate physical condition, and 11.36% in animals in good physical condition. It was noted that animals in poor physical condition displayed a greater rate of bovine schistosomiasis infection. This could be attributed to the compromised and vulnerable state of the animals, which may be triggered by insufficient nutrient intake, secondary complications, and/or mixed parasite infection.[41] Consequently, animals with poor physical condition and weakened immune status become more suppressed, leading to a delayed response to Schistosoma infection.[40] This delay provides an opportune time for the establishment and fertility of parasites in animals.

The prevalence of bovine schistosomiasis was significantly greater in the extensive management system (30.20%) than in the semi-intensive management system (21.87%) and intensive management system (4.08%). This difference was highly significant (p = 0.000). This finding aligns with the research conducted by,[10] who also noted a greater prevalence of bovine schistosomiasis in extensive management systems (17.9%) than in semi-intensive management systems (9.6%) and intensive management systems.[42] This finding also showing that animals in extensive management systems are more susceptible to Schistosoma infection than are those in semi-intensive and intensively reared systems. The higher prevalence observed in extensively managed cattle can be attributed to the fact that disease transmission requires contact between animals and swamp snails and cercariae.

The prevalence of schistosomiasis varies according to the age of the animal. A low prevalence was observed in adult animals (13.91%), while the highest prevalence was observed in young animals (37.68%) and old animals (21.17%). This difference among age groups was found to be statistically significant. This result is consistent with the findings of,[43] who reported that the prevalence of the disease is influenced by the age of the cattle, with a higher prevalence observed in animals less than 2 years old. The highest prevalence of schistosomiasis in cattle less than 2 years old is attributed to their lack of immunity against new infections. Compared with older cattle that can graze in marshy areas throughout the day, these young animals are more susceptible. As cattle age, the occurrence of schistosomiasis decreases due to the development of immunity in chronically infected individuals, which suppresses the production of eggs. Immunity does not solely prevent the maturation of challenge infection but rather suppresses worm fecundity, leading to a decrease in the fecal egg count. This is in contrast to the increase in worm burdens of schistosomes with the age of naturally infected animals. Furthermore, the duration of exposure to continuous schistosomiasis also reduces susceptibility to reinfection in cattle.

The prevalence of schistosomiasis was found to be 25.15% in male animals and 18.26% in female animals. However, there was no statistically significant difference ($P>0.05$) between the sexes. Similar findings have been reported by.[16,44,45] This difference may be attributed to the exposure of both sexes to similar grazing areas and the same watering system, which ultimately results in an equal chance of developing the disease. During necropsy, it was determined that 18.23% of the 384 slaughtered cattle had adult worms in their mesenteric veins. These findings align with previous reports by,[15] who reported a prevalence of 17.2% (66/384) based on postmortem examination of slaughtered cattle for schistosome adult worms in their mesenteric veins.

Conclusion

In this study, the prevalence of bovine schistosomiasis was 21.28% according to the coprological examination and 18.23% according to the abattoir survey. In the present study, a high occurrence of schistosomiasis was confirmed at both the abattoir and field levels. A higher incidence of *Schistosoma* infection can cause significant economic loss to the local community. Risk factors such as age, body condition and management had significant effects on the incidence rate of schistosomiasis in cattle, but sex and origin did not have significant effects. In particular, extensive cattle management has been performed ten times for intensively managed animals. Moreover, as observed, the study area was suitable for the survival of the snail, which further worsened the situation. In view of the above conclusions, farmers should reduce cattle management in extensive systems. Based on the current prevalence estimates, Ethiopian public health institutions and other responsible bodies should focus on substantially reducing this high level of prevalence, as it has public health implications.

Data Sharing Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethical Approval and Consent to Participate

This research involved the use of ethical statements. Ethics approval was obtained from Haramaya University in accordance with the principles established by the institution. This study was granted ethical approval by Haramaya University's Institutional Ethics Research Review Committee, College of Veterinary Medicine (Ref. No: IHRER/234, 13 September 2022). The manual bears the title "The guide is entitled" Guidelines for Ethics in animal-related research and Teaching involving animals. Animals were approached with great care according to the guidelines for the ethics of animal research. In addition, we obtained verbal informed consent from the animal owners, which was approved by the ethics committee before sample collection.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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