Original Article

Bovine and ovine schistosomiasis: prevalence and associated host factors in selected sites of South Achefer district, northwest Ethiopia

Yirsaw Kerie[1] Zewdu Seyoum[2*]

Abstract

Schistosomiasis is a snail-borne trematode infection in man and animals in tropical and subtropical countries. It is an economically important disease caused by several *Schistosoma* species and results in economic losses through mortality and morbidity from severe infection and from long-term effect of moderate- and long-standing chronic infection. This study was conducted from November 2013 to April 2014 to determine the prevalence and potential host-related risk factors of bovine and ovine schistosomiasis in selected sites of South Achefer district, northwest Ethiopia. About 532 faecal samples were collected from randomly selected cattle and sheep from three purposively selected peasant associations. The samples were processed with sedimentation technique to detect *Schistosoma* ova using light microscopy. Results indicated that the overall prevalence of schistosome infection was significantly higher ($P < 0.05$) in the cattle (24.6%) than in the sheep (2.3%). Only *Schistosoma bovis* ova were recorded in the present attempt. A significant ($P < 0.001$) association of *S. bovis* infection with poorer body condition score was observed in the cattle, but not in the sheep. However, schistosome infection was not associated ($P > 0.05$) with age or gender in either species. Therefore, well-planned deworming aimed at reducing the prevalence and impact of *S. bovis* infection in ruminants could be worthwhile in the study sites.

Keywords: cattle, prevalence, schistosome infection, sedimentation, sheep, South Achefer

[1]*Amhara National Regional State Bureau of Agriculture*
[2]*University of Gondar, Faculty of Veterinary Medicine, Department of Para-clinical studies, P.O. Box 196, Gondar, Ethiopia*
***Correspondence**: zewdus@yahoo.com*

Introduction

Schistosomiasis is a snail-borne trematode infection in man, domestic animals and wild animals in tropical and subtropical countries (Singh et al., 2004; Sumanth et al., 2004; Islam et al., 2011; Zangana and Aziz, 2012). In livestock sector, it is an economically important disease caused by several *Schistosoma* species, which inhabit the vascular system of final hosts (Lefevre et al., 2010). Schistosomiasis is well recognized as the major helminthosis of domestic animals in Africa and Asia (Sumanth et al., 2004; Islam et al., 2011). It is a threat to 530 million cattle while it infects over 165 million cattle in Africa and the Middle East (Al-Kennany et al., 2009; Islam et al., 2011). In animals, the disease causes significant economic losses through mortality and morbidity from severe infection and long-term effect of moderate- and long-standing chronic infection (Edward and Androwsi, 2002).

Animal and human schistosomiasis is dependent on environmental factors such as moisture, rainfall, temperature, water bodies (stagnant ponds, swamps, streams, rivers, irrigation canals, marshes and dams) and snail intermediate hosts (Niaz et al., 2010; Li et al., 2012). Moreover, schistosome infection is closely associated with infested water bodies with traditional grazing and watering systems (Arshad et al., 2011). These factors tend to be conducive of enzootic schistosomiasis, which is characterized by the high prevalence and significant losses of productivity in ruminant population. The impact of schistosomiasis is expected to increase in the future as a result of intensified animal husbandry and water conservation which create ideal conditions for schistosome transmission (Islam et al., 2011; Kamanja et al., 2011).

In Ethiopia, animal schistosomiasis due to *S. bovis* has been reported and its prevalence ranges from 1.5% to 33.8% in ruminants (Lo and Lemma, 1973; Ameni et al., 2001; Mengistu et al., 2012). Reports have also shown that schistosomiasis is highly endemic in Ethiopia (WHO, 2010; Getachew et al., 2014). It is, therefore, expected to cause high economic losses due to mortality, low fertility, retarded growth, weight loss, anaemia, low milk and meat yield, poor productivity (poor conversion rate), and increased livestock susceptibility to other diseases. Consequently, information about the disease in a given area is essential in order to propose and establish cost-effective and practicable control strategies against the impact of the disease. Although South Achefer, northwest Ethiopia consists of wetland fields (Fig 1) and river banks that favour the breeding and development of *Schistosoma* species, and also the biological vectors (snails), there has been no previous report regarding the prevalence of schistosome infection in cattle and sheep in this area. Moreover, there have been no epidemiological data regarding risk factors of the disease. Therefore, the aims of the present study were: 1) to determine the prevalence of bovine and ovine schistosomiasis in South Achefer, northwest Ethiopia and 2) to identify host-related risk factors associated with the disease.

Materials and Methods

Study sites: South Achefer is one of the 150 districts found in Amhara Regional State, northwest Ethiopia. It is located at 11°51'N latitude and 37°10'E longitude, 502 km from Addis Ababa, the capital city of Ethiopia. The altitude of the district ranges from 1,500 to 2,500 meters above sea level and the mean annual rainfall varies between 1,400 to 1,594 mm with the average annual temperature range from 25 to 29°C. The district has many banks of rivers, streams, ponds, stagnant marshy water bodies, irrigation canals and swampy areas. The livestock population found in the district includes cattle (153,612 heads), shoats (80,868 heads), equines (16,721 heads) and poultry (74,689) (CSA, 2008).

Study design: A cross-sectional study design was employed from November 2013 to April 2014 to determine the prevalence of schistosome infection in cattle and sheep and to identify potential host-related risk factors associated with the infection rate in the study area.

Study population: Sampling units of the studied population were cattle and sheep from three purposively selected kebeles (peasant associations) (Aferefida, Gedema and Kerguraji). The studied animals were indigenous zebu cattle (*Bos indicus*) and Dangla sheep which were kept under traditional husbandry system. Cattle are mainly kept for milk consumption, market and draft power while sheep are kept for meat and market purpose. All studied animals have often been allowed to graze whole day near and around the Lesser Abay River (tributary of the Blue Nile) and its tributaries and Birantie River. All relevant animal information such as species, sex, age, body condition and location was recorded at sampling time. Attempts were made to include all ages (young ≤ 2 years and adult > 2 years) and sex (male and female) of the studied population. The age of each animal was estimated using the dentition pattern of the animal as described in Gatenby (1991). Body condition score of each animal was determined according to Nicholson and Butterworth (1986) for cattle and Steele (1996) for sheep.

Sampling method and sample size determination: A simple random sampling method using the lottery technique was used to select animals for the study from the three selected peasant associations. Sample size of the studied animals was calculated by the single population proportion formula given by Thrusfield (2007) using 95% confidence interval and 5% absolute precision. Therefore, 532 animals (405 cattle and 127 sheep) were sampled.

Faecal sample collection and examination: Fresh faecal samples were collected directly from the rectum of each selected animal during the study period. All collected faecal samples were preserved in a clean universal bottle using 10% formalin. Then, the samples were processed and diagnosed using sedimentation techniques as indicated by Hansen and Perry (1994) and Urquhart et al. (1996).

Statistical analysis: Raw data obtained from field and laboratory analysis were entered into Microsoft Excel and analysed using SPSS version 17.0. Descriptive statistics were utilized to summarize the raw data. The prevalence of schistosome infection was expressed as a percentage by dividing the total number of animals positive by the total number of animals examined. 95% CI of the prevalence of schistosome infection was calculated with binomial confidence interval exact method using STATA version 11. Then, odds ratio (OR) was calculated to determine the degree of effect of host-related risk factors (age, species, sex, and body condition) with the prevalence of animal schistosomiasis. Results were considered statistically significant when $P < 0.05$.

Results

Overall prevalence of schistosome infection in cattle and sheep: From the 532 examined samples (405 cattle and 127 sheep), 143 (26.9%) samples were found to be positive for *Schistosoma bovis* ova. Significantly higher (odds ratio (OR) = 4.58, $P < 0.001$) *S. bovis* infection rate in the cattle (32.4%) was observed than in the sheep (9.5%). Similarly, the overall infection rate in animals with poor body condition was significantly higher than in animals with medium (OR = 5.102, $P < 0.001$) and good (OR = 9.23, $P < 0.001$) body condition. However, there was no significant association observed between age or sex of the studied animals and *S. bovis* prevalence (Table 1).

Table 1 Sex-wise distribution of *Schistosoma bovis* infection in ruminants

Species	Sex	Examined animals	N. of infected animals (%)	95% CI
Bovine	Female	357	118 (33.1)	28.2-38.2
	Male	48	13 (27.1)	15.3-41.8
Ovine	Female	121	11 (9.1)	4.6-15.7
	Male	6	1 (16.7)	0.42-64.1
Overall Prevalence		**532**	**143 (26.9)**	**23.2-30.9**

95% CI: 95% confidence interval

The age-wise distribution of *S. bovis* infection in young and adult cattle was found to be 32.8% and 32.1%, respectively. Similarly, in young and adult sheep it was found to be 10.9% and 8.9%, respectively. Therefore, the prevalence of *S. bovis* infection did not vary ($P > 0.05$) among the young and adult groups of cattle and sheep (Table 2).

Table 2 Age-wise distribution of *Schistosoma bovis* infection in ruminants

Animals	Age	Examined animals	N. of infected animals (%)	95% CI
Bovine	Young	171	56 (32.8)	25.8-40.3
	Adult	234	75 (32.1)	26.1-38.4
Ovine	Young	37	4 (10.8)	3.02-25.4
	Adult	90	8 (8.9)	3.91-16.8

95%: 95% confidence interval

Cattle with a poor body condition (66.7%) were more infected with *S. bovis* than cattle with medium (15.8%) (OR = 10.6, $P < 0.001$) and good (8.8%) (OR = 20.67, $P < 0.001$) body condition. In contrast, in sheep, the infection with *S. bovis* was not associated with the body condition score (Table 3).

Table 3 Prevalence (%) of *Schistosoma bovis* infection vs body condition score

Species	BCS	Examined animals	N. of infected animals (%)	95% CI
Bovine	Poor	141	94 (66.7)^{a}	58.2-74.4
	Medium	196	31 (15.8)^{b}	11.0-21.7
	Good	68	6 (8.8)^{b}	3.30-18.2
Ovine	Poor	74	7 (9.5)	3.90-18.5
	Medium	41	4 (9.8)	2.72-23.1
	Good	12	1 (8.3)	0.21-38.5

Different letters in the same column indicate significant differences; BCS: body condition score

Discussion

Schistosomiasis is a snail-borne trematode infection in man, domestic ruminants and wild animals in Asia and Africa (Sumanth et al., 2004). It has been the focus of various studies because of its medical, veterinary and social importance (Atupele et al., 2009; Niaz et al., 2010). Therefore, the diagnosis of schistosomiasis in animals and human beings is a key step to propose and establish a control strategy (Niaz et al., 2010). According to Martin et al. (2008) and Zhou et al. (2008), determination of the target population for chemotherapy in endemic areas, assessment of morbidity and evaluation of control strategies can all be built with results of diagnostic tests. Therefore, the present study was conducted to determine the prevalence and to identify the risk factors associated with the occurrence of schistosomiasis in bovine and ovine population in South Achefer, northwest Ethiopia. Accordingly, the overall prevalence of schistosome infection in the present studied animals was found to be 26.9%. This percentage is within the ranges of previous attempts (10.2-29%) in Ethiopia

(Yalelet, 2004; Almaz and Solomon, 2011; Mengistu et al., 2012; Almaz et al., 2013; Lulie and Guadu, 2014). However, it is higher than those reported in the studies of Lo and Lemma (1973), Fromsa et al. (2011) and Merawe et al. (2014) in southern, southwest and northwest Ethiopia, respectively. According to Narcis et al. (2004), Pfukenyi et al. (2006), Niaz et al. (2010), Arshad et al. (2011) and Li et al. (2012), this difference might be due to variations in environmental factors (agro-ecology and climate), sampling periods, epidemiological factors (availability of stagnant water body, marshy area and drainage system for irrigation practice which favours the development and multiplication of snail intermediate hosts) and management system of the studied areas. This is also supported by the explanations of Jesus et al. (2004), Narcis et al. (2004) and Langeler et al. (2004) that the prevalence and occurrence of schistosomiasis in a given area could be influenced by local climate conditions, presence of water reservoirs, lakes, rivers, and availability of suitable final and intermediate hosts. In general, our report clearly demonstrates that *S. bovis* infection in ruminants, particularly in cattle, is a great concern in the studied area.

Schistosomiasis is considered to be a much more serious and important infection in domestic ruminants, particularly in cattle (Kassuku et al., 1986; Agrawal, 2011), corresponding to the results of the present study that the prevalence of *S. bovis* infection was significantly higher in cattle than in sheep. Also, Islam et al. (2011) reported higher prevalence of *S. bovis* infection in cattle than in small ruminant in Bangladesh. This might be attributed to the difference in drinking and grazing behaviour of cattle and sheep. In contrast to sheep, cattle have more chance of coming into contact with snail and cercariae because of the water bodies and marshy areas where they drink and graze regularly. Similarly, Lefevre et al. (2010) explained that cattle mostly tended to graze and cross marshy areas which exposed them to cercariae in contaminated water. Therefore, higher prevalence of *S. bovis* can be found in cattle. Sheep mostly prefer a dry environment to graze and show a distinct aversion to immersion in water, or even avoid walking through it, reducing their risk of exposure to *S. bovis*. This is also supported by the report of Chiejina (1994) stating that the availability of snail intermediate hosts and the grazing habits of the final hosts to a large extent determined the epidemiology and seasonal pattern of infection with trematodes.

In the present study, the sex-wise distribution of *S. bovis* infection did not show any variation in the bovine and ovine populations. This is in agreement with reports in Ethiopia and elsewhere in the world (Niaz et al., 2010; Almaz and Solomon, 2011; Kamanja et al., 2011; Merawe et al., 2014). This might be due to the fact that both sex groups are allowed to graze and drink in similar pasture land and water points, exposing them to the infection comparably. Therefore, the infection appeared to be well distributed between both sex groups. Similarly, age was not related to the distribution of *S. bovis* infection in the studied animals. This is inconsistent with reports of many researchers across the world (Pfukenyi et al., 2006; Fromsa et al., 2011; Islam et al., 2011; Kamanja et al., 2011; Mengistu et al., 2012; Merawe et al., 2014) who stated a significant effect of age on *S. bovis* infection in the studied animals. This difference may be due to the performance of the technician, the parasite limited fecundity rate and the false negative results. According to Taylor et al. (2007), in young animals the prevalence is higher since they have no immunity to resist new infection. In addition, as the age of the animal advances the prevalence decreases, which may be because cronically infected animals develop immunity against infection and egg production is greatly suppressed (Aradaib et al., 1993). The immunity against schistosome infection does not act primarily by absolute prevention of maturation of challenge infection, but mainly by suppression of worm fecundity, by which faecal egg count decreases in contrast to worm burdens of schistosomes, which increases with the age of naturally infected animals (De Bont and Vercruysse, 1998).

The *S. bovis* infection rate was associated with the poor body condition score in the present study in cattle. Similarly, Fromsa et al. (2011) and Merawe et al. (2014) affirmed that the infection rate increased with animals which had a poor body condition score. This could be that the acquired immunity status of poor body condition and weak animals becomes more suppressed and susceptible, which might be due to malnutrition and other parasitic infections. Moreover, *S. bovis* infection can result in weight gain loss or poor body condition score and weak acquired immunity (Niaz et al., 2010). Therefore, infected animals may require a long period of time to respond against *S. bovis* infection, allowing suitable time for the establishment and fecundity of parasite in animals. This finding also coincides with the work of Lulie and Guadu (2012) which accounted the prevalence of *S. bovis* infection more common in animals with poor body condition score than medium and good body condition score. In contrast to cattle, the body condition score of the sheep was not associated with the occurrence of schistosome infection. This may be due to the very small sample size of sheep and the imbalance in sampling ratio. In addition, this might be due to the lesser tendency for sheep to graze in wetland, reducing their exposure to cercaria of *Schistosoma* in the studied area.

In conclusion, the present study demonstrates the occurrence of *S. bovis* infection with the overall prevalence of 32.4% in cattle and 9.5% in sheep in the studied area. The infection rate was significantly associated with the body condition score, but not with the sex and age of sampled animals. Therefore, the findings of this study will be helpful in making a strategy for the control of schistosomiasis in cattle and sheep of the studied sites to prevent economic loss. In addition, well-planned deworming activities are essential in order to reduce the exposure rate of animals to *Schistosoma* and the impact of schistosome infection in the area.

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บทคัดย่อ

อุบัติการณ์และปัจจัยที่เกี่ยวข้องกับโรค Bovine และ ovine schistosomiasis ในเขตเอเชเฟอร์ใต้ ตะวันตกเฉียงเหนือ สาธารณรัฐเอธิโอเปีย

เยเซา เคียรี่[1] ซูดู สือลัม[2*]

Schistosomiasis เป็นโรคที่เกิดจากพยาธิใบไม้ ซึ่งมีหอยเป็นสัตว์พาหะ โรคนี้พบในคนและสัตว์ในประเทศ เขตร้อนชื้นและกึ่งร้อนชื้น โรคนี้ก่อให้เกิดความเสียหายทางเศรษฐกิจ มีอัตราการป่วยและเสียชีวิตสูง ในรายที่ติดเชื้อรุนแรง และมีผลต่อเนื่องยาวนานในรายที่ติดเชื้อแบบเรื้อรัง การศึกษาครั้งนี้ได้ศึกษาอุบัติการณ์และปัจจัยที่เกี่ยวข้องของโรค bovine และ ovine schistosomiasis ในเขต**เอเชเฟอร์**ใต้ ตะวันตกเฉียงเหนือ สาธารณรัฐเอธิโอเปีย ระหว่างเดือนพฤศจิกายน 2013 ถึง เมษายน 2014 โดยเก็บตัวอย่างอุจาระโคและแกะ จำนวน 532 ตัวอย่าง ตรวจตัวอย่างด้วยวิธีตกตะกอน เพื่อตรวจหาไข่ พยาธิ Schistosoma ผ่านกล้องจุลทรรศน์แสงสว่าง พบอุบัติกาณ์ของ Schistosoma ในโค (24.6%) ซึ่งสูงกว่าในแกะ (2.3%) โดยพบไข่พยาธิชนิด *Schistosoma bovis* และพบความสอดคล้องของสภาพร่างกายสัตว์ในโคกับการติดเชื้ออย่างมีนัยสำคัญ ($P < 0.001$) แต่ไม่พบในแกะ และพบว่าการติดเชื้อไม่เกี่ยวข้องกับอายุและเพศของสัตว์ ($P > 0.05$) โดยสรุปการวางแผนการถ่ายพยาธิที่ดี จะช่วยลดอุบัติการณ์และผลกระทบของการติดเชื้อ *Schistosoma bovis*

คำสำคัญ: โค อุบัติการณ์ การติดเชื้อ *Schistosoma* การตกตะกอน แกะ **เอเชเฟอร์ใต้**

[1]สำนักการเกษตรแห่งชาติ เขตแอมฮารา

[2]มหาวิทยาลัย กอนดา คณะสัตวแพทยศาสตร์ ภาควิชา พาราคลินิก, กอนดา, สาธารณรัฐเอธิโอเปีย

***ผู้รับผิดชอบบทความ** E-mail: zewdus@yahoo.com*