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Spatial Distribution and Risk Mapping of *Fasciola hepatica* and *Fasciola gigantica* Infections in Cattle Slaughtered in Eswatini, July 2023 to January 2024 – The Case of Eswatini Meat Wholesalers

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ABSTRACT

Reports have suggested an increase of human fascioliasis caused by Fasciola hepatica between 1970 and 1990, with 2 594 reports of infected persons in 42 countries located in all continents. Approximately 17 million people worldwide are infected with fascioliasis. The disease poses a substantial health burden for over 90 000 Disability-Adjusted-Life-Years (DALYs) due to abdominal complications. Livestock belonging to ethnic groups traditionally residing near water sources have been reported to carry a risk of infection with Fasciola gigantica. Slaughterhouses identify the parasites during routine inspection of slaughtered animals in Eswatini and the loss from condemned livers is of concern. Infected livestock release eggs that reach water and eventually develop to metacercariae that infects other animals and humans on water plants. Therefore, high prevalence in livestock is a major threat of fascioliasis in humans. This study aims to determine the prevalence, geospatial distribution and risk factors of Fasciola spp in order to promote awareness among cattle farmers and to implement strategies to control the infection among cattle reared in Swazi farms and grazing areas. During the period of investigation (July 2023 to January 2024), 168/326 (52%) of the carcasses inspected were found infected with either Fasciola hepatica or F. gigantica. Female cattle were more likely to be infected compared to their male counterparts (OR=0.26 95%CI 0.16 – 0.44). The infection rate appeared to increase with increasing age of the cattle. This prevalence causes economic losses of about E156 480(8 842.70USD) through loss of liver due to condemnation. Geospatial distribution of the infected cattle revealed three Clusters: Cluster 1 – Mnkayane/Ngwempisi, Cluster 2 - Nhlambeni/Siphofaneni/Mafutseni and Cluster 3 – Sithobela. Cluster 1, the only one in the Highveld had the largest number of infected cattle. Our study suggests that the prevalence of fascioliasis could be high in Eswatini. Comprehensive studies should be conducted at various slaughter houses in order to reveal the true prevalence rate in the country.

Keywords

Fasciola hepatica, Fascioliasis, Eswatini, Epidemiology of Fasciola hepatica/gigantica.

Introduction

Fascioliasis is a parasitic zoonotic disease of herbivorous animals and emerging as a cause of disease in humans. The disease is caused by two helminth species, *Fasciola hepatica* and *F. gigantica*. Worldwide, over 17 million people are infected, and 180 million are at risk of infection across more than 70 countries, including Europe, Asia, Africa, Oceania, and the Americas [1-3]. Globally, the disease is estimated to incur 90,000 Disability-Adjusted-Life-Years (DALYs) [1-3,5], due to the associated abdominal problems. This estimate, however, does not yet account for the immunosuppression, neurological or ocular effects due to fascioliasis, the actual burden could thus be even higher [2,6]. Human fascioliasis is an emerging disease [6-8], and a further increase in incidence might be expected due to global warming influencing intermediate host abundance and parasite transmission [9]. Human fascioliasis has become a neglected zoonotic disease across Africa [1-3]. Animals and humans acquire fascioliasis following ingestion of metacercariae encysted in water-plants such as watercress, rice, dandelion, *Nasturtium*, and *Mentha* spp. [10,11]. High livestock infections in an area are a strong predisposing factor for increased human infections. In livestock, high infections lead to reduced yield of milk, meat and decreased fertility [12,13]. Fascioliasis is perceived as a significant animal health and economic problem for animal slaughter houses in Eswatini (Vusi Dlamini (Eswatini Meat Wholesalers – *personal communication*). Economically, worldwide losses in animal productivity due to fascioliasis were conservatively estimated at over USD3.2 billion per annum according to a 1999 publication [14]. The economic losses are categorized as direct losses, which consist of drug costs, drenches, labour, and liver condemnation at abattoirs; and indirect losses associated with decreased productivity such as reduced production, poor growth rate, increased costs for replacement stock, reduced production and quality of milk, and lower feed conversion rates in cattle [15].

The geographical distribution of *Fasciola spp* is strongly linked to climatic and environmental factors such as the presence and proximity of water bodies to grazing areas. These factors create a favourable environment for the survival and transmission of free-living fluke stages and of the snail intermediate hosts of the parasites [16,17]. Climate change and environmental factors have been widely reported to affect *Fasciola* developmental stages and snail vectors [18], hence are major factors that influence the distribution of both *Fasciola* species by altering habitats suitable for their intermediate snail hosts. Changes in temperature and precipitation patterns create new habitats conducive to the intermediate snail host belonging to the family Lymnaeidae proliferation. Increased rainfall may enhance moisture levels in environments where these snails thrive, facilitating their reproduction and survival [1,19]. In animals, fascioliasis leads to a notable reduction in milk production as well as weak reproductive rates [20], with significant associated costs of treatment and meat condemnation, representing substantial economic losses [21,22]. Data on fascioliasis is not readily available in Eswatini. However, considering results from other countries, we have reason to believe that fascioliasis is prevalent among both humans and domestic animals. This study aims to investigate the prevalence of fascioliasis in cattle in one abattoir in Eswatini and to determine the spatial distribution of fascioliasis identified among cattle slaughtered in this abattoir. The presence of fasciolosis due to *F. hepatica* and *F. gigantica* at abattoir surveys in some parts of the country has long been known. However, studies aimed at estimating its prevalence and economic significance in the country have never been conducted. Most studies aimed at estimating the prevalence and determining the distribution patterns of *Fasciola spp* have mostly been conducted among developed countries, suggesting that these infections have largely been neglected among developing countries. Therefore, while this study is not comprehensive and still leaves gaps for many potential sites of the country but information from our study provides clues on the general prevalence of fascioliasis and largely implies that comprehensive studies should be conducted to provide a clear picture of the country-wide prevalence and economic significance of facioliasis. The aim of this study was to estimate the point prevalence of fascioliasis and evaluate risk factors and the direct financial loss caused by *Fasciola spp*. in slaughtered cattle at Eswatini Meat Wholesalers.

Methods

Study Area

The study was conducted at the Eswatini Meat Wholesalers (Ngwenya). Eswatini Meat Wholesalers is located on the North eastern part of the country between Mbabane and Oshoek border post. The Wholesalers also run an abattoir where cattle, bought from various farms in the country, are slaughtered and inspected before despatch to butcheries and meat outlets that operate in the country. The number of cattle reared in Eswatini was estimated at 603 656 in 1996 and, 490 070 (81%) and 95 712 (16%) are reared in Swazi Nation Land (SNL) by subsistence farmers and in title deed land (TDL) by commercial farmers, respectively. A total of 17 874 were reared in Government Ranches (GR) [23].

The livers of all cattle slaughtered at Eswatini Meat Wholesalers between July 2023 and January, 2024 were examined for the presence of *Fasciola spp* adult worms during routine meat inspections. Meat inspection serves as an important disease detection strategy among slaughtered cattle because it has high test specificity (SP = 100%) for liver flukes [24] and reportedly higher sensitivity than coprological assays [9]. Parasites were identified by incising the liver along the bile ducts according to routine meat inspection procedures. No further pathological assessment was made as the study took place during routine meat inspections conducted by the qualified and experienced local meat inspector at Eswatini Meat Wholesalers. Carcasses were identified as positive when one or more flukes were recovered without any attempt to quantify the level of infection by recovering and counting all flukes from each liver. All positive liver samples are disposed through destruction according to the guidelines of the Ministry of Agriculture, Eswatini. Information on the origin of each animal found to be infected was sourced from records of the company from which a geospatial distribution was prepared using ArcGIS (Version 10.8.2, Redlands, California, USA). The prevalence rates were plotted according to the coordinates of the village of origin of the animal to produce a geospatial distribution on the map of Eswatini.

Environmental Data

The study used Environmental Systems Resource Institute (ESRI) shape files sourced from the Central Statistics Office (CSO) in the form of Eswatini localities shape files and rivers data. These files work compatibly with the mapping software ArcGIS 10.8.2 which was used in the mapping of the distribution of *Fasciola hepatica* and *F. gigantica* in Eswatini with environmental covariates such as rainfall, rivers and temperatures. The average winter/summer seasonal rainfall was sourced from the Eswatini Meteorological Services Department for the period of four years, from January 2020 to January 2024. The rainfall data presented was for the major towns where weather stations are available, and thus required aggregation and processing on ArcGIS 10.8.2 for spatial generalization to the rest of Eswatini through the interpolation tool of kriging. Then a generalized raster layer was produced to represent the average rainfall for Eswatini in the 12-month period from July 2023 to January 2024.

Mapping

Coordinates of all dipping tanks from which the cattle were bought by Eswatini Meat Wholesalers were identified. The mapping of the distribution of *F. hepatica* and *F. gigantica* was prepared through the use of ArcMap 10.1 mapping software (Redlands, California, USA). The analysis explored spatial distribution of *F. hepatica* and *F. gigantica* rates in particular dependency on environmental parameters (rainfall and/or rivers) using simple maps and tables. The maps were produced by overlaying the fascioliasis incidence data with that of the rainfall and temperature data from the Eswatini weather stations to come up with the final distribution maps.

Results

A total of 326 bovine carcases were slaughtered and examined for *Faciola hepatica* or *F. gigantica* infection between June 2023 and January 2024 (7 months period). A total of 168 (52% Range 30 – 86%) of the carcasses inspected were found to have either *F. hepatica* or *F. gigantica* adult worms or both (Table 1). The cases were traced to 20 dip tanks where the cattle were bought. It is reasonable to assume that the cattle were reared within the surrounding communities around the dip tank. Dip tank 497 (Gwabhe) and 325 had the highest prevalence rates at 86% and 70% respectively. The dip tank with the least number of infections was dip tank number 499 (30%). However, even the least infections are relatively high at 30%.

Infection rate was higher in females (51.8%) than in male cows (48.2%) (OR=0.25 95% CI 0.16 – 0.44) p<0.001) even though there were fewer females than males among the slaughtered animals (Table 2). Cattle that were 5 – 7 years old were not significantly different in fascioliasis infection from cattle that were 0 – 4 years old (OR=1.11 95%CI 0.76 – 1.84 p = 0.6784). However, older cattle at 8 – 10 years old have a more than two times rate of infection compared to cattle that are 0 - 4 years old (OR = 2.26 95%CI 1.43 – 3.61 p=0.0002) (Table 2).

The prevalence of fascioliasis at Eswatini Meat Wholesalers causes economic losses of about SZL156 480(8 842.70USD) through loss of liver due to condemnation. The weight of each bovine liver varies between 4 and 10kg. Therefore, to make this calculation, an average weight of 8kg was assumed. The current cost of one bovine liver per kg in Eswatini is SZL60.00. Therefore, 326 livers at 8kg each would amount to a loss of SZL156 489 ($8 842.70) for the duration of our study i.e. 7 months. Our data was collected during the rainy season when infection levels are high due to increased grazing next to rivers. Other studies reported higher losses and these could be attributed to that our study sampled cattle from one abattoir while some studies were conducted in several abattoirs. On the other hand, higher prevalence is likely to be encountered in herds receiving poor veterinary services and/or irregular deworming practices.

Prevalence of *Fasciola hepatica* and *F. gigantica*

Table 1: Data collected over 7 months (June 2023 – January, 2024).

Dip Tank Number and name	Number of cattle slaughtered	Total positive	% positive
325	10	7	70
537	17	9	53
517	29	11	38
177	22	9	41
308	6	4	67
514	9	4	44
529	115	58	50
80	10	6	60
504	6	4	36
528	11	7	64
526	8	4	50
499	10	3	30
527	8	3	38
560	6	2	33
552	10	5	50
544	14	8	57
498	7	4	57
497	14	12	86
823	7	4	57
456	7	4	57
Total	**326**	**168**	**52**

Table 2: Estimated odds ratio (OR) from logistic regression model for the association between fascioliasis infestation (Yes, No) and explanatory variables (sex, age, and liver gross weight).

Variable	Number of cattle (%)	Positive for fascioliasis	Infection rate (%)	OR (95% CI)	*p-value*
Sex					
Male	204 (63)	81	48.2		1
Female	122 (37)	87	51.8	0.26(0.16 – 0.44)	<0.0001
Total	326	168	51.5		
Age at slaughter					
0 – 4 years	167	40	24		1
5 – 7 years	166	44	26.5	1.11 (0.76 – 1.84)	0.6784
8 – 10 years	151	82	49.5	2.26 (1.43 – 3.61)	0.0002
Total	326	168	51.5		
Gross weight of liver at slaughter (kg)					
>0 – 3	**104**	**23**	**9**		**1**
>3 – 6	**72**	**29**	**40.3**	**1.82 (0.93 – 3.57)**	**0.058**
>6 – 9	**64**	**38**	**59.4**	**2.68 (1.41 – 5.15)**	**0.0011**
>9	**86**	**78**	**90.7**	**4.10(2.31 – 7.41)**	**<0.0001**
Total	**326**	**168**	**51.5**		

Analysis of the Geospatial Distribution

Spatial distribution of fascioliasis is influenced by the availability of snail intermediate hosts of *Fasciola spp.,* which in turn is associated with several factors including: climate (temperature and rainfall), and geographical location (altitude). The occurrence of *Fasciola hepatica* and *Fasciola gigantica* infections are driven by environmental factors [25,26] and environmental variables show clustering across different geographical areas [27]. Spatial analysis was used to explore whether fascioliasis infection was clustered in space as this could help identify environmental factors associated with infection. Almost all the carcasses that had high fascioliasis were located in the Highveld and Middleveld of Eswatini and the Lowveld had the least prevalence. The areas could be divided into three clusters. Cluster 1 (located in Mankayane/Ngwempisi, Manzini region), Cluster 2 (located in Siphofaneni/Nhlambeni and Mafutseni, Manzini region) and Cluster 3 (located in Sithobela, in the Lubombo region) (Figure 1). Most cases were traced to Cluster 1, then Cluster 2 and only a few cases were located in Cluster 3. We have to quickly mention that this does not suggest that fascioliasis cases were only from these areas, but these were the areas from which Eswatini Meat Wholesalers bought their cattle for slaughter. The cattle that did not have any infections were not spatially spotted hence we do not know the areas that did not have endemic fascioliasis. However, a few cases were located in isolation e.g. around Motjane – Nkhaba and some around Maphiveni.

Several factors contribute to the observed spatial distribution of the two species of liver flukes responsible for fascioliasis in Eswatini. Mankayane (Cluster 1) is located at an altitude of 1990m above sea level, while Siphoneni, Nhlambeni, Mafutseni and Sithobela are located at 211m, 333m, 610m, and 377m, respectively. The largest number of cases were from Cluster 1 (Mankayane), but the significance of the difference could not be tested. The altitudes in Eswatini, being a small country may not differ significantly to cause reasonable differences in temperature and rainfall such that it influences spatial distribution of disease. However, most of the fascioliasis cases were from the higher altitude Cluster (Figure 1).

Fascioliasis prevalence was plotted by dipping tank and average precipitation. Prevalence of bovine fascioliasis was found to be higher in areas with higher rainfall (e.g. Mankayane and Ngwempisi) compared to those areas in lower altitudes that had lower rainfall (Figure 2). This finding is in agreement with other reports that suggested higher prevalence of fascioliasis in regions with higher rainfall and more permanent water bodies. Higher rainfall and temperature have a positive effect on the growth and development of the snail vectors of *F. hepatica* and *F. gigantica*. Therefore, areas with higher rainfall and temperatures have a higher risk of fascioliasis. However, some researchers have suggested that climate factors surprisingly show smaller association than those related environmental factors and herd management [16,26,28]. Our study shows larger positivity results among cattle bought from Sithobela even though the number of cattle is small. Sithobela is very warm and higher temperature supports development and multiplication of *Lymnaea* snails, the intermediate host of *F. hepatica* and *F. gigantica*. This finding suggests that rainfall and temperature independently influence survival and multiplication of snails. Nonetheless, extreme environmental conditions such as heavy downpours and very high temperatures have a contradictory effect on snail survival and multiplication. Heavy rains wash snails downstream, hence failing to colonise some parts of rivers especially those in slopy parts such as the rivers in the Highveld of Eswatini.

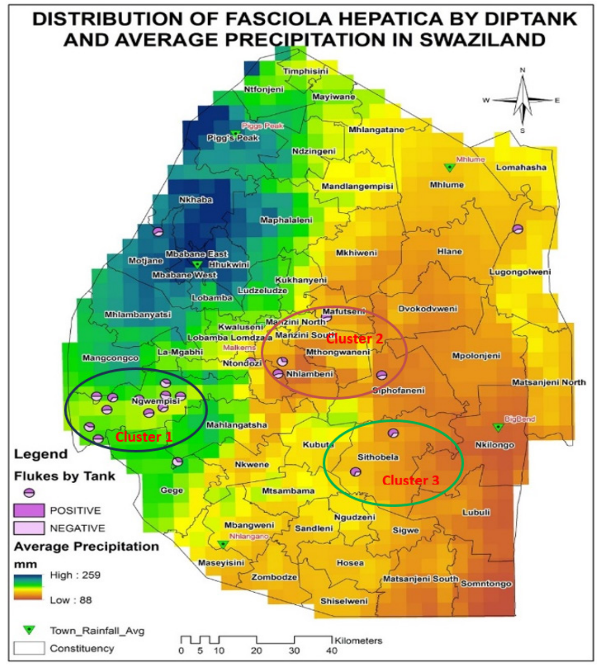

Figure 1: Distribution of *Fasciola hepatica* or *F. gigantica* by dip tank and average precipitation in Eswatini.

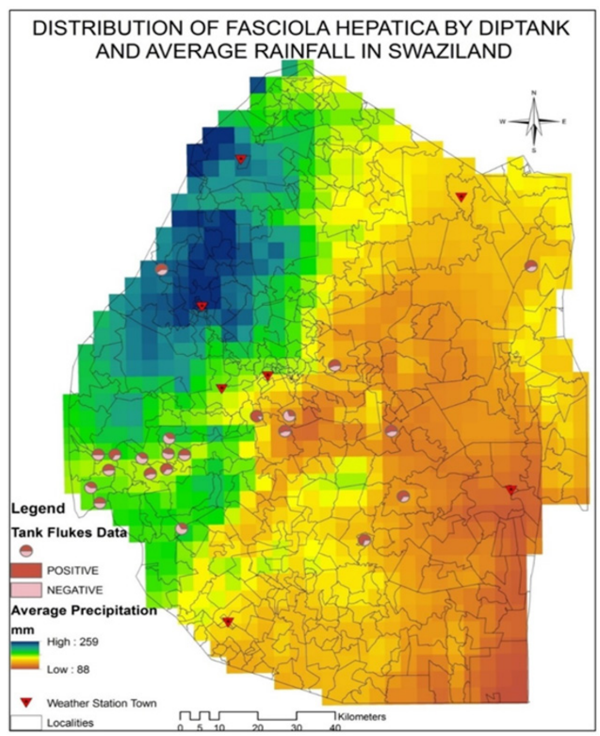

Figure 2: Distribution of *F. hepatica*/*F. gigantica* infections by Dip tank and rainfall.

Eswatini has many rivers and other water sources. While the Highveld has many rivers and natural streams, the Lowveld has many reservoirs that are commonly used to irrigate sugar cane among many other commercial crops. Most smaller streams in the Lowveld run only during the rainy season and dry up in winter. Even though some of the rivers captured in this study may not have water flowing at all or during certain months, the network of rivers and streams transversing the area suggests that rivers, being one of the risk factors of fascioliasis are abundant in the clusters found with high prevalence (Figure 3). Rivers, streams, wetlands, dams and other water bodies play an important role in the transmission of fascioliasis where they serve as habitat for the snail intermediate hosts of fascioliasis.

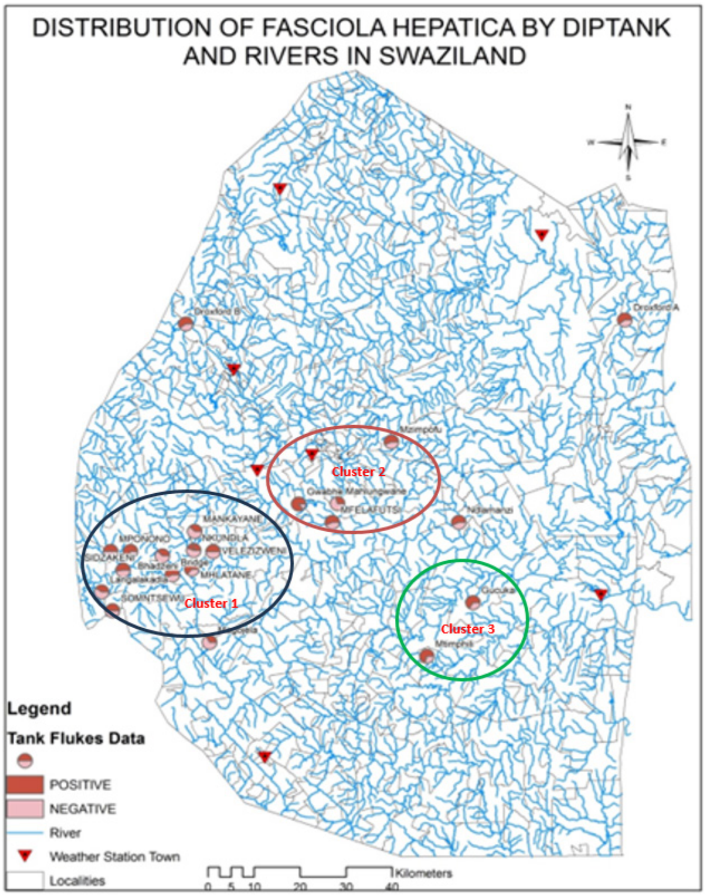

Figure 3: Spatial distribution of fascioliasis by dipping tank and rivers in Eswatini.

Discussion

This is the first study reporting prevalence and geospatial distribution of *Fasciola* infections among cattle slaughtered at an abattoir in Eswatini. Studies conducted among adult dairy cattle in the United Kingdom reported prevalence rates of fasciolissis at 48% to 76% [29,30]. Elsewhere in Western Europe, similar prevalence estimates of 37%, 50% and 61% were reported in Belgium, Germany, and Spain, respectively [29,31,32]. These studies are in agreement with our findings of 52% of infected carcasses in cattle slaughtered at Eswatini Meat Wholesalers. This data suggests that, much as we cannot be absolutely sure of the representativeness of Eswatini Meat Wholesalers of other abattoirs, but the difference could be insignificant. We therefore do not have reason to believe that the prevalence of fascioliasis among cattle in Eswatini is significantly different from 52%. The differences in prevalence observed in other studies could be attributed to several factors, one of which could be the season of the study or the amount of rainfall received in that area annually. Studies performed during rainy seasons generally reported high prevalence compared to those performed in dry seasons.

Our study suggests that fascioliasis infection was higher among female animals compared to their male counterparts (OR=0.26 95%CI 0.16 – 0.44, $p<0.0001$). This could be due to the fact that farmers usually keep female cows for a longer period for the purpose of reproducing to increase the herd and for milking purposes. Older animals were found to have higher infection rates than younger animals. This makes sense because the older animals have been exposed for longer than younger animals. These differences in the infection rates with different age groups have been reported by several researchers [9,33,34].

Climatic factors such as rainfall and temperature are essential for the transmission of *F. hepatica* and *F. gigantica* and were previously considered to have a major impact on the risk of fascioliasis in ruminants [35]. Both rainfall and temperatures are positively associated with survival and transmission of intermediate hosts and larval stages of *F. hepatica* and *F. gigantica* and this partly explains the variation observed in the spatial distribution between the three clusters identified [36]. However, this assertion should be interpreted with caution because the climatic variations in the three clusters is very minimal and the study did not investigate the prevalence at a wider variety of climatic areas. The ability of climatic conditions to modulate the extent and intensity of *F. hepatica* infestations is well documented [37,38]. Rainfall or moisture are necessary for the development of *F. hepatica*. However, large amounts of rainfall inhibit *F. hepatica* infestation because it washes away the parasite larvae separating them from the snail hosts [39,40]. Cluster 1 is located around Mankayane, an area located at an elevation of 1990.5metres above sea level, where annual high temperatures reach 26.13^{o}C and annual low temperatures are 14.4^{o}C. Mankayane typically receives about 44.47 millimetres of precipitation and has 98.31 rainy days annually [41]. In temperate regions, the optimal growth of *Lymnaea* species of snail, the intermediate hosts of *F. hepatica* and *F. gigantica* exhibited marked variations in growth, longevity and attainment of sexual maturity at different temperatures and diets [42]. The effect of 30^{o}C is highly significant as far as the duration of reproduction of a snail individual is concerned. However, room temperature has its biggest effect on the rate of egg production, the time required for the development of embryo and the hatchability of eggs. Therefore, with temperatures ranging between 14.4^{o}C and 26.13^{o}C at Mankayane, this range includes room temperatures (25^{o}C), suggesting that temperatures in Mankayane support the rate of egg production among *Lymnaea* snail intermediate hosts.

Our study reports economic losses of SZL156 480 (8 842.70 USD) at Eswatini Meat Wholesalers that results from the condemnation of infected livers. However, the true loss could be higher than this because of seasonality changes that were not considered in the calculations. Nonetheless, this financial loss, which is only due to liver condemnation, demonstrates that fascioliasis remains one of many causes of economic burden associated with fascioliasis in Eswatini. Loss in cattle infected with fascioliasis may also occur due to reduced weight of infected animals, reduction in growth rate of animals, and reduced milk production. Therefore, all these losses contribute to decreases of the household income among small-scale farmers as reported elsewhere [43]. Economic losses from bovine fascioliasis have been reported in Ethiopia, where a yearly direct financial loss of liver was estimated at 47 945.24USD [44]. Economically, worldwide losses in animal productivity due to fascioliasis were conservatively estimated at over 3.2 billion USD in 1999 [14]. Economic losses could be listed as direct losses; which consist of drug costs, drenches, labour, and liver condemnation at abattoirs; and indirect losses associated with decreased productivity, poor growth rate, increased cost for the replacement of the stock, reduced quantity and quality of milk produced, lower feed conversion rates in cattle [15]. In Brazil, a loss of US$210 million per year was reported [45]. The study went on to suggest that fascioliasis distribution was strongly associated with contact of cattle with water sources such as rivers, streams, dams, etc. These findings are in agreement with our findings which suggest that most infections were from Mankayane/Ngwempisi area, which are located around the Highveld which has many water sources that support growth and multiplication of the snail vectors. Cattle with larger liver size were more likely to contain adult worms of *F. hepatica* or *F. gigantica*. The larger sizes (gross weight) of infected cattle the more likely that the cow will also be of a larger size and older, hence the more likely that the cow would have experienced repeated infection increasing the likelihood of carrying parasites at slaughter.

Our study found out that more cases were reported from areas in higher altitudes compared to areas in low altitudes. Other studies suggested a possible association between low altitudes and higher occurrence of fascioliasis in herds [46-49]. It is logical to believe that higher altitudes are likely to have a lower risk of fascioliasis because of the higher moisture content, higher rainfall and lower temperatures which may not adequately support development and multiplication of the snail vectors. Therefore, the findings in our study could be rejected and the contradicting results could have been influenced by selection bias of the study area(s).

A single treatment of cattle with an antihelminth drug is not adequate to prevent re-infection in a single season. A study conducted in areas surrounding Lake Chad observed persistent high prevalence of *F. gigantica* infection in cattle which showed that a single pre-rainy season treatment does not prevent rapid re-infection despite the partial migration away from the high-risk areas at Lake Chad into drier areas. The study suggested a locally adapted strategic control package for fascioliasis in cattle in the Lake Chad area ought to integrate targeted triclabendazole treatment and seasonal transhumance practices.

Conclusion

Our study suggests that the prevalence of fascioliasis could be high in Eswatini. More comprehensive studies should be conducted at various slaughter houses in order to reveal the true prevalence rate in the country from which decision-making processes will be based. In order to reduce fascioliasis in cattle and reduce transmission to humans, cattle and goats should be subjected to regular examination and treatment (deworming) with an effective antihelmithic drug so as to eliminate the fluke burden of the host animals and minimize pasture contamination by reducing faecal egg outputs and thus interrupting the life cycle of the parasite. Veterinary services in the areas where cattle were confirmed to be infected (Mankayane/ Ngwempisi, Siphofaneni/Nhlambeni/ Mafutseni, and Sithobela) should implement a compulsory deworming programme. Studies to estimate the infection of humans in other parts of the country are also strongly recommended. A strong education programme for cattle farmers must be implemented to increase knowledge of the effect and risk factors of fascioliasis infection in domestic animals and humans.

Limitation

One limitation of this study was the use of the cross-sectional design, i.e. the study being implemented at a single time point. Any projections of prevalence estimate for *Fasciola* infestation and associated financial losses could be affected by seasonal variations in infection rates. In addition, animal trade and movements are common within the study area, but we only recorded the last reported area of origin of the slaughter animals prior to transportation to the abattoir. Abattoir data are not primarily collected for research purposes; hence several methodological flaws should always be anticipated. Our study was conducted only during the rainy season, and as such, we don't know the prevalence of fascioliasis during the winter or dry season. Also, our study was conducted in one area (Eswatini Meat Wholesalers) which might be buying cattle from a limited number of dipping tanks. A countrywide study of all slaughter houses would give a more accurate and complete picture of the prevalence. The changes produced by climate factors in the spatial distribution of fascioliasis occur in the long term. Other studies were able to draw strong conclusions on key factors that explain the spatial distribution of fascioliasis through the development of models for much larger areas (country or continent) for periods of several years. However, our results give a snapshot of the prevalence of fascioliasis in certain areas in Eswatini and this information may be used to make decisions likely to prevent fascioliasis or mitigate measures for fascioliasis control or prevention in the identified areas or in others not identified in this study.

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