

Research Article

Epidemiology and economic loss of coenurosis in small Ruminants slaughtered at mojo halal export abattoir, Oromia regional state, East Shoa Zone, Ethiopia

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Abstract

Coenurosis is an important parasitic disease affecting small ruminant's production which causes significant economic losses. A cross-sectional study was carried out from November, 2019 to May, 2020. To estimating the prevalence of coenurosis in small ruminants and determines the risk factors, to assess the community knowledge on the epidemiology of coenurosis and estimate the financial loss due to brain condemnation. A total 674 small ruminants were by a simple random sampling procedure. Data was analyzed using STATA version 11. Chi square test and logistic regression analysis were used to determine the association between prevalence of coenurosis and potential risk factors. From the total 512 goat and 162 sheep examined for coenurosis 6.02% and 8.6% were found positive respectively. There was significance difference between the risk factors and coenurosis infection. More coenurosis infected small ruminants were found in highland 9.7% (Odd ratio= 2.31, 95% Confidence Interval: 1.14, 4.64; P=0.017) than midland and lowland. There was high prevalence of coenurosis in adult than young age of small ruminants. From 45 positive cysts were examined to identify fertility and viability by using cyst viability and fertility procedure, 17.8% calcified, 68.9% sterile and 13.3 % fertile. The diameter of positive cysts showed 46.7%, 42.3%, 11% small, medium and large respectively. From 100 respondents' 86% of respondents has agreed on the sign of coenurosis, 14% has not agreed. The annual financial losses due to brain condemnation were estimated at 124,821 dollar.

Introduction

Ethiopia's estimated livestock population is often said to be the largest in Africa. In the country, there were approximately 60.39 million cattle, 31.3 million sheep, 32.74 million goats, 0.46 million camels and 56.06 million poultry [1]. Ethiopia has great livestock potential, but it is not properly exploited due to several factors such as poor management system, unimproved genetic potential, inappropriate disease control policy and lack of veterinary services [2]. Among livestock population small ruminants are important domestic animals in the country. Sheep and Goat production enterprises are very attractive, high contribution of meat and generate cash income from export of meat, edible organs and skin, also they are adaptable to abroad range of environments, have short generation cycles and high production rate [3].

Helminth parasites confronted with challenges in developing country of an ever-rising human population and food shortage, such enormous economic losses caused by the silent predators are intolerable [4]. These diseases are also known to cause public health problems as humans can be infected from accidental ingestion of parasite eggs/larvae passed into the environment with feces from definitive hosts [5,6]. Under helminth parasite Cestodes, of the family Taeniidae which infest the dogs (definitive host) are intermediate host species where they cause Coenurosis, Hydatidosis, and Cysticercosis [7].

From cestode parasite coenurosis is problem of small ruminant's production in Ethiopia [8]. It is the larval stages of *Taenia multiceps* cause both public health due to accidental ingestion of parasite eggs or larvae and veterinary significance

because they cause economic loss due to condemnations of infected brain [9]. Coenurosis is the stage of *Taenia multiceps* always develops in the brain of small ruminant's population [10]. The disease is much more common in rural areas of Ethiopia where dogs and domestic animals live in a very close association. Additionally, where home slaughtering of small ruminants is still predominant and uncooked offal and carcass wastes are normally given for dogs [11].

The prevalence of the disease was reported in different area of the country: 3.78%, 4.7%, 7.6%, 12.5%, 13.5%, 16.6% and 20.2%. The main source for infection of coenurosis is from maintaining the parasitosis in nature, access by dogs to the brains of dead or slaughtered sheep and goat that were infected with coenuri. Domestic and wild canids such as dog, fox, wolf and jackals are the reservoirs for parasite and shepherded dogs, owner of animals, agro ecology, cyst of parasite, source of infections and transmissions of parasite considered as a risk factor of the disease in sheep and goats [12]. Coenurosis due to ingestion of larval stages of *Taenia multiceps* can occur in both an acute and chronic disease form. Acute case it occurs during the migratory phase of disease, usually 10 days after ingestion of the large number of tape worm eggs. Young lambs aged 6–8 weeks are most likely to show signs of acute disease [13]. The signs are associated with an inflammatory and allergic reaction. There is transient pyrexia and relatively mild neurological signs such as listlessness and a slight head aversion. Occasionally the signs are more severe and the animals may develop encephalitis, convulse and die within 4–5 days [14].

Coenurosis is diagnosed based on epidemiology, clinical sign and post mortem findings. It is more complicated and severe when the oncospheres settle in the CNS tissue. Recently a best technique used for diagnosed the disease is Computed Tomography (CT). It allowed precise evaluation of the size and location of the cyst, which appeared as a hypo attenuating structure is a mass effect [15]. Coenurosis may be found upon necropsy in the brain of sheep and goat but the condition needs to be differentiated from other local space occupying lesions of the cranial cavity and spinal cord including abscess and tumor [16]. The common and widely applied treatment for this disease is surgical removal of the cysts under general anesthesia of the animal, the approach has a very good success rate, especially when the lesion is accurately located [17]. The important control method of the disease are; To prevent dogs from ingestion of uncooked offal, keeping the dog health service, prevent backyard slaughtering and disposal of heads of small ruminants, community education about spread and causes of disease and to giving recommendation on the epidemiology of the disease [18]. Coenurosis is an economically important disease as it causes serious problems especially in the sheep and Goat industry and breeding. It has 100% mortality rate which cause severe economic losses in small ruminants [19].

In developing countries like Ethiopia there is close contact between dogs and small ruminants, lack of knowledge of the population on epidemiology of coenurosis, free access of dogs to the head of ruminants, containing coenurosis vesicles, the absence of regular deworming of dogs are the most important

drivers for perpetuation of *T. multiceps* cycle and the persistence of coenurosis that leads to high economic losses of the country [12]. The disease cause major economic losses due to decreasing production, mortality rate which treatments cost, brain condemnation, time and loss of energy to keeping sick animals [20].

Human infection occurs if eggs are accidentally ingested as result of poor personal hygiene after being shed in the faces of the dog. After ingestion of the eggs, larvae hatch, penetrate the intestinal wall and migrate to various tissues, where they develop in to large, cystic larvae. Symptoms are secondary to the presence of a cyst in a vital structure [10].

Losses occur when farmers not succeed in animal production because of Coenurosis regularly and decisively lead to the list of parasite infection [21–23]. Recently, in Ethiopia there is a paucity of information and comprehensive study is not available on epidemiological study of the disease. In addition significance of coenurosis in small ruminants slaughtered for export purpose at newly emerging export abattoirs is not studied in detail. Similarly, there is lack of recent information on Coenurosis in study area.

This area is known for its commercial, domestic and export abattoirs established currently.

Therefore, the objectives of this research were

- To estimate the current prevalence and determine the risk factors of Coenurosis in small ruminants slaughtered at Halal Export Abattoir.
- To assess the community knowledge on the epidemiology of coenurosis
- To estimate the Financial loss due to brain condemnation by coenurosis in small ruminants slaughtered at Mojo Halal export abattoir

Materials and methods

Description of study area

The study was conducted in Halal export abattoir and Mojo town. Mojo is found in the Central Ethiopia, Eastern Shoa zone of the Oromia region. This town exists at latitude and longitude of 8°N 39°E with an elevation between 1788 and 1825 m above the sea level. The abattoir is specialist's abattoir for the export of Fresh, Hygienic, Organic and Quality Chilled mutton. It is located in Lumee Woreda, Oromia regional state, East shoa zone, 73 km east of Addis Ababa. This location enables livestock to be easily sourced as the abattoirs is placed in the vicinity of Goat Sheep and Cattle grazing areas. All the animals slaughtered at HEA are strictly Sharia compliance under the supervision of Supreme council for Islamic affairs, Oromia, Ethiopia and expert veterinarians. All product processed at the abattoir is exported to various locations around the Middle East. All meat and meat product shipments are accompanied by international sanitary certificates issued by the veterinary authorities of the Ministry of Agriculture (Figure 1).

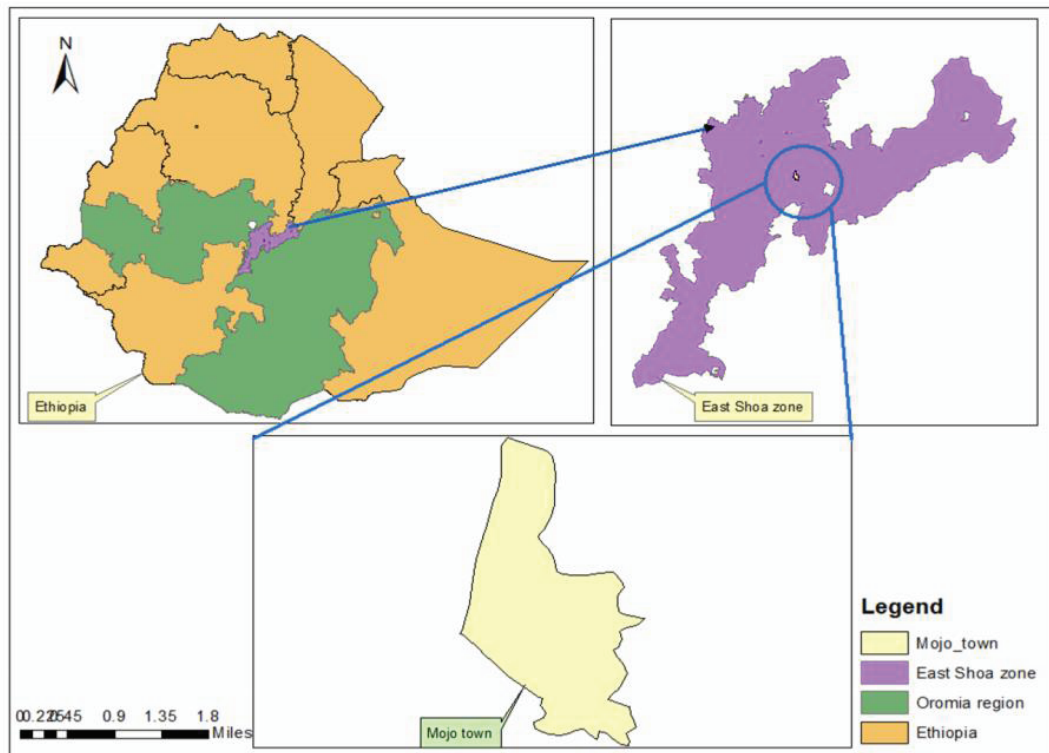


Figure 1: Map of study area.

Study animals

All local breed's sheep and goats that originated from high land, midland and low land area of country for slaughter in Halal export abattoir were included in the study population. Consequently, all male sheep and goats were subjected for the study by simple random sampling technique which sampling and age of the animals were grouped based on dentition, for those which have not erupted permanent incisor teeth, are classified as young, while those with pair or more permanent incisor teeth erupted were classified as adult [24].

Study design and sample size

A cross-sectional study type was carried out from December, 2019 to May, 2020. By using simple random sampling technique, the total numbers of animals required for the study were calculating based on the formula given by Thrusfield, (2005). $n = 1.96^2 P_{exp} (1 - P_{exp}) / d^2$, where n = required sample size, P_{exp} = expected prevalence, d = Absolute precision. Previously the prevalence study conducted in deferent area of the country, but the agro ecology of previous study and these studies is not same, because of that to take 50% of expected prevalence. Using 5% degree of absolute precision, 384 animals need to be sampled. For this study, the required sample size was 384, but in order to increase precision, it was maximized to 674 (512 Goats and 162 Sheep) sample size.

Study methods

Abattoir survey: Active abattoir surveys were conducted on sheep and goat before animals was slaughtered based on simple random sampling technique. During ante-mortem

examination of each study animal were given an identification number based on species of animals (512 goat and 162 sheep), age, weight of animals, body condition, farming system, month of animals slaughtered, agro-ecology was recorded. During study period the sampled animals was classified three times for identify the monthly change of the cyst of parasite based on availability of animals. The first time 250(200 goat and 50 sheep) were sampled. Second 200(150goat and 50sheep) were sampled and thirdly 224(162 goat and 62sheep) were sampled.

Brain examination: The heads of slaughtered sheep and goats was collected, followed by skin removal and careful opening of the skull using a machete without damaging brain. Meninges were incised using a scalpel blade to expose brain tissue. Whole brain of individual animal was collected and examined for the fertility and viability cyst in parasitological laboratory.

Cyst fertility and viability test: All the positive samples were transported to Halal export abattoir laboratory for confirmation of cyst fertility and viability. After individual cysts were examined grossly for calcification and degeneration, size of cysts was measured. The surfaces of each cyst were sterilized with alcoholic iodine solution. To reduce intracystic pressure was penetrated with scalpel and scissors then the content to be transferred to sterile container. Then examine contents under microscope (40X) for the presence of protoscoleces into the cyst [25]. The cysts which contain no protoscoleces were sterile cyst. Similarly, viability of the protoscoleces was assessed by motility of flame cells as well as ease of staining with 0.1% aqueous eosin solution and examination under light microscope. Lived of protoscoleces did not take the dye whereas; the dead ones stained with the dye [26].



Questionnaire survey

To determine farmers and abattoir workers knowledge on the epidemiology of coenurosis open stionnaire were administered. Two Keble's (kolba and shela kiltu) were selected where export abattoir exists and to sell positive brain which containing cyst for the community those lives those Keble's. The selection criteria of an interview for farmers depended on owning dog(s) and back yard slaughtering system. A total of 100 (80 farmers and 20 abattoir) were interviewed randomly to assess knowledge based the formula recommended by Arsham [27]. $N = 0.25/SE^2$, $SE = 5\%$, $N = 100$, Where $N =$ sample size, $SE =$ standard error assuming the standard error of 5% and the confidence interval of 95%. The sample sizes for the questionnaire survey were expected to be 100 (50 Shelakiltu and 50 Kolba) Kebles. The results were expected to generate information on the community and abattoir workers knowledge on the epidemiology of coenurosis.

Assessment of direct economic loss

The direct economic losses from international markets due to brain condemnation of small ruminants with Coenurosis cysts in Halal export abattoir were estimated by adopting the formula [28]. During estimate direct economic loss assessment to take the average of five year of animals slaughtered in the abattoir and to estimate the finical loss [23].

$$EL = Srx * Coy * Roz$$

Where,

EL- Estimated annual economic loss of the brain from

Domestic or international market due to coenurosis,

Srx- Annual sheep and goats slaughter rate of the abattoir,

Coy- Average cost of the brains in the abattoir,

Roz - Condemnation rates of sheep and goats brain

Data management and analysis

The datageneratedwerestored in Microsoft excelspreadsheet and analyzed using STATA version 11.0. Percentage, chi square test, univariable logistic regression analysis were performed, to quantify the association between risk factors and coenurosis and odds ratios (OR) and 95% confidence intervals (CI 95%) were used to quantify the degree of association between risk factors and coenurosis. These variables were categorized during data analysis. The categories of the variables were as follows: Species of animals (sheep vs. Goat), agro ecology (highland Vs. midland Vs. lowland), age (adult Vs. young), farming system (extensive Vs. semi intensive), body condition (good Vs. lean Vs. medium), and month of slaughtered (December Vs. January Vs. February), weight of animals classified based on criteria of export standard (<18kg Vs. 18-22kg Vs. >22kg).

Results

Prevalence of coenurosis

Out of the total 674 small ruminants examined for the

presence of coenurosis an overall prevalence of 6.67%. Out of 512 goats examined for coenurosis 31(6.02%) were positive.

Similarly, out of the 162 sheep examined 14 (8.6%) were positive for coenurosis.

Association of risk factors with conurosis infections

The results of the association of different risk factors with the prevalence of coenurosis using chi square(X^2) test. Slightly higher prevalence of coenurosis infection was recorded in sheep than goat. prevalence of coenurosis infection was not significantly associated at species level ($P > 0.05$). However coenurosis infection was significantly associated risk factors; age, weight, agro ecology, farming system, body condition and season of animal slaughtered ($p > 0.05$) as presented in Table 1.

Univariable logistic regression for hypothesized risk factors

During the Univariable logistic regression analysis, for all the risk factors, the first level of each independent variable (the category of a risk factor with lowest prevalence) was used as a reference Category for measuring the degree of association between the disease and risk factors. Prevalence was 9.7%, 8.2% and 4.4% in high land, midland and lowland (Table 2).

Table 1: The association between coenurosis prevalence and risk factors.

Risk factors category	no of animals	no of positive	Prevalence (%)	X2	p-value
Species					
Sheep	162	14	8.6	1.32	0.25
Goat	512	31	6		
Agro ecology					
Lowland	359	16	4.4	6.15	0.017
Midland	133	11	8.2		
Highland	182	18	9.8		
Age					
Young	361	15	4.1	7.93	0.006
Adult	313	30	9.5		
Wight					
>22kg	126	5	3.9		
18-22kg	314	13	4.1		
<18kg	324	37	11.5		
Farming system					
SI	251	8	3.1	7.81	0.007
Extensive	423	37	8.7		
Body condition					
Medium	522	19	3.6	35.52	0
Fat	89	8	8.9		
Lean	63	15	23		
Month					
January	302	15	4.9	4.83	0.039
February	156	9	5.7		
December	216	21	9.7		

Univariable logistic regression analysis showed that the risk of infection in highland (OR: 2.31, 95 % (1.14, 4.67) higher than midland and lowland. The odd of coenurosis infection in adult was 2.44 times than in young. The odd of coenurosis infection in weight (<18kg) was 3.15 higher than 18–22kg and >22kg and the Odd of (18–22kg) 1.04 times more than in >22 kg. The Odd of coenurosis infection based on body condition of animal level lean was 7.1 times than fat and medium and odd of fat was 2.24 times more than in medium. The odd of coenurosis based on farming system extensive was 2.91 times more than in semi intensive. The odd of coenurosis infection based on month of animal slaughtered was in December 9.72% times than February 2.06 times than December and January and in December 1.1 times than in January. Uni-variable logistic regression analysis also showed that there was a strong association (OR>1) between positivity and age, weight, agro ecology, farming system, body condition and season of animal slaughtered.

There was no association between species of animals (sheep and goat) (OR < 1) (Table 2).

Cyst characterization

The predilection sites of positive cyst were 16.7%, 66.6% and 16.7% right cerebral hemisphere, left cerebral hemisphere and cerebellum respectively. The number of cyst(s) per examined brain ranged from one to three (1 – 3) and the heads infested by one cyst accounted for 60% of the total heads. 33% and 7% were infested by two and three cysts respectively. Similarly from total forty five positive cysts were recovered, 46.7%, 42.2% and 11.1% small, medium and large size respectively. Out of 45 positive cysts were examined to identify cyst calcified, fertility and viability, 17.8%, 68.9% and 13.3% calcified, sterile and fertile respectively Figure 2.

Questionnaire survey

For determination of community knowledge in relation to coenurosis based on personal information a total 100 respondents were received from two Keble were export abattoirs exist and sell to positive brain of small ruminants to community. From two Keble 86% of respondents agreed the occurrence of the case in small ruminants, but 14% of respondents not know the case (never see on small ruminants). The result of interview showed >40 and 31–40 age has more agreed on circling than 20–30 age of respondents. The male respondent has more known the sign of the disease than female respondents. Abattoir worker respondent has more known the case than farmer's respondent. Similarly, the result of interview showed Tertiary and secondary level of education has more know the case than Illiterate respondents (Table 3).

Out of the 100 respondents, for identify the farmer and abattoir workers knowledge on cause and mode of transmission of the disease 94% were totally not know about the cause of coenurosis and the mode of transmission and 6% of respondents are agreed on the cause and transmission. For identify community knowledge on stage of the coenurosis shows circling 82% respondents agreed at adult stage and 18% agreed at young stage of small ruminants. From 100 respondents for awareness of farmer's knowledge on source

Table 2: Univariable logistic regression of hypothesized risk factors for coenurosis in small ruminants at Mojo Halal export abattoir.

Risk factors category	no of animals	Prevalence (%)	OR (95% CI)	P-value
Species of animals				
Goat	512	6.05%	1.00	
Sheep	162	8.64%	0.6(0.35, 1.31)	P= 0.253
Agro ecology				
Lowland	359	4.4%	1.00	
Midland	133	8.2%	1.92(0.86, 4.25)	P=0.027
Highland	182	9.7%	2.31(1.14, 4.67)	P=0.017
Age				
Young	361	4.1%	1.00	
Adult	313	9.5%	2.44(1.29,4.63)	P=0.006
Weight				
>22kg	126	3.9%	1.00	
18-22kg	314	4.1%	1.04(0.36, 2.99)	P= 0.009
<18kg	234	11.5%	3.15(1.18,8.41)	P=0.022
Body condition				
Medium	522	3.6%	1.00	
Fat	89	8.9%	2.24(0.96,5.21)	P=0.06
Lean	63	23%	7.1(3.45, 14.59)	P=0.000
Farming system				
SI	251	3.1%	1.00	
Extensive	423	8.7%	2.91(1.33, 6.35)	P =0.007
Season				
January	302	4.9%	1.00	
February	156	5.7%	2.06(1.03, 4.09)	P=0.039
December	216	9.7%	1.17(0.50, 2.74)	P= 0.039



Figure 2: Positive brain containing with coenurosis cysts during sample collection.

of dog food, 100% respondents agreed the food of dogs from leftover and not agreed on scavengers.

Out of 100 respondents during questionnaire surveys for awareness of farmers knowledge on dog managements 90% of respondents agreed on free all time and herding and 10% of respondents agreed on tie at day/night. The result of questionnaire survey found that, the farmers decision for sick small ruminants, 72% of farmers slaughtered at home, 22%



farmers sale at livestock market or butcher and 6% farmers do nothing sick sheep and goats with coenurosis. Similarly the result of questionnaire found that Ways of disposal system during animals die with counurosis 79% of respondents throw raw brain to dogs, 21% throw into bush and not agreed burn, burry and Eaten by family members animals that had died (Table 4).

The wild carnivores particularly stray dogs, hyena and fox which might serve as definitive host for the T. multiceps were seen in different frequencies in the grazing land from questionnaire respondents. The frequencies of stray dogs in the grazing land often greater than hyenas and fox were the occasionally and never in grazing land (Table 5) Figure 3.

Direct financial loss evaluation

Observation during this study revealed that 14(8.6%) sheep brain and 31(6.02%) goat brain were condemned out of the

Table 5: Wild carnivore's information frequency in grazing areas with small ruminants.

Wild carnivores information	Frequency (%)		
	Often	Occasionally	Never
Stray dogs	91%	9%	0
Fox	1%	9%	89%
Hyena	4%	78%	18%

Table 3: Determination of community knowledge status in relation to coenurosis based on personal information.

Personal Information	No of Respondent's	Knowledge	Status on circling (%)	P-value
PAS	Shela Kiltu	50	46(92%)	0.059
	Kolba	50	40(80%)	
Age	20-30	55	42(76.36%)	0.07
	31-40	29	27(93.1%)	
	>40	16	16(100%)	
Sex	Female	15	13(86.66)	0.8
	Male	85	72(84.7%)	
Occupation				
	Farmers	80	65(81.25%)	0.3
	Abattoir worker	20	20(100%)	
Educational status				
Illiterate	74	62(83.78%)	12(16.21%)	0.8
Secondary	20	17(85%)	3(15%)	
Tertiary	6	6(100%)	-	

Table 4: The assessment of community knowledge on epidemiology of coenurosis.

Community Knowledge	Total no. of respondents	% of response	
		yes	no
Knowledge on the reason of cause	100	6%	94%
Knowledge on transmission	100	6%	94%
Stage of sign occurred		% of response	
Young	100	18%	
Adult	100	82%	
Source of food for dogs			
Leftover	100	100%	
Scavenger	100	0	
Dog keeping style			
Free all-time	100	90%	
Tie at day/night	100	10%	
Farmers decision for sick animals			
Sale to market	100	22%	
Slaughter at home	100	72%	
Do nothing	100	6%	
Ways of disposal system			
Throw to dog	100	79%	
Throw to bush	100	21%	
Buried	100	-	
Burned	100	-	
Eaten by family member	100	-	



Figure 3: Presence of stray dogs and small ruminants on grazing land.

total infected animals. The average retail market price of sheep and goats brain was 5.75\$ from international market. Based on these data, average number of animals slaughtered per annum in five year and percentage of brain/animal condemnation per annum were 324,000 and 6.67%, respectively. Therefore, based on the above information, total financial losses due to coenurosis were calculated by using the formula indicated under study design:

$$EL = \sum S_{rx} * C_{oy} * R_{oz} = 324,000 * 5.75\$ * 6.67\% = 124,821\$USD (3,994,272 \text{ Ethiopia birr}).$$

Discussion

Coenurosis is known parasite case in Ethiopia especially in the highland part of country where environmental conditions are favorable for development of parasite cysts [29,30]. The present study reported an overall prevalence of 6.67% in small ruminants. Our results are within the range of the prevalence estimated in previous studies in Ethiopia, which ranged from 20.2% in Debre Berhan [31] and 1.25% in Bishoftu Elfora export abattoir [32] in small ruminants. The overall prevalence is higher than the study reported 4.7% by [22,31] in Ethiopia and lower than the study reported 15.5% [33] in Turkey. The difference in the result might be due to environmental conditions which are favorable for the development of cysts.

The prevalence of coenurosis in this study was relatively lower in goat (6.02%) as compared with sheep (8.64%) which

is comparable to the Bishoftu Elfora export abattoir 2.6% in sheep, 1.25% in goat [32], in Ethiopia, in Iran 9.8% in sheep [14] and 45.6 % in Tanzania [12]. However, it was higher prevalence in goat than sheep the previous study reported prevalence of 3.9% in goat and 2.5% in sheep at Hashim export abattoir [20], 11.7% in goat and 4.9% in sheep at Elfora export abattoir [23] and 12.44% in goat and 2.3% in sheep at three export abattoir (Elfora, Hashim and Luna) [34] in Ethiopia, in Mozambique 13.8% in goat [35]. The variation of the result might be due to grazing habit of animals, geographical condition, closely contact between study animals and definitive host of parasite (dogs) and social condition.

The study revealed that the overall prevalence of coenurosis in sheep slaughtered at Halal export abattoir was 8.64 % in sheep which is lower than the prevalence of 20.2% from Debre Berhan [31], 12.6% from Bale [36] and Oryan, *et al.* (1994) in Iran (9.8% in sheep). However, it was higher than the reported prevalence of 2.5% reported from Hashim export abattoir [20], 4.7% from Ethiopian Health institute [22], 4.9% Bishoftu Elfora export abattoir [23], 2.6% Bishoftu Elfora export abattoir [32] and 2.3% in sheep at three export abattoir (Elfora, Hashim and Luna) [34] and Sharma and Chauhan (2006) in Ethiopia (5% in sheep). Similarly prevalence of coenurosis at Halal export abattoir was 6.05 lower in goat than prevalence 11.7% at Elfora export abattoir [23] and 12.44% at three export abattoir (Hashim, Elfora and Luna) [34] in goat in Ethiopia 43.3% in Tanzania [12] in goat, 13.8% in Mozambique [35] in goat. However it was higher than the reported prevalence 3.9% at Hashim export abattoir [20] and 1.25% at Elfora export abattoir [32] in Goat. Variation of the results might be due to different agro ecological condition of animals and presence carnivore's animals which are definitive and final host of coenurosis in grazing land of small ruminants.

The prevalence of study revealed that higher in highland (9.7%) and midland (8.2%) than lowland (4.4%) based on agro ecological condition of study animals. Comparative study was higher than the reported prevalence 15.2% in midland and 11% in lowland [23]. The great variation might be due to the higher percentages of ecological variables like, rain fall, relative humidity and air temperature are considered to be the influencing factors for coenurosis. In rainy season, rain causes spread of feces of dog, fox (final host) over the grasses and these contaminates are responsible for the increased occurrence of gid during rainy season [37].

Statistically significance showed higher prevalence in adult (9.5%) Compared to young small ruminants (4.1%) is consistent with earlier studies [23] the result might be due to higher ingestion of cysts with increasing age and the shows the clinical sign after long period of time. Comparative results were reported Higher prevalence of coenurus was recorded in young 6.8% animals than adult 1.9% small ruminants (Worwu *et al.*, 2019), 5% adult [34] and [38] 4% adult and 5.3% in adult in different parts of Ethiopia. Previous studies showed that coenurosis in small ruminants is common in young animal [39,40]. This higher prevalence in young is most probably attributed to under developed immunity and young

animals thus higher infection rate in these animals where as the adults have acquired immunity [41]. The study showed statistical significance higher prevalence in <18kg (11.5%) as compared to 18–22kg (4.1%) and >22kg (3.9%) of weight animals was a reason might be attributed large weight herds to getting contaminated region of grazing permanently as result reduction of pastures and shepherd dogs feed large herds in insufficient pastures. On the other hand, the disease may be loss of weight of animals.

The higher prevalence in lean body condition as compared to medium and fat in small ruminants this might be due to the problem of selecting sheep and goat with good body condition from the flock during purchasing as it is confusing due to the presence of wool especially sheep and the apparently health animal was loss there body condition. Statistical significance showed that higher prevalence in extensive management system (8.7%) than semi intensive (3.1%). Monthly prevalence of coenurosis was found 9.7% in December, 5.7% in February and 4.9% January. Comparative study was higher than study reported 3% December 3.7% January, 4% February in small ruminants (Adane *et al.*, 2015). The variation might due to temperature of the months, at high temperatures, cyst of parasite they died in a few hours. The cyst takes approximately eight months to mature, during which it becomes progressively larger, as the volume of cysts fluid increases [42].

The cyst may be localized in any part of the brain more commonly in the cerebral hemisphere (Parihar, 1988) in the present study right cerebral hemisphere (16.7%), left cerebral hemisphere (66.6%) and cerebellum (16.7%). This observation shows the high percentage of cyst were located in left part of cerebral hemisphere is higher than the right cerebral hemisphere, the result higher than the study reported by Adem, 2006 (62% in left, 30% in right) mengistu, *et al.* [23] (38% left and 17% right) and Adane, *et al.* [20] (18.3% left and 10% right) in Ethiopia. Vink *et al.*, 1997 in Mozambique (62% in left, 30% in right), Miran, 2015 in Tanzania (56.1% Right and 41.5% in left in sheep and 46.2% left and 46.2% right in goat). This difference suggests that there are equal chances of the cyst to lodge at any site of the brain, but the higher percentage of localization of the cysts in the cerebral hemisphere is most probably due to its higher biomass than the other part of brain, and the circling is always from left side to the right [43–55].

All of the 45 positive brains of small ruminants were found to contain only 1 to 3 cysts in each brain Thus, 44.4% of the positive brains had only one cyst which is lower than Hayelome, 2008 (81% one cyst per brain). The finding shows higher one cyst in each brain than two and three cysts per brain of positive small ruminants findings of the current study agrees with the observation of Achenef, *et al.* [31], Adem [34] and Hayelome [38,56–89] indifferent parts of Ethiopia (One to three cysts per brain). From 45 positive brains of small ruminants were contain 46.7% small, 42.2% medium and 11.1% large size of cyst. Our overall finding that 45 of coenurus cysts were 17.8%, 68.9% and 13.3% calcified, sterile and fertile respectively. The study showed that coenurosis is a well known small ruminant's health problem based on questionnaire survey. From farmers and abattoir workers knowledge where 86% of respondents



had seen the disease and 14% had not seen the disease on small ruminants. However, they have lack of knowledge on the cause and how it is transmitted. Considering the livestock keeping and husbandry that have persisted for several decades in the area, it is not of doubt that farmers aware of livestock diseases that normally prevail within their herds and flocks. The established timeline indicated that respondents from shela kiltu (92%) and 80% kolba community respondents known the disease (coenurosis) has been prevalent in their Keble, however 8% in shela kiltu and 20% in kolba respondents were not had seen the disease in there Keble. However, there were the same perceptions on when the disease was seen for the first times in two studies Keble's.

The observation shows knowledge of the disease higher >40(100%) age of respondents than 2030(76.36%) age but there was no knowledge on epidemiology of the disease. Similarly the male (86.6%) respondents had higher knowledge than the female (84.7%) respondents of the disease and the tertiary (100%) level of education had higher knowledge than illiterate (83.7%) and primary/secondary (85%) level of education. All over 100% respondents indicated that the disease (coenurosis) has been shows the sign at adult stage than young stage of sheep and goats. According to their explanations on the disease magnitude, initially coenurosis shows the sign gradually after same month of animal ingestion the cysts of parasite. Knowledge on cause and the mode of transmission is very important in the control of the disease [18]. It has been found that the coenurosis is maintained by close interactions between the definitive and intermediate hosts (dogs and small ruminants).

This is facilitated by the very limited knowledge on the cause and transmission of coenurosis in study area. It is important that during home slaughters of small ruminants and brain tissues which are seen as not fit for human consumption are simply thrown away into the bush were the grazing land of small ruminants and nearby stray dog(s) to feed. To throw brain of small ruminants to dogs actually cultivates the disease problem when they contain an infective material by increasing the risk of small ruminant's infection. The result of questionnaire survey shows absence of community knowledge is increasing the prevalence of disease if definitive host to ingest infected brain which contain *Taenia multiceps* cyst.

The observation from respondents shows improper disposal of infective brain or throwing into the bush and/or direct feeding brain by dogs, dog management like feeding left over, absence of deworming of dogs by anthelmintics, dog keeping style which is most dogs free all the time and sometime these are shepherd dog that increases the chance of pasture contamination by there faeces. Presence of wild life (stray dogs, fox and hyena) on grazing land of small ruminants frequently, decision of farmers during animals sick (sale to the market, home slaughtering) was seen as an important factor which contributes to the epidemiology of the disease.

The annual estimated financial loss in the present study need to be cautiously interpreted as it would be affected by factors which are dynamic and change over time due to market price of sheep and goat as condemnation of the brain,

prevalence of disease and number of animals slaughtered every year which can change the amount of financial loss from year to year. Financial loss analysis due to coenurosis in small ruminant slaughtered, retail price of brain in international market and prevalence of the disease at study time in Halal export abattoir. Based on the information, estimated financial loss due to coenurosis in small ruminants during the study period was 124,821\$USD (3,994,272 ETB) per annum. Financial loss analysis reported by [21-23] mentioned that coenurosis in small ruminants is a major cause for condemnation of brain (85.7%) in Ethiopia from apparently healthy slaughtered sheep and goat.

Conclusion and recommendations

Coenurosis is one of the most important problems of small ruminant's production in developing country including Ethiopia. The study clearly indicated that coenurosis affects small ruminants in study area. According to this study higher prevalence of coenurosis was recorded in animals from highland and midland than those from lowland parts of the country. Similarly the prevalence of coenurosis was also higher in adult than young small ruminants. This suggests coenurosis is responsible for huge economic losses in both sheep and goats production of the country. In appropriate disposal of heads being practiced by the abattoirs can enhance the continuation of the life cycle between the intermediate and final host. Questionnaire survey showed that major factor that plays a great role in the persistence of the disease is mainly human factor that is lack of knowledge on epidemiology of the disease including appropriate control measures.

Based on above conclusion the following recommendations were forwarded:

- Farmers and all community should aware about the danger of feeding uncooked disposal of head for dog and backyard slaughtering of small ruminants
- Level of community knowledge should increasing on the epidemiology of the disease and how it can be prevented
- To interrupt the life cycle of the parasite the carcasses or offal and brains of the intermediate hosts should not given to dogs nor left for wild carnivores.
- The appropriate disposal system of abattoir should practice for condemnation heads of small ruminants.
- Further epidemiological studies should be needed on different region of country.

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