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Research Article

Prevalence and Economic Significance of Hydatidosis in Sheep Slaughtered in Hotels and Restaurants of Bako, Shambu and Nekemte Towns

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Abstract

A cross-sectional study with systematic random sampling was conducted to estimate the prevalence and economic significance of cystic hydatidosis in sheep slaughtered at hotels and restaurants of Bako, Shambu and Nekemte towns from July 2021 to October 2023. Hydatid cysts were identified macroscopically during postmortem examination and their fertility and viability were determined. Cystic hydatidosis was observed in 41 sheep (18.81%) and 82 organs. A total of 38(8.7 %) lungs, 30(7.3%) livers and 14(3.2%) mesenteries were found to be infected with hydatid cysts. There were no cysts recorded in the heart and kidney. Out of the total 82 cysts encountered in sheep organs, 70(80.7%) were sterile while 12(19.3%) were fertile. Viability of protoscoleces from fertile cysts in sheep was 3.2%. Lung was the major organ affected followed by liver and mesentery. Logistic regression analysis showed that prevalence of cystic hydatidosis in relation with cyst severity and size, cyst fertility and viability was statistically significant (P<0.05). The total annual economic loss due to cyst of hydatidosis in the study towns was estimated to be 5,659,709.94 Ethiopian birr. Therefore; this study indicated the economic importance of cystic hydatidosis in sheep in the study areas and attention is needed for integrated approaches for the prevention and control the disease.

Keywords: Economic loss; Cystic hydatidosis; Sheep; Prevalence

Introduction

Ethiopia has a high livestock population and favorable environmental conditions, but the benefit from livestock output is insignificant. The factors those caused this low productivity are complex and interrelated including inadequate feed and nutrition, traditional management system, and widespread diseases [1]. Among many prevalent livestock diseases, parasitosis represents a major health problem hampering livestock productivity in tropics including Ethiopia. Cystic hydatidosis is among the major parasitic diseases that has reduced meat production due to carcass or organ condemnation [2]. It is a hydatidosis caused by the larval stage (metacestode) of *Echinococcus granulosus* with a great economic and public health significance. Cystic hydatidosis is caused by ingestion of ova of the cestode Echinococcus granulosus and then formation of the larval stage in different organs and tissues of host animals [3]. Cystic hydatidosis is of public health and economic importance not only in areas of endemicity but also in non-endemic countries. In Ethiopia, cystic hydatidosis is known and documented since the 1970's and it is one of the major causes of organ condemnation in most abattoirs and slaughter houses that leads to huge economic losses. It is potentially a zoonotic parasite in areas where cattle, sheep, and goats are still slaughtered traditionally and offal is easily accessible to scavenging dogs and other wild carnivores [1]. Animal handlers, veterinarians, and dog owners are all at higher risk of infection since the eggs are shed with feces in the environment leading to contamination of fruits, vegetables or water intake for indirect transmission and direct contact with the fur of an animal containing eggs which results transmission on hands to the mouth [4]. Studies conducted so far regarding hydatidosis in large and small ruminants concentrated only in abattoirs where at least anti and post-mortem inspection is conducted. Backyard slaughtering of cattle, sheep and goats is still practiced in Ethiopia and uncooked offal and carcass wastes are normally fed to dogs and cats. This practice in relation to the absence of proper meat inspection procedure, the presence of large population of stray dogs and lack of proper legislation with this regard increases the chance of transmission to animals and humans. In addition, information on the magnitude of hydatidosis in small ruminants where backyard slaughtering is practiced across various agro ecology is lacking. Thus this study is designed with the objectives:

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To determine the prevalence of hydatidosis in the study area

To identify risk factors associated with prevalence of Hydatidosis in sheep slaughtered at Hotels and Restaurants selected towns.

To estimate the direct and indirect economic losses associated with hydatidosis.

Materials and Methods

Description of Study Area

A cross-sectional study with systematic random sampling was conducted from October 2021 to June 2023 in Hotels/restaurants of Bako, Shambu and Nekemte towns of West Shewa, Horro Guduru Wollega and East Wollega Zones, respectively. The hotels/restaurants were selected based on information given from towns' administrations. Bako is a town in central Ethiopia located in the West Shewa Zone of the Oromia Region, on the Addis Ababa to Nekemte town. The town has a longitude and latitude of 9°08'N 37°03'E with an elevation of 1743 meters above sea level. Bako is the administrative center of Bako Tibe woreda [5]. Shambu town is located in Horro Guduru Wollega Zone, which is about 314 km west of Addis Ababa in geographical coordinates of 09º29´N and 37º26´E, and an elevation of 2,503 metres above sea level [6]. The Nekemte town lies on a latitude and longitude of 9°5'N 36°33'E. Nekemte has an altitude of 2108m above sea level with the average temperature of 17.6°C and annual rainfall of 1998 mm [6]. Mixed crop-livestock agriculture is the main production system in the areas. The area has one long rainy season extending from March to mid-October. The monthly mean temperature varies from 14.9 °C to 27 °C [7].

Study Animal

A study animal was sheep presented to hotels/restaurants of Bako, Shambu and Nekemte towns for slaughtering from different areas. Ages, sex, and body condition of the animals were considered during the study period. Pre-slaughter inspection was conducted before slaughtering and postmortem examinations such as inspection, palpation, and incision of suspected organs were undertaken.

Study Design, Sampling Method and Sample Size Determination

A cross-sectional study design with systematic random sampling was employed during the study period. The sample size was calculated based on previous report (determined from the study conducted by Gemeda, 2020) according to Thrusfield (2005) with expected prevalence of 14.6% and desired precision of 5% as follows:

$N= 1.96^2 P_{exp} (1-pexp)/d^2$

Where, N = sample size

P_{exp} = expected prevalence

D=desired absolute precision

P_{exp}=14.67% and D=0.05, then N=193. But, to increase the precision the sample size was raised to 218 (based on sampling capacity and accessibility of sampling units).

Characterization of Hydatid Cysts

Post-mortem examination through inspection, palpation and incision of internal organs such as lung, liver, heart, spleen and kidney were made and the minimum and maximum cyst burden per organ were recorded. Hydatid cysts were collected and transported to laboratory for characterization. Gross examination of individual cyst for any evidence of degeneration and calcification was made. In detail all cysts found in organs were counted and subjected to systematic size measurement (diameter) using a ruler and classified as small cyst (<3cm), medium cyst (3-5 cm) and large cyst (>5cm) [10]. The fertility and sterility of hydatid cyst was determined by the method described by Daryani *et al*., (2006). Individual hydatid cyst was collected and the cyst wall was carefully incised. The contents were poured in to a clean glass Petri dish and examined under a microscope (40×) for the presence of hydatid protoscolices. Cysts with white dots on the germinal epithelium or brood capsule were characterized as fertile cysts. Then the fertile cysts were further subjected to viability test. In detail a drop of the sediment containing the protoscolices were placed on the microscope glass slide. A drop of 0.1% aqueous eosin solution was added to equal volume of hydatid fluid on the microscope slide followed by with cover slip and observed under microscope (40×). Those cysts completely or partially excluded the dye were categorized as viable (fertile) while those absorbed the dye were considered as non-viable. Then infertile cysts were further classified as sterile or calcified. Sterile hydatid cysts were characterized by their smooth inner lining characterized by slightly turbid fluid in their content. Calcified cysts produced a gritty-sound heard at incision [12].

Assessment of Direct and Indirect Financial Loss

The Direct economic loss associated with hydatidosis was calculated on the basis of organs condemnation by using the formula described by Polydrous, (1981) as follows.

ACOC= (ASS*PO1C*O1C)

Where, ACOC= Annual cost of organs condemned

a) ASS=Average number of sheep slaughtered per year at selected slaughter houses

b) PO1=Percentage of each organ condemned

c) O1C=Mean cost of each organ in selected slaughter houses

The indirect economic loss from carcass weight reduction due to hydatidosis in sheep was assessed according to Polydrous, (1981). The annual cost of carcass weight loss due to hydatidosis (ACC) was estimated by the product of the total number of sheep slaughtered annually (NS) at the selected slaughter houses, the overall prevalence of hydatidosis in sheep (OP), the carcass weight loss in individual animals due to hydatidosis (CWL) and the average market price of 1kg sheep carcass (AMP) in Bako, Shambu and Nekemte towns.

This is represented as

ACC = NS*OP*CWL*AMP

Therefore, the economic loss from both direct and indirect losses equals the sum of the two (ACOC+ACC).

Data Management and Analysis

The data collected from anti-mortem and post mortem inspection, and laboratory test results were entered into Micro Soft Excel spread sheet 2010 program and analyzed using STATA Version 11.0 (STATA corp. College Station, Texas, USA). Mean

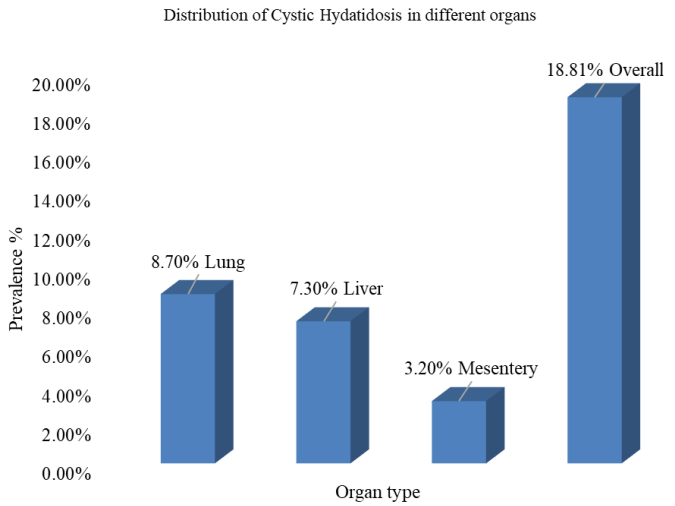

Figure 1: prevalence of cystic hydatidosis in different organs.

and percentage were used to calculate the prevalence at 95% Confidence Interval (CI) and 5% significance level. The association between different risk factors and prevalence of cysts was assessed by the chi-square ($\chi 2$) test. Multivariable logistic regression analysis was conducted to determine the association between risk factors and occurrence of cystic hydatidosis in the sheep.

Results

Questionnaire Survey Result

A total of 43 key informants out of which 19 butcher men, 5 veterinary officers, 8 veterinary pharmacists, 9 veterinary clinicians and 2 abattoir workers were interviewed in this study. About 94.7% of the butcher men inspected the meat by themselves while 5.3% used expert. There was no small ruminants' abattoir in all three study towns. Almost half (50.56%) of the key informants responded as there was no proper drainage system in the private slaughter houses. A 31.6% of the butcher men buried affected organs, 15.8% sell to other person while 52.6% of them provided the organs for dogs. About 73.7% of the butcher men did not know as dogs are the final host for the hydatid cyst and did not care for themselves. All key informants responded that there was no restraining and regular deworming of stray dogs and there was no supervision of hotels and restaurants with regard to backyard slaughtering practices in the towns.

Prevalence of Cystic Hydatidosis in Sheep in the Study Towns

The present study showed that there was epidemiological distribution of cystic hydatidosis in all study towns but statistically insignificant Table 1). Out of 218 examined sheep, 41 (18.81%) were found to be infected with one or more hydatid cysts. The prevalence of cystic hydatidosis had no relationship with sex, age and body condition ($p < 0.05$). Lung (8.7%) and liver (7.3%) were the most frequently infected visceral organs followed by mesentery (3.2%) (Figure 1).

Table 1: Distribution of cystic hydatidosis in the study towns.

Towns	Number of examined samples	Number of positive samples	Prevalence %	x^2	P- value
Nekemte	125	22	17.6		
Bako	68	10	14.71	5.7077	0.058
Shambu	25	9	36		
Overall	218	41	18.81		

Table 2: Prevalence of Ovine hydatidosis by origin of animals examined.

Risk Factors (Origin of animal)	No. Examined	No. Positive	Prevalence (%)	X^2	P-Value
Bandira	59	9	15.25		
Gebasembeta	7	1	14.29		
Getema	41	12	29.27		
Arjo	14	1	7.14		
Diga	4	0	0		
Jimate	4	0	0	11.65	0.006
Sorga	4	0	0		
Sekela	14	8	57.14		
Gitilo	2	0	0		
Leku	2	1	50		
Sheboka	27	8	29.63		
Jare	29	0	0		
Bako	5	0	0		
Hareto	7	2	28.57		

Table 3: Prevalence of cystic hydatidosis by sex, age and body condition.

Sex	No. examined	No. positive	Prevalence %	x^2	P- value
Female	180	38	21.11		
Male	38	3	7.89	3.5891	0.058
Age					
Young	88	12	13.64		
Adult	128	29	22.66	3.246	0.197
Old	2	0	0		
BCS					
Poor	108	17	15.89		
Medium	82	19	23.17	3.3251	0.505
Good	28	5	15.38		

Table 4: Sterility and fertility test result of hydatid cyst positive organs.

Cyst characteristic							
Sterility test	Number (%)	x^2	P-value	Fertility test	Number (%)	x^2	P-value
Sterile	70 (85.37)	212.2699	0.000	Fertile	12 (14.63)	212.3868	0.000
Calcified	43 (61.43)			Viable	10 (12.2)		
Degenerated	27 (38.57)			Non-viable	2 (2.43)		

The prevalence of cystic hydatidosis in relation to the origin of animals was higher in sekela followed by Leku which was statistically significant between the sources of animals. When we compare the prevalence of cystic hydatidosis in relation to origin of animals; it is significantly prevalent in Shambu than Bako and Nekemte towns.

Ante Mortem Examination

Regular visit of animals brought for slaughter was made to conduct ante mortem examinations. During ante mortem examination, recording was undertaken about origin, sex, age, and body condition of individual animal. Depending on their body condition, sheep were ranked as good, medium and poor according to Thompson and Meyer (1994). The age of sampled animals were determined as young, adult and old by using dental eruption methods.

Post-Mortem Examination

The prevalence of cystic hydatidosis was significant ($p<0.05$) between the calcified and degenerated cysts, cyst burden and

Table 5: Cyst burden and size category distribution of hydatid cyst in the study towns.

Cyst burden		Number (%)	x^2	P- value
	Mild	52 (63.41)	211.62	0.000
No.	Mderate	17 (20.73)		
	Severe	13 (15.85)		
Total		82 (100)		
Cyst size				
	Small	54 (65.85)	211.65	0.000
	Medium	21 (25.61)		
	Large	7 (8.54)		
Total		82 (100)		

Table 6: Multivariable logistic regression analysis of risk factors.

Risk factors	No. examined	No. positive	Prevalence %	Odd ratio (OR)	95% CI	p-value
Sex						
Male	38	3	7.89	1		
Female	180	38	21.11	0.48	1.45-3.26	0.09
Age						
Old	2	0	0	1		
Young	88	12	13.64	-		
Adult	128	29	22.66	0.58	0.69-1.27	0.32
Body condition						
Good	28	5	15.38	1		
Poor	108	17	15.89	-		
Medium	82	19	23.17	0.77	0.38-2.19	0.74
Fertility						
Degenerated		27	38.57	1		
Calcified		43	61.43	2.45	0.63-1.22	0.042
Viability						
Non-viable		2	2.43	1		
Viable		10	12.2	3.25	1.75-4.78	0.001
Cyst burden						
Severe		13	15.85	1		
Moderate		17	20.73	0.62		
Mild		52	63.41	2.14	0.46-1.35	0.027
Cyst size						
Large		7	8.54	1		
Medium		21	25.61	1.75		
Small		54	65.85	3.84	1.27-3.96	0.023

Table 7: Direct economic loss of hydatid cyst affected sheep organs in the study areas.

Organ	No. of organ condemned due to cyst	Average price of each organ	Total price (ETB)
Liver	28	90.79	2542.12
Lung	39	12.32	480.48
Mesentery	15	84.42	1266.30
Total	82	187.53	4288.90

cyst sizes whereas no significant association between sex, age and body condition was observed. Multivariable logistic regression analysis showed that the odd of infection by calcified cyst was 2.45 times higher than in degenerated one. The odd of cystic hydatidosis infection in non-viable cysts was 3.25 times higher than in viable cysts. Mild cysts were 2.14 times more likely to occur than moderate and severe cysts. The odd of cystic hydatidosis infection in small size cysts was 3.84 times higher than in large size cysts (Table 6).

Economic Loss Assessment

Direct financial loss assessment of organ condemned due to cystic hydatidosis was calculated as the mean retail market price of each organ multiplied by the total number of organ condemned during the study period. Accordingly; the direct economic loss due to the condemnation of cystic hydatidosis positive organs (liver, lung and mesentery) was 18,138.21 ETB. The indirect economic loss due to cystic hydatidosis was 5,641,571.73 ETB Per year. Thus, the overall estimated annual financial loss due to cystic hydatidosis in the study towns was 5,659,709.94 ETB. The average annual numbers of slaughtered sheep at all study towns were 77,069.

Discussion

The prevalence of cystic hydatidosis in the present study was higher (18.81%) than the study conducted by Gemeda 2020 at the Addis Ababa abattoir (14.67%). Assefa *et al*. (2015) and Abiyot *et al*. (2011) reported cystic hydatidosis prevalence of 8.02% and 8.05% in sheep at the Addis Ababa abattoir and Modjo export abattoir, respectively. These findings are lower than the current finding (18.81%). Berbri et al. (2015) also reported a lower prevalence of cystic hydatidosis in sheep (11%) in Morocco's small ruminants slaughter houses. This might be due to the fact that the previous studies were done at standardized abattoirs in contrary with the present study which was conducted at backyard slaughtering. On the other hand Feyera and Adem (2023) reported similar cystic hydatidosis prevalence (18.9%) in sheep. Erbeto *et al*. (2010) also reported a 19.94% of cystic hydatidosis prevalence at Addis Ababa abattoir which agrees with the current finding.

On the contrary, the prevalence of cystic hydatidosis in the present study was found to be lower than previous findings reported by Kumsa and Mohammedze (2012) in sheep (29.5%) in Jimma Town. The difference in the prevalence of cystic hydatidosis in sheep might be due to variations in agro-ecology and sample size difference at different study sites. The age-based prevalence of cystic hydatidosis in the present study was higher in adult (22.66%) than the young ones (13.64%) which agrees with the finding of Erbeto *et al*. (2010) whose report showed 9.8% in adult and 7.4% in young sheep. In this study, the fertility rate of cysts was found to be significantly higher in lungs compared to the liver this is in agreement with Kebede *et al*. (2009). It has been reported that the relatively softer consistency of lung tissue allows easier development of the cyst [22].

Conclusion and Recommendations

Cystic hydatidosis is prevalent in the study areas and it is a disease of major economic and public health importance in Ethiopia. The prevalence of cystic hydatidosis and its estimated corresponding economic losses in the study areas from organ condemnation was high. The economic losses from both direct and indirect losses recorded was about 69,139.77 ETB per year.

Therefore; the following recommendations are forwarded:

- Stray dogs should be controlled in the study towns in order to prevent cyclable transmission of hydatidosis.
- Proper disposal of affected organs should be practiced in the community.
- Well-equipped and standardized small ruminants abattoirs should be established in each study towns.
- Regular monitoring and evaluation of hotels and restaurants in the study towns should be exercised.
- Regular deworming of stray dogs against cystic hydatidosis should be practiced in In the study area
- Public awareness creation should be made on the means of transmission, prevention and control strategies of cystic hydatidosis.
- Further studies should be done on different livestock species in order to design and implement comprehensive preventive and control approaches.

Author Statements

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