

Prevalence, Economic Importance and Characterization of Cystic Echinococcosis in Cattle Slaughtered at Addis Zemen Town, South Gondar, Ethiopia

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Abstract: A cross sectional study was conducted from October 2013 to March 2014 to determine the prevalence, economic importance, organ localization, fertility and viability of cystic echinococcosis in cattle slaughtered for human consumption at Addis Zemen town, South Gondar, Ethiopia. During the study period out of the 384 randomly sampled and examined cattle, 27.6% (N=106) were found infested with hydatid cyst and significant associations ($p < 0.05$) were observed between the occurrences of the disease and origins of the animal, highest in cattle that are originated from the lowland areas than that of mid highland areas (OR =2.078). Though no statistically significant associations ($p > 0.05$) observed within sex and age group of cattle, female cattle (35.5%) were more frequently affected than male (26.1%) and older age group (28.6%) than young (16.1%). Among the 106 hydatid cysts collected from various organs of affected cattle, 66.04% (N=70) were fertile of which 27.36% (N= 29) were viable. In contrast to various organs infested, liver and lung were the most affected once that harbors 32.1% (18 out of 56 examined) and 19% (4 out of 21 examined) viable cysts respectively. Results of this study showed that bovine hydatidosis pose significant financial losses in the study area with total estimated value of 281,180.07 ETB (14,059.00 USD) per year from the direct and indirect losses. Therefore strategically designed parasite lifecycle interruption and disease control measures are necessary in order to decrease the financial losses as well as zoonotic risks to humans.

Key words: Addis Zemen • Cattle • Ethiopia • Hydatidosis • Prevalence • Zoonosis

INTRODUCTION

Cystic echinococcosis (CE) also called hydatidosis is one of the most common, severe zoonotic parasitic diseases caused by the larval stage of *Echinococcus granulosus* (*E. granulosus*) which affect both human and animal, with multiform complications. *E. granulosus* is now recognized to have genotypes 1-10 which are commonly referred as *E. granulosus sensu stricto* (genotypes G1-G3), *E. equinus* (G4), *E. ortleppi* (G5) and *E. canadensis* (G6-G10). Additionally, mitochondrial studies have identified *E. felidis* as a distinct species although phylogenetically closely related with *E. granulosus sensu stricto* [1]. Among the different genotypes, *E. granulosus sensu stricto*, *E. ortleppi* and *E. canadensis* cause human CE while *E. equinus* is believed to be not zoonotic and the pathogenicity of

E. felidis to human is unknown [2] though mechanical dysfunction of organs due to the cysts and anaphylaxis, as a consequence of the cyst burst and releasing fluid, is a serious manifestation in human. Beyond the zoonotic and health problems, the disease incur huge economic burden on livestock industry and it has been estimated to cause over two billion USD losses per annum globally [3].

In Ethiopia the diseases is much more common in rural areas and amongst pastoralists where dogs and domestic animals live in a very close association and where humans cohabit with dogs fed on raw livestock offal [4,5,6]. Though hydatidosis has been known and documented in Ethiopia as early as 1970, the prevalence of the disease in domestic ruminants and dogs remains high and the diseases is still one of the major causes of organ condemnation in most abattoirs [7,8]. Hence the disease has serious public health and socio economic

implications, to develop and implement efficient prevention and control strategies, detailed epidemiological information are essential. Therefore this study is designed to see the prevalence of CE, characterize the cyst and estimate the economic impact of the disease in the study area for the betterment of prevention and control measures.

MATERIALS AND METHODS

Study Area: Addis Zemen, the district capital of Libo-Kemkem woreda in Amhara regional state, Ethiopia is located at an altitude of 2000m above sea level, 11° 29' N. latitude and 37° 29' longitude, 645 km away from Addis Ababa. The average annual rainfall and temperature is 1550 mm and 29.5°C respectively. Crop production is mainly based on summer rainfall and very little irrigation is practiced in the winter season [9]. Animals for slaughter came to the study area from nearly all South Gondar districts that have a livestock population of 1,326,764 cattle [9] and predominantly male cattle are subjected for slaughter in the abattoirs.

Study Animals: The study animals were indigenous zebu cattle brought from various localities to Addis Zemen abattoir as well as to hotels and restaurants for slaughtering and consumption purposes.

Sample Size Determination: The total sample size used for the study was 384 cattle which are determined using the formula given by Thrusfield [10] as shown below, at 95% confidence interval, 0.05 absolute precision and 50% expected prevalence, because there were no previously done and documented prevalence study reports on cystic echinococcosis in the study area.

$$N = \frac{1.96^2 (p_{exp})(1-p_{exp})}{d^2}$$

where,

N = Required sample size

p_{exp} = Expected prevalence

d = desired absolute precision (50%)

Study Design and Methodology: A cross sectional study was conducted in the study area following systematic random sampling method, by choosing the first case and the interval between cases using lottery method, followed by anti-mortem and postmortem inspections, cyst characterizations and financial loss estimations.

Ante-mortem Examination: During the ante-mortem examination, origin of the animal, sex, body condition and age were recorded and animals were tagged with code number for further follow-ups and investigations. Body condition of the animal were grouped as poor, medium and good following the guideline provided by Nicolson and Butterworth [11], whereas estimation of age was carried out by checking the teeth eruption using the approaches forwarded by De Lahunta and Habel [12] and grouped into two, young (3-5 years) and old (≥ 5 years).

Post-mortem Examination: Postmortem examination was conducted thorough visual inspection, palpation and systematic incision of visceral organs particularly the lung, kidney, liver, spleen and heart following the meat inspection guideline provided by O.I.E. [13].

Cyst Characterization: Cyst characterizations were done based on the presence or absence of brood capsules containing protoscolices in the hydatid fluid. Cysts were identified and classified as fertile and infertile following the method described by Macpherson [14]. Infertile cysts were further classified as sterile (fluid filled cyst without protoscolices) or calcified following the guideline given by Soulsby [15]. To test the viability, the cyst wall was penetrated by a needle, opened and the contents were examined microscopically (40x) for the amoeboid-like peristaltic movements of protoscolices according to the standard procedure of Smyth and Barrett [16]. In doubtful cases, a drop of 0.1% aqueous eosin solution was added to equal volume of protoscolices on a microscope slide with the principle that viable protoscolices partially or completely exclude the dye while the dead ones take it up [14,16].

Financial Loss Estimation: Total financial losses due to hydatidosis were calculated by considering the direct financial losses due to condemnation of affected organs and the indirect losses due to carcass weight losses. Annual financial loss due to organ condemnation was determined by considering annual slaughter rate of cattle, prevalence of hydatidosis in the study area and by considering an estimated 5 % carcass weight loss due to hydatidosis as per Polydorou [17]. The average carcass weight of Ethiopian local breed cattle is estimated as 108kg following Negassa study [18] and the total financial loss was calculated as the summation of the direct and indirect losses using the formula given below [19, 20].

Annual Financial Loss Due to Organ Condemnation (Direct Loss):

$$= (CSR * P_{HLu} * C_{PLu}) + (CSR * P_{HLi} * C_{PLi}) + (CSR * P_{HHc} * C_{PHc}) + (CSR * P_{HKi} * C_{PKi})$$

Annual Financial Loss Due to Carcass Weight Loss (Indirect Loss):

$$= 5\% * CSR * P_H * CPB * 108Kg$$

where:

- CPB = Average market price of one Kg beef.
- C_{PHc} = Mean cost of one bovine heart.
- C_{PKi} = Mean cost of one bovine kidney.
- C_{PLi} = Mean cost of one bovine liver.
- C_{PLu} = Mean cost of one bovine lung.
- CSR = Average number of cattle slaughtered per year.
- P_H = Prevalence of hydatidosis in the study area.
- P_{HHc} = Percentage of heart condemned.
- P_{HKi} = Percentage of kidney condemned.
- P_{HLi} = Percentage of liver condemned.
- P_{HLu} = Percentage of lung condemned.

Data Analysis: Data obtained from ante-mortem and postmortem findings as well as characterization of hydatid cysts were coded and uploaded into a pre designed format of Microsoft Office Excel 2007. Descriptive statistical analyses were done by using software: StataSE version-11 and SPSS-16 for Windows. To compare the association between the degree of infestation and hypothesized risk factors, Odd's Ratio (OR) and Chi-square (X²) values were used.

RESULTS

Prevalence: The overall prevalence of bovine cystic echinococcosis in the study area were 27.6% (N=106) and harbor one or more (up to twenty) hydatid cyst at a time in different visceral organs like lung, liver, heart, spleen and kidney (Table 1).

Among the various expected risk factors, cattle that are originated from the lowland area showed higher prevalence than that of mid highland cattle (P<0.05 and OR =2.078), on the other hand, though there is no statistically significant associations observed between the disease occurrence and sex, age group and even body condition of the animal (P>0.05), female cattle had showed relatively higher prevalence than male (OR= 1.56) and

younger age group cattle showed lesser prevalence than older age groups (OR= 0.48) (Table 1).

Frequency of Hydatid Cyst in Different Organs: Among the various organs infested by hydatid cyst the most frequently affected organ was liver (52.8%, N=56) followed by lung (19.8%, N=21) and kidney (18.9%, N=20). In the liver, occurrence of hydatid cysts were more frequent in older age group (=5 years) than younger, in lowland originated cattle than the mid highland originated cattle and in male than that of female cattle. Heart and spleen were found to be the list frequently infested organs with hydatid cyst and found in older age group cattle (Table-2).

Fertility and Viability of Hydatid Cysts: Among the 106 hydatid cysts collected and examined for fertility and viability 66.04% (N=70) were fertile, of which 27.36% (N=29) were viable and the remaining 38.68% (N=41) were not viable. Among the viable cysts majority (>62.07%) were located in the liver followed by lung. On the other hand, out of the non fertile cysts 20.75% (N=22) were sterile and 13.21% (N=14) were calcified (Table 3 and Table 4).

In relation to the potential risk factors, viable hydatid cysts were relatively higher in cattle that are originated from lowland 82.76% (N=24) than from mid highland 17.24% (N=5), in older age group 89.66% (N=26) than young 10.34% (N= 3) and in male 89.66% (N= 26) than female 10.34% (N=3) cattle. Besides, good body conditioned cattle harbor more viable hydatid cysts than poor body conditioned cattle though majority (74.2%) of good body conditioned cattle were found to be negative from CE (Table 1 and Table 4).

Financial Losses

Direct Financial Loss: The direct financial loss was calculated by taking loses due to organ condemnation, using the formula described in the methodology part of this paper, percentage of organ condemnation (heart 0.9%, kidney 19.8%, liver 58.5% and lung 24.5%) and mean market price of organs in the study area (cattle heart & liver 25 Ethiopian Birr (ETB) for each, kidney 20 ETB and lung 5 ETB). By taking the average number of cattle slaughtered per year in the study area, which is 2019 cattle, based on the district livestock agency records, the estimated direct financial loss was 40,450.67 ETB (equivalent to 2,022.53 USD in the current exchange value) per year.

Table 1: Prevalence of cattle hydatidosis slaughtered in Addis Zemen town, South Gondar Zone, Ethiopia in relation to sex, body condition, age and origin of the animal

Result	Origin		Sex		Body Condition			Age	
	LL	MHL	Female	Male	Poor	Medium	Good	Young	Old
Positive	89 (30.9%)	17 (17.7%)	22 (35.5%)	84 (26.1%)	12 (25.0%)	43 (31.2%)	51 (25.8%)	5 (16.1%)	101 (28.6%)
Negative	199 (69.1%)	79 (82.3%)	40 (64.5%)	238 (73.9%)	36 (75.0%)	95 (68.8%)	147 (74.2%)	26 (83.9%)	252 (71.4%)
Total	288	96	62	322	48	138	198	31	353
	X ² (1)=6.27		X ² (1)=1.56		X ² (2)=1.374			X ² (1)=0.48	
	P=0.012		P=0.130		P=0.503			P= 0.136	
	OR= 2.078		OR= 1.56					OR= 0.48	

Where: X²= Chi-square value; OR= Odd's ratio; LL= Lowland; MHL- Mid highland

Table 2: Frequency of hydatid cyst infestation in various organs of cattle slaughtered at Addis Zemen town, South Gondar Zone, Ethiopia and associated risk factors

		Infested Organs						
		Lung (N=21)	Liver (N=56)	Heart (N=1)	Spleen (N=2)	kidney (N=20)	Lung & Liver (N=5)	Liver & Kidney (N=1)
Origin	LL	20(18.9%)	48(45.2%)	1(0.9%)	2(1.9%)	12(11.3%)	5(4.7%)	1(0.9%)
	MHL	1(0.9%)	8(7.6%)	0(0.0%)	0(0.0%)	8(7.6%)	0(0.0%)	0(0.0%)
Age	Young	0(0.0%)	4(3.8%)	0(0.0%)	0(0.0%)	0(0.0%)	1(0.9%)	0(0.0%)
	Old	21(19.8%)	52(49.0%)	1(0.9%)	2(1.9%)	20(18.9%)	4(3.8%)	1(0.9%)
BC	Poor	2(1.9%)	7(6.6%)	0(0.0%)	1(0.9%)	1(0.9%)	1(0.9%)	0(0.0%)
	Medium	9(8.5%)	23(21.7%)	0(0.0%)	1(0.9%)	9(8.5%)	1(0.9%)	0(0.0%)
	Good	10(9.4%)	26(24.5%)	1(0.9%)	0(0.0%)	10(9.4%)	3(2.8%)	1(0.9%)
Sex	Male	11(10.4%)	48(45.3%)	1(0.9%)	1(0.9%)	17(16.1%)	5(4.7%)	1(0.9%)
	Female	10(9.4%)	8(7.5%)	0(0.0%)	1(0.9%)	3(2.8%)	0(0.0%)	0(0.0%)

Where: BC= Body condition; LL= Lowland; MHL= Mid highland

Table 3: Distribution of hydatid cyst in various organs of cattle slaughtered at Addis Zemen town, South Gondar Zone, Ethiopia

Infested Organs	Cyst Characteristic				Total
	Fertile		Non Fertile		
	Viable	Non-Viable	Sterile	Calcified	
Lung	4	14	2	1	21
Liver	18	13	16	9	56
Heart	0	1	0	0	1
Spleen	0	2	0	0	2
Kidney	3	11	3	3	20
Lung & Liver	4	0	0	1	5
Liver & Kidney	0	0	1	0	1
Total	29 (27.36%)	41 (38.68%)	22 (20.75%)	14 (13.21%)	106 (100%)

Indirect Financial Loss: The indirect financial loss (carcass weight reduction) was calculated by taking a 5% carcass weight loss due to hydatidosis [17] and 108 kg as average carcass weight of Ethiopian zebu cattle [18]. By considering 27.6% cattle hydatidosis prevalence and 80 ETB average market price for one

kilogram beef in the study area, the indirect financial loss was estimated to be 240,729.41 ETB (12,036.47 USD) annually and the total financial loss estimated due to hydatidosis was the sum of the direct and indirect financial losses, 281,180.07 ETB (14,059.00 USD) per year.

Table 4: Association of expected risk factors and hydatid cyst characters identified from cattle slaughtered at Addis Zemen town, South Gondar Zone, Ethiopia

Expected Risk Factors		Cyst Characteristic				Total (N=106)
		Fertile		Non Fertile		
		Viable (N=29)	Non viable (N=41)	Sterile (N=22)	Calcified (N=14)	
Origin	LL	24 (82.76%)	35(85.37%)	20(90.91%)	10(71.42%)	89(83.96%)
	MHL	5 (17.24%)	6(14.63%)	2(9.09%)	4(28.57%)	17(16.04%)
Age Group	Young	3 (10.34%)	2(4.88%)	0(0.00%)	0(0.00%)	5(4.72%)
	Old	26 (89.66%)	39(95.12%)	22(100%)	14(100%)	101(95.28%)
BC	Poor	4(13.79%)	3(7.32%)	2(9.09%)	3(21.43%)	12(11.32%)
	Medium	11(37.93%)	19(46.34%)	8(36.36%)	5(35.71%)	43(40.57%)
	Good	14(48.28%)	19(46.34%)	12(54.55%)	6(42.86%)	51(48.11%)
Sex	Male	26(89.66%)	30(73.17%)	16(72.73%)	12(85.71%)	84(79.25%)
	Female	3(10.34%)	11(26.83%)	6(27.27%)	2(14.29%)	22(20.75%)

Where: BC= body condition; LL= lowland; MHL= mid highland

DISCUSSION

Cystic echinococcosis is responsible for a substantial health and economic burden, particularly to low-income societies and because of indications of an increasing number of cases in certain areas, it is becoming an emerging or re-emerging disease [2].

The prevalence of CE varies from year to year, from place to place and even from month to month due to differences in culture, social activities and management of dogs in different geographical locations [21]. In the present study area, dog management could be grouped into three: “*Owned dogs*” that are living mainly in the urban area and controlled by the owners; “*Semi-owned dogs*” that are released during the night time and roam freely including in the abattoir waste disposal areas; and “*Homeless stray dogs*” that are freely roaming day and night everywhere any time. The prevalence of bovine hydatidosis in cattle slaughtered for human consumption at Addis Zemen town, South Gondar, Ethiopia, based on the present study, was 27.6%, which is relatively higher than previous reports from different abattoirs of the country: 12.7% in Kombolcha [22]; 13.61% in Dessie [23]; 15.2% in Birsheleko [19]; 20.5% in Arbaminch [24] and 2.8% in neighboring country, Khartoum, Sudan [25] but almost the same as reports of Gondar(28%) and Ambo (29.69%) abattoirs [26, 27].

The reason for the variation in prevalence could be multi-factorial. Various researchers repeatedly reported the occurrence of significant differences in the prevalence of cystic echinococcosis between study locations (altitudes), season (annual rainfall) or origin of the animal [2]. The variation could be also associated to strain difference in *E. granulosus* [28] and other factor like social activity and attitudes to dogs [14].

In this study, though expected risk factors like sex, age group and body condition didn’t show statistically significant associations with the disease prevalence, female cattle had showed relatively higher prevalence (35.5%) than male (26.1%) and older age group (28.6%) than younger (16.1%) which is in agreement with the study results of Belen & Paul [2]; Endalew & Ibrahim [26]; Miheret *et al.* [8] and Endrias *et al.* [27].

Among the 106 hydatid cysts collected and examined 66.04% (N=70) were fertile, of which 27.36% (N= 29) were viable and are located in liver and lung as a predominant predilection site than other organs. This result is in line with most investigators’ work in Ethiopia: like in Gondar by Endalew & Ibrahim [26]; in Diredawa by Miheret *et al.* [8]; in Dessie by Melaku *et al.* [23] and in Ambo by Endrias *et al.* [27]. In contrast to other reports, in this study good body conditioned cattle harbor more viable hydatid cysts than poor body conditioned cattle may be because the sample size of good body conditioned cattle in this study were higher than poor body conditioned, hence most of the time cattle with good body condition (after fattening) are slaughter for human consumption. Similarly higher rate of infestation in liver than lung is registered, may be because of the fact that onchosphers are disseminated from the intestine through hepato-portal vein route and first reach to highly capillary field organ, liver [15].

The financial loss due to cattle hydatidosis in the study area was also significant with an estimated amount of 281,180.07 ETB, which is equivalent to 14,059.00 USD per annum from the direct organ condemnation and indirect body weight losses alone. The actual economic loss due to CE could be more than the one estimated by this work, hence loses due to impaired productivity, animal treatment costs, death of the animal from the disease and effects on human health are enormous.

CONCLUSION AND RECOMMENDATION

Cystic echinococcosis is a prevalent, neglected parasitic disease in cattle which can incur significant economic losses in the study area and the country at large, adding not insignificant health and economic burden to humans. Therefore a sound understanding of the epidemiology of *Echinococcus* in animal hosts, proper disposal of offal in the abattoirs, frequent de-worming and management of dogs are essential for effective control and safe guard the public health.

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