

Research Article

Cross Sectional Study on Prevalence, Public Health and Economic Importance of Bovine Hydatidiosis in Setit Humera, Tigray Region, Northern Ethiopia

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Abstract

Background: Hydatidiosis is a neglected parasitic disease with high public health and economic importance globally.

In Humera, there was no known research undertaken about hydatid disease in abattoir. Thus, this current study was conducted to assess the prevalence, public health and economic significance of bovine hydatidiosis in Setit Humera.

Methods: A cross-sectional study was conducted from January to August 2019 to study the prevalence, cyst characterization, economic and public health importance of Bovine Hydatid cyst in Setit Humera.

Results: Out of 423 heads of cattle slaughtered and examined, 28.8% were infected with hydatid cyst. There was statistically significant difference ($P < 0.05$) in the prevalence of hydatid cyst among animals of different body condition. The prevalence was highest in poor body condition than medium and good body conditions. Animals in poor body condition were 4 times ($OR = 4.051$) more likely to acquire the disease than the medium and good body condition. Lungs, 44.26% (54/122) and liver, 41.8% (51/122) were the most affected organs. Out of the total of 122 cysts examined for the fertility test, 34.43% (42/122), 36.89% (45/122), 25.4% (31/122) and 3.28% (4/122) were found to be fertile, sterile, calcified and mixed respectively. Out of the total 43 fertile cysts tested for viability, 41.86% (18/43) were viable cysts. Hospital and clinic case-book survey between September, 2014 and December, 2018 performed in Kahsay Abera Hospital, Welkayit clinic and Selam surgical clinic showed that out of the total of 525,148 patients admitted for ultrasound examination, 7 hydatid cyst cases were registered. This represents a point prevalence of 1.34 cases per 100,000 humans. The total annual economic loss due to bovine hydatidiosis in Humera municipal abattoir was found to be 2,466,783.64 Ethiopian Birr (82,226.12 US\$).

Conclusion: High prevalence of bovine hydatidiosis is observed in cattle in the study area. Thus, attention needs to be paid to further study the disease in animals and humans in the area.

Keywords: Abattoir; Humera; Hydatidiosis; Prevalence; Public health

Abbreviations

CE: Cystic *Echinococcus*; CFSPH: Center for Food Security and Public Health; CSA: Central Statistical Agency; DHIS: District Health Information System; HMIS: Health Management Information System; NTD: Neglected Tropical Diseases; WHO: World Health Organization

Background

Ethiopia possesses the largest livestock population in Africa. An estimate indicates that the country is home for about 60.39 million cattle, 31.3 million sheep and 32.74 million goats [1]. However, the contribution of the livestock sector to the national economy has been

reported to be small compared to its potential. One of the main causes of the mismatch between herd population size and production output from livestock in Ethiopia is undoubtedly the widespread occurrence of huge number of infectious and parasitic diseases, causing morbidity, mortality and market restrictions, which drastically reduce animal production [2].

Hydatidiosis is one of the major parasitic problems of domestic animals and it is a zoonotic disease affecting humans and their livestock, thereby causing significant socioeconomic and public health impacts, mostly in developing countries [3]. Hydatid cyst is defined as the cystic stage of *Echinococcus*, a very small tapeworm of dogs. At its intermediate cyst, it forms cysts in the internal organs, especially in liver and lungs and some infections can be fatal in humans if the cyst ruptures and causes anaphylactic shock [4].

Cystic Echinococcosis (CE) is a zoonotic disease caused by the larval stage of *Echinococcus granulosus* for which domestic intermediate hosts (cattle, sheep, goats and camels) are major reservoirs for the occurrence of human hydatidiosis [5]. Dogs are the major source of infection to humans, and the majority of documented human Cystic *Echinococcus* cases are caused by *E. granulosus* with a life cycle that occurs mainly within a rural setting between sheep and shepherd dogs [6]. It represents a significant global human disease burden in resource poor communities [7]. This multi host parasite

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is prevalent all over the world, and annually, the economic loss in livestock due to this parasite is significant [8,9].

The prevalence, economic and public health impact of CE is higher in rural communities of developing countries where there is close contact between dogs, intermediate host species, and man [10,11]. In Africa, hydatid disease is reported more commonly in cattle, which are communally owned or raised on free range, and associated more intimately with domestic dogs. Hydatidosis in domestic ruminants inflicts enormous economic damage due to the condemnation of affected organs and lowering of the meat, milk and wool production. Cystic Echinococcosis (CE) is a significant public health problem with high endemicity in East and Central Africa [12].

Echinococcosis is a neglected tropical disease, which affects the poorest population living in remote, rural areas, urban slums and in conflict zones. It has an important public health importance and can cause substantial economic losses [13]. As the case with other neglected tropical diseases, echinococcosis has a low profile and status in public health priorities. The WHO estimates that about one billion people are affected by neglected tropical disease [14]. In Ethiopia, hydatidosis has been known and documented as early as 1970s. Hydatidosis is the major cause of organ condemnation in most Ethiopian abattoirs and leads to huge economic losses [15-18]. In Ethiopia, the occurrence of CE has been reported from dogs [19] cattle, sheep and goats [20] and humans [21]. Additional surveys are required to estimate the burden of the disease in humans, and to provide information needed for national control strategies. Slaughter houses provide valuable information on the prevalence of hydatidosis and also play a significant role in the control of the disease by breaking its lifecycle. The occurrences and financial significance of bovine cystic echinococcosis has also been reported from northern Ethiopia [22]. In Tigray regional state and/or elsewhere in other parts of Ethiopia More studies were not done after 2012-2013 on financial losses of Bovine Hydatidosis except some studies conducted in Bahir Dar [23] and Asella [24].

Echinococcosis affects the socio-economically disadvantaged of the world. In humans, it causes morbidity as a result of parasite larval stages in the liver, lungs and the brain. This leads to clinical signs because of mass effects, allergic reactions or through tissue necrosis/fibrosis. Echinococcosis causes collateral economic damages to the poor rural farmers because it affects livestock. This occurs as result of condemnations of the affected organs such as the liver. Echinococcosis also leads to poor animal health and production which ultimately leads to economic losses to livestock owners. Infection with *E. granulosus* results into 10% reduction in the life performance of the animal in terms of meat quality, fiber production, milk production and number of surviving off springs [14].

There are some researches done in Tigray regional state for example a study conducted on Prevalence, cyst characterization and economic importance of bovine hydatidosis in Mekelle municipality abattoir, Northern Ethiopia [25], but the current study had filled the gap in public health aspects. In addition to this in the current study, study animals were Begait breeds which are among the promising breeds of cattle in their production in Ethiopia. Other scholars also studied on Economic and Zoonotic Importance of Bovine Hydatidosis in Shire Municipal Abattoir, North West Zone, Tigray Region, Ethiopia, but the fertility and viability of cysts were not checked and the duration of the study was too short only October to December [26].

The peculiar geographic feature of Humera due to the presence of Tekeze River and bushy areas along the riverside is an ideal home for many foxes and hyenas. Hence, besides domestic dogs these wild carnivores can play a significant role in maintenance of the life cycle and can become potential source of infection for domestic ungulates. There is also huge consumption of vegetation in the study area [27-29].

In Humera, there was no known research undertaken about hydatid disease in abattoir. But it is expected to be highly prevalent due to wide spread of backyard slaughtering practices, the absence of meat inspection procedures and the long-standing habit of the people to feed their dogs with raw offal's. Hence, there is need of more information on the prevalence, distribution and the risk factors for echinococcosis in people and animals living in the study area. The zoonotic potential needs to be assessed and the impact of echinococcosis in Humera especially in communities that interact closely with dogs, livestock, and wild life. There is a need to identify what are some of the practices that perpetuate the condition in the study area. The public health and economic significance and the prevention and control mechanisms of bovine hydatidosis is not well known in the area. Thus, this current study was conducted to fill the information gap in the study area on bovine hydatidosis. Therefore, the objective of this study was to assess the prevalence, public health and economic significance of bovine hydatidosis in Setit Humera. In addition, the Specific objectives are to determine the prevalence of Bovine Hydatidosis in Setit Humera abattoir, to characterize Hydatid cyst, to assess the public health importance of the disease in the study area and to assess the economic impact of the disease in the study area.

Methods

Description of the Study Area

The study was conducted in Setit Humera town. Setit Humera town is located in the Western Zone of the Tigray Regional state, Northern Ethiopia. It is the administrative center of the Western Zone of Tigray. It has latitude 14°17'N and longitude 036°39'E at an altitude of 637 m above sea level (Figures 1 and 2).

Agriculture is the main occupation of the population of the area. The agricultural activities are mainly mixed type with cattle rearing and crop production under taken side by side. Extensive system of livestock management predominate the area and dogs are commonly used for control and guarding of herds of cattle and flocks of sheep and goats. The use of dogs for herding cattle could facilitate transmission of *Echinococcus* to this species and other animals sharing grazing land [30].

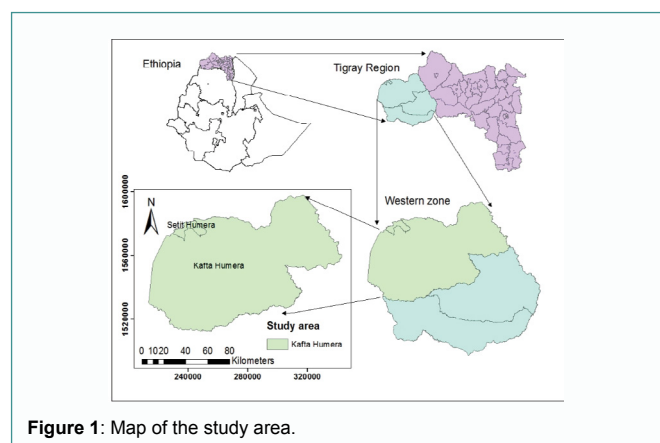


Figure 1: Map of the study area.

Rainfall in the study area is generally characterized by low inter annual and seasonal variability. The mean of rainfall is 540.6 and varies from 357.8 mm and 650 mm minimum and maximum respectively. On average the main rainy season (June-September) contributes 85% to the annual rainfall totals. The mean maximum temperature varied from 33°C to 41.7°C, while the mean minimum temperature varied from 17.5°C to 22.2°C. Generally, climate is characterized by distinct dry (October-May) and wet seasons (June- September) [30].

Main cattle breeds raised in the study district are the local Arado (in both high land and lowland areas) and Begait (Barka) cattle (in lowland areas). There is still very few number of cross breeds of cattle especially in the high land areas. Western zone of Tigray which includes; Kafta Humera, Tsegede and Welkayit woredas possess a total of 762,893 heads of Cattle. Kafta Humera woreda possess 237,307 heads of cattle, 103,616 head of goats and 152,391 head of sheep. Of the 237,307 heads of cattle 62,808 are Begait cattle [30]. Welkayit woreda possess 316,513 heads of cattle, 110,003 head of goats, 354 head of sheep, heads 8,597 of Donkey, 876 heads of mule, and 281 head of camel [31]. Tsegede woreda possess 209,073 heads of cattle, 123,810 head of goats, 39,266 head of sheep, 12,062 heads of Donkey 1,412 head of camel, 184,945 poultry, 544 swine, 5,863 and 1,386 traditional and modern, respectively hive honeybee. Some 1968 are Begait cattle [32].

Study population

The study had included all breed type of Cattle that were brought to Setithumera municipal abattoir from western zone of Tigray for slaughtering purpose. Specifically, the breed type includes; Arado, begait and cross breeds.

Study design and Sampling methodology

Study design: A cross-sectional study design was employed from January 2019 to August 2019 to study the prevalence, public health and associated determinant factors responsible for hydatidiosis in the study animals slaughtered in Setithumera municipal abattoir. In the study; prevalence, ante mortem, postmortem, cyst characterization, economic and public health importance studies were conducted.

Sampling technique and sample size determination: The study animals were selected using simple systematic random technique. Sample size was conducted using random sampling techniques which ensure the sample is evenly distributed across the study population. The sample size was calculated according to Thrusfield [33]. The average is 50% to be determined with 95% confidence interval (95% CI) and 5% desired absolute precision ($d=0.05$).

$$n = 1.962 (p) (1-p)$$

$$d^2$$

Where n = Sample size

p = expected prevalence

d = desired level of Precision

Accordingly, based on the above formula the required sample size was 384. To increase the accuracy of the study, the total number of sample size was increased to 423.

So as not to saturate the sample size this systematic sampling had included not only on the day of inspection but also in the whole period of study. For this number of animals slaughtered over the past five years were calculated and our sample size per month was calculated

based on this estimation.

Prevalence study: To study the Abattoir prevalence of bovine hydatidosis post-mortem examinations through inspection, palpation and incision of internal organs such as lung, liver, heart, spleen and kidney were made and the organ distribution and rate of infection of hydatidosis was recorded. For CE positive animals, the cysts were subjected to systematic size measurement (diameter) using a ruler and classified as small cyst (<3 cm), medium cyst (3 cm to 5 cm) and large cyst (>5 cm) [34]. The total numbers of mature cysts obtained per organ was counted in different organs. The fertility and sterility of hydatid cyst was recorded in order to investigate the viability of the cyst as per Tsimoyiannis [35].

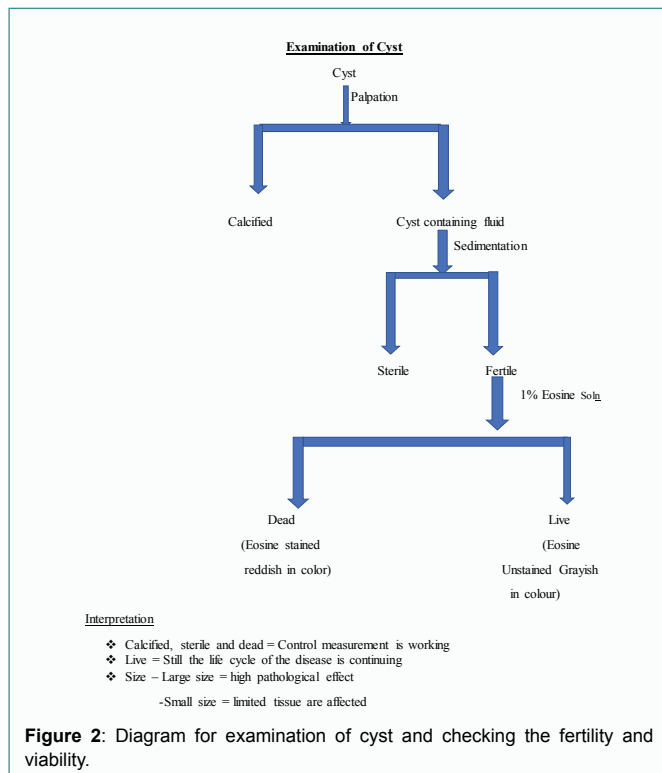
Ante mortem examination: During ante-mortem examination, each study animal was given an identification number. Age, sex, breed, market source and body condition of animals were recorded. The Body condition of each of the study cattle was scored as poor (score 1, 2, 3), medium (score 4, 5, 6) and good (score 7, 8, 9) [36]. Concurrently, their age was categorized in years (≤ 2 , 2-4 and ≥ 5) as per (De-Lahunta and Habel) [37] recommendation principles. Regular visit was made to conduct ante mortem examination of animals brought for slaughter.

Post mortem examination: The inspection procedures used during the post mortem examination consisted of primary and secondary examinations. The primary examination had involved visual inspection and palpation of organs and viscera. The secondary examination had involved further incisions in to each organ if a single or more cysts found. Lungs, liver, kidney and heart of each animal were examined grossly. Each organ was incised once or twice with knife. Whenever and wherever cysts were present, they were removed, put in to polythene bags separately, labeled and then taken to humera agricultural research center animal health research laboratory for further fertility and viability studies.

Cyst characterization: The total number of hydatid cysts were counted and recorded per affected organ. The cyst burdens were also recorded in correspondence with body condition scoring. Hydatid cyst size was measured by ordinary rulers and classification made based on cyst diameter as small cyst (less than 3 cm), medium (3 cm-5 cm), large (greater than 5 cm) [34].

Cyst size, fertility and viability studies were expressed at animal level. If the animal is with multiple cysts two cysts were taken for examination. The examination was done under objectives (40x) magnification for the presence/absence of protoscolex. The protoscolices present as white dots on the germinal epithelium or brood capsule or hydatid sands within the suspension, the cyst was categorized as fertile. Then the fertile cysts further were subjected for viability test. For clear vision a drop of the sediment consisting of protoscolices was placed on microscope glass slide and a drop of 0.1% aqueous eosin solution was added and covered by cover slip and was observed under microscope (40x), with principle that viable protoscolices exclude the dye while dead ones take it up [38-40]. Furthermore, fertile cysts were characterized their smooth inner lining usually with slightly turbid fluid in its content. The infertile cysts were classified as sterile or calcified. Typical calcified cysts produced a gritty sound feeling upon incision [35].

Economic loss assessment: The economic loss assessment due to hydatidosis in cattle was estimated by taking into account the average number of cattle slaughtered and the degree of organ condemnation



per annum at Setithumera. The direct economic loss attributed to hydatidosis was made using the formula indicated by (Orgunrinade) [41].

$ACLLHKC = (CSR * PL1C * L1C) + (CSR * PL2C * L2C) + (CSR * PHC * HC) + (CSR * PKC * KC)$
Where, ACLLHKC= Annual cost of liver, lung, heart, and kidney condemned

a) CSR=Average number of cattle slaughtered per year at the abattoir

b) PL1=Percentage of liver condemned

c) L1C=Mean cost of one liver in Setithumera town

d) PL2C=Percentage of lung condemned

e) L2C=Mean cost of one lung in Setithumera town

f) PHC=Percentage of heart condemned

g) HC=Mean cost of one heart in Setithumera town

h) PKC=Percentage of kidney condemned

i) KC=Mean cost of one kidney in Setithumera town.

The indirect economic loss from carcass weight reduction due to hydatidosis in cattle was also assessed according to the equation (Polydorou) [42]. The annual cost of carcass weight loss due to hydatidosis (ACC) was estimated by the product of the total number cattle slaughtered annually (Ns) at Setithumera, the overall prevalence hydatidosis in each species (OP), the carcass weight loss in individual animals due to hydatidosis (CWL) at this abattoir and the average market price of 1 kg carcass cattle carcass (AMP) in Setithumera town and this is represented as

$$ACC = Ns \times OP \times CWL \times AMP$$

Therefore, the economic loss from both direct and indirect loss equals the sum of the two that is: - ACLLHKC + ACC

Public health importance: The human study was conducted by collection of secondary data of human cases at Kahsay Abera General Hospital and some private and government clinics. To assess the status of human hydatidosis in the study area retrospective data from Kahsay Abera General Hospital and other clinics case books and HMIS and or DHIS was collected.

Secondary hospital and clinical book survey data: The purpose of this study was to estimate the prevalence of disease in human and identify associated risk factors. Risk factors like Patients'; sex, age and place of origin were taken in to consideration. The human study was ethically conducted as a retrospective review of human cases from 2014 to 2018 at Kahsay Abera General Hospital and other governmental and private clinics. Kahsay Abera hospital is the referral hospital in Western zone of Tigray. Diagnostic imaging (radiography and ultra sound) records for the period 2007 to 2011.E.C of diagnosed human CE cases was obtained for each of the positively diagnosed cases.

Data management and analysis: Abattoir data and Retrospective hospital and clinic data was collected and recorded on Microsoft Excel. The outcome variables for the abattoir study were cases of "Echinococcosis" detected during routine postmortem inspection at the abattoir. The STATA software version 13 program (2014) was applied for the statistical analysis of the data obtained from the study. The prevalence of hydatidosis was calculated as the number of positive observations divided by the total sample size multiplied by 100. Logistic regression was used to expressed results and compare risk factors (to determine infection rate on sex, age, and market source and body condition).

Results

Overall prevalence

Out of the total 423 heads of cattle slaughtered and examined, 28.8% were infected with hydatid cyst, harboring one or more cysts involving different visceral organs (lung, liver, heart and kidney) rib and uterus. There is statistically significant difference ($P < 0.05$) in the prevalence of hydatid cyst among animals of different body condition. The prevalence was highest in poor body condition than medium and good body conditions. Animals in poor body condition were 4 times ($OR = 4.051$) more likely to acquire the diseases than the medium and good body condition (Table 1).

Distribution, intensity and size of hydatid cysts

The study showed that lungs and livers were the most commonly affected organs by hydatid cyst. Overall, higher numbers of hydatid cysts were observed in the lungs (44.26%; 54/122) and in the liver (41.8%; 51/122) than in the other organs as shown in Table 2. During the study period cysts were collected from affected organs and differentiated into small, medium or large size cysts. The study revealed that medium (42.62% (52/122)) size cysts were with highest proportion than those with small (40.98% (50/122)) and large (13.12% (16/122)) size cysts (Table 2).

Hydatid cyst characterization

Morphological characterization of a total of 122 hydatid cysts of cattle revealed the presence of 34.43% (42/122) fertile, 36.89% (45/122) sterile and 25.4% (31/122) calcified cysts. Of the total of 43 fertile and mixed hydatid cysts tested for viability, 41.86% (18/43)

Table 1: Logistic regression analysis of risk factors with prevalence of Hydatidosis.

Risk factors	Category	No of animals examined	No of positive animals (%)	Odds Ratio	95 % CI	P- value
Sex	Male	400	115(28.7)			
	Female	23	7(30.4)	1.084	0.435,2.705	0.862
Age	Adult	166	41(24.7)			
	Old	215	70(32.6)	1.472	0.935,2.317	0.095
	Young	42	11(26.2)	1.082	0.450,2.34	0.842
Breed	Cross	20	5(25.0)			
	Begait	183	52(28.4)	1.19	0.412,3.444	0.747
	Arado	220	65(29.5)	1.258	0.439-3.605	0.669
Body condition	Good	110	18(16.4)			
	Medium	166	39(23.5)	1.57	0.845,2.917	0.154
	Poor	147	65(44.2)	4.051	2.221,7.390	0
Market Source	Highland	11	2(18.2)			
	Midland	24	5(20.8)	1.184	0.192,7.320	0.856
	Lowland	388	115(29.6)	1.896	0.403,8.910	0.418
Total		423	122(28.8)			

Table 2: Cyst size and count in relation to involved organs in cattle examined at Humera Municipality Abattoir.

Organs	Type of hydatid cysts									
	Small		Medium		Large		Mixed		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Lung	22	18.03	19	15.57	11	9.02	2	1.64	54	44.26
Liver	22	18.03	23	18.85	5	4.1	1	0.82	51	41.8
Kidney	1	0.82	2	1.64	0	0	0	0	3	2.46
Heart	2	1.64	0	0	0	0	0	0	2	1.64
Spleen	0	0	4	3.28	0	0	0	0	4	3.28
Liver and Lung	3	2.46	3	2.46	0	0	0	0	6	4.92
Lung, Liver and Heart	0	0	1	0.82	0	0	0	0	1	0.82
Lung, Liver, Rib and Uterus	0	0	0	0	0	0	1	0.82	1	0.82
Total	50	40.98	52	42.62	16	13.12	4	3.28	122	100

Mixed=Small and Medium or Medium and Large or small, medium and large.

were viable cysts as indicated in (Table 3).

From apparently healthy animals, 423 cattle were randomly selected and postmortem examination was carried out through visual inspection, palpation and incision of visceral organs during period of study, 122 (28.8%) were found infected with hydatid cysts in the abattoir, harboring one or more cysts in different visceral organs (lung, liver, kidney, heart, spleen), Rib and Uterus. The total of 122 cattle found positive, 54 (44.26%) had cysts merely in lungs, 51(41.80%) in liver, 3 (2.46%) in kidney, 2 (1.64%) in heart and 4 (3.28%) in spleen, whereas, the rest of 8 (6.56%) infections involved multiple organs. Prevalence of hydatidosis in different organs of cattle slaughtered in study area is described below (Table 4).

Financial loss assessment

In the current study, 62 lungs, 3 hearts, 59 livers, 3 kidneys and 4 spleens were condemned due to bovine hydatidosis during the study period with an economic loss of 39,777.4.312, 4968, 645,408, 9936 and 648 ETB, respectively. In the present study the total annual direct economic loss due to bovine hydatidosis was found to be 700,737.4 ETB per annum (Table 5).

The annual indirect bovine hydatidosis economic loss in the study area was estimated based on the average annual kill of cattle (3600), prevalence of Hydatidosis (28.84%), current average price of 1 kg of beef (270 ETB), dressed average carcass weight of adult Zebu cattle (126 kg) and A reduction of 5% in meat production due to hydatidosis were considered and it was found to be 1,766,046.24 ETB annually. The total annual economic loss due to bovine hydatidosis in Setit Humera municipal abattoir was then calculated as the summation of

the direct annual economic losses due to organ condemnation and indirect annual economic losses from carcass weight loss and was found to be 2,466,783.64ETB per annum (Tables 6 and 7).

Retrospective hospital and clinical case-book survey

From the total of 525,148 patients subjected to ultrasound examination, 7 (0.00134%) human cystic echinococcosis cases were registered between September, 2014 and December, 2018. This represents a point prevalence of 1.34 cases per 100,000 humans. Among these 4 were from Kahsay Abera General Hospital, 2 from Welkayit clinic, and 1 from Selam Surgical Specialty clinic. Accordingly, Welkayit clinic had the highest rate for hydatidosis cases 0. 00879% (n=22736) (Table 8).

Prevalence of human cystic echinococcosis at kahsayabera general hospital, welkayit clinic and selam clinic by sex.

Seventy-one percent (71) of the cases diagnosed were females and 29% (2/7) male (Figure 3). The records were showing that the main clinical symptom observed in all the cases was ascites. Other clinical signs included jaundice, chronic cough and abdominal pain. Prevalence of human cystic echinococcosis at kahsayabera general hospital, welkayit clinic and selam surgical specialty clinic by age.

The age range for positive human CE observed at Kahsay Hospital and the clinics was 16 to 75 years with a mean of 52 years. A total of 7 cases out of 525148 were recorded. All the cases were found in the liver. Six of the cases were adults (age range: 48-75 years) whereas the other case involves a 16-year-old female (Table 9).

Discussion

Table 3: Cyst fertility and viability test in different organs slaughtered in study area.

Examined organ	No of cysts examined	Fertility test				Viability test		
		Fertile (%)	Sterile (%)	Calcified (%)	Mixed (%)	Viable (%)	Nonviable (%)	Mixed (%)
Lung	54	21(38.89)	20(37.04)	12(22.23)	1(1.85)	10(45.45)	9(40.9)	2(9.09)
Liver	51	15(29.41)	20(39.22)	16(31.38)	0(0.0)	6(40.0)	6(40)	3(20)
Kidney	3	1(33.34)	1(33.34)	1(33.34)	0(0.0)	0(0.0)	1(100)	0(0.0)
Heart	2	0(0.00)	1(50)	1(50)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Spleen	4	3(75)	1(25)	0(0.0)	0(0.0)	1(33.34)	2(66.67)	0(0.0)
Liver and Lung	6	1(16.67)	1(16.67)	1(16.67)	3(50)	1(25.0)	0(0.0)	1(25)
Lung, Liver and Heart	1	0(0.00)	1(100)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Lung, Liver Rib and Uterus	1	1(100)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(100)
Total	122	42(34.43)	45(36.89)	31(25.40)	4(3.28)	18(41.86)	18(41.86)	7(16.28)

Mixed=Calcified and Sterile or Sterile and Fertile

Table 4: Prevalence of hydatidosis in different organs of cattle slaughtered in study area.

Organs infected	No examined	No positive	Prevalence	Proportion (%)
Lung	423	54	12.8	44.26
Liver	423	51	12.1	41.8
Kidney	423	3	0.7	2.46
Heart	423	2	0.5	1.64
Spleen	423	4	0.9	3.28
Liver and Lung	423	6	1.4	4.92
Lung, Liver and Heart	423	1	0.2	0.82
Lung, Liver Rib and Uterus	423	1	0.2	0.82
Total	423	122	28.8	100

Table 5: Number of slaughtered ruminant and organs condemned at Humera Municipal abattoir.

Species of animals	No. of slaughtered animals annually	Condemned organs due to hydatid cyst									
		Lung		liver		Kidney		Heart		Spleen	
		No.	%	No.	%	No.	%	No.	%	No.	%
Cattle	3600	120	3.34	136	3.78	16	0.45	24	0.67	20	0.56

Table 6: Average Cost and Weight of Carcass and Offals at humera town.

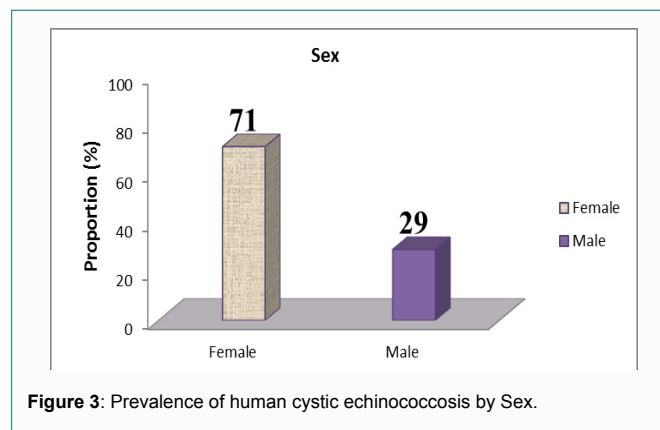
Offals/Carcass	Cost per kg
Mean cost of one liver	3.32kg*120=398.4
Average price of one kg carcass	270
Mean cost of kidney	0.5+0.5*120=120
Mean cost of one heart	0.5Kg*120=60
Mean cost of one lung	2.92kg*8=23.36
Mean cost of one spleen	2kg*3=6

Table 7: Direct economic loss due to organ condemnation as a result of bovine hydatidosis during the study period.

Organ examined	Number % of organs condemned	Average unit price (birr)	Average annual kill of bovines	Total price (birr)
Lung	62(47.3)	23.36	3600	39,777.40
Heart	3(2.3)	60	3600	4968
Liver	59(45.0)	398.4	3600	645,408
Kidney	3(2.3)	120	3600	9936
Spleen	4(3.0)	6	3600	648
Total	131(100)			700,737.40

In the present study the prevalence of bovine hydatidosis at Setit Humera Municipal abattoir was found to be 28.84% which is comparable with the results found 28.09% at Mekelle municipal abattoir [25], 28.6% at Debre Birhan Municipal Abattoir [42] and 30.7% at Jimma municipal abattoir [43].

The present study was much higher compared to the prevalence of 6.51% at Debre Berhan Municipal reported by [44] and is higher than the 25.92% prevalence studied by [26] in Shire municipal abattoir but, it is lower than the reports in cattle slaughtered at Asella which is

**Figure 3:** Prevalence of human cystic echinococcosis by Sex.

63.7% reported by [24] and at Hawasa municipal abattoir 52% which is reported by [45]. This variation in prevalence of cystic echinococcosis among cattle of different areas in Ethiopia could be attributed to factors including differences in agro ecology, difference in sample size, age of slaughtered animals, the times at which studies took place, stocking rates and movements of animals, animal husbandry systems, awareness, culture and religion of the society, and attitude to dogs in different regions of the Country [28,11,46,47].

In the present study, assessments of Echinococcosis infection were made to establish relationship between ages, body condition, sex, market source and breed of the affected animals (Table 10). The study indicated that there was statistically significant difference in infection rates among different body condition ($p < 0.05$). Animals in poor body condition were 4 times ($OR = 4.051$) more likely to acquire the diseases than the medium and good body condition. This might be due to the fact that animals with poor body condition have low immunity to combat against the disease and poor body condition is probably a reflection of the effect of relatively high cyst burden. However, this finding disagrees with other findings who reported existence of no statistically significant difference in Echinococcal infection between the different body conditions of affected animals [45].

Attempts made to assess the relation between the infection rate and sex of the animals. The result revealed that no statistically significant association exists between sex and occurrence of the disease this agrees with the finding of [48]. This may be due to indiscriminate exposure to risk irrespective of sex in the management of the study area. In reverse, it disagrees with the research findings of [49] who reported as the disease had occurred more in females than males. The explanation behind this was female animals are not slaughtered in younger ages as long as they are fertile. Female animals are sent to abattoir after milking and getting calves for years.

Table 8: Prevalence of *Echinococcus* cases in the public hospital and private clinics in Setit Humera town (September 2014-December 2018).

Year		No. of patients admitted					Sub total		
		Kahsay Abera General Hospital		Welkayit Medium Clinic		Selam Surgical Specialty Clinic			
		Admitted	Case (%)	Admitted	Case (%)	Admitted			Case (%)
2014	92303	1 (0.0010)	3740	0(0)	3242	0(0)	99285	1(0.00100)	
2015	90550	1 (0.0011)	3975	0(0)	1981	0(0)	96506	1(0.00103)	
2016	103684	1 (0.0009)	4005	1(0.0249)	2848	0(0)	110537	2(0.00180)	
2017	85201	0 (0)	4253	1(0.0235)	3268	0(0)	92722	1(0.00107)	
2018	116337	1 (0.0008)	6763	0(0)	2998	1(0.00033)	126098	2(0.00158)	
Grand total	488075	4(0.00081)	22736	2(0.00879)	14337	1(0.00697)	525148	7(0.001332)	

Table 9: Cases of Human Hydatidosis at Kahsay Abera General Hospital, Welkayit clinic and Selam Surgical Specialty clinic by age, sex and place of origin (2014-2018).

Hospital or Clinic Name	Sex	Age	Address/kebele	Year
Kahsay Abera General Hospital	F	16	Maykadra	2014
Kahsay Abera General Hospital	M	52	-	2015
Kahsay Abera General Hospital	F	65	-	2016
Welkayit Clinic	F	48	Dansha	2017
Welkayit Clinic	F	60	Humera	2018
Kahsay Abera General Hospital	F	48	Adiremets	2018
SelamSurgicaSpecialty clinic	M	75	Humera	2018

Key: -'-data not available

Statistical analysis was also made to establish relationship between market source of animals and prevalence of the disease and it was not significantly related ($P>0.05$), and is in agreement with [50]. This may be due to difficulty in getting exact origin of the animals and exchanging of the animals in local markets. But this finding contradicts with other reports, who reported that there is significant correlation between bovine hydatidosis and animal origin that could be attributed to difference in social activity, attitudes to dogs, and climatic conditions in different regions [51].

In the study, the absence of significant variation in the prevalence of Hydatid cysts in cattle of various breeds, ages, agro ecologies and production systems most probably suggests that cystic echinococcosis

is widely distributed with high adaptability to different environments, breeds of cattle and production systems due to the presence of high population of freely scavenging stray dogs as well as wild canids in close association with the family and farm animals in all agro ecological zones in Ethiopia as has been suggested before [50]. In support to this idea, in this study there was no significant association between breed and age of animals and the infection rate of Hydatid cyst.

It is well known that among the organs involved, lungs and livers are the most commonly infected organs by hydatid cysts due to the reason that lungs and livers possess the first large capillary sites encountered by the migratory *Echinococcus* Onchosphers (Hexacanth embryo) (Figure 4A-F).

A finding of the present study is also in line with the above reason although more incidence rate of hydatid infection was noticed in lungs and livers of the examined animals. The findings of highest prevalence and largest number of hydatid cysts in the lungs than all the other organs followed by livers in our study are in agreement with several reports. Similar results were obtained by various workers [45-47].

In the present study, the lung and liver (44.26% and 41.80%) were the most commonly infected organs. The spleen, kidney and heart (3.28%, 2.46% and 1.64%) were the least affected organs in the

Table 10: Determining the Age of Cattle by the Teeth.

Age	Features
At birth to one month	Two or more of the temporary incisor teeth present. Within first month, entire 8 temporary incisors appear.
2 years	As a long-yearling, the central pair of temporary incisor teeth or pinchers is replaced by the permanent pinchers. At 2 years, the central permanent incisors attain full development.
2-1/2 years	Permanent first intermediates, one in each side of the pinchers, are cut. Usually these are fully developed at 3 years.
3-1/2 years	The second intermediates or laterals are cut. They are on a level with the first intermediates and begin to wear at 4 years.
4-1/2 years	The corner teeth are replaced. At 5 years the animal usually has the full complement of incisors with the corners fully developed.
5 to 6 years	The permanent pinchers are leveled, both pairs of pinchers are partially leveled, the corner incisors show wear.
7 to 10 years	At 7 or 8 years the pinchers show noticeable wear; at 8 or 9 years the middle pairs show noticeable wear; and at 10 years, the corner teeth show noticeable wear.
12 years	After the animal passed the 6th year, the arch gradually loses its rounded contour and becomes nearly straight by the 12th year. In the meantime, the teeth gradually become triangular in shape, distinctly separated, and show progressive wearing to stubs

Source: (Johnson, 1999) [57].

Table 11: Description of Body condition scores in Zebu Cattle.

Score	Condition	Features
1	Emaciated L -	Marked emaciation (animal would be condemned at ante mortem examination).
2	Very thin L	Transverse processes project prominently, neural spines appear sharply.
3	Thin L +	Individual dorsal spines are pointed to the touch; hips, pins, tail-head and ribs are prominent. Transverse processes visible, usually individually.
4	Boarderline M -	Ribs, hips and pins clearly visible. Muscle mass between hooks and pins slightly concave. Slightly more flesh above the transverse processes than in L +.
5	Boarderline M	Ribs usually visible, little fat cover, dorsal spines barely visible.
6	Good M +	Animal smooth and well covered; dorsal spines cannot be seen, but are easily felt.
7	Very good F -	Animal smooth and well covered, but fat deposits are not marked. Dorsal spines can be felt with firm pressure, but feel rounded rather than sharp.
8	Fat F	Fat cover in critical areas can be easily seen and felt; transverse processes cannot be seen or felt
9	Very fat F+	Heavy deposits of fat clearly visible on tail-head, brisket and cod; dorsal spines, ribs, hooks and pins fully covered and cannot be felt even with firm pressure.

Source: (Nicholson and Butterworth, 1986) [36].

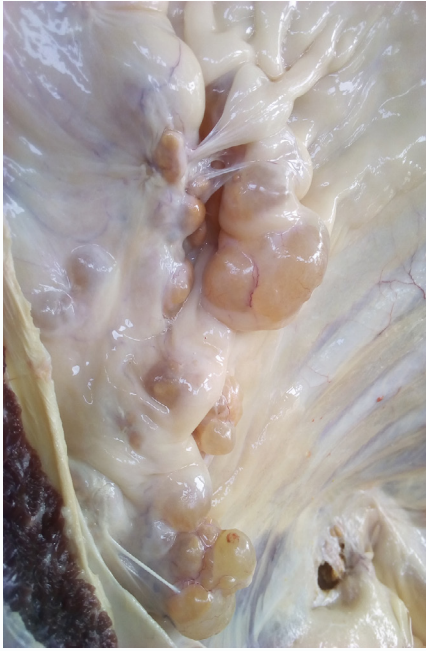


Figure 4A: Important Pictures of the Study. A) Hydatid Cyst in the Ribs of Cattle.



Figure 4C: Hydatid Cyst in the Lung.



Figure 4B: Post mortem Examination.

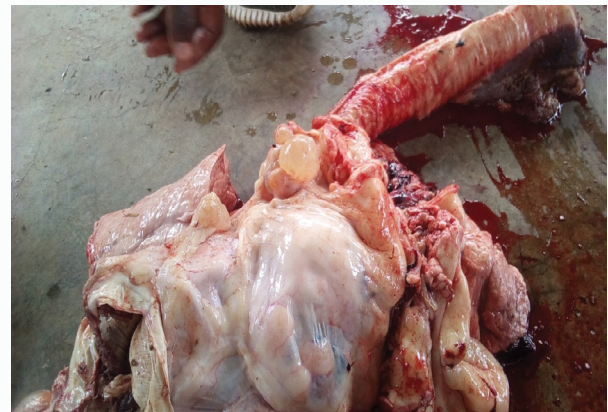


Figure 4D: Hydatid Cyst in the Lung.

study animal. This might be mainly due to the lung and liver possess first great capillaries encountered by the migrating *Echinococcus* oncosphere (hexacanth embryo), which adopt the portal vein route and primarily negotiate hepatic and pulmonary filtering system sequentially before any other peripheral organ is involved [52]. From the organ prevalence study, the lung was found to be the most commonly affected organ followed by liver may be due to the presence of greater capillary beds in the lungs than other organs [27] (Table 11).

Our overall finding indicated that 36.89%, 34.43%, 25.4% of hydatid cysts were sterile, fertile and calcified cysts. This finding

supports previous arguments by several investigators in Ethiopia that assume sheep to have a greater fertile cysts and role than cattle as an intermediate host of cystic echinococcosis [53,54]. However, the findings in the present study of a high overall prevalence (in 28.8% of cattle) and high fertility (34.43%) of hydatid cysts, in line with previous findings, [11,27] imply that cattle are still important as a potential source of infection to dogs and other definitive hosts of this parasite.

From the total 122 hydatid cysts examined in this study, 22 (18.03%) were small, 19 (15.57%) medium and 11 (9.02%) large. The higher proportion of medium and small cysts is indicative of immunological response of the hosts that reduced the expansion of cyst size. This study also showed that higher numbers of medium to large cysts were formed on the lung. The reason for high percentage of medium and large cysts in the lung might be due to softer consistency of the lung that allows easier development and expansion of the cyst. Small cysts were found to be more calcified than medium and large cysts which can be due to the host defense mechanism dealing with



Figure 4E: Embedded Cystic echinococcus on the Liver.



Figure 4F: Location of the Slaughter House nearby the Tekeze River.

parasite more efficiently at the early larvae stage of development [55]. However, the developing and fully developed metacystode are said to be able to escape anti-oncosphere immunity [56].

In the human hydatidosis survey, the positive proportion of human hydatidosis was found to be low at 1.34 cases per 100,000 (7/525148) of those who admitted for examination at Kahsay Abera General Hospital, Welkayit clinic and Selam Surgical specialty clinic in the study period. Due to under diagnosis and under reporting of the disease, only a few cases were reported and therefore the reported disease estimate may not indicate the true situation. Even this data was collected by a systematic approach like by collecting case book data and communicating with the medical specialists, unless this cannot be gained from the HMIS and DHIS data recording system, the disease is simply treated under helmenthiasis. Some of the health institutions also don't possess the required examination tools like an ultrasound. The recording of 7 cases indicated that CE poses a public health problem in the study area. Studies in different parts of Ethiopia like 0.044% in Bahirdar [29] and have shown higher prevalence. Other community- based surveys were also conducted in Southern Ethiopia in 1987 and 1996, 1.6% (n=1997) and 0.5% (n=3224) were respectively screened with ultrasound [56,57]. These differences in prevalence could be due to difference in sample size, availability of

diagnostic modalities and knowledge of medical experts towards cystic *Echinococcus*.

The current finding showed that CE has a zoonotic importance. This may be because of the low public awareness, backyard slaughtering practices, poor control measures and presence of a large number of stray dogs that contributed to human infection. The study area is lacking modern diagnostic facilities, and there is inability to offer treatment by the most vulnerable sections of the society. In the study area there is a good habit of consuming vegetables and this can facilitate the disease transmission. However, despite such limitations, careful examination of hospital/clinic records provided a useful indication of infection rates.

In the current study, an assessment was done on annual economic loss due to bovine hydatidosis at Setit Humera municipal abattoir. Losses from organ condemnation and carcass weight loss in infected cattle were assessed and estimated at 2,466,783.64ETB (82,226.12 US\$).

The current estimate is greater than estimates done by [26] (366,639.95 ETB) in Shire Muncpal abattoir. However, it is lower than 3,730,328 ETB that estimated by [42] in Debre Berhan municipal abattoir. The difference in economic loss estimates in various abattoir or regions may be due to the variations in the prevalence of disease, mean annual number of cattle slaughtered in different abattoirs, and variation in the retail market price of organs. Considering the current result, hydatidosis is an important disease of cattle in Setit Humera and its surroundings, causing substantial visible and invisible losses if we take into account the local economic environment. It causes considerable economic loss in livestock due to condemnation of organs and denied weight gain of infected stocks. Losses like reduction in Milk production were not considered hence, it could mean that the actual economic loss due to CE is higher than what is recorded during meat inspection. In addition, Back-yard slaughters are quiet rampart in the communities and this could mean that the actual economic loss due to CE is higher than what is recorded during meat inspection.

Conclusion and Recommendations

Echinococcosis or hydatidosis is a disease of considerable importance from both public and economic importance point of view. The present study has shown that bovine hydatidosis is a major cause of organ condemnation at Humera Municipality abattoir. This is relatively higher prevalence of hydatidosis and the associated economic losses calls for serious attention.

Therefore; based on the above conclusion the following recommendations are forwarded:

- Stray dogs should be eliminated from pastures and places of slaughter house
- Regular deworming of dogs in the area to reduce environmental contamination by the parasite eggs.
- Proper and strict disposal of rejected/condemned organs due to hydatidosis to restrict dogs accessing them.
- Fencing off abattoirs to restrict access by dogs.
- Backyard slaughtering of animal should be prohibited through designing and reinforcing of legislations, construction of the slaughter house which fulfill the necessary facilities
- Proper meat inspection services should be implemented.

- Continuous education should be given to butchers, abattoir workers, meat sellers and dog owners as to the danger of the hydatid cyst to humans and animals.
- Veterinarians and public health experts should work together to control zoonoses
- Public should be aware about the route of infection, to maintain personal hygiene, especially to wash hands after handling dogs and their feces.
- Increase public education and awareness on parasitic zoonoses and the risks associated with consuming un-inspected meat
- Traceability study on the origin of the parasite could be important as the source can also be from wild carnivores like fox in addition to dog.
- Further study on molecular Genetic characterization of *Echinococcus* isolates from various intermediate hosts is needed

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Authors Contribution

ZN; Conceptualization, investigation, designed the methodology, performed laboratory analysis, did statistical analysis, wrote original draft. EnK: designed methodology, reviewed and edited final draft, and Et K: Participated in conceptualization, methodology and edited final draft. All authors participated in its critical review and edited the manuscript. All authors read and approved the final version of the manuscript.

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Availability of Data and Material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethical Approval and Consent to Participate

The study was approved by the Institutional Review Board of the College of veterinary Sciences, Mekelle University. Written informed consent was obtained from all study participants.

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