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Bovine Hydatidosis: Prevalence, Associated Risk Factors and Economic Burden in Nekemte Municipal Abattoir, East Wollega Zone, Oromia, Ethiopia

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Abstract: Hydatidosis (*Cystic echinococcosis*) is a zoonotic parasitic infection of many mammalian species caused by the larval stage of *E. granulosus*. It is one of the most important parasitic diseases of livestock that has both economic and public health significance. Hence this research was designed to assess the prevalence, associated risk factors and economic burden due to the disease in Nekemte municipal abattoir. A cross-sectional study was employed between the period of May to August 2020. Out of the total 355 cattle examined, 99 (27.89%) (95% CI: 23.28-32.86) were found positive to hydatid cysts. A significant higher infection rate was observed in older cattle 89(29.47%) (95% CI: 24.39-34.96) than young 10(18.87%) (95% CI: 9.44-31.97) ($P \leq 0.05$). Of the total 99 detected infection, 41 (11.55%) (95% CI: 8.42-15.34) involved lungs and 24 (6.76%) (95% CI: 4.38-9.89) were detected in liver but the rest 34 (9.58%) (95% CI: 6.72-13.12) had multiple organ infections. Considering the economic burden, the total annual economic loss from organ condemnation and carcass weight loss due to bovine hydatidosis at Nekemte, Municipal Abattoir was estimated at 183, 620.65 US$. From this study, it can be concluded that hydatidosis is an important disease of cattle in the study area, causing substantial visible and invisible losses resulting in considerable economic loss in livestock due to condemnation of organs and denied weight gain of infected livestock. So control and prevention is extremely important.

Key words: Bovine Hydatidosis · Condemnation · Economic Burden · Nekemte · Prevalence

INTRODUCTION

The world human population is growing at a rate much faster than food production and this increase is mainly in developing countries, which are unable to assure adequate food for their people. Developing countries have nearly 2/3 of the world's livestock population, but produce less than a third of the world's meat and a fifth of its milk [1]. Similarly, in spite of large livestock population in Ethiopia, the productivity remains marginal due to malnutrition, prevalent diseases and management problems.

Cystic echinococcosis (CE) is a zoonotic parasitic infection of many mammalian species caused by the larval stage of *E. granulosus* [2]. The definitive hosts of the parasite, *E. granulosus*, are dogs which harbor the adult parasites and excrete the parasite eggs along with their feces, while livestock and human are the intermediate hosts [3]. Hydatid disease is characterized by cyst containing numerous tiny protoscolices that most often develop in the liver and lungs and also develop in the kidneys, spleen, nervous tissue, bone and other organs [4]. The disease is characterized by the formation of large fluid field cyst in the internal organs of the intermediate host. The parasites are found worldwide and cause serious public health problem in certain parts of the world. In addition, hydatidosis is the major causes of organ condemnation and huge economic losses [5].

Hydatidosis is one of the most important parasitic diseases of livestock that has both economic and public health significance. The disease occurs throughout the world and causes considerable economic losses and public health problems in many countries. It is associated with severe morbidity and economic loses and it is one of

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the world's most geographically widespread zoonotic diseases. The pathogenesis of hydatidosis heavily depends on the extent and severity of the infection and the organ on which it is situated. The occasional rupture of hydrated cysts often leads to sudden death due to anaphylaxis, hemorrhage and metastasis. Previous studies have shown that CE represented a considerable economic and public health significance in different countries [6]. Hydatidosis causes decreased livestock production and condemnation of offal containing hydatid cysts in slaughterhouses. Despite the large efforts that have been put into the research and control of CE, it still remains a disease of worldwide significance. In some areas of the world, Cystic Echinococcosis caused by *E. granulosus*isa re-emerging disease in places where it was previously at low levels [7].

Morphologically adult Echinococcus only a few millimeters long (rarely more than 10 mm) and usually has no more than six segments. Anteriorly, an adult Echinococcus possesses a specialized attachment organ. The scolex that has four muscular suckers and two rows of hooks, one large and one small; on the rostellum, the body or strobila is segmented and consists of reproductive units (Proglotids), which may vary in number from two to six [8]. In the intermediate host, *E. granulosus* diagnosis depends on the detection of the larval cyst form, which can occur in almost any organ, but particularly in the liver and lungs. The diagnostic repertoire includes imaging techniques, mainly ultrasound (US) and computed tomography (CT) examination for abdominal echinococcosis, X-ray for lung echinococcosis and immunodiagnostic tests [9]. The diagnosis of echinococcosis in dogs or other carnivores requires the demonstration of the adult cestodes of *Echinococcus* spp. in their feces or the small intestine or the detection of specific Copro Antigens or Copro DNA [10].

Echinococcosis in both humans and animals has an economic importance in many parts of the world. For example, in the North African countries, the cost to human health treatment and animal losses was estimated at US$ 60 million per year [11, 12]. In Jordan alone, a more recent estimate was reported at an equivalent of US$ 20 million [13]. Hydatidosis in animals is equally an economic problem and results in growth delays; the qualitative and quantitative production loss of meat, milk, wool; the fall in fertility as well as the seizures of viscera (offal) during meat inspection [14, 15]. In Uruguay, the annual losses were estimated at US$ 6.2 million from the organs seizure and the loss of livestock productions [14].

In Queensland Australia, hydatid disease was thought to cost the meat industry, conservatively about U$2.7 million annually through loss of offal sale [16]. The economic importance of echinococcosis in livestock is due to the condemnation of the whole edible carcasses and offal such as liver, lung and heart [14]. In severe infection, the parasite may cause retarded performance and growth and reduced quality and yield of meat and milk [17]. For instance, in Yugoslavia, a 10% reduction in milk yield and 5% in carcass weight due to hydatidosis has been described [15]. Even though the disease is prevalent in Ethiopia, there are fewer studies which do not comply with its importance. Therefore, this research was conducted with the objectives of determining the prevalence and associated risk factors as well as economic importance of hydatidosis due to organ condemnation and carcass weight loss in Nekemte municipal abattoir.

MATERIALS AND METHODS

Study Area: This study was conducted in Nekemte town at Nekemte Municipal Abattoir which is found at the Western part of the country in Oromia regional state. The town is located at about 352 km west of Finfinne (Addis Ababa), the capital city of Oromia and Ethiopia. The town is geographically located between 09°03’957’’-09°06’593’’N latitude and 36°32’928’’ -36°43'206" Elongitude (Fig. 1). The area has an altitude ranging between 2100 to 2250 meter above sea level. The annual rainfall is ranging between 1500 to 2200 mm with a minimum and maximum annual temperature of 20°C to25°C respectively. The area has livestock population of 74574 of cattle; 11110 sheep; 1007 goats; 5074 equines and 36186 heads of chickens [18]. Slaughtered animals came to Nekemte Municipal Abattoir from different marketing areas of East Wollega Zone. The livestock production is characterized by extensive production system in which indigenous cattle are kept under traditional management system. The study was conducted between the periods of May to August 2020.

Study Design and Study Animals: A cross sectional study design was carried out to assess the prevalence and economic significance of hydatid cyst in slaughtered cattle at Nekemte Municipal Abattoir. For this study, a total of 355 indigenous Zebu cattle slaughtered during the study period were included.

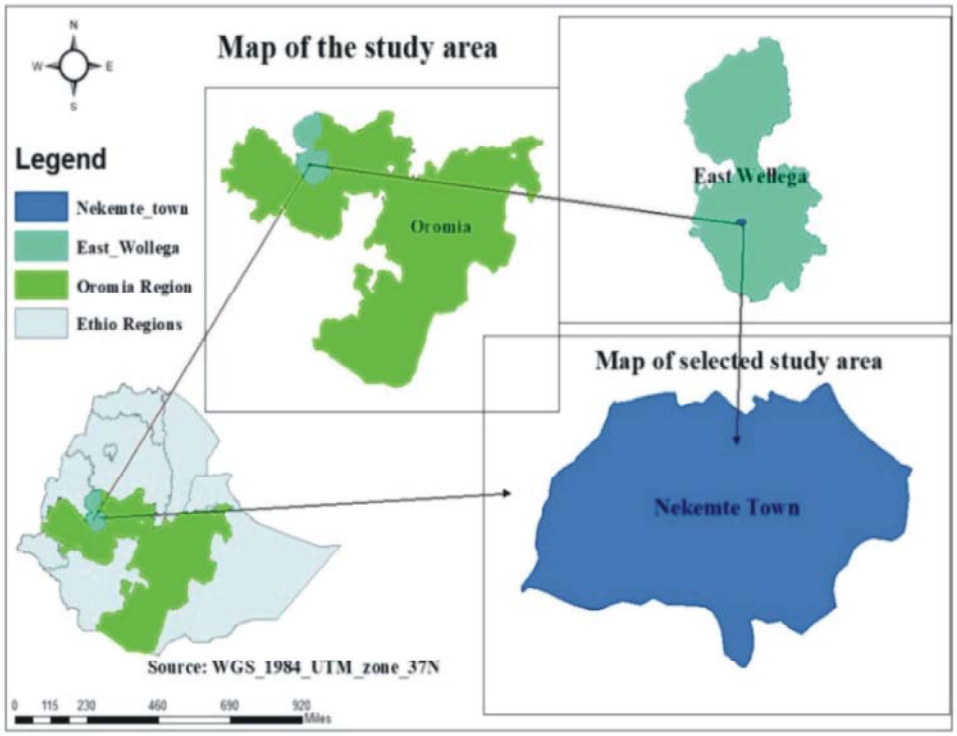

Fig. 1: Map of the study area

Sample Size Determination: The sample size was calculated according to Thrustfield [19] by considering a prevalence of 36.3% reported by Abera [20] as expected prevalence and 5% standard error at 95% confidence interval.

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

where,

N = required sample size,
Pexp = Expected prevalence (36.3%),
D = Desired absolute precision. Accordingly, 355 cattle were sampled.

Data Collection: Regular visits (two days per week) were made to conduct ante and post mortem examination of slaughtered cattle. During ante mortem examination age and body condition of each animal was recorded. The age of the animals was determined on the basis of the dentitions as described by Kelly [21] and two age groups were considered; below and above five years. It was difficult to precisely indicate the geographical origin of all animals slaughtered at the abattoir and relate the findings on hydatidosis to a particular locality. The body condition scoring was done according to Nicholson and Butterworth [22] and classified in to three categories as poor, medium and good. Since almost all the cattle presented to slaughtering in the study area were male and local breed, infection prevalence regarding sex and breed variation were not included. All the animals were identified on the basis of enumerated marks on their body surface using ink and this marking was transferred to all visceral organs during postmortem inspection. During post mortem examination, each visceral organ particularly the liver and lung were systematically inspected by visual inspection, palpation and incisions for the presence of hydatid cyst [23] and total numbers of hydatid cysts were collected and counted per infected organs.

Economic Analysis: To determine the economic losses due to hydatidosis in cattle, both direct and indirect losses were considered. The calculation of the direct losses is based on condemned organs (lung and liver, the indirect losses were assessed on the basis of live weight reduction due to hydatidosis. In calculating cost of condemned edible organs and carcass weight loss, four different meat sellers were selected randomly to establish the price per unit organ and the collective price of lung

and liver was determined. Average price was drawn out from that data and this price index was later used to calculate the meat loss in terms of Ethiopian birr (ETB). A 5% estimated carcass weight loss due to bovine hydatidosis described by Endrias [24] was taken into account to determine the carcass weight loss. Average carcass weight of an Ethiopian zebu was taken as 126 kg, as estimated by International Livestock Center for Africa. The ability of foreign currency exchange of Ethiopian birr during the study period was 1ETB = 0.046 US$.

Direct Loss from Organ Condemnation:
Annual economic loss= (PI1*Tk*C1) + (PI2*Tk*C2)).

where
PI1 = Percent involvement of lung out of the total examined
PI2 = Percent involvement of liver out of the total examined
C1 = Average market price of lung
C2 = Average market price of liver
TK = Average of annual slaughtered cattle

Indirect Loss from Carcass Weight Loss:
Annual economic losses due to carcass weight loss=Ns*Ci* Pa [24].

where Ns=Total number of animals slaughtered and positive for hydatidosis; Ci=Carcass weight lost in individual animals; Pa=Average market price of a kg of beef in Nekemte town. Annual economic losses were calculated by adding both direct and indirect losses.

Statistical Analysis: Collected data were coded and stored in to Microsoft excel spread sheet and analyzed by using SPSS version 20. The prevalence was calculated as the number of positive samples divided by the total number of examined samples. Chi-square (χ^2) test was used to evaluate the association of different host related factors such as age and body condition of cattle. 95% CI was taken and P-value $\leq$ 0.05 was considered as significant.

RESULTS

Evaluation of Prevalence and Risk Factors of Bovine Hydatidosis: In the current study, out of 355 heads of cattle slaughtered and examined, 99 (27.89%) were found to be infected with hydatid cyst in either of the examined visceral organs (lung, liver and/or both liver and lung at the same time). Based on the origin of animals, highest prevalence (40.74%) was observed in Arjo Gudatu and Sasiga. The difference in prevalence rate among the origin of animals was statistically not significant (Table 1).

Based on the age group, highest prevalence (29.47%) was observed in adult age category. Age prevalence has shown a statistically significant variation (P<0.001) (Table 2).

Prevalence was also assessed in terms of body condition score and found highest prevalence (41.89%) poor body condition. The difference in prevalence rate among the body condition scores was statistically insignificant (p=0.446) (Table 3).

Distribution of Hydatid Cyst in Different Organs: Out of the 99 cattle positive, 41 (11.55%) had cysts merely in lungs, 24 (6.76%) in liver, whereas, the rest of 34 (9.58%) infections involved multiple organs (Table 4).

Estimation of Economic Loss

Loss Due to Organ Condemnation (Direct Economic Loss)

Direct Loss: In this study, a total of 75 lungs (74.76%) and 58livers (59.59%) were totally condemned due to the presence of hydatid cysts (Table 5). The mean unit price of these organs in Nekemte town during the study period was 35 ETB for lung and 55 ETB for liver, while the mean price of 1 kg beef is 180 ETB. Mean number of animals slaughtered annually at the municipal abattoir was determined from the records of the last 1 year and it was 12, 000. Then, the annual economic loss due to organ condemnation was estimated as follows:

Carcass Weight Loss (Indirect Economic Loss)
IACW = CSR*CL*BC*Prevalence

where:
IACW = Indirect annual carcass weight loss
CRS = Average number of cattle slaughtered per year at Nekemte municipal abattoir.
CL = Carcass weight loss in individual cattle due to Hydatidosis
BC = Average price of 1 kg beef in Nekemte town
Prev = Prevalence of hydatid cysts at Nekemte municipal abattoir

IACW = CSR*CL*BC*Prevalence
IACW = 12, 000*(126*5%)*180*27.89%
= 12000*(126*0.05)*180*0.2789
= 12000*6.3*180*0.2789
= 3, 795, 271.2 ETB.

Table 1: Prevalence bovine hydatidosis across origin of animals

Origin	No. of examined	No. Positive	Prevalence (%)	95% CI	P-value
Bako Tibe	41	16	39.02	24.20-55.50	0.054
Arjo Gudatu	81	33	40.74	29.95-52.23	
Diga	80	29	36.25	25.79-47.76	
Sibu Sire	75	11	14.67	7.56-24.73	
Nekemte	78	10	12.82	6.32-22.32	
Sasiga	81	33	40.74	29.95-52.23	
Total	355	99	27.89	23.28-32.86	

Table 2: Prevalence of hydatidosis in different age groups

Risk factors	No. of examined	No. Positive	Prevalence (%)	95% CI	P-value
Young	53	10	18.87	9.44-31.97	<0.001
Adult	302	89	29.47	24.39-34.96	
Total	355	99	27.89	23.28-32.86	

Table 3: Prevalence of Hydatidosis in Cattle Slaughtered based on their body condition

Body condition	Animals examined	Infected	Prevalence (%)	95% CI	P-value
Poor	74	31	41.89	30.51-53.93	0.446
Medium	162	39	24.07	17.71-31.41	
Good	119	29	24.37	16.97-33.09	
Total	355	99	27.89	23.28-32.86	

Table 4: Distribution of hydatid cysts in different organs of positive cattle

Organs infected	Animals	No. of cases	Prevalence (%)	95% CI	P-value
Lung only	355	41	11.55	8.42-15.34	0.003
Liver only	355	24	6.76	4.38-9.89	
Lung and liver	355	34	9.58	6.72-13.12	
Total	355	99	27.89	23.28-32.86	

Table 5: Distribution of hydrated cysts in different organs and Proportion of organs involved in the study animals

Organs Examined	Organ Affected	From infected animals	From total examined animals	Proportion
Liver	355	58	59.59	16.33
Lung	355	75	74.76	21.12
Total	355	133		27.89

Annual economic loss due to organ condemnation = (PI1*Tk*C1) + (PI2*Tk*C2)

Direct Loss= (0.2112*12, 000*35) + (0.1633*12, 000*55)

=88, 704 ETB+107, 778ETB=196, 482ETB.

Therefore, annual economic losses in Nekemte Municipal Abattoir = Annual economic losses due to organ condemnation + Annual economic losses due to carcass weight loss.

Annual economic losses= 196, 482ETB+3, 795, 271.2ETB=3, 991, 753.2ETB or 183, 620.65US$ (currency during the study period=1 ETB=0.046).Hence, the total loss from organ condemnation and meat production loss in cattle slaughtered at Nekemte municipal abattoir is estimated at 3, 991, 753.2 ETB or 183, 620.65US$.

DISCUSSION

The current study revealed that the overall prevalence of hydatid cyst was 27.89% (95% CI: 23.28-32.86) (Table 1). This result is similar with previous work of Yetnayet [25] who reported a prevalence of 27.2% from Gondar town. Nevertheless, it is higher than the reports of Tsehaye [26] in Debre Birhan (7.2%), Kebede *et al*. [27] in Tigray region (22.1%) as well as Azlaf and Dakkak [28] in Morocco (22.9%) from other African countries.

On the other hand, the current finding is lower than the reports of Abera [20] and Tolosa *et al.* [29] in Jimma abattoir, who reported prevalence of 36.3% and 31.15% respectively. The present report is also lower than the reports of Endrias *et al.* [24] from Ambo (48.9% in cattle), Nigatu *et al.* [30] from Bahir Dar (46.8% in cattle) and Regassa *et al.* [2] from Hawassa (52.69% in cattle). Furthermore, the current prevalence is significantly lower than the finding of Kebede [31] who reported a prevalence of hydatidosis to be 79.5% in Gondar, Injibara and Finote Selam municipal abattoirs. Factors like difference in

culture, social activity, animal husbandry systems, lack of proper removal of infectious carcass, attitude to dogs in different regions and the difference in strains of *E. granulosus* that exist in different geographical situations might have contributed to the variation in prevalence in the different areas of the country [32].

In the present study, a significant variation was observed in the rates of infections between age groups where animals above 5 years of age were highly infected (Table 2). This is in agreement with the findings of Azlaf and Dakkak [28] and Regassa *et al*. [2]. This could be mainly due to the fact that aged animals have longer exposure time to eggs of *E. granulosus* weaker immunity to combat against the infection [33]. In addition, most of the slaughtered animals were culled animals due to lower productivity and hence were exposed to the diseases (parasitic ova) over long period with an increased possibility of acquiring the infections.

The prevalence of hydatidosis was slightly higher in cattle having poor body condition, 41.89% (95% CI: 30.51-53.93) followed by medium body condition (24.07%) (95% CI: 17.71-31.41) and Good (21.00%)(95% CI: 16.97-33.09) but did not show statistically significant association (Table 3). Polydrous [24] explained that in moderate to severe infections, the parasite may cause retarded performance and growth, reduced quality of meat and milk, as well as live weight loss.

In this study, it has been shown that hydatid cysts occurred most commonly in the lungs (11.55%) (95% CI: 8.42-15.34) followed by liver (6.76%)(95% CI: 4.38-9.89)(Table 4).Similar findings were reported by Abebe [34], Haftay [35], Yechale [36] and Zelalem [37] which showed that lung and liver are the most common sites of hydatid cyst in domestic animals. This is due to the fact that 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. This might be due to the fact that cattle are slaughtered at older age and during this period, liver capillaries might be dilated and allow most oncospheres directly pass to the lung and result in more positive lungs. Additionally, it is possible for the hexacanth embryo to enter the lymphatic circulation and be carried via the thoracic duct to the lungs in such a way that the lungs may be infected before or instead of liver [38].

In the current study, it was emphasized to carry out an assessment on annual economic losses due to bovine hydatidosis at Nekemte Municipal Abattoir. Losses from organ condemnation and carcass weight loss (meat production loss) in infected cattle were assessed and estimated at 183, 620.65US$. The current estimation is much greater than previous estimation by Kebede *et al.* [27] in Tigray region (25, 608ETB). However, it is lower than the finding from Hawassa municipal abattoir (1, 791, 625.89ETB) Regassa *et al*. [2]. The difference in economic loss estimation in various abattoirs/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 [24].

CONCLUSION

The result of this study indicated that the overall prevalence of hydatidosis was 27.89%. The distribution of hydatid cysts by age showed that the prevalence in old animals is higher than in young animals. For the location of hydatid cyst in carcass organs, lung was found to be the most affected organ (75%). There was paucity of information on control and prevention options of the disease. Considering the current result, hydatidosis is an important disease of cattle in Nekemte and its surroundings, causing substantial visible and invisible losses (183, 620.65US$). Therefore, thorough meat inspection should be always practiced; the veterinarians should strictly examine the organs like lung and liver of the slaughtered cattle for strict condemnation and regular testing and treatment of dogs should be practiced throughout the country. As it is mandatory for launching a control program, proper disposal of affected offal's is always must and all the condemned organs should be either buried or incinerated.

Declarations

Ethical Approval: Ethical review board of school of Veterinary Medicine, Wollega University reviewed and approved this study. Survey protocols were done according to the required guideline which was approved by the ethical review board. The purpose of the study was explained for the respondents before the beginning of the study. Support letter was obtained from Wollega University and permission to the data gathering was granted.

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