European Journal of Biological Sciences 12 (4): 131-142, 2020
ISSN 2079-2085

DOI: 10.5829/idosi.ejbs.2020.131.142

# Prevalence, Economic and Public Health Significance of Bovine Hydatidosis in and Around Hawassa Town, Sidama Regional State, Ethiopia

*[1]Tinsae Kebede, [2]Kebede Mekonnen and [2]Abdullah Beka*

[1]Shalla District Livestock Resource Development Office,
Department of Animal Health, Aje, West Arsi Zone, Oromia, Ethiopia
[2]West Arsi Zone Livestock Resource Development Office,
Department of Animal Health, Shashemene, Oromia, Ethiopia

**Abstract:** A cross-sectional study was conducted from November 2017 to April 2018 at Hawassa municipal abattoir with the aim of determining the prevalence, public health and economic significance of Bovine Hydatidosis. Of the total 540 examined animals selected through systematic random sampling, 234 (43.3%) were found to harbor hydatid cysts. Infection rate among different age groups of examined animals were found to be statistically significant ($p<0.05$) with the higher infection was detected in above five years (51.7%) ($\chi^2=18.4006$), than below five years (33.3%). However, no significant variation was observed with related to breed, body condition and origin of animals ($p>0.05$). Hydatid cysts occurred most commonly in the lung (18.14%) followed by the liver (3.15%), spleen (1.3%), heart (0.56%) and kidney (0.37%). From a total 517 recovered cysts, 171 (33.08%), 145 (28.05%) and 58 (11.22%) were small, medium and large cysts, respectively. Concerning the fertility test, of the total 517 cysts, 205 (39.6%) fertile, 169 (32.63%) sterile and 143 (27.7%) calcified cysts were obtained. Questionnaire survey comprising 200 participants showed some difference on the knowledge about the disease and its transmission form. The response has indicated that majority of the participants were not aware of the importance of treating their dogs against parasites, provision of good house and appropriate waste disposal system. The total annual financial loss from organ condemnation and carcass weight due to bovine hydatidosis at Hawassa municipal abattoir was estimated to be 158446.142 ETB. From the result, it can be concluded that hydatidosis is one of the most economically important cattle disease in the area warranting serious attention. Therefore, appropriate control and prevention measures need to be taken in order to minimize the economic loss associated with the problem and to prevent the zoonotic risk to the public health.

**Key words:** Hydatid Cyst · Ante Mortem · Organ Condemnation · Post Mortem · Zoonotic Risk

## INTRODUCTION

Developing countries have nearly two third of the world's livestock production but produces less than a third of the world's meat and a fifth of its milk [1]. Similarly, Ethiopia is known to have the largest livestock population in Africa. Ethiopia has 55.02 million cattle, 27.35 million sheep, 28.16 million of goats, 1.1 million camels, 1.96 million horses and 6.95 million donkeys [2]. Cattle in Ethiopia are almost entirely of zebu types which relatively do well under the traditional production system [3].

The cattle population in Ethiopia consists of 99.4% indigenous, 0.5% crossbreeds and 0.1% exotic breeds which are chiefly kept under smallholder subsistence farming. Livestock plays vital roles in generating income to farmers, creating job opportunities, ensuring food security, providing services, contributing to asset, social, cultural and environmental values and sustain livelihoods [4, 5]. The subsector contributes about 16.5% of the national Gross Domestic Product (GDP) and 35.6% of the agricultural GDP [6]. However, the contribution from these huge livestock resources to the national economy is disproportionately small, owing to

**Corresponding Author:** Tinsae Kebede, Shalla District Livestock Resource Development Office, Aje, West Arsi Zone, Oromia, Ethiopia.

several factors such as drought or malnutrition, management problems, poor genetic performance and livestock diseases [7, 8].

Among the many prevalent livestock diseases, parasitic infections are major causes of death of the animals, exacerbated by many risk factors, such as malnutrition and starvation; and recurring drought, which occurs at times, has a heavy roll in decreasing the animal population production and its products [9, 10]. Hydatidosis is among the major parasite diseases contributing to low productivity of meat production due to carcass or organ condemnation, in particular [11]. It is caused by the larval stage of the dog tapeworm *Echinococcus granulosus* [12, 13].

Cystic echinococcosis (CE) is a chronic zoonotic disease condition associated to infection with the larval stage (hydatid cysts) of the dog's Echinococcus [14]. Echinococcus is belong to Kingdom: Animalia; Phylum: Platyhelminthes; Class: Cestoda; Order: Cyclophyllidea; Genus: Echinococcus; Species: *E. granulosus* [15]. Two hosts (definitive and intermediate hosts) are involved in the completion of the life cycle of *E. granulosus*. The definitive hosts are carnivores which harbor mature tape worms in the intestine [16]. Livestock and humans are the main intermediate hosts [17] for whom the outcome of infection is the development of hydatid cysts in the lung, liver or other organs [18, 19]. *Echinococcus granulosus* is transmitted from the intermediate host to the definitive host by frequent feeding of offal. Consuming offal containing CE can lead to infection of definitive host [20]. The cysts develop into tapeworms, which mature in the definitive host's small intestine. Adult tapeworms are very small, less than 6 mm and they shed gravid proglottids or eggs in the faeces of canids [19]. Eggs are transmitted via oral route to an intermediate host and larvae subsequently lodge in organs such as the liver, lungs or others organs [21].

Considering the economic significance due to hydatidosis in Ethiopia, significant degrees of monetary losses were estimated at various levels in different locations. Such reported estimates includes annual losses of 25, 608 ETB (2, 807.89 US$) by Kebede *et al*. [22] in Tigray; 1, 791, 625.89 ETB (131, 737.19 US$) in cattle slaughtered at the Hawassa municipal abattoir [23] and 473, 173.75 ETB (51, 883 US$) by Kebede *et al*. [24] in cattle slaughtered at the Debre Markos abattoir. Accordingly, factors like absence of proper meat inspection procedures, poor management of food animals, lack of awareness about food borne diseases and lack of adequate number of abattoirs compared to the fast growth rate of human population are all thought to contribute significantly to the high prevalence of hydatidosis in many parts of Ethiopia [25].

Human cases of hydatidosis are frequently reported from different corner of the country and the disease is much more common in the rural areas of Ethiopia where dogs and domestic animals live in a very close association [26]. Hence knowledge on the extent of hydatidosis and associated economic loss in cattle would have paramount importance in justifying the need of an effective control scheme by considering the public health damages and economic loses. Despite these, the recent status of hydatidosis in livestock and its public health and economic impact is not well known in Hawassa municipal abattoir.

Therefore, the main objectives of the present study were:

- To assess the prevalence of bovine hydatidosis and its associated risk factors.
- To estimate the financial losses of bovine hydatidosis at Hawassa Municipal abattoir.
- To show the distribution of hydatid cysts in different organs among cattle slaughtered at Hawassa town municipal abattoir.
- To assess the public significance of bovine hydatidosis in and around Hawassa town, Sidama National Regional State, Ethiopia.

## MATERIALS AND METHODS

**Description of the Study Area:** The study was undertaken from November 2017 up to April 2018, at Hawassa town, the capital city of Sidama National Regional State. It is located at 275 km South of Addis Ababa along the Addis Ababa-Moyale highway. Hawassa is situated at an altitude of 1, 790 m above sea level and geographically lies between 4°27'and 8°30' N latitude and 34°21'and 39°1' E Longitude. The area receives average rainfall annually ranging from 800 to 1, 000 mm of which 67% falls in the long rainy season, which extends from June to September. The rainfall is bimodal with the short rainy season occurring from March to May and the long rainy season from June to September followed by the dry season from middle of September to February. The mean minimum and maximum temperatures of the area were 20.1°C and 30°C, respectively and 51.8% mean relative humidity. The farming systems are mainly characterized by the presence of subsistence mixed farming, of both livestock and agricultural crop production. Extensive system of livestock management predominate the area [27, 28].

**Study Population:** The study population included local and cross breed of apparently healthy cattle brought from various localities for slaughter to Hawassa municipality abattoir during the study period. This population comprised of cattle of different body condition, sex and age groups. Most of the study animals were males though females with reproductive problem, poor performance and end productive life were also encountered. It was difficult to precisely indicate the geographical origin of all animals slaughtered at Hawassa Municipal abattoir and relate the findings on hydatidosis to a particular locality. Nevertheless, attempts made in this regard revealed that majority of them were brought from nearby markets including Tula, Hawassa, Negelle Arsi, Shashemene, Koffele and Bishan Guracha.

**Study Design:** The study design employed was cross-sectional study type with aims of determining the prevalence and financial loss of bovine hydatidosis/echinococcosis in Hawassa municipal abattoir. Additionally, cyst characterization was also included. Information like origin, body conditions, age, sex, species and lesions distribution as well as nature of the cyst was recorded using standard format before and after slaughter, respectively.

**Sample Size Determination:** The required sample size for the study was calculated using the formula given by Thrustfield [29] and taking a 52.69% expected prevalence [23], 95% confidence interval and 5% desired absolute precision. Thus,

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

where: N = is the required sample size, Pexp = the expected prevalence (52.69%), d = is the desired absolute precision (0.05), z = value at 95% (1.96)

Accordingly, the calculated sample size was found to be 383. However, to increase the precision of the study, a total of 540 cattle were randomly sampled and examined in the study for a better conclusion. These sample sizes were selected by systematic random sampling method during the ante mortem inspection. Sampling of cysts for physical size and fertility characterization was done purposively by taking the most prominent superficial hydatid cysts from randomly selected hydatidosis positive bovine visceral organs. 109 individuals filled the questionnaires and 91 were interviewed. The participants were selected by simple random sampling after getting list of human health professionals, abattoir workers, animal health practitioners, butchers and mixed social standards such as students, civil servants and farmers.

**Active Abattoir Survey**

**Ante-Mortem Examination:** Ante mortem inspection recommended by Gracey and Collins [30] was utilized. Regular visits (3 days per week) were made to Hawassa municipal abattoir during the period from November 2017 to April 2018. On average 30 animals were examined per visit. During ante mortem inspection, each of the study animals was given an identification number (with a paint mark on their body). Then, study animals were selected and animal information such as age, sex, breed, body condition score and origin of the animals were recorded. Interview was also conducted to obtain data on animal's origin and carcass and offal examinations were conducted at postmortem inspection. Estimation of age was carried out by examination of the teeth eruption using the approach forwarded by De Lahunta and Habel [31] and two age groups were considered; less or equal to five years and above five years. Body condition of cattle was subjectively classified as poor (hide bound with obvious bony prominences and deep sunk tail base), medium (ribs and other bony prominences noticeable on visual inspection but have fair fleshy background on palpation) or good (bony structures notable only on palpation) depending on recommendations forwarded by Nicolson and Butterworth [32]. Finally, apparently healthy animals were passed for slaughter during the study period.

**Post-Mortem Examination:** Post mortem inspection is the most common method in use to detect bovine hydatid cyst [33]. Postmortem examination comprised visual inspection, palpation and incision of the lungs, liver, heart, spleen and kidneys of each animal for the presence and distribution of hydatid cysts. Cysts were carefully removed from each infected organ of all affected animals and collected in clean containers, to allow the number and characteristics of the cysts to be determined. Individual cysts were carefully incised and examined for presence of protoscolices. To determine the fertility of each cyst, the pressure of the cyst fluid was reduced by using a sterile hypodermic needle. Then the cyst was incised with a sterile scalpel blade and the content poured into a glass petri dish and examined. The presence of protoscolices attached to the germinal layer in the form of a brood capsule or in the cyst fluid was considered suggestive of fertility. Sterile hydatid cysts were characterized by their smooth inner lining, usually with a slight turbidity of the contained fluid; cysts identified as calcified sounded and felt gritty when incised.

**Hydatid Cyst Characterization:** The infected organs from each positive animal were collected and recorded. The total numbers of hydatid cysts were counted and recorded per infected organ. Cyst size measurement, cyst counting, cyst fertility and viability determination was also conducted. The size of the diameter of the collected hydatid cyst was measured and classified as small (diameter less than 4 cm), medium (diameter between 4 and 8 cm) and large (diameter greater than 8 cm) [34].

The collected hydatid cysts were taken to Hawassa University School of veterinary medicine, Veterinary parasitology and pathology laboratory. Individual cyst was carefully incised and examined for protoscolices which look like white dots on the germinal epithelium; such cysts were characterized as fertile cysts. Fertile cysts were subjected for viability test. A drop of the sediment, containing the protoscoleces was placed on microscopic glass slide and covered with coverslip and observed for amoeboid like peristaltic movement (flame cell activity) objective × 40. A drop of 0.1% aqueous eosin solution was added to equal volume of protoscolices in hydatid fluid on a microscopic slide with the principle that protoscolices should completely or partially exclude the dye while the dead one took it up [35]. Furthermore, infertile hydatid cysts were classified as sterile or calcified by their smooth inner lining usually with slight turbid fluid in its content. Typical calcified cysts produce a gritty sound feeling upon incision [36, 37].

**Financial Loss Assessment:** 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, liver, heart, spleen and kidney) and the indirect losses were assessed on the basis of live weight reduction due to hydatidosis [38]. The financial loss due to organ condemnation was analyzed based on the average annual slaughter capacity of the abattoir, average market price of each organ in Hawassa town and rejection rate of each organ. Average market price was determined based on the interview made with 10 personnel of the abattoir and butchers and collective price of lung, liver, heart, spleen and kidney was determined. Based on 2 years retrospective abattoir data, the average annual slaughter of Hawassa municipal abattoir was estimated to be 17, 868 cattle. A 5% estimated carcass weight loss due to bovine hydatidosis described by Getaw *et al*. [39] 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 [40]. Percent involvement of each organ was considered in the calculation then the loss and economic significance of the parasite was determined by the following formula as calculated by Ogunirale [41].

$$LOC = (NAS \times Plu \times Cplu) + (NAS \times Phr \times Cphr) + (NAS \times Pli \times Cpli) + (NAS \times Psp \times Cpsp) + (NAS \times Pkid \times Cpkid)$$

where: LOC= Loss due to organ condemnation, NAS= Mean number of cattle slaughtered annually, Plu= Percent involvement of lung, Cplu= Current mean retail price of lung, Phr= Percent involvement of heart, Cphr= Current mean retail price of heart, Pli= Percent involvement of liver, Cpli= Current mean retail of liver, Psp= Percent involvement of spleen, Cpsp= Current mean retail of spleen, Pkid= Percent involvement of kidney, Cpkid= Current mean retail price of kidney.

To estimate the economic loss encountered from carcass weight losses, information on the mean retail market cost of 1 kg beef at Hawassa town was obtained from butchers during the study period, the average annual slaughter rate of cattle at Hawassa town municipal abattoir was estimated from retrospective data of the last two years and the average carcass weight loss of 5% due to hydatidosis were used. Thus, indirect loss was calculated as:

$$LCWL = NAS \times Ph \times CPB \times 5\% \times 126\ kg$$

where: LCWL = Loss from carcass weight loss, 5% = Estimated carcass weight loss due to hydatidosis, NAS = Average number of cattle slaughtered animals, Ph = Prevalence of hydatidosis, CPB = Current average price 1 kg beef at Hawassa town (180 Birr), 126kg = Average carcass weight (dressing percentage) of adult Zebu cattle. Finally, the total economic loss was calculated by considering the loss from both organ condemnation and carcass weight loss. Thus:

$$\text{Total economic loss} = LOC + LCWL$$

**Questionnaire Survey:** The perception of the communities towards human hydatidosis cases was evaluated and assessed by carefully preparing a well-designed questionnaire and applying suitable interviewing techniques. Study participants for both questionnaire and interview were selected through simple random sampling method. This was achieved initially by getting a list of human health practitioners, veterinarians, abattoir workers, butchers, students, civil servants and farmers from the health office, livestock development office, abattoir, hotels, schools, public service office and

Table 1: Socio-demographic characteristics of peoples participated in the study

| Variables | Category of respondents | No. of respondents | Percentage (%) |
|---|---|---|---|
| Sex | Male | 134 | 67 |
| | Female | 66 | 33 |
| Age | 10-20 | 5 | 2.5 |
| | 20-30 | 9 | 4.5 |
| | 30-40 | 49 | 24.5 |
| | 40-50 | 110 | 55 |
| | Above 50 | 27 | 13.5 |
| Residence | Urban | 142 | 71 |
| | Rural | 58 | 29 |
| Occupation | Farmer | 38 | 19 |
| | Student | 19 | 9.5 |
| | Abattoir worker | 31 | 15.5 |
| | Butcher | 42 | 21 |
| | Human health practitioner | 18 | 9 |
| | Veterinarian | 18 | 9 |
| | Civil servant | 34 | 17 |
| Educational status | Illiterate (cannot read and write) | 9 | 4.5 |
| | Primary school | 48 | 24 |
| | Secondary school | 56 | 28 |
| | Diploma | 42 | 21 |
| | First Degree | 34 | 17 |
| | Above First Degree | 11 | 5.5 |
| | Total Number | 200 | |

agriculture office found in Hawassa town, respectively. Accordingly, 42 butchers, 31 abattoir workers, 18 veterinarians and 18 human health professionals were given questionnaire to answer, while 91 respondents of mixed social groups were interviewed (Table 1). Therefore a total of 200 study participants were considered.

**Ethical Approval:** During conducting questionnaire survey for assessing public health significance of hydatidosis, all study participants were informed about the objective and techniques of the study and also the participation were on voluntary basis. Principles and guidelines set in the World Medical Association declaration of Helsinki concerning ethical principles for medical research involving human subjects were properly followed [42].

**Data Management and Analysis:** All the data collected from ante-mortem, post-mortem and laboratory findings were recorded on an A4 paper and then entered in to Microsoft excel sheet. The data was analyzed using SPSS version 16. Analyses were made at 95 % level of confidence and 5 % precision. Statistically significant associations between variables are considered to exist if the p-value is less than 0.05.The prevalence of cystic echinococcosis was computed with descriptive statistics (percentage). Chi-square statistical test was applied to determine the associations between the various potential risk factors and the prevalence of hydatid cyst in the examined animals. The economic loss from condemnation of organs and weight loss in the abattoir was made by taking the current selling price of organs and beef into consideration.

## RESULTS

**Prevalence of Bovine Hydatidosis:** In this study, a total of 540 cattle at Hawassa municipal abattoir in Hawassa town were examined for the presence of hydatid cysts. Out of the total examined cattle, 234 (43.3%) were found to harbor hydatid cysts in one or more of their internal organs. In this study, body condition, age, breed and origin were considered as potential risk factors for the occurrence of hydatidosis. Rate of infection in different age groups ($\leq$ 5 and >5 years) was assessed and described (Table 2). Age prevalence has shown a statistically significant variation ($p<0.05$, $\chi^2 = 18.4006$) with older group having higher infections. Prevalence was also assessed in terms of body condition score. It was found that cattle having medium body condition had the highest prevalence (44.56%) followed by good (42.2%) and poor (41.1%). There was no significant difference revealed between body condition scores with regard to cyst detection ($p>0.05$, $\chi^2=0.425$). No statistically significant difference

Table 2: Prevalence of hydatidosis and associated risk factors

| Variable categories | No. of examined | No. of infected animals | Prevalence (%) | Chi-square ($\chi^2$) | p-value |
|---|---|---|---|---|---|
| Age | | | | | |
| ≤5 years | 246 | 82 | 33.3 | 18.4006 | 0.001 |
| >5 years | 294 | 152 | 51.7 | | |
| Breed | | | | | |
| Local | 481 | 211 | 43.9 | 0.5105 | 0.475 |
| Cross | 59 | 23 | 38.9 | | |
| Sex | | | | | |
| Male | 519 | 223 | 42.9 | 0.735 | 0.393 |
| Female | 21 | 11 | 52.4 | | |
| Body condition | | | | | |
| Poor | 73 | 30 | 41.1 | | |
| Medium | 294 | 131 | 44.56 | 0.425 | 0.811 |
| Good | 173 | 73 | 42.2 | | |
| Origin | | | | | |
| Hawassa | 96 | 52 | 54.2 | | |
| Tula | 147 | 88 | 59.9 | | |
| Koffele | 72 | 34 | 33.7 | 0.9452 | 0.988 |
| Shashemene | 83 | 18 | 47.2 | | |
| Negelle Arsi | 91 | 33 | 36.3 | | |
| Bishan Guracha | 20 | 3 | 15 | | |
| Adama | 21 | 4 | 19.05 | | |
| Harar | 10 | 2 | 20 | | |
| Total | 540 | 234 | 43.3% | | |

($p>0.05$) in hydatid cyst prevalence was observed between breeds of animals. However, higher prevalence was observed in local breeds (43.9 %) than cross breeds of cattle (38.9%). Rate of infected animals based on origin was assessed and has shown statistically insignificant variation ($p>0.05$, $\chi^2 = 0.9452$).

**Distribution of Hydatid Cysts among Visceral Organs of Cattle:** Out of the total 234 cattle harboring hydatid cysts in their organs, single and multiple infections of organs were recorded. Out of these, 127 cattle were infected at only a single organ and the remaining 107 had infections in two or more organs. Of the total examined organs, the highest proportions of hydatid cysts were observed in lungs and liver. Of the 234 cattle positive, 98 (18.14%) had cysts merely in lungs, 17 (3.15%) in liver, 7 (1.3%) in spleen, 3 (0.56%) in heart and 2 (0.37%) in kidney, whereas, the rest of 107 (19.82%) infections involved multiple organs (Table 3). In this study, it was shown that hydatid cysts occurred most commonly in the lung (18.14%) followed by the liver (3.15%), spleen (1.3%), heart (0.56%) and kidney (0.37%).

**Cyst Characterization:** Counting, size measurement and fertility and viability determination of the cysts were conducted. A total of 317 cysts of lung, 156 cysts of liver, 30 cysts of spleen, 10 cysts of heart and 5 cysts of kidney origins were taken and subjected to cyst characterization. Out of the total hydatid cysts recovered in cattle, 171 (33.08%) were small, 145(28.05) were medium and 58(11.22) were large and the rest 143(27.66) were calcified cysts (Table 4). Systematic measurement of the cysts based on size in different organs showed that majority of large and medium-sized cysts were found in lungs, while a large number of small sized and calcified cysts were found in liver.

From the total of 517 hydatid cysts, 205 (39.6%), 169 (32.63%) and 143 (27.7%) were fertile, sterile and calcified cysts, respectively (Table 5). 155 (48.9%) fertile , 97 (30.7%) sterile , and 64 (20.2%) calcified cysts in the lung, 42 (26.9%) fertile, 48 (30.8%) sterile and 66 (42.31%) calcified cysts in the liver, 2 (20%) fertile, 6 (60%) sterile and 2 (20%) calcified cysts in the heart, 5 (16.67%) fertile, 14 (46.67%) sterile and 11 (36.67%) calcified cysts in the spleen and 1 (20%) fertile, 3 (60%) sterile and 1 (20%) calcified cysts of kidney were recorded.

Out of 205 fertile cysts which were subjected for viability test, 130 (63.4%) were viable and 75 (36.6%) were non-viable (Table 6). The cyst condition in terms of organ involvement was found. Out of fertile cysts obtained from the lung (155), 98 (63.23%) and 57 (36.8%) were viable and nonviable cysts, respectively. 42 (20.5%) fertile cysts in the liver, of which 31 (73.81) were viable and 11 (26.2%) were nonviable. 2 (0.98%) fertile cysts in the heart, all are

Table 3: Distribution of hydatid cysts in different organs of positive cattle

| | Number of animals | | |
|---|---|---|---|
| Organs affected | Examined | No. of cases | Percentage (%) |
| Lung | 540 | 98 | 18.14 |
| Liver | 540 | 17 | 3.15 |
| Heart | 540 | 3 | 0.56 |
| Spleen | 540 | 7 | 1.3 |
| Kidney | 540 | 2 | 0.37 |
| Lung and Liver | 540 | 74 | 13.7 |
| Lung and Spleen | 540 | 5 | 0.93 |
| Lung and Heart | 540 | 3 | 0.56 |
| Liver and Heart | 540 | 2 | 0.37 |
| Liver and Spleen | 540 | 4 | 0.74 |
| Lung, Liver and Spleen | 540 | 16 | 2.96 |
| Lung, Heart and Liver | 540 | 3 | 0.56 |
| Total | 540 | 234 | 43.3% |

Table 4: Cyst size and counts in relation to organ involvement

| | Number of the different cyst sizes | | | |
|---|---|---|---|---|
| Organ | Small | Medium | Large | Total |
| Lung | 91(28.71) | 112(35.3) | 49(15.5) | 317(61.32) |
| Liver | 64(41.03) | 19(12.2) | 7(4.5) | 156(30.2) |
| Heart | 6(60) | 3(30) | 0(0.00) | 10(1.9) |
| Spleen | 7(23.3) | 10(33.3) | 2(6.67) | 30(5.8) |
| Kidney | 3(60) | 1(20) | 0(0.00) | 5(0.97) |
| Total | 171 (33.08) | 145 (28.05) | 58 (11.22) | 517 |

Table 5: Fertility/sterility of cysts collected from different organs

| Organ | Fertile cyst (%) | Sterile cyst (%) | Calcified (%) | Total (%) |
|---|---|---|---|---|
| Lung | 155(48.9) | 97(30.7) | 64(20.2) | 316(61.2) |
| Liver | 42(26.9) | 48(30.8) | 66(42.31) | 156(30.12) |
| Heart | 2(20) | 6(60) | 2(20) | 10(1.93) |
| Spleen | 5(16.67) | 14(46.67) | 11(36.67) | 30(5.8) |
| Kidney | 1(20) | 3(60) | 1(20) | 5(0.96) |
| Total | 205 (39.6) | 169 (32.63) | 143 (27.7) | 517 |

Table 6: Viability of fertile cysts collected from organs of infected cattle

| Organ involved | Viable cyst | Nonviable cyst | Total |
|---|---|---|---|
| Lung | 98(63.23) | 57(36.8) | 155(75.61) |
| Liver | 31(73.81) | 11(26.2) | 42(20.5) |
| Heart | 0(0.00) | 2(100) | 2(0.98) |
| Spleen | 1(20) | 4(80) | 5(2.44) |
| Kidney | 0(0.00) | 1(100) | 1(0.5) |
| Total | 130(63.4) | 75(36.6) | 205 |

nonviable, there were no viable cysts obtained from heart. 5 (2.44%) fertile cysts in the spleen, of which 1 (20%) was viable and 4 (80%) were non-viable cysts. A fertile cyst which was obtained from kidney (1) was non-viable.

**Estimation of Financial Loss:** From the total of 540 cattle examined, 234 (43.3%) were found harboring hydatid cysts. Besides, 199 (36.9%), 116 (21.5%), 11 (2.04%), 32 (5.9%) and 2 (0.4%) of the hydatid cysts were located in the lungs, liver, heart, spleen and kidneys, respectively. The overall prevalence of hydatidosis and percentage involvement of lung, liver, heart and kidney were used as input to estimate the financial loss attributable to organs condemned in the present study.

Average market price of lung, liver, heart, spleen, kidney and a kilogram of beef was found to be 10, 40, 30, 20, 30 and 180 Ethiopian Birr (ETB), respectively in Hawassa town at the study period. The mean annual numbers of cattle slaughtered at Hawassa municipal abattoir during the last two years was 17, 870 and the

overall prevalence of hydatidosis was found 234 (43.3%) during the study period. By applying the formula described in the material and methods section, direct financial losses due to condemnation of organs and indirect financial losses due to carcass weight loss were calculated as follows on annual basis.

LOC = (NAS x Plu x cplu) + (NAS x Pli x Cpli) + (NAS x Phr x Cphr) + (NAS x Pkid x Cpkid). = (17870 x 0.4 x 10) + (17870 x 0.21 x 40) + (17870 x 0.02 x 30) + (17870 x 0.06 x 20) + (17870 x 0.004 x 30)
LOC = 30, 736.4+64, 546.44+4, 610.46+9220.92+922.092 = 110, 036.312 ETB
LCWL = NAS × Ph × CPB × 5% x 126 kg = 17870 × 0.43 × 180 x 0.05 × 126 = 48409.83 ETB/annually

Accordingly, the economic loss due to organ condemnation was calculated to be 110, 036.312 ETB per annually. For calculating indirect loss due to carcass weight reduction, a 5% carcass weight loss brought by hydatidosis and 126 kg, average carcass weight of Ethiopian adult cattle was considered here to estimate the economic loss and computed result showed a loss of 48409.83 ETB annually. The total economic loss can be evaluated by considering both loss of offal and carcass weight loss in cattle slaughtered at Hawassa municipal abattoir was estimated at 158446.142 ETB.

**Public Health Significance of Hydatidosis:** From the total of 200 participants, 87 (43.5%) had heard of human hydatidosis. Of these, 57 (65.5%), 20 (23%) and 10 (11.5) participants got information about way of acquiring hydatidosis from school, health extension workers and electronic medias, respectively. From the 87 (43.5%) participants who had heard of human hydatidosis, 35 (40.23%) were able to mention one or more ways of transmission to humans. 17 (19.5%), 22 (25.3%) and 10 (11.5%) were able to list one, two, three and more than three correct means of transmission to humans, respectively. From 200 participants, 118 (59%) who had heard of dog tapeworm, 51 (43.2%), 24 (20.34%) and 32 (27.12%) were capable to list contaminated pasture, contaminated drinking water and both as means of transmission to animals, respectively, while the remaining 11 (9.3%), did not know about the transmission to animals.

## DISCUSSION

The current study reveals that the prevalence of bovine hydatidosis at Hawassa Municipal abattoir was found to be 43.3%. In the current finding, the prevalence of hydatidosis in cattle at Hawassa municipal abattoir was lower than with the report of 72.4% which was recorded by Fikadu [43] in Assela town, prevalence of 50.78% in Dodola by Tolossa *et al*. [44], 48.9% in Debre Markos by Kebede [45] and 46.5% in Debre Zeit by Jobre *et al*. [9]. This may be described to difference in environmental conditions, livestock intensity and livestock movement. On the other hand this might be due to the difference in availability and repetition in contact among the infected intermediate and final hosts and vice- versa that contributes to the differences in prevalence rates [46]. But it is slightly higher than the prevalence of 34.05% in Bahir Dar by Nigatu *et al*. [47], prevalence of 32.1% in Mekelle which was recorded by Berhe [48]. The finding is quite higher than with the prevalence of 17% in South Wollo [49], 18.6% at Adigrat [50] and 33.5% in Kombolcha [51].

With regards to rate of infection of hydatidosis in different age groups of cattle, significant difference ($p<0.05$) was observed. Animals with more than 5 years of age were highly affected. The difference in infection rate could be mainly due to the fact that aged animals have longer exposure time to eggs of *E. granulosus* in addition to weaker immunity to combat against the infection [52]. This finding is similar to the finding of Lobago [53], Yihdego [54] and Umur [55].

Out of the 234 infected cattle, 11 (52.4%) were females and 223 (42.9%) males were positive with ($p>0.05$, $\chi^2=0.73$) which suggests that there is no association between sex and prevalence of the disease. This may be due to small number of female animals slaughtered at the abattoir during the study. The result has similarly registered by Temesgen [56]. In this study, it has been shown that hydatid cysts occurred most commonly in the lung and followed by liver. This might be due to the fact that cattle are slaughtered at older age, during which period the liver capillaries are dilated and most oncospheres pass directly to the lungs; additionally, it is possible for the hexacanth embryo to enter the lymphatic circulation and be carried via the thoracic duct to the heart and lungs in such a way that the lung may be infected before or instead of liver [57]. The higher number of calcified cysts in the liver could be attributed to relatively higher reticuloendothelial cells and abundant connective tissue reaction of the organ [58].

The percentage of fertile cysts recovered was 39.6%. This is low compared to 70% in the Great Britain, 96.9% in South Africa and 94% in Belgium [57] but comparable to Elmahdi *et al*. [14] who reported 22% fertile hydatid cysts from central Sudan. Elmahdi *et al*. [14] also reported low (3%) prevalence from Central Sudan.

The variation in fertility rate among different species and in different geographical zone could be due to the difference in strain of *E. granulosus*. When we compare the fertility rate among the organs, it was higher in lung than liver. This is due to lung has been relatively softer consistent tissue which allows the easier development of the cyst and the fertility rate of hydatid cysts may show a tendency to increase with advancing age of the hosts.

In this study, hydatidosis was found to acquire financial loss that was estimated to be 158446.142 ETB in cattle of the study area. Previous studies have also estimated the annual financial losses associated with bovine hydatidosis from different parts of the country. For instance, Regassa *et al*. [23] reported 1, 791, 625.89 ETB and Zewdu *et al*. [59] reported 160, 032.23 ETB in Hawassa and Ambo municipality abattoirs, respectively. The difference in the calculated economic loss in the various abattoirs may be due to the variations in the mean annual number of slaughtered cattle, prevalence of hydatidosis and variation in the retail market price of organs in different regions.

In the current study, 43.5% of the study participants had awareness on hydatidosis. 49.3% of butchers, 54.6% of abattoir workers and 62.0% of health professionals had awareness about the disease. The findings for householders and butchers are higher compared to the earlier reports from other parts of the country. According to the study of Kebede *et al*. [45], none of the householders and butchers had awareness, while 100% of the abattoir workers and 75% of health professionals were found to be aware of dog tapeworm in Bahir Dar town, Northern Ethiopia. From those participants who had heard of hydatidosis 4.2 % were able to mention contaminated environment, water, fruits and vegetables and close contacts with infected dogs as means of transmission of the parasite to humans. These findings are almost similar to the study done earlier by Qaqish *et al*. [60], about 1.8 to 7% of interviewed in Jordan were able to mention contact with dogs as a source for humans to contract cystic echinococcosis.

## CONCLUSION AND RECOMMENDATIONS

Prevalence of bovine hydatidosis observed in the present study was high (43.3%) and certainly reflects the potential hazard to public health in the area and causing enormous financial loss. Lung and liver were the major organs harboring hydatid cyst and large number of cysts was fertile. Lung had high proportion of fertile and viable cysts. There is generally poor knowledge or perception of communities about the disease, its sources of infection and modes of transmission. The estimated direct financial loss due to organ condemnation in the study abattoir was high. This may be due to higher percent of organ evolvement. Therefore, the problem warrants well organized control interventions including appropriate meat inspection and disposal of condemned organs as well as public awareness should be created on the transmission cycle of hydatidosis and the stray dogs should be controlled, Strategic de-worming of dogs should be implemented, Feeding of infected offal's to dogs should be avoided and all infected visceral organs should be buried properly.

## REFERENCES

1. World Health Organization (WHO), 2011. Report of the WHO Informal Working Group on cystic and alveolar echinococcosis surveillance, prevention and control, with the participation of the Food and Agriculture Organization of the United Nations and the World Organization for Animal Health, Department of Control of Neglected Tropical Diseases, Geneva, Switzerland, pp: 1-26.
2. Center for Statistic Agency (CSA), 2013. Federal Democratic Republic of Ethiopia, Central Statistical Authority, Agricultural sample survey (2012/2013). Report on livestock and livestock characteristics (Private and Peasant Holdings), Addis Ababa, pp: 9-20
3. Kebede, T., S. Adugna and M. Keffale, 2018. Review on the Role of Crossbreeding in Improvement of Dairy Production in Ethiopia. Global Veterinaria., 20: 81-90.
4. Getu, A., T. Guadu, S. Addisu, A. Asefa, M. Birhan, N. Mogese, M. Chanie, B. Bogale, A. Alebie, A. Feresebhate and T. Fantahun, 2016. Crossbreeding Challenges and Its Effect on Dairy Cattle Performances in Amhara Region, Ethiopia. Journal of Animal and Feed Research, 6: 96-102.
5. Horato, M., T. Kebede and A. Beka, 2020. Prevalence and Distribution of Bovine Ticks in and around Asella town, East Arsi Zone, Oromia, Ethiopia. Acta Parasitologica Globalis, 11: 142-149.
6. Hailu, A., 2013. Crossbreeding effect on milk productivity of Ethiopian local cattle: challenges and opportunities. Scholarly Journal of Agricultural Science., 3: 515-520.
7. FAO, 1995. Livestock development strategies for low income countries. Proceedings of the Joint, FAO, pp: 6-8.

8. Kebede, T. and T. Zekarias, 2020. Prevalence and Financial Loss Estimation of Hydatidosis of Cattle Slaughtered at Shashemene Municipal Abattoir. European Journal of Biological Sciences, 12: 54-63.
9. Jobre, Y., R. Lobago, R. Tiruneh, G. Abebe and P. Dorchie, 1996. Hydatidosis in three selected region in Ethiopia: an assessment trial on its prevalence, economic and public health importance. Rev. Med. Vet., 147: 797-804.
10. Mekuriyaw, A., G. Kebede, T. Zenebe, T. Kabeta and A. Demssie, 2016. Prevalence of Bovine Hydatidosis and Its Cyst Characterization in DebreZeit Elfora Export Abattoir, Oromia Regional State, Ethiopia. Nat. Sci., 14: 87-98.
11. Abebe, F. and Y. Jobre, 2011. Infection prevalence of hydatidosis (Echinococcus granulosus, Batsch, 1786) in domestic animals in Ethiopia: A synthesis report of previous surveys. Eth. Vet. J., 15: 11-33.
12. Alemu, S., M. Melese and L. Lemma, 2017. Characterization, Prevalence and Economic Significance of Hydatidosis in Cattle Slaughtered at Masha Municipal Abattoir, Southern Ethiopia. Adv. Bio. Res., 11: 319-326.
13. Nebyou, M. and D. Adugna, 2014. Prevalence, cyst viability, organ distributions and financial losses due to hydatidosis in cattle slaughtered at Nekemte municipial abattoir, Western Ethiopia. J. Vet. Med. Anim. Health, 6: 280-288.
14. Elmahdi, I., E. Ali, Q. Magzoub, M. Ibrahim, A. Saad and M. Roming, 2004. Cystic echinococcosis of livestock and human in central Sudan. A. Trop. Med. Parasitol., 98: 473-479.
15. Hossein, M., S. Ebrahim, F. Dezaki, B. Kheirandish, S. Ezatpour, M. Jahanbakhsh and H. Fasihi, 2014. Scolicidal Effects of Black Cumin Seed (*Nigella sativa*) Essential Oil on Hydatid Cysts. Kor. J. Parasitol., 52: 653-659.
16. Zhang, W., J. Li and D. McManus, 2003. Concepts in immunology and diagnosis of hydatid disease. Clin. Microbio. Rev., 16: 18-36.
17. Oku, Y., R. Malgorb, U. Benavidezb, C. Crmonab and H. Kamiyac, 2004. Control program against hydatidosis and the decreased prevalence in Uruguay. Int. Congr. Ser., 1267: 98-104.
18. Dorny, P., N. Praet, J. Deckers and S. Gabriel, 2009. Emerging food-born parasites. Vet. Parasitol., 163: 196-206.
19. Budke, C., P. Deplazes and P. Torgerson, 2006. Global socio economic impact of cystic echinococcosis. Emerg. Infect. Dis., 12: 296-303.
20. Junghanss, T., A.M. Silva, J. Horton, P.L. Chiodini and E. Brunetti, 2008. Clinical management of cystic echinococcosis: state of the art, problems and perspectives. Am. J. Trop. Med. Hyg., 79: 301-311.
21. Rahdar, M., S.H. Maraghi, A. Rafei and M. Razijalali, 2008. Comparison of some electrolytes in hydatid cyst fluid and serum of liver hydatidosis of sheep in Jundishapur. J. Microbio., 1: 10-14.
22. Kebede, W., A. Hagos, Z. Girma and F. Labago, 2009b. Echinococcosis/hydatidosis: its prevalence, economic and public health significance in Tigray region, North Ethiopia. Trop. Anim. Health Prod., 41: 865-871.
23. Regassa, F., A. Molla and J. Bekele, 2010. Study on the prevalence of cystic hydatidosis and its economic significance in cattle slaughtered at Hawassa municipal abattoir. Trop. Anim. Health Prod., 42: 977-984.
24. Kebede, N., A. Abuhay, G. Tilahun and A. Wossene, 2009c. Financial loss estimation, prevalence and characterization of Hydatidosis of cattle slaughtered cattle slaughtered at DebreMarkos municipality abattoir, Ethiopia. Trop. Anim. Health Prod., 41: 1787-1789.
25. Kebede, N., A. Mitiku and G. Tilahun, 2009a. Hydatidosis of slaughtered animals in Bahir Dar Abattoir, Northwestern Ethiopia. Trop. Anim. Health Prod., 41: 43-50.
26. Fromsa, A. and Y. Jobre, 2011. Infection prevalence of hydatidosis in domestic animals in Ethiopia: A synthesis report of previous surveys. Ethio. Vet. J., 15: 11-33.
27. Central Statistical Agency (CSA), 2014. Agricultural sample survey 2013/ 2014: Report on livestock and livestock characteristics (private holdings): Statistical Bulletin, pp: 2-39.
28. Sidama Zone Agricultural and Rural Development Office (SZARDO), 2014. The Annual Report, Hawassa, Ethiopia.
29. Thrusfield, M., 2007. Veterinary Epidemiology, Government Department of Navy, 2nd edn. Black well science Ltd, pp: 182-198.
30. Gracey, J. and S. Collins, 1992. Meat Hygiene. 5th edition, BailliëreTindall, Oval Road, London NW17DX, pp: 413-420.

31. De Lahunta, A. and R. Habel, 1986. Teeth, Applied Veterinary Anatomy. WB Saunders Company, pp: 4-6.
32. Nicholson, M. and M. Butterworth, 1986. A guide to condition scoring of zebu cattle. International Livestock Centre for Africa, P.O. Box 5689, Addis Ababa, Ethiopia.
33. Herenda, D., P. Chambers, A. Ettriqui, P. Seneviratna and J. DaSilva, 1994. Manual on meat inspection for developing countries. FAO, Rome. pp: 160-164.
34. Schantz, P.M., 1990. Parasite zoonoses in perspective. Int. J. Parasitol., 21: 165-166.
35. McPherson, C.N., 2001. Epidemiology of Echinococcus granulosus in transhumant situations, pp: 156-163.
36. Soulsby, E., 1982. Helminths, Arthropods and Protozoa of Domesticated Animals, 7th ed. Lea and Tebiger, Philadelphia, pp: 119-127.
37. Parija, S.C., 2004. Text book of Medicine and Parasitology, Protozology and Helmentology. 2nd edn. India, New Delhi, pp: 5-39.
38. Torgerson, P.R., B. Shaikenov and O. Kuttybaev, 2002. Cystic Echinococcosis in Central Asia: New epidemic in Kazakhstan and Kyrgyzstan. Int. J. Parasitol., 22: 99-105.
39. Getaw, A., D. Beyene, D. Ayana, B. Megersa and F. Abunna, 2010. Hydatidosis: Prevalence and its economic importance in ruminants slaughtered at Adama municipal abattoir, Central Oromia, Ethiopia.
40. International Livestock Research Center for Africa (ILCA), 1979. Trypanotolerant livestock in East and Central Africa: General study. ILCA monograph, Addis Ababa, Ethiopia, pp: 147.
41. Ogunirale, A., 1980. Bovine Fasciolosis in Nigeria: Inter-current parasitic and bacterial infections. Trop. Anim. Health Prod., 14: 121-125.
42. WMA, 2008. Principles and guidelines set in the Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects.
43. Fikadu, O., 1997. Study on the prevalence and economic significant of hydatidosis in ruminants, E. granulosus in dogs in around Assela. DVM Thesis, FVM, AAU, DZ, Ethiopia.
44. Tolossa, Y., D. Ayana, A. Amin and T. Jibat, 2016. Hydatidosis/Echinococcosis: its prevalence, economic and public health significance in Dodola district, Western Arsi zone of Oromia region, Ethiopia. Sci. Parasitol., 17: 7-15.
45. Kebede, N., 2010. A retrospective survey of bovine hydatidosis in three abattoirs of Amhara National Regional State, Northwest, Ethiopia. Trop. Anim. Health Prod., 42: 323-325.
46. Njoroge, E., M. Mbithi, J. Gathuma, T. Wachira, T. Gathura, J. Magambo and E. Zeyhle, 2002. A study of cystic echinococcosis in slaughter animals in three selected areas of Northern Turkana, Kenya. Vet. Parasitol, 104: 85-91.
47. Nigatu, K., M. Abebe and T. Getachew, 2009. Hydatidosis of slaughtered animals in Bahir Dar Abattoir, Northwestern Ethiopia. Tropical Animal Health and Production, 41: 43-50.
48. Berhe, G., 2009. Abattoir survey on cattle hydatidosis in Tigray region of Ethiopia. Trop. Anim. Health Prod., 41: 1347-1352.
49. Bizuwork, A., K. Nigatu, T. Tariku, T. Getacho and K. Tesfu, 2013. Occurrences and financial significance of bovine cystic echinococcusis in Southern Wollo, North- eastern Ethiopia. J. Vet. Med. Anim. Health, 5: 51-56.
50. Assefa, A. and H. Tesfay, 2012. Haydatidisis in cattle slaughtered at Adigrat Municipial abattoir, Ethiopia. Vet. W. J., 6: 734-738.
51. Nasr, W. and M. Pal, 2016. Prevalence, Cyst viability, Fertility and Economic Significance of Bovine Hydatidosis in an abattoir at kombolcha, Ethiopia. Har. Vet., 55: 17-22.
52. Himonas, C., 1987. The fertility of hydatid cyst in food animals in Greece. Helminth Zoonosis, pp: 21-54.
53. Lobago, F., 1994. Echinococcosis/hydatidosis in Konso/ Southern Ethiopia: an assessment trial of its prevalence, economic and public heath importance. DVM Thesis, AAU, FVM, Debrezeit, Ethiopia, pp: 23-24.
54. Yihdego, H., 1997. Hydatidosis: Prevalence and economic impact in bovine at Mekele municipal abattoir, zoonosis and infection in dogs. DVM thesis, AAU, FVM. Debrezeit, Ethiopia.
55. Umur, S., 2003. Prevalence and Economic Importance of Cystic Echinococcosis in Slaughtered Ruminants in Burdur, Turkey. J. Vet. Med., 50: 247-252.
56. Temesgen, A., 2008. Cattle hydatidosis in Addis animals slaughtered at Addis Ababa Abattoir. Ababa abattoir and its zoonotoc risk. J. Parasitol. Vect. Biol., 4: 1-6.
57. Arene, F., 1995. Prevalence of hydatid cysts in domestic livestock in the Niger Delta. Trop. Anim. Health Prod., 17: 3-5.

58. Lahmar, S., M. Kilani, P.R. Torgerson and M.A. Gemmell, 1999. Echinococcus granulosus larvae in the livers of sheep in Tunisia: the effects of host age. Ann. Trop. Med. Parasitol., 93: 75-81.
59. Zewdu, E., Y. Teshome and A. Makwoya, 2010. Bovine Hydatidosis in Ambo Municipality Abattoir, West Shoa, Ethiopia. Eth. Vet. J., 14: 1-14.
60. Qaqish, A.M., M.A. Nasrieh, K.M. Al-Qaoud, P.S. Craig and S.K. Abdel-Hafez, 2003. The seroprevalence of cystic Echinococcosis and the associated risk factors, in rural agricultural, bedouin communities in Jordan. Iran J. Parasitol., 22: 2-7.