Hydatidosis/Echinococcosis: its prevalence, economic and public health significance in Dodola district, western Arsi zone of Oromia region, Ethiopia

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Abstract. A cross-sectional study on bovine hydatidosis was conducted in Dodola municipality abattoir from November 2013 to April 2014 with the aim of investigating the prevalence, cyst characterization and assessment of financial losses in cattle slaughtered for human consumption. Out of the total 384 cattle examined 195 (50.78%) were found infected with hydatidosis. From the examined animals, 97 (25.26%), 79 (20.57%), 12 (3.13) and 7 (1.82%) contained hydatid cyst in their lungs, livers, spleens and hearts, respectively. Age related infection was significant in that older animals were more infected (P<0.05, x2 = 5.3341, df =1). Hydatid cyst sized determination showed that there were a total of 147/274 (53.6%) small, 79/274 (28.8%) medium and 48/274 (17.5%) large sized cysts in their lungs, livers, spleens and hearts, respectively. Concerning the fertility test, 23.7%, 50.0% and 26.3% were fertile, sterile and calcified cysts respectively were observed. There was no reported case of human hydatidosis in the health centers during this study period which may not suggest that the study region is free of this disease. The total annual economic loss due to direct and indirect loss was estimated to be 168,881.05 Ethiopian Birr which is equivalent to 3,318,512.60 USD. The present study showed that hydatidosis is considerably prevalent disease of cattle in the study area with considerable economic and serious public health concern.

Keywords: Bovine; Dodola; Fertility; Echinococcosis/Hydatidosis; Prevalence; Oromia.

Introduction

Hydatidosis (Cystic echinococcosis) caused by the larval stage (metacestode) of Echinococcus granulosus is the most widespread parasitic zoonoses. Dogs are the usual definitive hosts whilst a large number of mammalian species can be intermediate hosts, including domestic ungulates and man ( Soulsby, 1986; Torgerson and Budke, 2003; Eckert and Deplazes, 2004). The outcome of infection in livestock and human is hydatid cyst development in lung, liver or other organ. Hydatid cyst causes severe
disease and death in human (Eckert and Deplazes, 2004).

The disease occurs throughout the world and causes considerable economic losses and public health problems in many countries (Ansari-Lari, 2005; Majorowski et al., 2005). Hydatidosis causes decreased livestock production and condemnation of offal containing hydatid cysts in slaughterhouses (Eckert and Deplazes, 2004; Azlaf and Dakkak, 2006). Despite the large efforts that have been put into the research and control of echinococcosis, treatment cost and lost wages, it still remains a disease of worldwide significance. In some areas of the world, cystic echinococcosis caused by E. granulosus is a re-emerging disease in places where it was previously at low levels (Torgerson and Budke, 2003). The fertility of hydatid cyst occurring in various intermediate host species is the most important factors in the epidemiology of the disease. The fertility of hydatid cyst varies depending on intermediate host species and geographical areas (Himonas et al., 1994).

Echinococcosis infection is endemic in East and South Africa Central and South America, South Eastern and Central Europe, Middle East, Russia and China. The highest incidence is reported mainly from sheep and cattle rearing areas (Subhash, 2004). Several reports from different parts of Ethiopia indicate that hydatid cyst is prevalent in livestock (Haylemelekot, 1995; Olika, 1997; Hagos, 1997; Weldegiorgis et al., 2008).

Therefore, this study was undertaken to:
1) determine the prevalence of bovine hydatidosis,
2) characterize cysts,
3) assess public health and economic significance of hydatidosis.

Material and methods

Study Area

The study was undertaken in Dodola town, Western Arsi zone of Oromia regional state, located 328 km Southeast of Addis Ababa. The area is found at a longitude of 39°11'E, and latitude of 06°59'N and the altitude with an elevation ranging from 2362 to 2493 meters above sea level. It is the administrative center of Dodola woreda. The climatic pattern of the study site is typical of that of the central part of the central plateau with main wet season from June to September usually preceded by a less pronounced wet period in March and April. The mean annual rainfall is 940 mm. The rainfall increases with altitude. The minimum and maximum temperatures are 3.8°C and 24.8°C, respectively. 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 and dogs are commonly used for control and guarding of herds of cattle and flocks of goats and sheep (Bale Zone Agricultural and Rural Development Office, 2012).

Study Animals

The study animals were indigenous cattle brought from various localities to Dodola municipal Abattoir. During ante-mortem examination, each animal received an identification number and age was determined. Estimation of age was done by the examination of the teeth eruption (De Lahunta and Habel, 1986). Two age groups were considered: above 5 years and below 5 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.

Sample Size and Sampling Method

There was no study conducted previously on the prevalence and economic importance of hydatidosis in Dodola municipality abattoir. A total of 384 indigenous zebu cattle slaughtered at Dodola municipality abattoir during this study period were inspected and examined.

Study Design and Methodology

The study design employed was cross sectional study type with objectives of determining the prevalence, economic and public health significance of hydatidosis/echinococcosis in Dodola town and its surrounding villages. Additionally, cyst characterization and
economic loss due to hydatidosis was also included.

Postmortem Examination

After slaughter different visceral organs of cattle including Liver, Lungs, Kidneys, Heart and Spleen were carefully examined by inspection, palpation and incision for presence of hydatid cysts. The observed non-calcified hydatid cysts were arbitrarily classified into large, medium and small based on their size according to procedures used by Dalimi et al. (2002). About 95% of the study animals were males. The total numbers of mature cysts obtained per organ were counted in different organs. The minimum and maximum cyst burden per organ was also recorded. The fertility and sterility of hydatid cyst was recorded in order to investigate the viability of the cyst. Fertile cysts were subjected to viability test. Fertility or sterility of hydatid cyst was determined by the method described by Weldegiorgis et al. (2008).

Cyst Fertility and Sterility

The pressure of the cyst fluid was reduced by using a sterile hypodermic needle. Then cyst was incised with a sterile scalpel blade and the content was poured into a glass Petri dish and examined. Either the presence of protoscolices attached to the germinal layer in the form of brood capsule or its presence in the cyst fluid was considered as indicative of fertility (Macpherson et al., 1985). Fertile cysts were further subjected to viability test. A drop of fluid from cyst containing the protoscolices were placed on the microscope slide, covered with cover slip, and observed for amoeboid like peristaltic movements with × 40 objective. For clear vision, a drop of 0.1% aqueous eosin solution was added to equal volume of protoscolices in hydatid fluid on microscope slide with the principle that viable protoscolices should completely or partially exclude the dye while the dead ones take it up (Macpherson et al., 1985). Sterile hydatid cysts are characterized by their smooth inner lining, usually with a slight turbidity of the contained fluid and typical calcified cyst that produced a gritty sound feeling upon incision (Parijia, 2004).

Economic loss analysis

To study 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 and spleen), and the indirect losses were assessed based on live weight reduction due to hydatidosis.

In calculating cost of condemned edible organs and carcass weight loss, fifteen different meat sellers were interrogated randomly to establish the price per unit organ and the collective price of lung, liver, heart, spleen, and kidney 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).

Average annual slaughter rate of cattle in Dodola municipality abattoir was estimated based on retrospective analysis of data recorded from four years which gives 1625 cattle. A 5% estimated carcass weight loss due to bovine hydatidosis described by (Polydorou, 1981) 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 (ILCA) (Yihdego, 1997).

Direct loss from organ condemnation

Annual economic loss = (PI1x TkxC1) + (PI2xTkxC2) + (PI3xTkxC3) + (PI4xTkxC4) (Ogunrinade and Ogunrinade, 1980)

Where,

PI1 = Percent involvement of lung out of the total examined
PI2 = Percent involvement of liver out of the total examined
PI3 = Percent involvement of spleen out of the total examined
PI4 = Percent involvement of heart out of the total examined
C1 = Average market price of liver
C2 = Average market price of lung
C3 = Average market price of heart
C4 = Average market price of spleen
Tk = Average annual kill of bovines (1625 cattle).
**Indirect loss from carcass weight loss**

Annual economic losses due to carcass weight loss = Ns x Ci x Pa (Polydorou, 1981).

Where,
- Ns = Total number of animals slaughtered and positive for hydatidosis (195 cattle)
- Ci = Carcass weight lost in individual animals
- Pa = Average market price of a kg of beef in Dodola.

Annual economic losses were calculated by adding both direct and indirect losses.

A structured questionnaire survey was used to assess the significance of hydatidosis among human population in the study area. In the questionnaire survey a total of 60 randomly selected health professionals from district and zonal health centers were interviewed. Moreover, retrospective data records from Dodola hospital casebooks were analyzed.

**Data management**

Data obtained from the study were coded and stored in Microsoft Excel, and then subjected to descriptive statistics and chi-square in order to assess the magnitude of the difference of comparable variables using SPSS version 20 software. Statistically significant association between variables is considered to exist if the p-value is less than 0.05.

**Results**

Out of a total of 384 indigenous zebu cattle slaughtered at Dodola municipal abattoir 195 [50.8%] were found infected with one or more hydatid cysts involving different organs. Rate of infection of hydatidosis in different age groups [<5 years and above] was statistically significant [P<0.05, df = 1] (table 1).

Out of 195 cattle infected 97 (49.7%) had hydatid cyst in their lungs, 79 (40.2%) in livers, 12 (6.2%) in spleen and 7 (3.6%) in heart (table 3).

**Cyst Characterization**

A total of 274 cysts were subjected to morphological analysis. Out of which, a total of 48 (17.5%) large cysts were observed on lung, liver, spleen and hearts measuring more than 10cm in diameter. The large and medium sized cysts were found in lungs, while higher numbers of small and calcified cysts were found in liver (table 4).

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**Table 1.** The prevalence of hydatid cyst in different age groups of zebu cattle slaughtered at Dodola municipal abattoir in Oromia region, Ethiopia

<table>
<thead>
<tr>
<th>Age groups (yrs)</th>
<th>No animals examined</th>
<th>Prevalence</th>
<th>X²</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 (&lt;5)</td>
<td>117</td>
<td>49</td>
<td>41.8</td>
<td></td>
</tr>
<tr>
<td>Group 2 (&gt;5)</td>
<td>267</td>
<td>146</td>
<td>54.7</td>
<td>5.3341  0.021</td>
</tr>
<tr>
<td>Total</td>
<td>384</td>
<td>195</td>
<td>50.78</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2.** Prevalence in male and female zebu cattle slaughtered at Dodola municipal abattoir in Oromia region, Ethiopia

<table>
<thead>
<tr>
<th>Sex groups</th>
<th>No animals examined</th>
<th>Prevalence</th>
<th>X²</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>271</td>
<td>131</td>
<td>48.3</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>113</td>
<td>64</td>
<td>56.6</td>
<td>2.1970  0.138</td>
</tr>
<tr>
<td>Total</td>
<td>384</td>
<td>195</td>
<td>50.78</td>
<td></td>
</tr>
</tbody>
</table>
The 274 Hydatid cysts were further examined for fertility test and higher fertile cysts 42 (36.5%) were detected on lung. About 72 (26.3%) cysts were found calcified while higher percentage of these calcified cysts was found in liver 40 (32.0%). The intensity of observed cysts was higher in lungs and liver with an average of 4 cysts per organ.

Cystic Echinococcosis (CE) in humans

According to information obtained from physicians and retrospective study of Dodola hospital case books, there was no human hydatidosis clinically diagnosed in spite of a greater likelihood for its being a significant problem.

Economic loss due to organ condemnation

A total of 97 lungs, 79 livers, 7 heart and 12 spleens were condemned due to hydatidosis with an economic loss of 4,925.70, 10,029.30, 236.60 and 126.95 ETB respectively. This was calculated from average market price of cattle liver (30 birr), cattle lung (12 birr), cattle heart (8 birr) and cattle spleen (2.50 birr) and the total number of organ condemned during the study period. On the other hand, annual economic loss was determined by considering annual slaughter rate of cattle and prevalence of hydatidosis per liver, lung, heart and spleen and it is calculated to be 15,318.55 ETB annually.

Economic loss due to carcass weigh. A 5% carcass weight loss due to hydatidosis (Polydorous, 1981) was considered as the information given previously to estimate the economic loss. The computed result showed a loss of 153,562.50 ETB per annum. Therefore, the total estimated economic loss in cattle at Dodola municipality abattoir due to hydatidosis was estimated to be 168,881.05 ETB which is equivalent to 3,318,512.60 USD at the exchange rate of ETB 19.65 to USD.

Discussion

Hydatidosis is known to be important in livestock and public health in different parts of the world and its prevalence and different workers in different geographical areas have reported economic significance. The
prevalence may however vary from country to country or even within a country. The prevalence of the disease in cattle (50.78%) slaughtered at Dodola municipal abattoir is greater than to those cattle slaughtered at Tigray region (22.1%) (Weldegiorgis et al., 2008), central Sudan 3% (Elmahdi et al., 2004) and Morocco 22.98% (Azlaf and Dakkak, 2006). A higher prevalence of hydatidosis (48.7%) has been reported from Ngorongoro district of Arusha region, Tanzania (Ernest et al., 2008). A lower prevalence rate was also reported from Burdur (Turkey) 13.5% (Umur, 2003) and from Thrace (Turkey) 11.6% (Esatgil and Tuzer, 2007). The variation in prevalence between different countries and regions may be attributed mainly to strains difference in E. granulosus that exist in different geographical situations (Arene, 1995). Other factors like difference in culture, social activity and attitude to dog in different regions might have contributed to this variation (Macpherson, 1985).

The prevalence rate of 50.78% in the study area was high. This might be due to the abundance and frequent contact between the infected intermediate and final hosts. It could also be associated to slaughtering of aged cattle, which have had considerable chance of exposure to the parasitic ova, backyard slaughtering of small ruminants, and provision of infected offal to pet animals around homesteads. Moreover, poor public awareness about the disease and presence of few slaughterhouses could have contributed to such a higher prevalence rate.

With regards to rate of infection of hydatidosis in different age groups of cattle, significant difference (P<0.005) was observed. Animals with more than 5 years of age were highly affected. The difference in infection rate could be mainly due to longer exposure time to E. granulosus. This finding is in agreement to the finding of Lobago (1994), Yihdego (1997), Umur (2003), Azlaf and Dakkak (2006) and Esatgil and Tuzer (2007).

The statistical analysis result indicated that there was no significant difference between the prevalence of bovine hydatidosis in both sexes. This might be due to the fact that all exposed groups might got access to infection with different degree based on the organ parasitized and the size attained by hydatid cyst. The incidence of the disease (infection) in the area in both animals and man can be determined from its level in dogs. It is also valuable to investigate the management, and feeding of dogs to discover how the cycle of infection maintained. Habit, customs and occupation, particularly attitude to dogs, may also influence the prevalence of metacestodes infection in a certain group (Macpherson et al., 1985).

From the organ prevalence study, lung is found to be the most commonly affected organ. This might be due to the fact that cattle are slaughtered at older age. During this period, the liver capillaries are dilated and most cysts directly pass 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 the liver and/or instead of the liver (Arene, 1995). Similar findings were reported by Yihdego (1997) and Olika (1997). But, this result contradicts with Soulsby (1986) and Lobago (1994).

Out of the total 274 examined hydatid cysts for size, 147 (53.6%), 79 (28.8%) and 48 (17.5%) were small, medium and large sized cysts respectively. The high proportion of small cysts may indicate that infection of animals as a result of heavy rainfall and continuous grazing in the past rainy seasons or due to immunological response of the hosts, which might have reduced the expansion of cyst size. Moisture and rainfall favor the survival of eggs of E. granulosus species and at the same time eggs may get chance to be disseminated by flood (Yihdego, 1997).

Lung harbored higher number of large sized cysts and medium sized cysts, while liver was found to harbor higher number of small and calcified cysts. The high number of large and medium sized cysts in lung may be due to relatively softer consistency (Smyth, 1994). The higher number of calcified cysts in the liver could be attributed to the reticuloendothelial and connective tissue of the organ (George and
Diame, 1981). This finding is similar to the findings of Yihdego (1997). Result of the present study revealed that lung is the most common organ which harbored fertile cysts followed by liver. This result is similar to other workers such as Himonas (1987) and Yihdego (1997). It has been stated that relatively softer consistency of lungs allow earlier development of cyst; and fertility of hydatid cysts may show a tendency to increase in advanced age of the host. This may also be related to reduction in immunological compatibility of the host at their older ages of infection (Arene, 1995).

The liver and lung are the most commonly infected organs. The heart and spleen are the least affected organs in the study animal. Similar findings were also obtained by various workers and it's indicated that the liver and lungs are the most commonly affected organs with hydatid cyst due to the reason that there are the first large capillary fields encountered by the blood borne onchosphere. However, development of hydatid cysts occurs occasionally in other organs and tissue when onchosphere escape in to the general systemic circulation (Smyth and Barret, 1980).

From the organ, prevalence study the lung is found to be the most commonly affected organ followed by liver. The liver infection may be a reflection of the route of parasite entry and seems to support the hypotheses of hepatic portal distribution of the onchosphere leading to the liver infection. The proportion of large and medium is higher in the lung than in the liver. Similar finding was obtained by in the same study area. Similarly, in the rare sites such as the abdominal cavity, where unrestricted growth is possible, the hydatid may attain very large size containing several liters of fluid (Nicholson and Butterworth, 1986).

The percentage of calcified cysts is found to be higher in the liver than in the lungs. This may be associated with the relatively higher reticuloendothelial cells and abundant connective tissue reaction of the organ (Khurro, 2002), which encapsulates the cyst within a fibrous wall up to 13 mm thick. From the fertility and viability study, the percentage of fertile cysts was found higher in lung than the liver, this is due to the relatively softer consistency of the lung allows easier development of the pressure cyst and fertility of hydatid cyst may show tendency to increase (Ahmadi and Meshkehkar, 2011).

Information about prevalence and fertility of hydatid cysts in various organs of cattle are important indicators of potential source of infection to perpetuate the disease to dogs. In our study the percentage of fertile cysts recovered was 32.5%. This is low compared to 70% in the Great Britain, 96.9% in South Africa and 94% in Belgium (Arene, 1995) but comparable to Elmahdi et al. (2004) and Ernest et al. (2008), who reported 22% and 21.3% fertile hydatid cysts from central Sudan and Ngorongoro district of Arusha region, Tanzania, respectively. Elmahdi et al. (2004) also reported low (3%) prevalence from Central Sudan. Hydatid cyst condition tends to follow size dependent pattern in that most of the small cysts were calcified. This can be due to the host defense mechanisms of killing more efficiently with parasitic larvae at the early stage of development (Himonas, 1987).

The questionnaire survey conducted to assess the public health significance of hydatidosis showed the awareness of most of health workers including physicians working in the hospitals and health centers was very low. During this study period, there was no reported case of human hydatidosis in the health centers. However, the complete absence of reported human hydatid cases from the study area may not suggest that the study region is free of this disease. Lack of modern diagnostic facilities, clinical similarities with other disease and its asymptomatic appearance and extended incubation period added to the inability to afford medical treatment by the most vulnerable section of the society could have contributed to the obtained result. Moreover, further study in this regard is necessary.

The annual economic loss due to bovine hydatidosis at Dodola municipality abattoir from direct and indirect losses was estimated to be 168,881.05 ETB. In addition to losses incurred in the abattoir, hydatidosis could have economic impact due to invisible losses like
impaired productivity; for example, reduced traction power of oxen, which results in reduced crop production. Moreover, cost of control, loss of life, productivity and treatment cost in humans magnifies the economic losses. Our finding of annual economic losses is much higher than the report of Weldegiorgis et al. (2008) who reported annual economic loss of 25,608 Ethiopian Birr in their study in Tigray region of Northern Ethiopia. Torgerson and Budke (2003) and Majorowski et al. (2005) reported significant total economic losses in monetary terms due to cystic echinococcosis both in the public health and livestock sector.

In conclusion, the prevalence of bovine hydatidosis observed in the present study was high and undoubtedly reflects the potential hazard to public health in the area and incurring huge financial loss due to organ condemnation and indirect weight loss. Among major risk factors facilitating the distribution of the disease are back yard slaughtering, lack of adequate fencing in existing slaughter house and absence of stray dogs control in the area. The problem warrants well organized control intervention through creation of public awareness in terms of knowledge of parasitic zoonotic diseases and control of stray dogs in order to minimize the risk of acquiring hydatidosis.

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References


