Annals of Parasitology 2021, 67(4), 627–635
doi: 10.17420/ap6704.379

Original paper

Cystic echinococcosis, a food-borne zoonotic neglected tropical disease in slaughtered cattle at Jimma Town municipal abattoir, Southwest Ethiopia

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ABSTRACT. Cystic echinococcosis (CE), also called hydatid disease (HD) is a parasitic disease caused by larval stage of *Echinococcus granulosus* and is considered as a food-borne zoonotic, neglected tropical disease (NTD). Backyard slaughtering and inadequate veterinary services are major risk factors for high prevalence of the disease in developing countries. Here, we determined the prevalence of HD in the cattle slaughtered in the municipal abattoir of Jimma Town, Southwest Ethiopia by an abattoir based cross-sectional study, which included 389 randomly selected cattle. The source of cattle, age, sex, breed, the body condition and any acute illness were assessed in ante-mortem investigations. Moreover, during post-mortem examination, vital organs suspected for hydatid cysts (HCs) were carefully examined by close inspection, digital palpation and sharp incision. Fertility and viability were tested for all HCs containing hydatid fluid. The overall prevalence of HC among the cattle was 52.9% (206/389). Lungs were the most affected organ 70.9% (146/206), and 29.6%, 62.1%, and 8.7% of the HCs were fertile, sterile and calcified, respectively. The HC abundance and viability had statistically significant association with the organs affected, and fertile HCs were most common at lung. Collectively, our study revealed that CE is highly prevalent in slaughtered cattle at the Jimma area, Ethiopia and lungs are the major affected organs. An integrated prevention and control strategies from various sectors through 'One Health' approach are essential to tackle the problem, and proper awareness must be built up among people about the devastating effects of the disease.

Keywords: cystic echinococcosis, hydatidosis, *Echinococcus granulosus*, food-borne zoonotic, neglected tropical disease (NTD)

Introduction

Cystic echinococcosis (CE) is an important zoonotic, food-borne parasitic disease caused by the larval stage of the tapeworm species *Echinococcus granulosus* has been listed to the neglected tropical diseases (NTDs). Prevalence of human echinococcosis is high in areas where human maintains close contact with the dogs, the definitive host, and various domestic herbivores, including livestock act as intermediate hosts [1]. Molecular surveys indicates that the genus *Echinococcus* comprises different species, of which *E. granulosus* is common [2,3]. *E. granulosus* has a global geographic

distribution infecting both humans and livestock [2], of which livestock such as cattle, sheep, goats and camels play vital roles in the transmission cycle of the parasite, however, humans get infection through accidental ingestion of the parasites' eggs with contaminated food and water, and act as dead-end host. Dogs and other canine/feline species are the obligate definitive host that are infected by ingesting infected offal (lung, liver, kidney, spleen, etc.) [4,5].

The persistence, emergence and re-emergence of CE are associated with several risk factors including large number of domestic and stray dogs infected with *E. granulosus*, and close association of dogs with food animals. Moreover, the lack of protected slaughterhouse, poor veterinary services, low awareness towards the disease, inadequate funding in zoonotic, helminth disease, poor inspection of meat and an open field disposal of infected visceral organs are associated with persistence and emergence of the disease [6–11]. As a global problem of humans and various species of livestock, the socio-economic impact of hydatidosis estimated to be significant in endemic areas. Its global burden is also associated with annual loss of livestock production [12]. CE is not only results in loss of money, it also worsens the protein deficiency in human due to the condemned organs and decreased productivity of infected animals [13]. In human, the disease is usually fatal until and unless CE is diagnosed early and removed radically by surgery. Globally, 200,000 new cases are diagnosed annually and ~3 million people are affected [14]. Annual DALYs losses due to CE is estimated to be 1009,662 and monetary loss is US$ 763, 980, 979 [12,14]. According to the report of 2017, the global burden of CE is about 184,000 DALYs [15].

According to the studies conducted in Ethiopia, the prevalence of CE in cattle ranges from 13–72% [16,17]. High prevalence of the disease in Ethiopia could be due to common risk factors including slaughtering in backyard, lack of meat inspection and provision of passing infected offal and dead animals to dogs [18]. Moreover, poor public awareness about hydatid disease (HD) and lack of standard slaughter houses also contribute to higher prevalence of hydatidosis [19]. The municipal abattoir of Jimma Town frequently condemn HC containing visceral organs without following the proper procedures of hazardous biological waste management. Moreover, a large number of domestic and stray dog live at the same niche of the municipal abattoir to feed on the condemned organs of slaughtered animals. The faecal materials of these dogs may contaminate the environment and contribute to continue the transmission cycle of the parasite. However, there is paucity of information about the epidemiology of HD in the cattle presented at Jimma Town municipal abattoir. Therefore, this study was conducted to determine the prevalence, fertility and viability of the HC in the cattle slaughtered at Jimma Town municipal abattoir.

Materials and Methods

Study setting and period

Jimma Town is located 352 km southwest of the capital city of Ethiopia (Addis Ababa), in Oromiya regional state in the latitude and longitude of (7°40′N 36°50′E). There are more than 2 million cattle, 900,000 sheep, 300,000 goats and 150,000 equines [20]. The study was undertaken from December, 2014 to February, 2015.

Study design, sample size and sampling technique

Only three abattoirs including Jimma Town, Agaro and Shebe are functional at the study areas but most of the slaughtering undertook at Jimma Town due the highest population of residence. We conducted an abattoir based cross-sectional survey to determine the prevalence of CE along with some other risk factors. All cattle slaughtered at those abattoirs were included as a study population for sampling. The sample size was determined by using single population proportion formula using the prevalence of hydatidosis among cattle population slaughtered in the study area 36.3% [21]. Moreover, we included a 10% non-response rate, which gave a sample size of 389. Although 30–40 cattle were prepared for daily slaughtering, we randomly selected daily 5–10 cattle using an identification code until the calculated sample size reached.

Ante-mortem examination

Age, sex, breed and body conditions of the selected cattle were determined during ante-mortem examination. The age of each cattle was estimated based on the dentition eruption chart by veterinary professionals [22]. The physical body condition of animals was classified into three as lean (score 1, 2 and 3), medium (score 4, 5 and 6) and fat (score 7, 8 and 9) as described in table 1 [23]. Moreover, the area from where the cattle came was determined by

Table 1. Age, geographical source and body condition of the cattle slaughtered in Jimma Town municipal abattoir, Southwest Ethiopia

Variables /categories	Status of hydatid cyst			OR	*P*-value
	Infected (N)	Total	(%)		
Age of cattle (years)					
≤ 4.5	123	224	54.9	1	0.37
> 4.5	83	165	50.3	0.83	
Geographical source of cattle (district)					
Seka	68	127	53.5	1.00	0.35
Dedo	33	67	49.2	.842	0.57
Serbo	31	62	50.0	.868	0.65
Agaro	53	86	61.6	1.393	0.24
Others*	21	47	44.7	.701	0.30
Status of body condition					
Medium	161	311	51.8	1	0.35
Fat	45	78	57.7	1.27	

*Cattle from Sigmo, Santema, Bedele, Sokoru, Asendabo and Omo Nada

asking the owner of the cattle during the arrival of the cattle in the market.

Post-mortem inspection

A thorough examination was conducted by close inspection, digital palpation and systematic incision of lung, liver, kidney, heart and spleen following the procedures recommended by Food and Agriculture Organization (FAO) by two independent veterinary professionals [24]. All organs with HC were removed as whole and size of the cysts (average cyst diameter) was measured using measuring ruler and classified as small (diameter less than 5 cm), medium (diameter between 5 cm and 10 cm) and large (diameter greater than 10 cm). Moreover, the number of HCs in each organ were counted [25]. The cysts containing hydatid fluid were collected and kept into separate container and labeled using permanent markers. The cysts were transported to the parasitology laboratory, Jimma University. Hydatid fluid was collected from all HCs and transferred into clean container. After repeated mixing the fluid, about 10 ml the fluid transferred into a clean test tube and centrifuged for 5 minutes at 5000 rpm. The contents from sediment were examined under a microscope for the presence of brood capsule containing protoscolices. The cysts were classified as sterile (cysts without any protoscolices) and fertile (cysts with protoscolices). Viability of the protoscolices was checked by observing amoeboid peristaltic movements (flame cell activity). Moreover, doubtful results were further examined after vital staining with 0.1% aqueous eosin solution and mixing with equal volume of hydatid fluid and allowed to stand for 15 minutes on a microscopic glass slide. The protoscolices were classified as dead (non-viable) when they took up the stain and live (viable) when they did not take the stain [26].

Data management and analysis

The data was coded and entered in to SPSS 20.0 software. Descriptive statistics was computed and summary values, such as frequency and percentage were determined. Association between *E. granulosus* infection and the age, districts of cattle origin, body condition were determined using bivariate analysis. Statistical significance was determined when the *P*-value is less than 0.05.

Results

Prevalence of HC

The overall prevalence of HC was 52.9% (206/389) among the cattle slaughtered at Jimma Town municipal abattoir. Among various visceral

Table 2. Cyst number, size, fertility and viability against the age, body condition and geographical source of cattle slaughtered in Jimma Town municipal abattoir, Southwest Ethiopia

		Cyst number			
		≤ 4 >	4		*P*-value
Age (years)	≤ 4.5	87	51		0.13
	> 4.5	36	33		
The body condition	Medium	107	55		0.72
Sources of cattle	Fat	31	14		
	Seka	51	18		0.09
	Dedo	23	10		
	Serbo	22	9		
	Agaro	26	27		
	Others	16	5		
Infected organ	Lung	92	54		0.01*
	Lung and liver	43	15		
		Cyst size			
		Small	Medium	Large	
Age (years)	≤ 4.5	36	27	44	0.43
	> 4.5	30	23	28	
The body condition	Medium	47	40	58	0.19
Sources of cattle	Fat	19	10	14	
	Seka	22	19	22	0.32
	Dedo	15	4	12	
	Serbo	9	8	9	
	Agaro	15	15	22	
	Others	5	4	7	
		Cyst fertility			
		Fertile	Sterile	Calcified	
Age (years) ≤	4.5	34	74	10	0.54
	> 4.5	26	54	8	
The body condition	Medium	47	76	38	0.42
Sources of cattle	Fat	11	18	13	
	Seka	19	35	14	0.81
	Dedo	7	9	14	
	Serbo	9	16	6	
	Agaro	18	25	10	
	Others	5	9	7	
		Cyst viability			
		Viable	Non-viable		
Age (years)	≤ 4.5	24	12		0.94
	> 4.5	16	8		
The body condition	Medium	32	16		0.85
Sources of cattle	Fat	8	4		
	Seka	13	6		0.29
	Dedo	6	1		
	Serbo	7	2		
	Agaro	10	9		
	Others	3	2		
Infected organ	Lung	31	19		0.04*
	Lung and liver (both)	8	9		

organs inspected, lungs were the major affected organ 70.9% (146/206) followed by liver (16.5%, 34/206) (Tab. 1). HC of different sizes were recovered, of which 72 (34.9%), 50 (24.3%), 84 (40.8%) were large, medium and small, respectively (Fig. 1), and number of HCs per organ ranged from 1 to 15.

All of the cattle involved in this study were male and local breed. Age of the cattle ranged from 3.0–6.5 years and majorities of the cattle 57.6% (224/389) were <4.5 years of age, and prevalence was significantly higher at the age of four years (57.4%). About 79.9% (311/389) of the slaughtered cattle had medium body conditions, followed by fat 19.8% (77/389). Almost similar number of HC was found in medium and large body sized cattle. The geographical sources of the cattle included from Seka (127, 32.6%), Agaro (86, 22.10%), Dedo (67, 17.22%), Serbo (62, 15.94%) and some others small districts around Jimma Zone (Bedele, Asendabo, Gatira, Yebu, Sigmo and Bilida) that accounts (47, 12.08%) (Tab. 1). The highest prevalence of HC was found among the cattle from Agaro geographical district 61.6% (53/86) followed by Seka district 53.5% (68/127) (Tab. 1).

Fertility and viability of HC

From the total of 206 HCs, 62.1% (128/206), 29.1% (60/206), and 8.7% (18/206) were sterile, fertile, and calcified, respectively. Most of the large cysts (60/72) were fertile, of which 66.7% (40/60) were viable and 33.3% (20/60) were non-viable (Tab. 2).

Age, body condition and geographical sources of the slaughtered cattle

The association between the prevalence of HC, age, physical body condition and the geographical sources of the slaughtered cattle were determined using bivariate statistical analysis. There was no statistically significant association between the HC infection and those independent variables (P>0.05) (Tab. 1). Almost similar crude odds ratio were observed among those independent variable and presence of HCs (Tab. 1).

The effect of HC number, size, fertility and viability were analysed against age, physical body condition and geographical sources of the slaughtered cattle. Nevertheless, there is no statistically significant association between the cyst number, size, fertility and viability with age, physical body condition and geographical source of the cattle (P>0.05) (Tab. 2). Both the cyst number and cyst viability showed statistically significant association with the location of the cyst in lung (P<0.05).

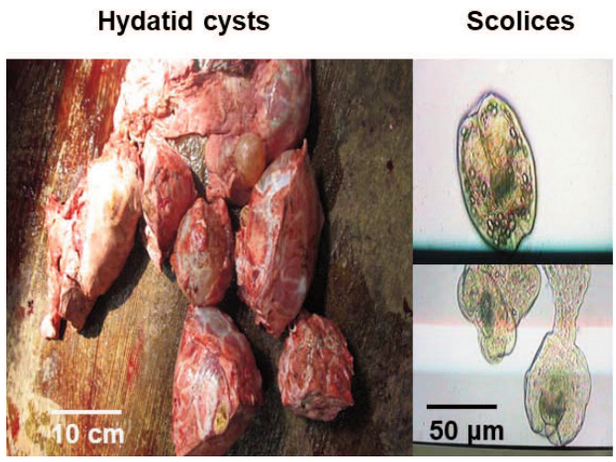

Figure 1. Hydatid cysts of different sizes along the scolices recovered

Discussion

In spite of significant progresses achieved to control parasitic disease, CE remains a considerable public health problem in many regions of the world [27] and remains persistent and re-emerging in low income countries (LiCs) where a resource for an intensive control program is limited.

The overall prevalence of HC among the cattle slaughtered at Jimma Town municipal abattoir was still pretty high (52.9%). This finding is almost similar with the prevalence (48–53%) reported at Hawasa [28], Shashemanne [29] and Debre Markos [30]; which suggests that HC is almost equally distributed in different parts of Ethiopia and warrants government attentions for the prevention and control activities across the country. However, higher prevalence (63–85%) of HC among slaughtered cattle was reported from Assela [31], Bale Robe [32], Gondar, and Finoteselam [33]. The population of dogs in the surroundings and human attitudes towards dogs' ownership and managements, and method of cattle rearing may be associated with higher prevalence of HC in the foresaid areas. In addition, backyard slaughtering practice of a cattle without inspection, and provision of feedings of infected offal's to dogs could favor high transmission and the prevalence of HC [34]. In the contrary, the prevalence of HC in the current study was higher than that of other studies (10 to 47%)

conducted in Ethiopia including Harar [35], Dessie [36], Birre-Sheleko and Dangila [37], Wolayita Sodo [38], Addis Ababa [39], Dire Dawa [40], Nekemte, Western Ethiopia [41], Ambo, [42], Jimma [21, 43], Shire Tigray [44], Mekelle, Tigray [45], Bahir Dar [17], Addis Ababa [46] and Adama [47]. The difference might be attributed to the increasing practice of the backyard slaughtering, loose regulatory enforcements, lack of awareness among communities towards the disease, and poor prevention and control measures towards zoonoses.

On the other hand, the prevalence of HC in our study was higher than the prevalence reported from other African countries (prevalence 4% to 26%) including Tanzania [48], Kenya [49], Zambia [50], and Morocco [51]. The variation could be ascribed to climate, culture of slaughtering and the disposal of infected organs, strength of prevention and control mechanisms in place in those countries in contrast to the current study area.

It is worth mentioning that the prevalence of CE in the municipal abattoir of Jimma Town has increased compared to previous studies that reported 31% to 36% [21,43]. This might be due to the lack of collaborative work for prevention and control of zoonoses among different sectors, poor management of dogs, lack of standard slaughter-house and lack of awareness towards the prevention and control of the disease.

Prevalence of HC was higher in aged animals (≥5years), which may be due to long time exposure of the cattle to parasite egg in the grazing area, thus increasing the possibility of acquiring the infections. Previous studies strongly suggest the prevalence of HC is heavily influenced by age of the cattle [17,52]. Among different visceral organs inspected for HC, lung is the major affected organ (70.9%). As the cattle get older and ready to be slaughtered, their liver capillaries are dilated and most cysts directly pass to the lungs [53]. There is a possibility that the hexacanth embryo enter into 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 [54]. This finding is in consistent with different reports on CE [17,33,37,42]. Greater attention should be given to the lungs during post-mortem examination of the slaughtered animal and during the disposal of offals infected with HCs.

Majorities of HCs (41.8%) are small in size. But large number of medium and large sized cysts were found in lungs and most of the calcified cysts were found in liver. The reason for highest percentage of medium and large cysts in the lungs could be due to softer consistency of the lung while the higher yield of calcified cysts in liver could be attributed to relatively higher reticuloendothelial cells and abundant connective tissue reaction of the organ. The high proportion of small cysts may be due to immunological response of the host which might preclude expansion of cyst size [42,55]. We observed that the highest proportion of HCs were fertile (29.1%, 60/206)) and viable (67.2%, 41/60), which conforms to the findings obtained from Addis Ababa, Ambo, Awassa and Birre-Sheleko and Dangila abattoir [28,37,39,42]. Large number of viable HCs favours further transmission of the disease at the study area and there will be a high risk for the definitive host to be infected. High fertility and viability of HCs in the cattle slaughtered in the study area undoubtedly reflect the potential hazard to public health in the area.

It can be concluded that, findings of present study reflect high impact of CE in the cattle that deserves serious attention by various stakeholders and professionals. Since slaughterhouse (abattoir) could be the major risk at urban settings for the emergence of CE, promoting the construction of standard abattoirs with appropriate disposal pits and incinerator are essential. Establishment of strong policy on dog keeping, handling, registration, treatment and elimination of stray dogs will alleviate the problem. Furthermore, as the urban settings might favour the transmission of CE to human population; further in-depth studies in human population should be encouraged. Integrated prevention and control programs towards CE from different sectors through “One Health” approach will alleviate the burden.

Acknowledgements

We would like to thank OHCEA Research Innovations Project (ORIP) for financial support and Jimma University for providing the laboratory facility. It is our pleasure to thank those veterinary professionals involved in the ante-mortem and post-mortem investigation during data collection, specially Dr. Hussen and Mr. Hailu. Moreover, we are indebted to Jimma Town municipality for permission to conduct the study in the municipal abattoir. Lastly, we are happy to acknowledge the owners of the cattle for provision of information regarding the geographical sources of the cattle.

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Received 24 October 2020
Accepted 23 July 2021