Global Veterinaria 11 (4): 465-471, 2013
ISSN 1992-6197
© IDOSI Publications, 2013
DOI: 10.5829/idosi.gv.2013.11.4.76146

Infection Rates, Risk Factors and Cyst Fertility of Hydatid Disease in Camels in Ayssaita District, Northeastern Ethiopia

[1]Dawit Gebremichael, [2]Aklilu Feleke, [3]Getachew Terefe and [4]Matios Lakew

[1]Department of Animal Science and Eco-tourism, Aksum University, Aksum, Ethiopia
[2]Department of Veterinary Microbiology, Immunology and Public Health,
Addis Ababa University, Debre Zeit, Ethiopia
[3]Department of Veterinary Parasitology and Pathology,
Addis Ababa University, Debre Zeit, Ethiopia
[4]Goal Ethiopia, Gulina District, Afar, Ethiopia

Abstract: Hydatidosis is highly public health problem and economic importance worldwide. A cross-sectional survey of camel hydatidosis was carried out on 421 camels from October 2012 to May 2013 in Ayssaita district. The main objectives of this study were to estimate the prevalence and identify the potential risk factors to acquire hydatidosis infection in camels slaughtered in backyard in pastoral area. The overall prevalence of camel hydatidosis was found to be 34.20% (95%CI: 29.65, 38.75). Based on the potential risk factors, the likelihood of acquiring camel hydatidosis was higher in female than male (OR = 1.73, 95% CI: 1.11, 2.69, P = 0.02), in old than young (OR = 5.75, 95% CI: 2.88, 11.49, P < 0.0001), in lean than good body condition (OR = 4.5, 95% CI: 2.15, 9.13, P <0.0001). Sources of water and feeding habit of camels was also found to be statistically significant (P<0.05). Of the 144 camels positive, 47.90% had cysts in the lungs only, 20.80% in the liver only, 29.90% in both liver and lung and 1.40% in the spleen alone with a total of 187 organs were infected. 62.35% and 42.35% were fertile and 67.92% and 66.67% of the fertile cysts were viable in lung and liver, respectively. Questionnaire survey to investigate on public awareness and its risk factors on pastoralists and revealed that only 4.29% of pastoralists indicated that they had been awared, but none of them were knowledgeable on its sources and transmission. Therefore, it is concluded as it is highly imperative to impart public health education to build up public awareness about the sources of infection and its control in the pastoral area.

Key words: Ayssaita · Backyard · Camel · Hydatidosis · Knowledge · Pastoralists · Risk Factors

INTRODUCTION

Camels are implicated as one of the important contributors of zoonotic infections in humans. Apart from the common pathogens, hydatidosis is known to have historical significance in pastoral areas. Camel plays a major role in the epizootiology of the disease, where it is the main domestic animal that lives in close contact with dogs [1]. Hydatidosis is a neglected cyclozoonotic disease affecting humans and their livestock, thereby causing significant socioeconomic and public health impacts, mostly in developing countries [2]. It represents a significant global human disease burden in poor pastoral communities. Hydatidosis is a major parasitic disease and is caused by the larval stage of the dog tapeworm *Echinococcus granulosus* (*E. granulosus*) and is characterized by the formation of cysts (hydatid cysts) varying in size [3,4]. Recent molecular characterization of human and animal *E. granulosus* isolates demonstrated that the camel strain (G6) is also equally important source of infection to humans [5, 6].

The emergence and re-emergence of zoonotic diseases are challenges to all professionals concerned with public health. Echinococcosis is emerging or re-emerging zoonotic disease in some areas [7]. Approximately, 2-3 million human cases are thought to

Corresponding Author: Dawit Gebremichael, College of Agriculture, Aksum University, Aksum, Ethiopia.
P.O. Box 314, Shire.

occur worldwide [8]. Hydatid disease, not only results in loss of millions of money in terms of public health each year, but also it worsens the protein deficiency for human consumption in terms of condemned organs and lowered productivity of infected animals [9, 10].

Hydatidosis is widespread in Ethiopia with great economic and public health significance [11, 12]. Cystic echinococcosis was also reported in humans from northern, central and southern parts of the country. Certain deeply rooted traditional activities could be commonly described as factors substantiating the spread and high prevalence rates of the disease. These include the wide spread backyard animals slaughter practice, the absence of rigorous meat inspection procedure and the long standing habit of most Ethiopian people to feed their dogs with condemned offal which in effect facilitate the maintenance of the perfect life cycle of *Echinococcus*[13].

Similarly, though some studies are available on infection rates and associated risk factors of hydatidosis in different species of livestock (mainly cattle) in Ethiopia, very little information is documented with respect to the epidemiology of the disease in camels and its public health risk. There is no doubt that the faculty of veterinary medicine of the Addis Ababa University has made extensive studies and serves as repository of baseline information for the country. However, there are obvious gaps in terms of geographic coverage. For instance, no studies on the prevalence and its risk factors of hydatidosis were carried out in Ayssaita, northeastern Ethiopia [11, 14]. Therefore, the main objectives of this study were, to estimate the prevalence and identify the potential risk factors that facilitate hydatidosis in camel slaughtered in backyard and assess the knowledge of pastoralists' vis-à-vis public health risk of camel hydatidosis in Ayssaita district.

MATERIALS AND METHODS

Study Area: The study was conducted in Ayssaita of Afar region and Ayssaita is bordered on the south by Afambo, on the west by Dubti, on the north by Elidar of the Afar region and on the east by Djibouti. It is 670km far from capital city of Addis Ababa. It is located at a latitude and longitude of 11°34' 6"N 41°26'12"E and an elevation of 340-360 masl. The woreda consists of 13 "*kebeles"* of which two are urban, five agro-pastoral and six pastoral "*Kebeles"*. The district has 115,171 livestock populations of which 71, 383 are cattle, 23,086 are goats, 16,943 are camels and 482 are equines. The major sources of water for pastoral and agro-pastoral communities and their livestock are rivers, well, ponds and stagnant water [15].

Study Design: A cross-sectional study was carried out on 421 camels from October 2012 to May 2013 to gather information on the epidemiology of hydatidosis, fertility and viability rates of cysts and identify potential risk factors for camel infection. For this purpose, camels drawn from different neighboring areas of Ayssaita district and slaughtered at backyard in Ayssaita were surveyed.

Study Population: The study population includes all camels (*Camelus dromedaries*) in Ayssaita livestock market brought from various localities and adjacent woreda especially from Elidar and Dubti. Camels purchased during market surveys, identified with relevant information and slaughter at backyard were considered as sampling units.

Methods of Data Collection:

Antemortem Inspection and Recording of Risk Factor: Potential risk factors for hydatidosis infection in camels were collected using structured questionnaire. Information about individual camels was obtained at the market place immediately after the owner agrees to sell the animal at the price negotiated by the buyer. Such information include, age (classified as young: less than five, middle age: five to ten and old: greater than ten years according to dentation and history [16], origin of the animal (Ayssaita, Dubti and Elidar), history of dogs-camel close association, camel feeding practices (browsing and grazing vs. grazing only), management system (pastoral vs. agro-pastoral) and sources of water for camels (river only vs. well, pond and stagnant water). Body condition scores were classified as lean, medium and good based on the rib, hump, coxial tuberosity, spinous transverse process of visibility and prominent [17].

Postmortem Examination: Postmortem examination was carried out on slaughtered animals through visual inspection, palpation and incision of suspected organs (lung, liver, heart, spleen etc.). Hydatid cysts were carefully removed by a circular incisions around the cysts and separately collected (for each organ) in clean containers for further cyst characterization. The cysts were then subjected to systematic size measurements (diameter) using a ruler and classified as small cyst (<4cm), medium cyst (4-8 cm) and large cyst (>8cm) [18].

Cyst fertility and viability: Individual cysts were grossly examined for degeneration and calcification. Then, 30% of non-calcified hydatid cysts (85 from the liver and a similar number from the lungs) were randomly selected for fertility and viability tests. The surface of each cyst was sterilized with alcoholic iodine solution. The pressure

of the cyst fluid was reduced by using a sterile hypodermic needle. Then cysts were incised with a sterile scalpel blade and the content was poured into a glass petridish to be examined. The presence of protoscolices either attached to the germinal layer in the form of brood capsule or its presence in the cyst fluid was considered as indicative of fertility by using a light microscope at 10x to 40x objective [19].

Fertile cysts were further subjected to viability test. 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 and observed under 40x objective [20].

Data Management and Analysis: Data obtained from antemortem, postmortem, laboratory and questionnaire results were coded and uploaded into Microsoft Excel 2010 spreadsheet computer program and analyzed using STATA version 11.0 for Windows (Stata Corp. College Station, USA). Univariate and multivariate logistic regression performed utilizing the same program for the first set of questions included potential risk factors. Odd ratio and 95%CI were computed and the 95% CI was used and results were considered statistically significant at $P < 0.05$.

RESULTS

Overall Prevalence: Four hundred twenty one camels were inspected during the study period. The overall prevalence of camel hydatidosis slaughtered in the backyard in Ayssaita was found to be 34.20% (95% CI: 29.65, 38.75). The distribution of cysts was higher in the lungs than in the liver and spleen (Figure 1). On the other hand, livers tend to carry larger number of cysts per organ (Mean 95%CI: 4.13 (3.71, 5.6) than the lungs and spleen (Table 1).

Risk Factors of the Logistic Regression Results: Univariable logistic regression analysis of the infection rate of hydatidosis was based on the potential risk factors presented below (Table 2). Univariable logistic regression analysis revealed that the odds of probability acquiring hydatidosis infection was found to be 1.73 times higher in females (OR = 1.73, 95% CI: 1.11, 2.69, P = 0.02) than in males. The likelihood of infection was also significantly higher in old (greater than ten years) camels than other age categories. Based on water sources, camels drinking in the well, stagnant and pond is higher infection rates than drinking in river only (OR=1.7, 95% CI: 1.10, 2.6, P=0.016), presences and owned dogs and contact of dogs with camels is higher prevalence than those of no possess dogs (OR=1.90, 95% CI=1.20, 3.04, P=0.01) and the probability of acquiring of hydatidosis is higher in camels frequently grazing (OR=1.6, 95% CI:1.08, 2.45, P=0.02) than those of browsing only. In the univariable analysis, camel management system (pastoral (31.48%) vs. agro-pastoral (35.1%) and origin (Elidar (30.17%), Dubti (35.44%) and Ayssaita (35.84) were not significantly associated with hydatidosis infection rates ($P > 0.05$). Sex (P= 0.017), age (P<0.0001), body condition (P= 0.03) and sources of water for camel (P= 0.04) were found statically significance with the infection rates of hydatidosis in the full model of multivariate logistic regression.

Cyst Size: The 579 recovered hydatid cysts at postmortem were first differentiated into calcified and noncalcified cysts. Accordingly, 62 (10.71%) were calcified whereas 517 (89.29%) were noncalcified. The cysts size measurement date for the noncalcified cysts were classified as small, medium and large (Figure 2). Accordingly, majority of large and medium sized cysts were found in the lungs (P<0.0001) whereas small cysts were almost equally prevalent in both liver and lungs. On the other hand, large number of calcified cysts were found in the liver (P=0.007).

Fertility and Viability of Hydatid Cysts: Among the noncalcified cysts, 170 cysts (85 from lungs and 85 from liver) were randomly examined for fertility tests. The results show that fertile cysts were more prevalent in the lungs than in the liver. Viability test was done on all the fertile cysts examined above. At this stage, percent viability of fertile cysts was comparable for both liver and lungs (Table 3).

Table 1: The distribution and number of organs infected with hydatid cysts from camels slaughtered in the backyard in Ayssaita district, northeastern Ethiopia

Organ	No. of infected organs	Frequency (%)	No. of cysts	No. of cysts in mean (95% CI) per organ
Lung only	69	47.901	202	2.93 (`1.55, 3.13)
Liver only	30	20.80	124	4.13 (3.71, 5.6)
Lung and liver	43	29.90	248	2.88 (1.74, 3.98)
Spleen	2	1.40	5	2.5 (1.40, 3.61)
Total	187	100	579	3.10 (3.11, 4.73)

Table 2: Logistic regression analysis for risk factors of camel hydatidosis infection slaughtered in the backyard in Ayssaita district, northeastern Ethiopia

				Univariate		Multivariate	
Risk factors	Category	No. examined	Prevalence	OR[a] (95% CI[b])	P value	OR (95% CI)	P value
Sex	Male	144	26.39	1		1	
	Female	277	38.28	1.73 (1.11, 2.69)	0.0015	1.78 (1.11, 2.84)	0.017
Age	<5	90	14.44	1		1	1
	10-May	170	25.88	2.38 (1.44, 3.93)	0	2.08 (1.22, 3.45)	0.007
	>10	161	54.04	5.75 (2.88, 11.49)	0	3.26 (1.72, 6.25)	0
Origin	Elidar	116	30.17	1			
	Dubti	79	35.44	1.27 (0.71, 1.79)	0.6	-	-
	Ayssaita	226	35.84	1.29 (0.70, 1.83)	0.58		
Body condition	Good	88	17.6	1		1	
	Medium	133	23.1	1.48 (0.74, 2.94)	0.02	1.49 (0.88, 2.50)	0.05
	Lean	200	49	4.5 (2.15, 9.13)	0	1.85 (0.83, 2.94)	0.03
Owned dogs and contact with dogs	No	124	25	1			
	Yes	297	38.05	1.90 (1.20, 3.04)	0.01	1.24 (0.74, 2.10)	0.42
Sources of water	River	159	27.04	1		1	
	Well, pond and stagnant	262	38.55	1.70 (1.10, 2.6)	0.016	1.45 (0.63, 2.21)	0.04
Sources feed and feeding habit	Browsing only	252	29.76	1		1	
	Browsing & Grazing	169	40.8	1.63 (1.08, 2.45)	0.02	1.23 (0.77, 1.89)	0.35
Management system	Agro-pastoral	108	31.48	1			
	Pastoral	313	35.1	1.18 (0.74, 1.88)	0.49	-	-

a: Odd Ratio, b: Confident Interval

Table 3: The fertility and viability rate of cysts randomly selected hydatid cysts from livers and lungs of camel in Ayssaita slaughtered in the backyard, northeastern Ethiopia

		Fertile cyst		Sterile cyst	
Organ involved	No. of cysts examined	No.	%	No.	%
Lung	85	53	62.35	32	37.65
Liver	85	36	42.35	49	47.65
Total	170	89	52.35	81	47.65
		Viable cyst		Non-viable cysts	
Organ involved	No. of cysts examined	No.	%	No.	%
Lung	53	36	67.92	17	32.08
Liver	36	24	66.67	12	33.33
Total	89	60	67.42	29	32.58

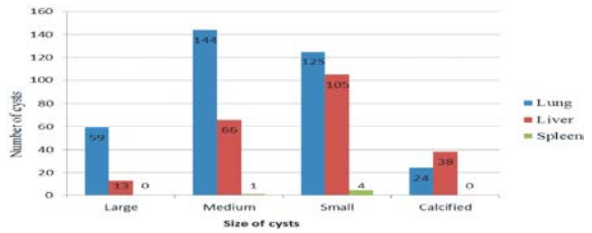

Fig. 1: Cyst size and conditions in relation with organ involvement in camel slaughtered in the backyard in Ayssaita district, northeastern Ethiopia

DISCUSSION

The overall prevalence of camel hydatidosis in the study area showed that 34.20% which is higher than that reported by Muskin, Hailu and Moti [21] in Ethiopia, [22] in Pakistan, [19] in Mauritania and [16] in southeastern of Iran. But, similar level of infection rates of hydatidosis was reported 35.25% in Iran [23] and 32.85% in Saudi Arabia [24]. However, the percentage of camels hydatidosis is rather low when compared to 61% from Kenya [25], 59.3% from central Iran [10] and 54% from Mauritania [19].

The variation in prevalence rate within the same species of animals could be attributed to the differences in season of the study, geographical locations and parasite strain differences. It has already been reported that the difference in the prevalence of hydatidosis from year to year and from place to place may be ascribed to differences in environmental conditions, hygienic status of slaughter houses, climatic conditions, contamination rate in the intermediate host, abundance of dogs, slaughtering manner and feeding status of animals, nature of the pasture and grazing patterns of animals [25, 26]. In Ayssaita, the close association of dogs with camels and household, presence of higher number of stray dogs,

widespread practice of backyard slaughtering, disposal of raw condemned organs through offering to dogs and non-deworming dogs could be the major predisposing factors for the disease.

With regards to the risk factor analysis, it was attempted to assess infection rates of hydatidosis with a comprehensive list of potential risk factors to identify factors relevant for prevention of the disease. In this study, female camels were more infected than males. Similar findings have been reported in Ethiopia [21] and in Iran [10, 23]. The most probable explanation could be the practice of slaughtering large numbers of female camels than males in the area that has made the sampling more skewed to the female side. In addition associated with keeping of female camel around the house milk purpose and they stay at the backyard where there are infected dogs and females remain longer than males for reproductive purposes in the area [21, 27].

This study has shown a remarkable variation in the prevalence of hydatidosis among three age categories with the highest prevalence being recorded in greater than 10 years old. This is consistent with the report of Ahmadi [23] who showed a progressively increasing prevalence rates with three different age categories. Similar trends were also reported in camel and other animals by different authors [16, 21, 28, 29]. This could be explained by, longer exposure time animals to eggs of *E. granulosus* weaker immunity in aged animals and the chronic nature of the disease that allows animals to keep cysts for prolonged period of time and hence were exposed to the disease over a long period of time, with an increased possibility of acquiring the infection [30, 31].

There was also statistically significant difference between infection rate and body condition score of the animals. Well feed animals with good body condition are known to resist or limit the severity of a variety of infections. The higher prevalence in poor conditioned animals could be the reflection of this [2]. The other possible explanation is that, hydatidosis infection could be responsible for the reduction in body condition through various means. It may result in reduced feed conversion ratio and decreased meat production [7].

Camels drinking in well, pond and stagnant water were at higher risk of hydatidosis infection as compared to those drinking in the river. Ponds source was a higher risk of echinococcosis than using rivers [32]. Use of water hole for drinking water which dogs have access and *E. granulosus* eggs survive longer may be important sources of infection for animals [33].

Our finding also suggested that grazing poses a higher risk of camel hydatidosis than browsing. This could be due to the fact that camels have high probability to get eggs from the ground. The current trend in the Afar region shows expansion of irrigated lands for sugar cane plantation consequently forcing camels to graze due to change of habitat.

In cyst fertility and viability, 62.35% from lung and 42.35% from liver found fertile cysts and 67.92% and 66.67% of the fertile cysts were viable in lung and liver respectively. The rate in the current study is slightly higher as compared to previous. The fertility of the cysts was documented 57.24% and 40% in lung and liver, respectively in Ethiopia [21]. Higher of fertile cysts were reported 76% from Mauritania [19], 58.17% from Iran [16]. Camels are found in the majority arid regions and commonly infected with *E. granulosus*, possessing a high cyst fertility rate [34]. On epidemiological grounds, camels appear to be an important reservoir for human infection [10]. Information about prevalence and fertility of hydatid cysts in various organs are important indicators of potential source of infection to perpetuate the disease to dogs. Genotype of infecting strain affects the fertility rate of the cysts in the intermediate hosts and thereby the infectivity of strain for subsequent hosts [35]. The fertile cyst was found higher in the lung due to soft consistency and favors to development, but the percentage of calcified cyst was found to be higher in the liver than in the lung. This may be associated with the higher reticuloendothelial cell and abundant connective tissue reaction of the organ [16, 36].

In conclusion, camel hydatidosis is one of the highly prevalent of parasitic diseases and the study results revealed a considerable higher infection rates. Sexes, age, body condition, sources of water and feeding habit of camels in the study area have found important risk factors. High fertility and viability of hydatidosis in camels have an epidemiological role in sources infection in human and animals. The questionnaire survey on public clearly indicated that generally poor knowledge of the disease, the throwing of slaughter wastes on to open ground and the ability of owned non-dewormed dogs to roam freely around and within houses and have none of simple slaughter house in the district are all causes of concern human and animal hydatidosis. In view of the present findings, public health education to build up public awareness about the sources of infection in the pastoral area, the government should give attention and building and make accessible slaughter houses to the

community with subsequent control over backyard slaughtering should be conducted. Since research on camel hydatidosis and its risk factors has considered only a limited number of parameters, further investigations of the serological aspects and identification of risk factors that may enhance transmission within the pastoralists should be conducted.

ACKNOWLEDGMENTS

We would like to thank the research project "Animal Health Improvement" under Addis Ababa University with sub thematic of "Investigation on Major Camel Diseases in Ethiopia" under Aklilu Lemma Institution of pathobiology for gives me an opportunity to work in this project.

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