Research Article

An Abattoir-Based Study on the Prevalence of Hydatidosis Infestation and Fertility of Hydatid Cysts in Slaughtered Herbivores (Food Animals) in Dhamar Province-Yemen.

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Abstract | Cystic echinococcosis is one of the most important emerging zoonotic parasitic diseases worldwide. This disease causes considerable economic losses and adverse public health challenges in most countries, including the Middle East countries. This study was designed to investigate the current prevalence of hydatidosis and to determine the fertility of hydatid cysts among some ruminants (both local and imported breeds of cattle, sheep, and goats) slaughtered in the abattoirs in Dhamar Province-Yemen. The samples were collected from the Central Corporation Slaughterhouse in Dhamar-Yemen from January 2019 to November 2020. During this period, a total of 29,071 and 5,705 samples were collected from local and imported food animals respectively. The results of analysed samples revealed that the distribution of the hydatid cysts among the local slaughtered animals were 318 (11 .63%), 613 (5.41%), and 28 (6.08%) for cattle, sheep, and goats respectively for the year of 2019 whereas in the year 2020, the results were 235 (9.69%), 685 (5.74%) and 32 (6.95%) respectively. Moreover, the prevalence rates of hydatidosis among the imported animals in the year 2019 (cattle, sheep, and goats) were 71 (4.76%), 36 (3.0%) and 39 (5.93%) while 93 (5.28%), 24 (4.8%) and 34 (6.8%) were recorded in the year 2020, respectively. With respect to the fertility rates of the hydatid cysts, 1236 (55.97%) were found to be sterile, 515 (23.32%) were fertile, 323 (14.62%) were calcified, and 174 (7.88%) were observed to have become encrusted (cheesy). Among the local breed, the fertility rate of lung hydatid cysts was higher with 995 (45.06%), followed by the liver with 777 (35.19%), whilst in the imported breed, the fertility rates were 152 (6.88%), and 100 (4.52%) in the lung and liver respectively. This study, observed that *Echinococcus granulosus* parasite was present in both large and small ruminants within the study area and was responsible for high rate of organ condemnation. Hence, strategic endo-parasite eradication with a strong surveillance system and good management practice of animals is needed in order to limit the impact of the disease among food animals and prevent human transmission.

Keywords | Cysticercosis; Parasitic Zoonoses; Neglected Tropical Disease; Food Animals; Dhamar Province; Yemen.

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INTRODUCTION

Cystic echinococcosis is a zoonotic infection affecting livestock that is often transmitted by cats, dogs, wolfs and foxes (Tamarozzi et al., 2020). The causative agent is the larval cystic stage of a small taeniid-type tapeworm belonging to the family cestoda class (*Echinococcus granulosus*) that may cause illness in intermediate hosts such as cattle, buffalo, sheep, goats, horse, camel, and deer (Khan et al., 2020; Miambo et al., 2020). The genus of *Echinococcus* is divided into four species: *Echinococcus granulosus*, *Echinococcus multilocularis*, *Ehinococcus oligarthrus*, and *Echinococcus vogeli* (Almulhim & John, 2021; Moro & Schantz, 2009). Both humans and herbivores represent the intermediate hosts of the tapeworm. Hydatidosis in humans is more common in rural areas where dogs (definitive host) and other domestic animals live in a close proximity making it easy for transmission (Abdulhameed et al., 2018; Craig & Larrieu, 2006). Infection follows ingestion of tapeworm embryo which later adheres to the intestinal wall by its six hooks after digestion, and then enters into circulation to reach the liver. Thus, liver is the most common site of the disease in humans, followed by the lungs and less frequently the heart, spleen, kidneys, bones, central nervous system, and other organs (Alghoury et al., 2010; Kammerer & Schantz, 1993). *Echinococcosis* is a major public health concern throughout the Mediterranean region, northern Africa, and Asia region, where canine pets and livestock are commonly raised (Alghoury et al., 2010).

The aim of this study was to investigate the prevalence of Hydatid disease among local and imported cattle, sheep, and goats, slaughtered at a major abattoir in Dhamar Province – Yemen, and to assess the fertility rates of the cysts with a view to understand its public health importance as well as making recommendations on measures to employ in order to reduce transmission of the disease between humans and different animal hosts.

MATERIALS AND METHODS

Study area

This study was conducted at the Central Corporation for Slaughterhouse in Dhamar Province-Yemen. Dhamar is situated 100 km to the south of Sana'a, north of Ibb, and west of Al-Bayda', with 2400-2500 m altitude, and it has an estimated human population of 351,000. Dhamar is located at 14°.58′N latitude, 44° 43′E longitude and at an altitude of 2425 mater above sea level (Al-Shaibani et al., 2015). Dhamar is in a fertile agricultural region, with major occupations being agriculture and livestock production. The average livestock wealth according to the Consultancy Agriculture Office report indicated the total livestock population to be 843,544 in the year 2012, comprising of 182,900 Bovine species, 2,033 Camel, 444,316 Ovine species and 214,295 Caprine species. The agricultural activities are mainly mixed type with cattle rearing and crop production such as corn, wheat, barley, and variety of vegetables such as potato, tomato, aubergine, carrot, cucumber.

Study Design and Sampling Procedure

Antemortem Examination: The study was carried out from January 2019 to November 2020. During the antemortem inspection, all animals were screened and their informations were recorded on an inspection card. The information includes: species, sex, number of animals, time and date of examined. Additional information of abnormal signs such as lameness, excessive excitability and severe weaknessas well as data relating to place of origin were also collected. The age of the animal was estimated by checking teeth eruption and wear.

Slaughterhouse Survey and Postmortem Examination: A total of 16272 slaughtered animals (8405 cattle, 5093 sheep, and 2774 goats) were examined using purposive sampling technique. Postmortem examination was carried out on slaughtered animals, the organs in the thoracic, abdominal and pelvic cavities were examined for the presence of hydatid cysts by visualization and palpation with emphasis on the lungs, liver, heart and spleen. The presences of haydatid cysts were recorded according to distribution on the organs. Organs and tissues containing hydatid cysts were collected and subjected to further cyst characterization to assess their status. Laboratory examination was carried out on all samples to assess the fertility of the hydatid cysts.

All the relevant data such as origin of the animals, species, gender, age, cyst distribution, and presence of other diseases were recorded.

Determination of Cyst Fertility and Viability

The heads of the parasite attached to the germ layer was removed by making an incision on the aqueous cyst bag after draining the hydatid fluid into a graduated beaker andincubated at 36 °C for 30 minutes for the contents to sediment. A volume of 10 ml of these sediment was transferred into a test tube and centrifuged at 1000 rpm for 3 minutes to separate the contents from the liquid part. The liquid part was discarded and the sediment was examined under a light microscope at 40x magnification. The presence of heads denotes fertility of the hydatid cyst, while sterility is when the hydatid cyst head is absent. Similarly, a drop of the sediment was stained with Eosin at a concentration of (0.1%) on a glass slide so as to visualise the cyst clearly as described by Macpherson (1985) and Gaduro and Desta (2019).

Table 1: Prevalence of hydatid cysts in cattle, sheep and goats slaughtered at Dhamar slaughter house

Host	Local	Imported	Number of sample size	Infected no	Infected %
Cow	5157	3248	8,405	553	6.57%
Sheep	23254	1300	24,554	1,298	5%
Goats	660	1157	1,817	73	4%
Total			34776		

Table 2: Results of a survey of hydatid cysts in an abattoir based on postmortem findings in ruminant slaughtered from Central slaughterhouse, Dhamar province 2019 to 2020

		No. of slaughtered animal (n)		No. of positive		Prevalence %	
Host	Source	2019	2020	2019	2020	2019	2020
Cow	L	2734	2423	318	235	11.63	9.69
	Ip	1489	1759	71	93	4.76	5.28
Sheep	L	11323	11931	613	685	5.41	5.74
	Ip	500	800	36	24	3	4.8
Goats	L	460	200	28	32	6.08	6.95
	Ip	657	500	39	34	5.93	6.8
Total		17,163	17,613	1105	1103		
%				6.43%	6.26%		

N-number of sample size in 2019 and 2020, L-indigenous breed, Ip-imported animals, N-number of infected organs

Table 3: Distribution of hydatid cyst in different organs of infected cattle sheep and goats slaughtered at Dhamar slaughter house during years 2019 and 2020

		2019				2020			
		lung	liver	heart	spleen	lung	liver	heart	spleen
Cow	Local	157	139	5	17	117	93	6	19
	Imported	36	28	2	5	46	29	3	15
Sheep	Local	321	249	24	19	369	275	15	26
	Imported	18	13	3	2	12	7	1	4
Goats	Local	14	9	1	4	17	12	0	3
	Imported	19	11	2	7	21	12	0	1
	Total	565	449	37	54	582	428	25	68
Percentage %		51.13%	40.63%	3.34%	4.88%	52.76%	38.80%	2.26%	6.16%

Table 4: Distribution of hydatid cyst in lung, liver, heart and spleen of infected cattle sheep and goats slaughtered at Dhamar slaughter house during study period

		Lung	Liver	Heart	Spleen
Cow	Local	274	232	11	36
	Imported	82	57	5	20
Sheep	Local	690	524	39	45
	Imported	30	20	4	6
Goats	Local	31	21	1	7
	Imported	20	23	2	8
	Total	1147	877	62	122
	Percentage %	51.94%	39.71%	2.80%	5.52%

Data analysis

A statistical software JMP (version 9.0.1 SAS Institute Inc., Cary, NC, USA) was used to analyze the data by determining the association between different variablesu using Chi-square test. Values that were obtained were considered significant at $p<0.05$.

RESULTS

A total of 34,776 animals were examined including 8405 cattle, 24554 sheep, and 1817 goats, at the Central slaughterhouse during the 2 years' study period (January 2019 to November 2020) as presented in Table 1. The prevalence of the hydatid cyst in the year 2019 and 2020 was 6.58%, 5.23%, and 4.02% respectively for cattle, sheep and goat species examined, also, there was no significant difference between them as indicated in Table 2.

The overall infection rate in slaughtered local cattle was 11.63% while that of imported cattle was 4.77% in the year 2019. Similarly, the infection rate for slaughtered cattle in the year 2020 was 9.70% in the local cattle and 5.29% in the imported cattle as shown in Table 2.

From a total of 11323 slaughtered local and 500 imported sheeps examined in Dhamar abattoir in 2019, the infection rate in local and imported sheeps was 5.41% and 7.20% respectively, while in the year 2020, out of 11931 slaughtered local breed of sheep examined, 5.74% were infected. Similarly, for imported breed of sheep, the value was 800 heads and the rate of infection was 4.8%, as shown in Table 2.

The study also showed that the prevalence of hydatid cyst in 2019 in the local and imported breeds of goats were 6.08% and 5.93% respectively, whereas in 2020, the infection rate was 6.95% and 6.80% in local and imported goats respectively. There was no statistically significant association in the prevalence of hydatid cysts in the local and imported breeds of goat during study period as shown in Table 3.

The findings of the study revealed that the lung was most commonly infected organ in cattle, sheep and goats followed by the liver, while the heart and spleen were the least affected organs in all the carcasses examined. In addition, 51% (565) and 40.63% (449) of hydatid cyst were recorded in the lung and liver in the year 2019 respectively as presented in Table 3. While lesser numbers {37 (3.34%) and (54) 4.88% }were observed in the heart and spleen of imported animals in the year 2019 respectively as presented in Table 3. However, hydatid cysts were not found in the kidney in all species during the study period. Statistically significant variation in the prevalence of hydatid cysts in the organs of local and imported animal species was observed, with the lung and liver showing a significant increase among the local cattle and sheep compared to imported, while no significant variation in organ distribution in goats was recorded during the study period as displayed in Table 3. In the year 2020, a significant difference in organ distribution was recorded between the local and imported breeds of animals with a total of 582 (52.76%) and 428 (38.80%) cysts recorded in the lung and the liver of local and imported animals respectively. However, no significant difference in the cyst distribution in the heart and spleen was recorded between the local and imported animal. The record obtained from the heart was 25 (2.26%), while that of spleen was 68 (6.16%) as presented in Table 3 showed there was significant difference ($P<0.05$) between prevalence of infection and organs distribution in the current study as shown in Table 4.

The gross lesion caused by hydatid cyst in the lungs in livestock revealed a solitary to multiple hydatid cysts of varying sizes as presented in Figure 1. Pathological lesions ranging from severe to moderate, usually table tennis ball shape but sometimes as big as a cricket ball were observed. The cysts were either fully immersed in the lung parenchyma or were partially immersed and visible on the lung surface. However, both the dorsal and ventral aspects of the lungs were affected single and multiple cysts of varying sizes on the parietal surface and visceral surface of the liver were observed as shown in (Figure 2). In addition, the cysts were soft and doughy to touch and were filled with clear to slightly turbid fluid. However, hydatid cysts (HCs) can be solitary or multiple as showed in (Figure 3) in spleen of cattle. The location of the cyst also determine the the cyst volume. The spleen and the heart show a decreased volume compared to the lung and liver which may be due to the structure of the spleen and heart (figure 3 and 4) that have small spaces between the tissue which hinders expansion of the cyst in spleen and heart compared to lung and heart.

The study showed that sterile cysts constituted the highest percentage in the total samples examined followed by fertile cysts in comparison to other types of cysts (calcified, and encrusted (cheesy). Out of the 2208 cysts examined, 1236 (55.97%) were sterile, 515 (23.32%) fertile, 323 (14.62%) calcified, and 174 (7.88%) encrusted (cheesy) as shown in (Table 5). In addition, Figures (5) and (6) also show the encrusted cysts in the liver and lungs of infected cows. While Figure (7) refers to the external shape of the spines on the tapeworm heads taken from the liver of an infected cow, and Figure (8) shows the external shape of the spines on the tapeworm heads. The rates of fertile, sterile, calcified, and encrusted cysts were (20.7%), (27.1%), (14.1%) and (7.26%) in local cattle respectively, and (14.3%), (39.16%), (24.5%), and (13.28%) in imported cattle, respectively. The rate of fertile cyst for in local and imported sheeps was (23.37%), and (24.64%) respectively, while (65.77%) of the cyst in local sheeps and (39.61%) in imported sheeps were sterile, while (11.4%) and (20.7%) calcified cysts were found in local and imported breeds of sheep respectively. However, (7.29%) encrusted cysts were found in local breed of sheep and (8.21%) were found in imported breed of sheep Table 5 shows that statistically

Table 5: Fertility rate of hydatid cysts of all local and imported slaughtered livestock.

		Fertile Cysts		Sterile Cysts		Calcified Cysts		Encrusted Cysts		Infected no	%
		N	%	N	%	N	%	N	%		
Cattle	Local	97	20.7	271	27.1	66	14.1	34	7.26	468	1.34
	Imported	33	14.3	56	39.16	35	24.5	19	13.28	143	0.41
Sheep	Local	237	23.37	667	65.77	116	11.4	74	7.29	1094	3.14
	Imported	87	24.64	164	39.61	73	20.7	29	8.21	313	0.9
Goats	Local	44	23.91	49	34.02	33	17.9	18	9.78	144	0.41
	Imported	17	36.95	29	63.04	0	0.00	0	0.00	46	0.13
Grand total		515	23.32%	1236	55.97%	323	14.62%	174	7.88%	2208	

Table 6: Fertility rate of hydatid cysts of all infected organs in local and imported slaughtered livestock.

	Lung				Liver				Heart				Spleen			
	Local		Imported		Local		Imported		Local		Imported		Local		Imported	
Fertile Cysts	234	23.51%	44	28.94%	256	32.94%	24	24.00%	4	7.84%	2	18.18%	17	19.31%	13	38.23%
Sterile Cysts	598	60.10%	91	59.86%	412	53.02%	65	65.00%	47	92.15%	9	81.81%	69	78.40%	19	55.88%
Calcified Cysts	96	9.64%	11	7.23%	76	9.78%	8	8.00%	0	0.00%	0	0.00%	2	2.27%	2	5.88%
Encrusted Cysts	67	6.73%	6	3.94%	33	4.24%	3	3.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
	995		152		777		100		51		11		88		34	
	45.06%		6.88%		35.19%		4.52%		2.30%		0.49%		3.98%		1.53%	

Figure 1: The lung of cattle showing multiple hydatid cysts of varying sizes

Figure 2: The liver of cattle showing multiple hydatid cysts of varying sizes

Figure 3: Spleen showing multiple hydatid cyst in the slaughtered cattle

significant differences (P<0.05) exist between the different forms oc cyst (fertile, sterile, calcified and encrusted). The percentages of fertile, sterile, calcified, and encrusted cysts in local goats were (23.19%), (34.02%), (17.9%) and (9.78%) respectively.However, only two forms of cysts (fertile and sterile) were observed in imported goats and their percentages were (36.95%) fertile and (63.04%) sterile as presented in (Table 5). Higher percentage of sterile cysts

followed by fertile cysts compared to calcified and encrusted cysts was discovered in cattle. It was observed that theorgan distribution of cysts was higher in local breeds compared to the imported breeds. The lungs and liver of local livestock have higher rates (45.06%) and (35.19) respectively, while the imported breeds appeared to have lower rates in the lungs and liver (6.88%) and (4.52%) respectively. Similarly, the heart and the spleenof local breeds have higher cysts rate (2.30% and 3.98%) in local breeds compared to (0.49% and 1.53%) found in the heart and spleen of imported breeds as presented in Table 6.

Figure 4: Showing the solitary hydatid cyst in the heart in cattle

Figure 5: Shows the presence of encrusted water cysts in the liver of local cattle.

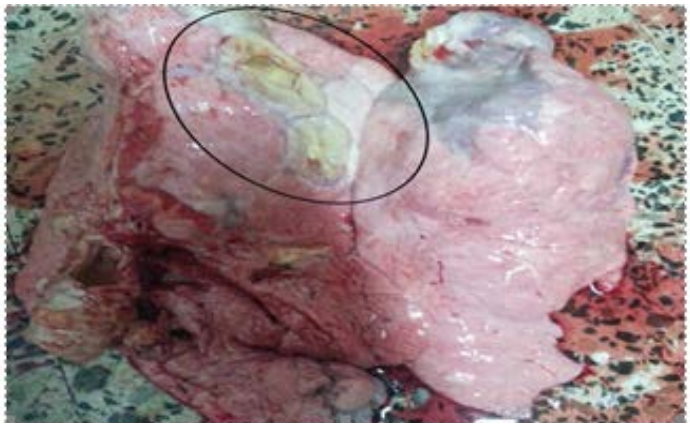

Figure 6: Indicate the presence of encrusted water cysts (encircled) in the lungs of local cattle.

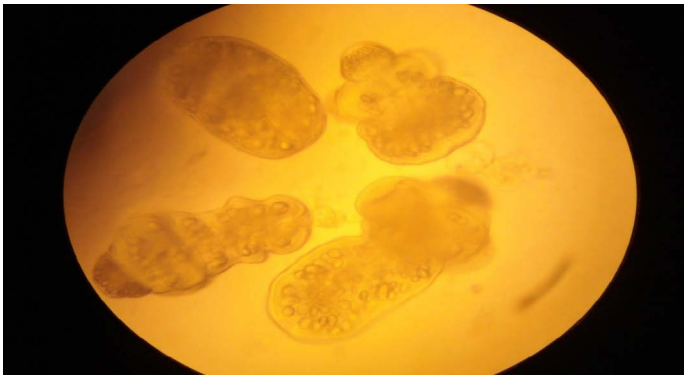

Figure 7: Showing the external shape of the spines on the tapeworm heads

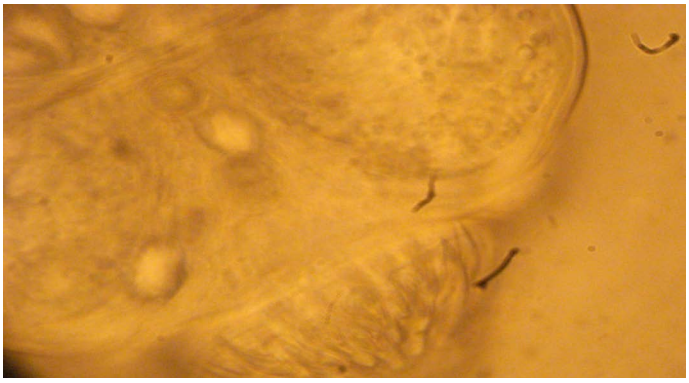

Figure 8: Shows the germinative membrane removed from a cyst taken from the liver of an infected cow.

DISCUSSION

This study undertaken to determine the rate of infection with hydatid cyst in farm animals slaughtered in the Central Corporation for Slaughterhouse Dhamar. This is due to the health and economic importance of the disease at the national and global level and because it is one of the important diseases spread among cattle, sheep and goats on a large scale. Cystic echinococcosis/hydatidosis in Yemen is still endemic and more common in women than men, and all ruminant animals (cattle, sheep, and goats) with hepatic and lung cysts representing the majority of cases (Abdulhameed et al., 2018; Alghoury et al., 2010). A Survey conducted in 2001 by Anis and AL-Gahdri on the endoparasites of stray dogs in Sana'a, Yemen showed that 57% of stray dogs were highly infected with the intestinal parasites especially *E. granulosus* with an incidence rate of 7.1%. Although post mortem inspection-based diagnosis of hydatid cyst is visible, there is usually a probability that some positive cases can be lost resulting in misdiagnosis (S et al., 2007). On the other hand, abattoir survey data is always used to estimate the disease burden. In addition, the abattoir survey also provides an opportunity for developing strategies through timely diagnosis and condemning carcasses infected with zoonoses.

The higher prevalence of hydatid cysts recorded in local breeds could be due to the semi-intensive and extensive management system commonly practiced for local breeds predominatly owned by poor rural farmers. This is because rural farmers keep their animals under poor hygienic conditions and in close proximity with dogs who occasionally scavenge inclyuding getting access to infected meat trimmings thereby introducing infection to livestock. This finding is in conformity with the result of AL-Gahdri, in Yemen, who reported a higher in local cow than imported (AL-Gahdri, 2009). Moreover, other important factors that may account for higher prevalence among local animals than imported are financial constraint that makes it difficult for rural farmers to provide medication and routine deworming to their animals, the impact of the floral which affects the grazing habits of animals, age, breed and type of feed and grazing which also depend on the system of semi-intensive rearing used there and presence of stray dog (Al-Shaibani et al., 2015). In a related study in Taiz city, an incidence of 33.76% was reported in cattle, which was higher than in our study. However, their finding in goats (6.13%) was similar with the result of the present investigation, while no infection was reported in sheep (Hezam et al., 2016).

Studies conducted in some middle east countries like Jordan, Iraq and Egypt, varying level of prevalence were reported with 4.3–40.2% in cattle, 0.2–44% in sheep and 0.3–26.7% in goats (Abdulhameed et al., 2018; Saeed et al., 2000). Some of the important factors that predispose animals to hydatidosis is ge, which reflects the long duration of exposure to infection that leads to a higher rate of spread. Hydatid cysts is reported to affect many organs including brain, heart, and bones, howerev, the liver (50–70 percent) and lung (20–30 percent) being the most affected (Sabouni et al., 2010). In this study, the lung and the liver were the organs with the most fertile hydatid cysts. This can be attributed to the fact that these organs have special blood circulation characteristics. About 75% of blood circulation is from the portal veins which transports various nutrients and hazardous substances from the digestive tracts to the liver for processing. On the other hand, the lungs have intensive capillary networks, and they are the frequent designation of the 6-hooked larvae cycled in with the blood from the intestine to continue to develop (Qingling et al., 2014). Moreover, we also observed that the prevalence was higher in lung (45.06%) than liver (35.19%). This may be due to the fact that the lung is softer in consistency compared to the liver and because most animals slaughtered are at older age during which period the liver capillaries are dilated and most cysts directly pass to the lungs (Tesfaye, 2019).

With respect to fertility of cysts, it was observed that the sterile cysts in cattle, sheep and goats was (55.97%), followed by fertile (23.32%) which were more than those of calcified (14.6%) and encrusted (7.88%) cysts in slaughtered animals in Dhamar slaughterhouse. In terms of fertile cysts, the liver rate was higher followed by lung among local animals. This cysts fertility trend observed indicates the importance of cattle in the transmission of *E. granulosus* in the study area. The fertility rate we found in cattle was slightly lower than the 36.2% and 45% reported by in lung and liver by Degefu and Damet in Ethipia (Degefu & Damet, 2014). However, much higher fertility rates have been previously reported in South Africa and Zimbabwe whith the disparity attributed to the age of the intermediate hosts and to the strain of *E. granulosus* which may differ due to host preference, development rate, infectivity, pathogenesis, antigencity and drug resistance (Degefu & Damet, 2014).

CONCLUSIONS

In conclusion, the high prevalence of hydatidosis in cattle, sheep, and goats may constitute a serious economic and public health problem in Dhamar province, Yemen. In order to limit the continuous spread of the parasite among susceptible hosts including humans, considerable attention should be given to proper disposal of infected offal in abattoir, prevent stray dogs from accessing the abattoir premises, and encourage routine treatment for livestock and household dogs within the study area.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTION

MNAO, and DAA conceptualized and designed the study. MNAO, DAA, AGO conducted the abattoir visitation and examination. MNAO and BG drafted the initial manuscript. all authors have reviewed, discussed, and agreed to their individual contributions prior and during submission of their article.

REFERENCES

Abdulhameed MF, Habib I, Al-Azizz SA, Robertson I (2018). Knowledge, awareness and practices regarding cystic

echinococcosis among livestock farmers in Basrah Province, Iraq. Vet. Sci. 5(1). https://doi.org/10.3390/vetsci5010017

Al-Gahdri (2009). Prevalence Of Hydatid cysts in carcasses of cattle in Dhamar Province/Yemen. An MSc Thesis, Faculty of Agriculture and Veterinary Medicine, Thamar University, Dhamar-Yemen.

Al-Shaibani I, Saad FA, Al-Mahdi H (2015). Cystic echinococcosis in humans and animals at Dhamar and Taiz governorates, Yemen. In Int. J. Curr. Microbiol. App. Sci. 4: 2. http://www.ijcmas.com

Alghoury A, El-Hamshary E, Azazy A, Hussein E, Rayan HZ (2010). Hydatid disease in yemeni patients attending public and private hospitals in Sana'a City, Yemen. Oman Med. J. 25(2): 88–90. https://doi.org/10.5001/omj.2010.26

Almulhim AM, John S (2021). Echinococcus Granulosus. Stat Pearls. https://www.ncbi.nlm.nih.gov/books/NBK539751/

Craig PS, Larrieu E (2006). Control of Cystic Echinococcosis/ Hydatidosis: 1863-2002. In Adv. Parasitol. 61: 443–508. Adv Parasitol. https://doi.org/10.1016/S0065-308X(05)61011-1

Degefu H, Damet T (2014). Hydatidosis of cattle and sheep, its economic importance and *Echinococcus granulosus* among stray dogs in South Wollo, Ethiopia. Ethiopian Vet. J. 17(2): 101. https://doi.org/10.4314/EVJ.V17I2.8

Guduro GG, Desta AH (2019). Cyst viability and economic significance of Hydatidosis in southern Ethiopia. J. Parasitol. Res. 2019.

Hezam K, Morshed AF, Hassan A, Abbas AB, Ghaleb H, Zhang J, Qahtan ASA (2016). Prevalence of Parasitic Helminthes among Slaughtered Animals in Slaughterhouses in Taiz, Yemen. Int. J. Curr. Microbiol. App. Sci. 5(8): 80-88

Kammerer WS, Schantz PM (1993). Echinococcal Disease. Infect. Dis. Clin. North America. 7(3): 605–618. https://doi.org/10.1016/S0891-5520(20)30545-6

Khan A, Ahmed H, Simsek S, Afzal MS, Cao J (2020). Spread of Cystic Echinococcosis in Pakistan Due to Stray Dogs and Livestock Slaughtering Habits: Research Priorities and Public Health Importance. Front. Pub. Health. 7. https://doi.org/10.3389/fpubh.2019.00412

Macpherson CN (1985). Epidemiology of hydatid disease in Kenya: a study of the domestic intermediate hosts in Masailand. Transact. Royal Societ. Trop. Med. Hyg. 79(2): 209-217.

Miambo RD, Afonso SMS, Noormahomed EV, Pondja A, Mukaratirwa S (2020). Echinococcosis in humans and animals in Southern Africa Development Community countries: A systematic review. Food Waterborne Parasitol. 20, e00087. https://doi.org/10.1016/j.fawpar.2020.e00087

Moro P, Schantz PM (2009). Echinococcosis: a review. Int. J. Infect. Dis. 13(2): 125–133. https://doi.org/10.1016/J.IJID.2008.03.037

Qingling M, Guanglei W, Jun Q, Xinquan Z, Tianli L, Xuemei S, Jinsheng Z, Huisheng W, Kuojun C, Chuangfu C (2014). Prevalence of Hydatid Cysts in Livestock Animals in Xinjiang, China. Korean J. Parasitol. 52(3): 331. https://doi.org/10.3347/KJP.2014.52.3.331

S L, FB C, AF, P, AH, JL, AG HA G, ME S (2007). Ultrasonographic screening for cystic echinococcosis in sheep in Tunisia. Vet. Parasitol. 143(1): 42–49. https://doi.org/10.1016/J.VETPAR.2006.08.001

Sabouni F, Ferdosian F, Mamishi S, Nejat F, Monnajemzadeh M, Rezaei N (2010). Multiple Organ Involvement with Hydatid Cysts. Iranian J. Parasitol. 5(2): 65. /pmc/articles/PMC3279838/

Saeed I, Kapel C, Saida LA, Willingham L, Nansen P (2000). Epidemiology of Echinococcus granulosus in Arbil province, northern Iraq, 1990-1998. J. Helminthol. 74(1): 83–88. https://doi.org/10.1017/S0022149X00000111

Stanaway JD, Parisi A, Sarkar K, Blacker BF, Reiner RC, Hay SI, Nixon MR, Dolecek C, James SL, Mokdad AH, Abebe G (2019). The global burden of non-typhoidal salmonella invasive disease: a systematic analysis for the Global Burden of Disease Study 2017. Lancet Infect. Dis. 19(12):1312-1324.

Tamarozzi F, Legnardi M, Fittipaldo A, Drigo M, Cassini R (2020). Epidemiological distribution of echinococcus granulosus s.L. infection in human and domestic animal hosts in european mediterranean and balkan countries: A systematic review. In PLoS Neglected Trop. Dis. 14(8): 1–23). Public Library of Science. https://doi.org/10.1371/journal.pntd.0008519

Tesfaye B (2019). Bovine Hydatid Cyst: Prevalence, Characterization, Public Health and Economic Importance at adama Abattoir, Central Ethiopia. Int. J. Vet. Sci. Res. 014–018. https://doi.org/10.17352/IJVSR.000035