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Original paper

An epidemiological study of hydatid cyst of *Echinococcus granulosus* isolated from sheep, goats and cattle in Sulaimani province, Kurdistan Regional-Iraq

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ABSTRACT. Cystic echinococcosis (CE) is a parasitic zoonosis caused by the larval stage of *Echinococcus granulosus sensu lato* with medical importance and economic effect. This study was carried out in Sulaimani province, Kurdistan Region, Iraq from October 2020 to November 2021. The study focused on the prevalence of cystic echinococcosis in slaughtered animals. The total prevalence was 8% (1324/16524), with a high rate in sheep (5.3%) and low rates in goats and cattle (1.9% and 0.76%, respectively). With respect to abattoirs involved in the study, the highest prevalence was detected in Kalar abattoir (16.8%) and the lowest in Sulaimani abattoir (4.4%). Among the infected animals, sheep in Kalar abattoir recorded the highest prevalence, while cattle in Sulaimani abattoir recorded the lowest prevalence (11.7% and 0.4%, respectively). Males of sheep, cattle, and female goats showed higher prevalence (66.7%, 76.2%, and 58.6%, respectively). Regarding organ involvements, males of cattle and sheep showed high liver involvement (81.25% and 72.2%, respectively), while females of goat showed the highest liver involvement (76%). Females of cattle and sheep showed high lung involvement (46.7% and 28.5%, respectively), but the males of goats showed the highest lung involvement (53.8%).

Keywords: cystic echinococcosis, hydatidosis, *Echinococcus granulosus senso lato*, cyst location, Kurdistan, Iraq

Introduction

Cystic echinococcosis (CE) is caused by the larval stage of *Echinococcus granulosus senso lato* and is one of the most important parasitic zoonosis of worldwide distribution, The parasite is a significant public health issue that results in economic losses, particularly in impoverished countries [1–3]. *Echinococcus granulosus* has a two-stage life cycle, with canids as a definitive host, and livestock and humans as an intermediate hosts. After ingestion of *Echinococcus* eggs transferred along with a dog's faeces and contaminating water or food, in intermediate hosts forms the larval stage, hydatid cyst [2–4]. This illness continues to pose a major hazard to human health and has a disproportionate effect on animal production [5–7]. Hydatid disease is mostly considered to be a rural disease [2]. However, several studies conducted in impoverished countries' urban areas have shown that domesticated dogs that scavenge near or inside slaughterhouses are at danger of consuming *Echinococcus granulosus*-infected offal [7,8]. Other significant risk factors, such as practicing slaughtering an animal in the backyard of their homes, improperly disposing of viscera, and ignoring treatment of dogs with anthelmintics, are frequently present in communities and are likely to increase the occurrence of hydatid cysts in humans and animals [9]. CE is prevalent in a number of Asian areas, including the Middle East (Iran, Iraq, Pakistan, and Saudi Arabia), Central Asia

Table 1. Prevalence of cystic echinococcosis among slaughtered animals in different abattoirs

Abattoirs	Slaughtered	Infected (n) %	
Sulaimani	10742	476	4.4
Halabja	1870	270	14.4
Kalar	2078	350	16.8
Kifri	396	36	9
Rzgari	1438	192	13.3
Total	16524	1324	8

(Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan), China, India, and Japan [10,11]. Hydatid cysts are an important parasite of animal production that contribute to economic loss by consuming edible organs such as livers and lungs [12,13]. The parasite has the opposite impact on performance and development, lowering meat and milk quality and output. Additionally, illness reduces fertility and the value of fleece [14]. According to a prior investigation, hydatidosis results in a 10% decrease in milk supply and a 5% reduction in carcasses [15–21]. In many countries, condemned organs or even the whole carcass constitute a significant financial loss [16,17]. There is little information on the frequency and economic impact of hydatidosis in Iraq. In Iraq, hydatid cysts are seen as a public health concern [18–20]. Several examples of hydatid cysts have been observed in Iraq's provinces.

Thus, the current study aims to determine the frequency of CE and its relationship to gender and cyst location in previously unresearched regions of Sulaimani province, including Sulaimani City, Halabja, Kalar, Kifri, and Rzgari, in the Kurdistan Region of Iraq.

Materials and Methods

From October 2020 to November 2021, the slaughterhouse will be visited four time one a season. Data from Sulaimani, Halabja, Kalar, Kifri, and Rzgari abattoirs were examined according to the Sulaimani Veterinary Directorate's official records. The number of sheep, goats, and cattle slaughtered (infected and uninfected animals) was counted and the infection prevalence was estimated for each animal and associated with the animal's gender and cyst location.

The following criteria were examined in hydatid cysts: cyst location (organ specificity), cyst fertility, and protoscolices vitality. The material including 15 individual goat cysts, 10 cattle cysts, and 25 sheep cysts. The samples were carried in a refrigerated box to the laboratory. Individual cysts were examined for deterioration and calcification on a gross level [22,23]. Then, based on the animal species, cyst size, and diseased organs, about 10% of hydatid cysts were randomly chosen for fertility and viability studies.

Fertility and viability

After aspirating cyst fluid, it was centrifuged and a drop of precipitated fluid was obtained using a Pasteur pipette and examined under a light microscope at a magnification of (40×) for the presence of protoscolices. Cysts lacking protoscolices were deemed sterile [24]. The viability of protoscolices was evaluated using the eosin dye (vital stain) [24]. Protoscolex with a

Table 2. Prevalence of cystic echinococcosis among slaughtered animals in different hosts

Abattoir	Infected animals (n) %						
	Total	Sheep		Goat		Cattle	
Sulaimani	10742	324	3	110	1	42	0.4
Halabja	1870	176	9.4	66	3.5	28	1.4
Kalar	2078	244	11.7	74	3.5	32	1.5
Kifri	396	24	6	10	2.5	2	0.6
Rzgari	1438	116	8	54	3.7	22	1.5
Total	16524	884	5.3	314	1.9%	126	0.76

Table 3. Prevalence of cystic echinococcosis among slaughtered animals in different intermediate hosts

Abattoir	Host	Slaughter	Infected (n) %	
	Sheep	6000	324	5.4
Sulaimani	Goat	4000	110	2.75
	Cattle	742	42	5.6
	Sheep	1300	176	13.5
Halabja	Goat	420	66	15.7
	Cattle	150	28	18.6
	Sheep	1400	244	17.42
Kalar	Goat	600	74	12.3
	Cattle	78	32	41
	Sheep	240	24	10
Kifri	Goat	130	10	7.6
	Cattle	26	2	7.6
	Sheep	900	116	12.8
Rzgari	Goat	500	54	10.8
	Cattle	38	22	57.8
Total		16524	1324	8

dormant flame cell or stained with eosin is thought to be dead [25].

Results

During the study period, 16,524 animals (sheep, goats and cattle) were slaughtered in the five official abattoirs (Tab. 1) recording 1324 (8%) CE cases in animals. The highest prevalence (16.8%) was recorded from Kalar abattoir, while the lowest prevalence (4.4%) in Sulaimani abattoir. Among the intermediate hosts, sheep had the highest infection rate while cattle had the lowest rate (5.3% and 0.76%, respectively) as shown in table 2. Prevalence of CE infection of different intermediate hosts (Tab. 3) was 8%, with the highest prevalence (17.42%) of sheep was in Kalar abattoir, while the lowest prevalence (5.4%) was in Sulaimani abattoir, the highest prevalence in goats (15.7%) was reported in Halabja abattoir and the lowest (2.75%) was in Sulaimani abattoir. Regarding cattle, the highest prevalence (57.8%) was from Rzgari abattoir and the lowest (5.6%) in Sulaimani abattoir. Regarding the gender, male sheep, and cattle, showed higher prevalence (66.7% and 76.2% respectively) (Tab. 4). With respect to infected organs, livers had a higher prevalence in both sheep and cattle (70.5% and 71.4%, respectively), also of goats, liver (62.4%), The lowest prevalence (4.3%) of infection was reported in kidneys of slaughtered animals with the highest (4.7%) being in cattle (Tab. 5). Regarding the gender, males of cattle had high prevalence in liver and sheep but males of goats had high prevalence in lungs involvements (Tab. 6). This study was performed at five abattoirs located in Sulaimani province.

Discussion

Cystic echinococcosis is prevalent in many regions around the world and is a major source of concern for public health. The incidence varies by host, infected organ, gender, and geographic region [22–25,27,36]. Numerous factors contribute to the infection's spread in the Kurdistan Region, including cultural, educational, and socioeconomic conditions. The largest prevalence of CE was found in sheep, which corresponds to the findings of [28–31]. In all of these trials, sheep had the highest prevalence of infection, though the rate fluctuated. These findings indicate that sheep are extremely susceptible to this parasite. Furthermore, molecular

Table 4. Prevalence of cystic echinococcosis among slaughtered animals according to gender

I	Slaughter	Infected animals (n) %					
		Total		Male		Female	
Sheep	9840	884	8.9	590	66.7	294	33.3
Goat	5650	314	5.5	130	41.4	184	58.6
Cattle	1034	126	12.1	96	76.2	30	2.9
Total	16524	1324	8	816	61.6	508	23.8

Table 5. Prevalence of cystic echinococcosis among slaughtered animals according to organ involvement

I	Total	Infected animals (n) %					
		Liver		Lungs		Kidneys	
Sheep	884	624	70.5	224	25.3	36	4
Goat	314	196	62.4	102	32.4	16	5
Cattle	126	90	71.4	30	23.8	6	4.7
Total	1324	910	68.7	356	26.8	58	4.3

Table 6. Prevalence of cystic echinococcosis in different organs among slaughtered animals and their relation to hosts gender

Host	Gender	Total	Infected animals (n) %					
			Liver		Lungs		Kidneys	
Sheep	Male	590	426	72.2	140	23.7	24	4
	Female	294	198	67.3	84	28.5	12	4
Goat	Male	130	56	43	70	53.8	4	3
	Female	184	140	76	32	17.3	12	6.5
Cattle	Male	96	78	81.25	16	16.7	2	2
	Female	30	12	40	14	46.7	4	13.3
Total		1324	910	68.7	356	26.8	58	4.3

tests conducted in Kurdistan established that the sheep strain (G1 genotype) is the predominant strain in this region. The low frequency of CE in goats and cattle is consistent with previous research [32] in Kalar and [33] in Sulaimani. All of these researchers attributed the low incidence to goats' feeding habits, which include eating the higher sections of herbage exposed to sunshine, which reduces the survival of parasite eggs; also, dogs have difficulty ascending to these areas for defecation. The low frequency of dogs in cattle may be attributed to their being raised in cowsheds with less exposure to dogs [34]. In terms of gender, male sheep, and cattle both had a higher prevalence (66.7%, 76.2%, respectively) than goat and females. However, these findings contradict previous research involving the same intermediate host, as the majority of those studies reported a higher prevalence in females [24,34–37,40] discovered that the gender of slaughtered animals had no significant effect on the distribution of CE, as the frequency of CE was extremely close between males and females sheep and cattle. Males had the highest prevalence of infection in this investigation, which could be explained by the high number of slaughter males in each species (Tab. 6), which was almost twice that of females, or by their age. The liver and lungs had the highest prevalence of CE, which is consistent [39–41]. This is because the liver serves as the first filter for larval infection, and the lungs serve as the second filter, and the oncosphere travels via the portal vein and first negotiates the hepatic and pulmonary filtering systems sequentially before involving any other peripheral organ [40–43].

In conclusion, rates of infection are equal in sheep and goat. A high number of hydatid cysts were observed; this is a considerable source of infection for dogs and other carnivores as final hosts, which transmit the parasite to human beings. Infection with high numbers helminths results in considerable direct losses of organs and carcasses, as well as indirect losses of production and performance.

This abattoir survey generally reflected the disease situation in the Sulaimani province and showed that the prevalence of hydatid cyst infections is generally lower than those reported from other regions of Iraq, and at the same time,

remains prevalent, and this inspection has helped illustrating the utility of records of meat inspection in observing situations of disease and establishing potential extended term trends. The study found that spring is crucial for animals as a result of its highest rates of infection, followed by summer seasons. Furthermore, this study provides a preliminary baseline data for the future monitoring of these potentially important parasitic diseases.

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References

[1] Jenkins D.J., Romig T., Thompson R.C.A. 2005. Emergence/re-emergence of *Echinococcus* spp. – a global update. *International Journal for Parasitology* 35: 11–12: 1205–1219. doi:10.1016/j.ijpara.2005.07.014

[2] Eckert J., Deplazes P. 2004. Biological, epidemiological, and clinical aspects of echinococcosis, a zoonosis of increasing concern. *Clinical Microbiology Reviews* 17(1): 107–135. doi:10.1128/cmr.17.1.107-135.2004

[3] Kern P., Ammon A., Kron M., Sinn G., Sander S., Petersen L.R., Gaus W., Kern P. 2004. Risk factors for alveolar echinococcosis in humans. *Emerging Infectious Diseases* 10(12): 2088– 2093. doi:10.3201/eid1012.030773

[4] McManus D.P., Zhang W., Li J., Bartley P.B. 2003. Echinococcosis. *The Lancet* 362(9392): 1295–1304. doi:10.1016/s0140-6736(03)14573-4

[5] Eckert J., Gemmell M.A., Meslin F.X., Pawlowski Z.S., World Health Organization 2001. WHO/OIE manual on echinococcosis in humans and animals: a public health problem of global concern. Paris, France: World Organization for Animal Health. https://apps.who.int/iris/handle/10665/42427

[6] Vuitton D.A., McManus D.P., Rogan M.T., Romig T., Gottstein B., Naidich A., Tuxun T., Wen H., da Silva A.M. 2020. International consensus on terminology to be used in the field of echinococcoses. *Parasite* 27: article number 41. doi:10.1051/parasite/2020024

[7] Torgerson P.R., Budke C.M. 2003. Echinococcosis – an international public health challenge. *Research in Veterinary Science* 74(3): 191–202. doi:10.1016/s0034-5288(03)00006-7

[8] Wachira T.M., Sattran M., Zeyhle E., Njenga M. 1994. Abattoirs and echinococcosis in Nairobi dogs. *Transactions of the Royal Society of Tropical Medicine and Hygiene* 88(2): 166–166. doi:10.1016/0035-9203(94)90279-8

[9] Moro P.L., Lopera L., Cabrera M., Cabrera G., Silva B., Gilman R.H. 2010. endemic focus of cystic echinococcosis in a coastal city of Peru. *The American Journal of Tropical Medicine and Hygiene* 71(3): 327–329. doi:10.4269/ajtmh.2004.71.327

[10] Possenti A., Manzano-Román R., Sánchez-Ovejero C., Boufana B., La Torre G., Siles-Lucas M., Casulli A. 2016. Potential risk factors associated with human cystic echinococcosis: systematic review and meta-analysis. *PLoS Neglected Tropical Diseases* 10(11): e0005114. doi:10.1371/journal.pntd.0005114

[11] Sadjjadi S.M. 2006. Present situation of echinococcosis in the Middle East and Arabic North Africa. *Parasitology International* 55(Suppl.): S197–S202. doi:10.1016/j.parint.2005.11.030

[12] Torgerson P.R., Oguljahan B., Muminov A.E., Karaeva R.R., Kuttubaev O.T., Aminjanov M., Shaikenov B. 2006. Present situation of cystic echinococcosis in Central Asia. *Parasitology International* 55(Suppl.): S207–S212. doi:10.1016/j.parint.2005.11.032

[13] Zhenghuan W., Xiaoming W., Xiaoqing L. 2008. Echinococcosis in China, a review of the epidemiology of *Echinococcus* spp. *Ecohealth* 5(2): 115–126. doi:10.1007/s10393-008-0174-0

[14] Torgerson P.R., Carmona C., Bonifacino R. 2000. Estimating the economic effects of cystic echinococcosis: Uruguay, a developing country with upper-middle income. *Annals of Tropical Medicine and Parasitology* 94(7): 703–713. doi:10.1080/00034983.2000.11813594

[15] Budke C.M., Campos-Ponce M., Qian W., Torgerson P.R. 2005. A canine purgation study and risk factor analysis for echinococcosis in a high endemic region of the Tibetan plateau. *Veterinary Parasitology* 127(1): 43–49. doi:10.1016/j.vetpar.2004.08.024

[16] Majorowski M.M., Carabin H., Kilani M., Bensalah A. 2005. Echinococcosis in Tunisia: a cost analysis. *Transactions of the Royal Society of Tropical Medicine and Hygiene* 99(4): 268–278. doi:10.1016/j.trstmh.2004.06.011

[17] Polydorou K. 1981. Animal health and economics. Case-study: echinococcosis with a reference to Cyprus [dogs]. *Bulletin de l'Office International des Epizooties (France)* 93(5–6): 981–992.

[18] Torgerson P.R., Dowling P.M. 2001. Estimating the economic effects of cystic echinococcosis. Part 2: an endemic region in the United Kingdom, a wealthy, industrialized economy. *Annals of Tropical Medicine and Parasitology* 95(2): 177–185. doi:10.1080/00034980020030948

[19] Maktoof A.R., Abu Tabeekh M.A.S. 2015. Classification of endemicity of cystic echinococcosis in Basra Governorate-Iraq. *Journal of Agricultural*

Research 1: 6–9.
[20] Thweni M.M. Yassen, L.J. 2015. Hepatic hydatidosis in man and livestock in Nassiriyah, Iraq. *International Journal of PharmTech Research* 7(2): 310–314.
[21] Al-Hassani N.A.A. 2013. A study of human hydatidosis: demographically and clinically in Hilla city. *Cough* 11: article number 24.
[22] Mero W.M., Jubrael J.M., Hama A.A. 2014. Prevalence of hydatid disease among slaughtered animals in Slemani Province/Kurdistan-Iraq. *Science Journal of University of Zakho* 2(1): 33–38.
[23] WHO. 2003. Manual of basic techniques for a health laboratory.
https://apps.who.int/iris/handle/10665/42295
[24] Daryani A., Alaei R., Arab R., Sharif M., Dehghan M.H., Ziaei H. 2007. The prevalence, intensity and viability of hydatid cysts in slaughtered animals in the Ardabil province of Northwest Iran. *Journal of Helminthology* 81(1): 13–17. d
doi:10.1017/s0022149x0720731x
[25] Esfandiari B., Youssefi M.R. 2010. Comparison of eosin and trypan blue staining in viability of hydatid cyst protoscoleces. *Global Veterinaria* 4(5): 456–458.
[26] Al-Fatalawei M.A.A. 2002. Epidemiological and biological study of hydatidosis in Al-Qadisia governorate. MSc. thesis. College of Veterinary Medicine, University of Baghdad, Iraq.
[27] Tashani O.A., Zhang L.H., Boufana B.A., Jegi A., McManus D.P. 2002. Epidemiology and strain characteristics of *Echinococcus granulosus* in the Benghazi area of eastern Libya. *Annals of Tropical Medicine and Parasitology* 96(4): 369–381. doi:10.1179/000349802125000952
[28] Eckert J., Deplazes P. 2004. Biological, epidemiological, and clinical aspects of echinococcosis, a zoonosis of increasing concern. *Clinical Microbiology Reviews* 17(1): 107–135.
doi:10.1128/cmr.17.1.107-135.2004
[29] Mohsen S.S., Jiyad A.L., Mohamad R.N. 2009. Genetic variation for epidemiological human *Echinococcus granulosus* from different regions of Iraq. *Al-Qadisiyah Journal of Veterinary Medicine Sciences* 8(1): 55–62.
[30] Meerkhan A.A., Abdullah A.M. 2012. The epidemiology of hydatidosis in different slaughtered animals in Duhok abattoir, Kurdistan Region of Iraq. In: Abstracts of Second International Conference, Bali, Indonesia, vol. 4: 45–48.
[31] Saida L.A., Nouraddin A.S. 2011. Epidemiological study of cystic echinococcosis in man and slaughtered animals in Erbil province, Kurdistan Regional-Iraq. *Tikrit Journal of Pure Science* 16(4): 45–50.
[32] Al-Ani W.A., Mohammad A.M.N., Al-Naimi U.A.M. 2012. Hydatidosis of slaughtered sheep in Baghdad City; bacteriological study of infected hydatid cyst fluid. *Mustansiriya Medical Journal* 11(2): 45–48.
[33] Meerkhan A.A., Mero W.M. 2018. Prevalence of *Echinococcus granulosus* in different intermediate hosts in Duhok Province, Kurdistan Region, Iraq. *Science Journal of University of Zakho* 6(1): 1–3.
[34] AL-Bosely A.R.I. 2014. Studies on epidemiology of hydatid cysts isolated from different intermediate hosts in Zakho, Duhok province, Kurdistan region, Iraq. MSc. thesis. Faculty of Science, University of Zakho.
[35] Bajalan M.M. 2006. Prevalence of echinococcosis in stray dogs and slaughtered livestock in Kalar district/Sulaimaniyah province/Kurdistan Iraq. MSc. thesis. College of Veterinary Medicine, University of Baghdad. doi:10.13140/RG.2.2.28205.59366
[36] Rasheed S., Kadir M. 2008. Prevalence of some parasitic helminths among slaughtered ruminants in Kirkuk slaughter house, Kirkuk, Iraq. *Iraqi Journal of Veterinary Sciences* 22(2): 81–85.
[37] Sargali A.M.A., Mero W.M.S. 2013. Epidemiological study of hydatid cyst of *Echinococcus granulosus* isolated from sheep and goats in Duhok Province, Kurdistan Region of Iraq. *Science Journal of University of Zakho* 1(1): article number 3843.
[38] Thompson R.A., McManus D.P. 2002. Towards a taxonomic revision of the genus *Echinococcus*. *Trends in Parasitology* 18(10): 452–457.
doi:10.1016/s1471-4922(02)02358-9
[39] Kamhawi S., Hijjawi N., Abu-Gazaleh A., Abbass M. 1995. Prevalence of hydatid cysts in livestock from five regions of Jordan. *Annals of Tropical Medicine and Parasitology* 89(6): 621–629.
doi:10.1080/00034983.1995.11812996
[40] Daryani A., Sharif M., Amouei A., Nasrolahei M. 2009. Fertility and viability rates of hydatid cysts in slaughtered animals in the Mazandaran Province, Northern Iran. *Tropical Animal Health and Production* 41(8): 1701–1705.
doi:10.1007/s11250-009-9368-x
[41] Kebede N., Mekonnen H., Wossene A., Tilahun G. 2009. Hydatidosis of slaughtered cattle in Wolaita Sodo Abattoir, southern Ethiopia. *Tropical Animal Health and Production* 41(4): 629–633.
doi:10.1007/s11250-008-9234-2
[42] Khalf M.S., Al-Faham M.A., Al-Taie L.H., Alhussian H.A. 2014. Genotyping of *Echinococcus granulosus* in samples of Iraqi patients. *IOSR Journal of Pharmacy and Biological Sciences* 9(3): 6–10. doi:10.9790/3008-09320610
[43] Temam B.D., Mukarim A.A. 2016. Study on prevalence and monetary loss attributed to hydatidosis in cattle slaughtered at Jimma Municipal Abattoir, Southwestern Ethiopia. *Global Journal of Medical Research* 16(2): 17–24.

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