

The monetary losses associated with hydatidosis in slaughtered ruminants in Turkey

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Article info

Received March 8, 2022
Accepted August 19, 2022

Summary

Hydatidosis is a parasitic zoonotic disease that negatively affects human and animal health and causes economic losses due to slaughter condemnation and risk to public health in developing countries. This study aims to determine the prevalence of Hydatidosis among slaughtered livestock in different regions of Turkey and calculate the financial losses associated with the zoonosis. For this purpose, livestock slaughter records from the livestock information system in 2020 were considered and direct and indirect economic losses were estimated. The study determined the prevalence of hydatidosis in small ruminants (0.03%) and cattle (0.0124%) and an average of 0.007% of the total number of livestock slaughtered during the period under study were infected with hydatid cysts. The direct and indirect economic losses were estimated at \$98.558 and \$466.891, respectively. The total monetary loss due to Hydatidosis in Turkey in the year 2020 was estimated at \$565.448. In conclusion, significant monetary losses due to Hydatidosis in slaughtered livestock is still an important economic issue to livestock traders in Turkey.

Keywords: Hydatid cyst; Ruminants; zoonosis; monetary loss; Turkey

Introduction

Hydatid cyst is an infection caused by the larval form of *Echinococcus granulosus* and is spread worldwide. The definitive host of *E. granulosus* are carnivorous, while herbivorous species such as sheep, goat, cattle, camel, horse, donkey and humans are its intermediate hosts (Díaz, 2017).

Hydatid cyst causes direct economic losses due to extermination of edible internal organs such as liver, lungs, kidneys, spleen and heart, and indirect financial losses through the reduction in carcasses yield and milk production as well as fecundity (Agudelo-Higuera, 2016). Although Hydatidosis occur worldwide except for Antarctica, its prevalence varies from country to country. According to the World Health Organization report, 2 – 3 million Cystic Echino-

coccosis cases are reported annually in humans (World, 2015).

Numerous studies on the prevalence of Hydatidosis among ruminants have been published. Hydatidosis in Persia was determined at the following levels, 15 – 10 % for cattle, 20 – 30 % for sheep, and 4 – 5 % for goats (Ghasemian *et al.*, 2018). In Pakistan it was reported as 15.79 % in cattle, 15.38 % in sheep and 3.25 % in goats, while it was found to be 8 % in sheep and 1 % in cattle slaughtered in Iraq (Halem *et al.*, 2018; Mohammed, 2021). The prevalence of Hydatidosis in cattle was reported at 18.2 % in India; 62.6 % in sheep and 28.9 % in goat slaughtered in Italy (Bosco *et al.*, 2021; Moudgil, 2021).

Hydatidosis is a very important parasitic disease causing economic losses throughout the world, especially in developing and underdeveloped countries. Monetary losses due to hydatid cyst have

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Table 1. The financial parameters used in the monetary loss analysis.

Parameter	Cattle	Sheep	Goat	References
Mean liver weight (kg/head)	8	1	1	Dursun, 2016
Mean heart weight (kg/head)	1	0.12	0.12	Dursun, 2016
Mean lung weight (kg/head)	3	0.5	0.5	Dursun, 2016
Current market price of liver (US\$/kg)	11.6	16.5	16.5	Anonymous, 2021a
Current market price of heart (US\$/kg)	4.8	8.6	8.6	Anonymous, 2021a
Current market price of lung (US\$/kg)	1	1	1	Anonymous, 2021a

been reported as US\$ 561,112 in Wales (Togerson & Dowling, 2001) US\$ 472,200 in Uruguay (Togerson *et al.*, 2000), 212.35 million USD in India (Singh *et al.*, 2014) and US\$ 141.605,195 in the USA (Budke, 2006).

The parasitic zoonotic disease is very important worldwide, especially in underdeveloped and developing countries (Asia, Mediterranean, and Middle East countries) such as Turkey. Globally, an annual livestock production loss of at least US \$141,6 million and possibly up to the \$2,2 billion is estimated due to cystic echinococcosis

The main aim of the current study, was to determine the prevalence of hydatidosis in cattle, sheep and goats slaughtered in

Turkey in 2020, compare the distribution of hydatid cysts in livestock organs depending on species, sex and regions as well as to estimate the economic losses associated with hydatidosis from slaughtered livestock in Turkey.

Materials and Methods

The retrospective data on the hydatid cyst occurrence observed on organs such as the liver of slaughtered cattle, sheep, and goats were obtained utilizing data mining procedure from the annual livestock slaughter records in Turkey's Livestock Information System of 2020. The distribution of hydatid cysts in various organs among

Table 2. Distribution of hydatid cysts in ruminants in different regions of Turkey.

Region	Animal species	Slaughtered Animals Number	Infected Animals Number	%	Infected Liver Number	%	Infected Lung Number	%	Infected Heart Number	%
Mediterranean region	Cattle	79531	69	0.087	52	0.065	18	0.023	4	0.005
	Small Ruminant	133134	31	0.023	16	0.012	15	0.011	1	0.001
	Total	212665	100	0.047	68	0.032	33	0.015	5	0.002
East Anatolia region	Cattle	46500	15	0.032	14	0.030	2	0.004	1	0.002
	Small Ruminant	29000	56	0.193	26	0.09	30	0.103	0	0.000
	Total	75500	71	0.094	40	0.052	32	0.042	1	0.001
Aegean Region	Cattle	217755	238	0.109	130	0.06	119	0.055	19	0.009
	Small Ruminant	176547	206	0.117	120	0.068	86	0.049	11	0.006
	Total	394302	444	0.113	250	0.063	205	0.052	30	0.008
Southeast Anatolia region	Cattle	112615	16	0.014	11	0.010	10	0.009	0	0.000
	Small Ruminant	208631	5	0.002	3	0.0014	2	0.001	1	0.000
	Total	321246	21	0.007	14	0.0044	12	0.004	1	0.000
Central Anatolia region	Cattle	346103	808	0.233	702	0.203	204	0.059	137	0.040
	Small Ruminant	151707	6	0.004	4	0.0026	2	0.001	0	0.000
	Total	497810	814	0.164	706	0.142	206	0.041	137	0.028
Black Sea region	Cattle	66926	69	0.103	38	0.057	47	0.070	8	0.012
	Small Ruminant	19056	0	0.000	0	0.000	0	0.000	0	0.000
	Total	85982	69	0.080	38	0.044	47	0.055	8	0.009
Marmara region	Cattle	168442	75	0.045	39	0.023	34	0.020	7	0.004
	Small Ruminant	333573	16	0.005	15	0.004	2	0.001	0	0.000
	Total	502015	91	0.018	54	0.011	36	0.007	7	0.001
Cattle Total		1037872	1290	0.124	986	0.095	434	0.042	176	0.017
Small Ruminant Total		1051648	320	0.030	184	0.017	137	0.013	13	0.001
Distribution summary		2089520	1610	0.077	1170	0.056	571	0.027	189	0.009

Table 3. The distribution of hydatid cyst in Turkey.

Cities	SAN		IA %		Ili %		Ilu %		IH %	
	C	SM	C	SM	C	SM	C	SM	Cattle	SM
Adana	5532	57429	0.253	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Adiyaman	4199	1528	0.071	0.000	0.048	0.000	0.000	0.000	0.048	0.000
Afyonkarahisar	54500	1081	0.006	0.000	0.004	0.000	0.000	0.000	0.004	0.000
Ağrı	1826	342	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aksaray	15539	0	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Amasya	19935	336	0.005	0.000	0.005	0.000	0.000	0.000	0.005	0.000
Ankara	75098	34650	0.049	0.000	0.049	0.000	0.000	0.000	0.041	0.000
Antalya	17585	26293	0.136	0.008	0.136	0.000	0.000	0.000	0.000	0.000
Ardahan	573	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Artvin	812	195	0.123	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aydın	41940	7288	0.157	0.027	0.119	0.027	0.000	0.000	0.012	0.000
Balıkesir	65961	140411	0.005	0.000	0.003	0.000	0.000	0.000	0.003	0.000
Bartın	2790	0	0.645	0.000	0.502	0.000	0.000	0.000	0.108	0.000
Batman	1509	5037	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bayburt	510	1	0.196	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bilecik	1987	863	0.201	0.000	0.101	0.000	0.000	0.000	0.050	0.000
Bingöl	3438	5596	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bitlis	378	2312	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bolu	4306	638	0.046	0.000	0.046	0.000	0.000	0.000	0.023	0.000
Burdur	14079	788	0.071	0.000	0.007	0.000	0.000	0.000	0.007	0.000
Bursa	27516	12917	0.036	0.000	0.004	0.000	0.000	0.000	0.004	0.000
Çanakkale	15113	23100	0.046	0.013	0.013	0.000	0.000	0.000	0.000	0.000
Çankırı	4466	1046	0.045	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Çorum	3910	32	0.179	0.000	0.102	0.000	0.000	0.000	0.026	0.000
Denizli	14218	17725	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diyarbakır	11898	84435	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Düzce	4698	0	0.043	0.000	0.043	0.000	0.000	0.000	0.000	0.000
Edirne	16086	56798	0.242	0.000	0.236	0.000	0.000	0.000	0.006	0.000
Elazığ	8443	2587	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Erzincan	2728	316	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Erzurum	8618	2115	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eskişehir	5443	629	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gaziantep	48897	85505	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Giresun	2133	319	0.281	0.000	0.281	0.000	0.000	0.000	0.094	0.000
Gümüşhane	489	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hakkari	166	2876	0.000	1.947	0.000	0.000	0.000	0.000	0.000	0.000
Hatay	6702	5713	0.179	0.000	0.134	0.000	0.000	0.000	0.060	0.000
Iğdır	987	1495	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
İsparta	11139	2426	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
İstanbul	1043	52420	0.096	0.000	0.096	0.000	0.000	0.000	0.000	0.000
İzmir	59536	93840	0.071	0.011	0.015	0.011	0.000	0.000	0.010	0.000
Kahramanmaraş	15361	6807	0.026	0.000	0.007	0.000	0.000	0.000	0.007	0.000
Karabük	1072	158	0.187	0.000	0.187	0.000	0.000	0.000	0.000	0.000
Karaman	2102	2388	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Kars	644	50	1.708	0.000	1.708	0.000	0.000	0.000	0.000	0.000
Kastamonu	3305	781	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Kayseri	56095	7765	0.004	0.039	0.000	0.000	0.000	0.000	0.000	0.000
Kırıkkale	2696	3765	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Kırklareli	12756	11240	0.008	0.000	0.008	0.000	0.000	0.000	0.000	0.000
Kırşehir	56952	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Kilis	102	1129	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Kocaeli	2838	569	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Konya	106939	94149	0.697	0.003	0.627	0.003	0.000	0.000	0.125	0.000
Kütahya	5246	1696	0.076	0.295	0.019	0.295	0.177	0.177	0.000	0.000
Malatya	16031	887	0.006	0.000	0.006	0.000	0.000	0.000	0.000	0.000
Manisa	22900	43861	0.022	0.005	0.022	0.005	0.000	0.000	0.000	0.000
Mardin	284	1066	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mersin	3983	29680	0.126	0.094	0.075	0.094	0.091	0.091	0.050	0.000
Muğla	11465	8226	0.933	2.273	0.837	2.273	2.273	2.273	0.837	2.273
Muş	777	827	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nevşehir	1635	158	0.061	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Niğde	7307	1784	0.014	0.000	0.014	0.000	0.000	0.000	0.014	0.000
Ordu	4872	4461	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Osmaniye	5150	3998	0.000	0.025	0.000	0.025	0.025	0.025	0.000	0.000
Rize	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Sakarya	8751	2060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Samsun	9728	9451	0.236	0.000	0.093	0.000	0.000	0.000	0.010	0.000	0.000
Siirt	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sinop	1652	78	0.061	0.000	0.061	0.000	0.000	0.000	0.061	0.000	0.000
Sivas	7167	141	0.167	0.000	0.167	0.000	0.000	0.000	0.000	0.000	0.000
Şanlıurfa	45680	24943	0.026	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Şırnak	46	4988	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tekirdağ	14923	32328	0.034	0.040	0.013	0.040	0.003	0.003	0.013	0.000	0.000
Tokat	5418	2638	0.221	0.000	0.074	0.000	0.000	0.000	0.037	0.000	0.000
Trabzon	1586	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tunceli	475	2207	0.211	0.000	0.211	0.000	0.000	0.000	0.211	0.000	0.000
Uşak	7950	2830	0.138	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Van	1416	7390	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Yalova	1468	867	0.341	0.000	0.341	0.000	0.000	0.000	0.068	0.000	0.000
Yozgat	754	5200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Zonguldak	3620	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

SAN (Slaughtered Animals Number), IA (Infected Animals); Ili (Infected Liver), Ilu (Infected Lung), IH (Infected Heart)

slaughtered animals in different cities and regions was determined. The estimation of direct economic losses due to condemnations of edible internal organs such as liver, lung and heart were computed using the following formula described by Umur (2003).

$$DL = N \times W \times V$$

DL: Direct losses due to of the organ for the considered species in the USD.

N: Number of the organ with hydatid cyst for the considered species

W: Mean weight of the organ for the considered species

V: The organ's current market value for the considered species in USD.

Table 1. The financial parameters used in the analysis

Indirect economic losses arising from the reduction of carcass production milk yield and fecundity were estimated using the following formula described by Benner *et al.* (2010).

$$IL_c: N \times P \times Y \times R \times V$$

Where

IL_c: Indirect economic losses arising from reduction of carcass production (US\$)

N: Number of the animal slaughtered or milked (Anonymous, 2021b)

P: Prevalence of hydatid cyst

Y: Mean annual carcass weight (kg) or milk yield per animal

R: Reduction in carcass weight (%) or milk yield

V: Current value of carcass or milk in US\$/kg

The mean weight of carcass was 270 kg for cattle, 30 kg for sheep and goats. Meanwhile, reduction of carcass weight has been reported as 1.1 % (Umur, 2003). The mean value of carcass was taken 5.7 US\$/Kg for cattle and 8 US\$/Kg for sheep and goats (Anonymous, 2021a).

The mean milk yield was 9000 L for cattle, 100 L for sheep and goats. Reduction of milk weight determined 2.5 % (Benner, 2010).

The mean market value of milk was taken 0.33 US\$/l for cattle and 0.74 US\$/l for sheep and goats (Anonymous, 2021a).

Calculating for fecundity production losses: The number of mean calves born annual (Anonymous, 2021b) X The prevalence of

hydatid cyst X reduction in born calves percent X current market value of calves (US\$) (Anonymous, 2021c).

The reduction in the birth rate was assumed as 5.5 % and the mean value of calves, lambs and kids was estimated to be 500 USD, 83.2 US\$ and 83.2 USD, respectively (Anonymous, 2021a). Estimated economic losses were calculated on market prices for 2020.

The results calculated in TL (Turkish lira) have been converted to US dollars (USD) at the exchange rate of 1 US\$ = 6.034 TL

Statistical analysis

The present study used the statistical package with the Social Sciences for Windows 16.0 (SPSS Inc., Chicago, IL, USA). A P <0.05 was considered significant.

Ethical Approval and Informed Consent

We had no conflict of interest to declare during the study. Since this study used retrospective data, no approval from the ethics committee was necessary.

Results

Hydatid cyst(s) was found in 1,290 (0.124 %) out of 1,037,872 slaughtered cattle, 320 (0.030 %) out of 1,051,648 slaughtered small ruminants, and 1610 (0.077 %) out of all the 2089520 slaughtered animals (cattle, shoats) in Turkey during the period under study. The highest prevalence of the infection was recorded in Central Anatolia Region (0.164 %); meanwhile the lowest was observed in the Southeastern Anatolia Region (0.007 %) (Table 2). The prevalence of hydatid cysts in slaughtered livestock in different provinces are presented in detail in Table 3.

The total monetary loss associated with hydatid cysts in Turkey in 2020 was estimated at 565.448 USD; the direct financial losses were estimated at 98.558 USD, while indirect economic losses were estimated at 466.891 USD (Table 4).

Discussion

Hydatid cyst is a common infection, particularly in rural areas globally. Boga, (2012) reported the prevalence of hydatid cyst in cattle (2.7 – 69.5 %), sheep (1.83 – 79.6 %), and goats (1.6 – 74.4 %) in Turkey. The prevalence of hydatid cyst assessed in this study among cattle (0.124 %) and sheep (0.030 %) was found to be lower than those reported in previous studies as 4.4 % in cattle and 6.36 % in sheep Karaman *et al.* (2015), 25 % in sheep and 3 % in cattle Düzlü *et al.* (2010), 15.63 % in cattle Erol *et al.* (2021). This decreasing may be explained from regularly used antiparasitic drugs. On the other hand because of regulations on animal welfare stray dogs are regularly controlled and treated against parasites. These measurements reduces the discharge of echinococcus eggs and contamination risks of ruminant intermediate hosts. The prevalence of Hydatidosis in cattle was reported at 18.2 % in India; 62.6 % in sheep and 28.9 % in goat slaughtered in Italy (Bosco *et al.*, 2021; Moudgil, 2021).

The lowest prevalence of hydatid cyst was found in Muğla province (Acıöz *et al.*, 2021) (0.21 %) and its highest prevalence was observed in Erzurum province (70.91 %) in Turkey (Arslan & Umr, 1997). Concerning the regions, the lowest prevalence of hydatid cyst was observed in Southeastern Anatolia Region (0.007 %), and the highest was in the Central Anatolia Region (0.164 %). These differences in hydatid cyst prevalences among geographical regions of Turkey can be attributed to differences in geographical, climate conditions and animal breeding systems that reduce the viability of eggs. Because contact with parasites in closed production systems is limited a lower prevalence of hydatid cyst is expected in animals raised in closed systems.

Monetary losses due to hydatid cyst have been reported in various regions of the world and within Turkey as follows; 58114.62 USD in Ethiopia (Guduro *et al.*, 2019), 152,003 USD in Kenya (Kere *et al.*, 2019), 232.3 million USD in Iran (Farisi-Harandi *et al.*, 2012), US\$ 73 million in Morocco (Saadi *et al.*, 2020), in Iraq US\$ 72.470 (Abdulhameed *et al.*, 2018), US\$ 141.605,195 in the USA (Budke, 2006), 15.532.242 EURO in Spain (Benner, 2010). Numerous studies considering the economic loss arising from hydatid cysts in Turkey have been conducted. In these studies the economic losses were estimated as US\$ 583/year in Burdur (Umr, 2003), TL₺ 3320/year in Erzurum (Balkaya & Şimşek, 2010), US\$ 31372/year in Kayseri (Düzlü *et al.*, 2010), US\$ 7708/year in Kars (Demir & Mor, 2011), US\$ 12.321/year in Bursa (Yıbar *et al.*, 2015) and US\$ 89.2 million /year in Turkey (Sarıözkan & Yalçın, 2009). In this current study, the financial losses due to Hydatidosis in Turkey was estimated at 565.448 USD. These differences in monetary losses could be associated with the methodology used in different studies, different geographical locations, different animal husbandry practices, study duration and the sample size used in different studies.

Livestock production in Turkey plays an important place in gross domestic production. Although Turkey possesses enough animal quantities, the mean yield per animal is low compared to those in developed countries. Hydatid cyst is one of the critical causes of yield reduction from animal husbandry in Turkey. This infection decreases the potential of animal production in Turkey and causes direct monetary losses due to condemnation of edible internal livestock organs such as the liver, lungs, kidneys, spleen during meat inspection. Besides, indirect losses such as carcass, milk, and fecundity reduction also occur as a result of this zoonosis.

Table 4. The financial losses of hydatid cyst in 2020 in Turkey.

Type of Losses	Loss Components	Species	Losses (in USD)
Indirect losses	Milk production	Cattle	212456
		Small Ruminant	926
	Carcass production	Cattle	37750
		Small Ruminant	1187
	Fecundity production	Cattle	211982
		Small Ruminant	2590
Summary			466891
Direct losses	Liver condemnation	Cattle	91508
		Small Ruminant	3027
	Lung condemnation	Cattle	1403
		Small Ruminant	74
	Heart condemnation	Cattle	2533
		Small Ruminant	13
Summary			98558
Summary of total economic loss			565448

Conclusion

The results of the current study show a significant decrease in the prevalence of Hydatidosis in Turkey however the monetary loss associated with the zoonosis per year is significant in a growing economy like Turkey and a considerable deprivation of proteins in the diet of the households due to condemnation of edible offals at meat inspection.

Conflict of Interest

We have no conflict of interest to declare.

Acknowledgment

The authors thank to Ministry of Agriculture and Forestry for making the data available for this study.

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