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A retrospective survey of liver flukes in livestock based on abattoir data in Kermanshah, west of Iran

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Abstract A retrospective study was carried from 2008 to 2013 to estimate the prevalence of liver flukes in ruminants slaughtered at the abattoir of Kermanshah province, west of Iran. A total of 663,633 animals slaughtered in the 5-year period and totally 1.95 % of livers were condemned due to liver flukes. Fasciolosis were responsible for 0.8, 0.7 and 1.5 % of liver condemnations, whereas 1, 0.8 and 1 % of liver were condemned because of *Dicrocoelium dendriticum* infection in the sheep, goats and cattle, respectively. A significant difference in the prevalence of liver flukes were observed among studied animals ($p < 0.001$) and the highest and lowest prevalence were detected in cattle and goats, respectively. Data showed significant seasonal pattern for distomatosis in sheep and goat ($p < 0.001$). Liver condemnations due to fasciolosis were prevalent in sheep and goats and cattle slaughtered during winter, summer and autumn, respectively, whereas dicrocoeliosis were common in autumn season for sheep and cattle and in winter for goats. This survey provides baseline data for the future monitoring of these potentially important parasitic infections in the region.

Keywords Liver fluke · Abattoir · Prevalence · Kermanshah · Iran

Introduction

Parasitic diseases are considered as a major problem in the health and food safety with animal origin and cause economic loss in countries where livestock industry is an important part of the agricultural products. The liver flukes (*Fasciola* spp. and *Dicrocoelium dendriticum*) are recognized as one of the most important ruminant's helminthic parasites which are found in many parts of the world including Iran (Kantzoura et al. 2011; Massoud et al. 2012).

The liver flukes can cause reductions in milk and meat production, condemnation of parasitized livers, abortion, increased mortality and the expense of control measures (Carnevale et al. 2013). The principal definitive hosts of these parasites are cattle, sheep and goat. However, certain other mammals, including humans, may be infected as an accidental host (McCann et al. 2010). *Fasciola* spp. has an indirect life cycle involving domestic and wild herbivorous mammals and humans as definitive hosts, and freshwater gastropods of the family of Lymnaeidae as intermediate hosts (Issia et al., 2009). *Fasciola hepatica* has a cosmopolitan distribution, while *F. gigantica* is found in tropical regions of Africa and Asia. Thus, the two fasciolid species overlap in many African and Asian countries, although in such cases the ecological requirements of the flukes and their snail intermediate host are distinct (Ashrafi et al. 2006). The presence of fasciolosis in Iran has long been known and its prevalence and economic significance has been reported by several researchers (Moghaddam et al. 2004; Ansari-Lari and Moazzeni 2006; Ashrafi et al. 2006;

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Borji and Parandeh 2010; Ghazani et al. 2008; Oryan et al. 2011; Khanjari et al. 2014). Although a review of available literature strongly suggests that fasciolosis exists in almost all parts of the country, but its prevalence among domestic animals is higher in the southern part of the country, whereas the number of reported human disease cases is significantly higher in the Northern provinces (Khanjari et al. 2014). The prevalence of human fasciolosis in many parts of Iran is quite high and was reported to be as high as 10,000 cases for some years (Massoud 1993; Abdou 2000). Recently, a minor emergence of fasciolosis, with 17 non-fatal cases, reported in the Kermanshah, western Province of Iran (Hatami et al. 2000). Dicrocoeliosis, a disease of grazing ruminants, is less severe than fasciolosis, While the economic losses, mainly due to condemnation of affected liver, are considerable (Ahmadi et al. 2010). Two intermediate hosts including a land snail (*Zebrina* sp., *Helicella* sp., *Cionella* sp.) and an ant (*Formica* sp., *Lasius* sp.) are necessary to complete parasite development. The Final host infection occurs by ingesting the infected ants (Le Bailly and Bouchet 2010). Unlike *Fasciola* spp., the intermediate hosts of *D. dendriticum* do not require a moist environment and are widely present in pastures (Otranto and Traversa 2002).

In the absence of statistically sound epidemiological data, evaluating liver fluke prevalence in livestock based on liver condemnation statistics might be useful. Most of the published reports in Iran are from the central, southern and northern parts of the country and there was not any data about *Fasciola* and Dicrocoelium in the western Iran (Moghaddam et al. 2004; Ansari-Lari and Moazzeni 2006; Ashrafi et al. 2006; Borji and Parandeh 2010; Ghazani et al. 2008; Oryan et al. 2011; Khanjari et al. 2014). Therefore this survey was designed to estimate the prevalence of liver flukes in abattoir populations of cattle, sheep and goats in the western part of Iran for the period 2008–2013.

Materials and methods

This study is a retrospective survey covering a period of 5 years from 4 April 2008 to 4 April 2013. All daily condemnation records for cattle, sheep and goats in the municipal abattoir of livestock animals, in Kermanshah (the capital of Kermanshah province, west of Iran) were used as the source of data. As part of an ongoing surveillance system, each slaughtered animal was examined individually by a meat inspector (veterinarian) in the course of his routine duties. The livers were inspected according to the method described by Ogambo-Ongoma (1972) to recognize fasciolosis and dicrocoeliosis and the parasites were identified by their morphological characteristics (Soulsby 1982; Reinecke 1983). The recorded data, acquired with visualization, palpation and incision of livers, was used to extract the prevalence rate of these parasites. The prevalence was collected on a monthly basis. This time interval was chosen as being likely to indicate any seasonal trends. Chi square test was used for comparison of the prevalence rates of fasciolosis and dicrocoeliosis between different animal species and for comparison of the prevalence rates between seasons for the same animal species. Differences were considered significant when $p < 0.05$, using computer software SPSS version 16 for windows.

The direct economic loss due to liver flukes condemnation was calculated by this procedure: DFL = CL × P × W, where DFL is direct financial loss, CL is number of condemned livers due to fasciolosis and dicrocoeliosis, P is average liver price (dollar/Kg), W is average liver weight (Kg).

The average weights of bovine and small ruminant's liver (W) were determined by weighting 50 bovine livers and the same number of sheep and goats livers in different ages. The average weights were calculated as 0.8 and 5.5 kg for small ruminants and bovine livers in this region, respectively. The average sell prices (P) for each kilogram of liver was 11.7 USD for cattle and 15.2 USD for sheep and goats in local butchers in different areas in Kermanshah province during 2008–2013.

Results

A total number of 663,633 slaughtered livestock (393,585 sheep, 81,080 goats and 188,968 cattle) were included in this study. The overall prevalence of distomatosis infection was 1.95 %. The data showed that 0.8, 0.7 and 1.5 % of the sheep, goats and cattle were infected by *Fasciola* spp. respectively. Dicrocoeliosis were responsible for 1, 0.8 and 1 % of liver condemnations in the sheep, goats and cattle, respectively (Tables 1, 2). Thus, Dicrocoeliosis was more prevalent than fasciolosis in both sheep and goats, whereas in cattle fasciolosis was more prevalent.

A significant difference in the prevalence of fasciolosis ($p < 0.001$, $X_2 = 876.04$) and dicrocoeliosis ($p < 0.001$, $X_2 = 20.50$) were observed among studied animals. The highest prevalence was observed in cattle, while the lowest prevalence recorded in goats.

The results showed significant seasonal pattern for distomatosis infection in sheep and goats (Tables 1, 2). A significant seasonal pattern was observed in cattle dicrocoeliosis, but not in cattle fasciolosis (Tables 1, 2). The highest prevalence of fasciolosis observed in winter for sheep ($p < 0.001$, $X_2 = 78.07$), in summer for goats ($p < 0.001$, $X_2 = 30.40$) and autumn for cattle ($p = 0.670$,

Table 1 The total number of animals slaughtered and seasonal prevalence rate (%) of liver hydatidosis in animals slaughtered during 2008 to 2013

Year	Animal	spring		Summer		Fall		Winter		Total	
		N	Inf (%)	*N*	Inf (%)	*N*	Inf (%)	*N*	Inf (%)	*N*	Inf (%)
2008–2009	Sheep	35,583	498 (1.39)	28,223	446 (1.58)	19,604	391 (1.99)	21,920	325 (1.48)	105,330	1,660 (1.6)
	Goat	6,814	94 (1.37)	8,615	108 (1.25)	7,477	83 (1.11)	4,493	49 (1.09)	27,399	334 (1.2)
	Cattle	12,614	159 (1.26)	13,966	166 (1.18)	11,828	223 (1.88)	12,025	219 (1.82)	50,433	767 (1.5)
2009–2010	Sheep	22,019	339 (1.53)	17,752	320 (1.8)	14,210	280 (1.97)	19,418	340 (1.75)	73,399	1,279 (1.7)
	Goat	5,398	77 (1.42)	6653	114 (1.71)	6,294	79 (1.25)	5,384	54 (1)	23,729	324 (1.4)
	Cattle	10,523	220 (2.09)	11,537	238 (2.06)	9,595	189 (1.96)	10,167	188 (1.84)	41,822	835 (2)
2010–2011	Sheep	23,015	364 (1.58)	26,340	403 (1.52)	14,996	186 (1.24)	16,105	155 (0.96)	80,456	1,108 (1.4)
	Goat	4,027	50 (1.24)	5,777	70 (1.21)	3,129	8 (0.25)	2,506	0	15,439	128 (0.8)
	Cattle	9,749	194 (1.98)	12,474	214 (1.71)	8,455	166 (1.96)	10,093	230 (2.27)	40,771	804 (2)
2011–2012	Sheep	14,370	90 (0.62)	19,082	97 (0.50)	14,950	172 (1.15)	16,800	142 (0.84)	65,202	501 (0.8)
	Goat	1,814	8 (0.44)	1,684	18 (1.06)	1,728	19 (1.09)	1,497	10 (0.66)	6,723	55 (0.8)
	Cattle	8,225	172 (2.09)	10,440	136 (1.30)	8,076	173 (2.14)	6,767	75 (1.10)	33,508	556 (1.7)
2012–2013	Sheep	17,183	129 (0.75)	20,395	247 (1.21)	14,493	228 (1.57)	17,127	162 (0.94)	69,198	766 (1.1)
	Goat	1,605	7 (0.43)	2,157	21 (0.97)	2,127	37 (1.73)	1,901	27 (1.42)	7,790	92 (1.2)
	Cattle	5,108	68 (1.33)	6,331	87 (1.37)	5,558	94 (1.69)	5,437	66 (1.21)	22,434	315 (1.4)
Total	Sheep	11,2170	1420 (1.3)	111,792	1513 (1.4)	78,253	1257 (1.6)	91,370	1124 (1.2)	393,585	5,314 (1.4)
2008–2013m	Goat	19,658	236 (1.2)	24,886	331 (1.3)	20,755	226 (1.1)	15,781	140 (0.9)	81,080	933 (1.2)
	Cattle	46,219	813 (1.8)	54,748	841 (1.5)	43,512	845 (1.9)	44,489	778 (1.7)	188,968	3,277 (1.7)

Table 2 The total number of animals slaughtered and seasonal prevalence rate (%) of lung hydatidosis in animals slaughtered during 2008 to 2013

Year	Animal	spring		Summer		Fall		Winter		Total	
		N	Inf (%)	*N*	Inf (%)	*N*	Inf (%)	*N*	Inf (%)	*N*	Inf (%)
2008–2009	Sheep	35,583	655 (1.84)	28,223	662 (2.34)	19,604	572 (2.91)	21,920	511 (2.33)	105,330	2,400 (2.3)
	Goat	6,814	109 (1.59)	8,615	60 (1.85)	7,477	115 (1.53)	4,493	79 (1.75)	27,399	463 (1.7)
	Cattle	12,614	212 (1.68)	13,966	264 (1.89)	11,828	303 (2.56)	12,025	285 (2.37)	50,433	1,064 (2.1)
2009–2010	Sheep	22,019	461 (2.09)	17,752	457 (2.57)	14,210	427 (3)	19,418	419 (2.15)	73,399	1,764 (2.4)
	Goat	5,398	114 (2.11)	6,653	161 (2.14)	6,294	120 (1.90)	5,384	67 (1.24)	23,729	462 (1.9)
	Cattle	10,523	290 (2.75)	11,537	257 (2.22)	9,595	197 (2.05)	10,167	226 (2.22)	41,822	970 (2.3)
2010–2011	Sheep	23,015	433 (1.88)	26,340	537 (2.03)	14,996	221 (1.47)	16,105	163 (1.01)	80,456	1,354 (1.7)
	Goat	4,027	76 (1.88)	5,777	85 (1.47)	3,129	15 (0.47)	2,506	0	15,439	176 (1.1)
	Cattle	9,749	227 (2.32)	12,474	248 (1.98)	8,455	160 (1.89)	10,093	197 (1.95)	40,771	832 (2)
2011–2012	Sheep	14,370	56 (0.38)	19,082	216 (1.13)	14,950	268 (1.79)	16,800	247 (1.47)	65,202	787 (1.2)
	Goat	1,814	8 (0.44)	1,684	9 (0.53)	1,728	45 (2.60)	1,497	36 (2.40)	6,723	98 (1.5)
	Cattle	8,225	119 (1.44)	10,440	208 (1.99)	8,076	381 (4.71)	6,767	169 (2.49)	33,508	877 (2.6)
2012–2013	Sheep	17,183	206 (1.19)	20,395	456 (2.23)	14,493	332 (2.29)	17,127	206 (1.20)	69,198	1,200 (1.7)
	Goat	1,605	32 (1.99)	2,157	59 (2.73)	2,127	53 (2.49)	1,901	31 (1.63)	7,790	175 (2.2)
	Cattle	5,108	114 (2.23)	6,331	189 (2.98)	5,558	131 (2.35)	5,437	91 (1.67)	22,434	525 (2.3)
Total	Sheep	112,170	1811 (1.6)	111,792	2328 (2.1)	78,253	4906 (2.3)	91,370	1546 (1.7)	393,585	7,505 (1.9)
2008–2013	Goat	19,658	339 (1.7)	24,886	474 (1.9)	20,755	348 (1.7)	15,781	213 (1.3)	81,080	1,374 (1.7)

$X_2 = 1.55$). Also, the highest prevalence of dicrocoeliosis observed in autumn for both sheep ($p < 0.001$, $X_2 = 229.90$) and cattle ($p < 0.001$, $X_2 = 42.32$) and in winter for goats ($p < 0.001$, $X2 = 18.29$).

The annual prevalence rates for these parasitic infections in 5-year period showed a considerable decline in the *fasciola* spp. infections, but dicrocoeliosis prevalence did not follow any uniform annual pattern (Tables 1, 2).

Average of annual direct economic loss due to liver condemnation in livestock was estimated to be 82,000 USD in 5-year period.

Discussion

Liver fluke infections cause considerable economic losses in livestock due to condemnation of organs. Therefore, it is justifiable to find reliable data for monitoring epidemiological aspects of disease and prepare a baseline data for future comparison. Although abattoir surveys have limitations, they are an economical way of gathering information on livestock disease. Also, a feedback from the slaughterhouse to the individual farm is of great value in the field of preventive medicine (Azami et al. 2013).

Based on the literature, there are numerous reports of fasciolosis and dicrocoeliosis from different countries in Asia such as Iraq, Pakistan, Turkey, Saudi Arabia, Tunisia, Bangladesh, India, China, Japan, Korea and also many parts of Iran (Ezatpour et al. 2014).

In the present survey, the overall prevalence of distomatosis was 1.95 %. The data showed that 0.8, 0.7 and 1.5 % of the sheep, goats and cattle were infected by *Fasciola* spp. respectively. Dicrocoeliosis were responsible for 1, 0.8 and 1 % of liver condemnations in the sheep, goats and cattle, respectively.

The prevalence of liver fluke infections recorded in the present study was generally lower than those reported from other regions of Iran including Guilan (Daryani et al. 2006), Mazandaran (Moghaddam et al. 2004), Khouzestan (Sahba et al. 1972), Lorestan (Ezatpour et al. 2014), Ardabil (Saffarbani 1999), Fars (Ansari-Lari and Moazzeni 2006), Shahr-e Kord (Manouchehehri Naini and Bagheri 2000) and Tehran Provinces (Khanjari et al. 2012).

The prevalence rate of liver flukes was considerably different in the neighboring countries of Iran. Jithendran and Bhat (1996) showed that 8.1 % of sheep and 4.1 % of goats were positive for dicrocoeliosis in India (Jithendran and Bhat 1996). In Turkey, the prevalence rate of fasciolosis and dicrocoeliosis were 3.99 and 23.55 % in sheep, and 0.48 and 2.65 % in cattle, respectively (Gargili et al. 1999). The prevalence rate of *F. hepatica* in sheep and goats in Pakistan was 51.3, and 14.8 %, respectively (Sharma and Raina 1989). In a study performed in Saudi Arabia, the prevalence rate of *Fasciola* spp. was 0.04 and 0.00 % in sheep and goats, respectively (Over et al. 1992). The corresponding figures from Iraq fascioliosis were 0.72 % in sheep and 3.30 % in goats (Wajdi and Nassir 1983).

The differences in prevalence of liver flukes may arise due to differences in environmental conditions that are conducive for the perpetuation of the parasite, abundance of infected definitive hosts, livestock husbandry, stocking rate, the nature of the pasture and grazing patterns of animals (Khanjari et al. 2014).

In the present study, the highest prevalence of distomatosis was observed in cattle, while the lowest prevalence recorded in goats.

This difference could be attributed to the fact that cattle are slaughtered at old age increase the risk of exposure to metacercaria, while sheep and goats are slaughtered at a relatively early age compared to cattle. Higher prevalence in sheep may be due to the grazing habits of the animal species; goats graze on leaves and branches on bushes and trees but sheep graze on plants on the ground where metacercaria are mostly found. Therefore, the possibility of infection with metacercaria is higher in sheep than in goats (Theodoropoulos 2011).

In regard to host species, dicrocoeliosis was more prevalent in both sheep and goats, whereas in cattle fasciolosis was more prevalent.

Dicrocoeliosis has been described in either lowlands or mountain pastures at high altitudes and it appears that chalk or alkaline soils favour the development of the snail intermediate hosts and ants (Rojo-Vázquez et al. 2012). Cringoli et al. showed that large pastures and the presence of streams/brooks in pasture may be risk factors for *D. dendriticum* infection (Cringoli et al. 2002). Moreover, it seems that, the migratory period can predispose small ruminants to infection, not only because of the presence of intermediate hosts, but also for the high stress induced by the transhumance on pasture-grazing nomadic sheep and goats (Oryan et al. 2011; Otranto and Traversa 2002).

The high prevalence of fasciolosis in cattle can be due to more anti helmenthic resistance of *Fasciola* spp. than *D. dendriticum* in the country.

The results of this study showed a significant seasonal pattern for distomatosis infection in sheep and goats. A significant seasonal pattern was observed in cattle dicrocoeliosis, but not in cattle fasciolosis. The highest prevalence of fasciolosis observed in winter for sheep, in summer for goats and autumn for cattle, whereas the highest prevalence of dicrocoeliosis observed in autumn for both sheep and cattle and in winter for goats.

The higher prevalence of fasciolosis during these seasons can be correlated with the meteorological data, which indicated high rainfall during autumn and winter and also with the prevalence of infection in snails, which was high during rainfall periods compared to other months of the year. Some researchers stated that the main periods for transmission of fasciolosis were spring and fall; however, potential infections during other periods of the year were possible (Khallaayoune and Hari 1991).

In contrast, the intermediate hosts of *Dicrocoelium* do not require a moist environment and are widely present in

pastures and also, the fluke eggs can survive for months on these pastures (Taylor 2012). Seasonality of this infection is favored by movement of the animals from lowland to mountain pastures where they become infected by the ants and then bring the infection back to the valley during the winter (Otranto and Traversa 2003).

The annual prevalence rates of these parasitic infections in 5-year period showed a considerable decline in the *fasciola* spp. infections, but dicrocoeliosis prevalence did not follow any uniform annual pattern. Hot and dry environmental condition in the past years and also a greater awareness among the farmers of the losses caused by fluke infections that caused more effective use of available treatments are some probable explanations for a considerable decline in fasciolosis prevalence.

Average annual direct economic loss due to liver condemnation in livestock was estimated as high as 82,000 USD in 5-year period. Regarding to the economic losses of liver flukes, it is so important to conduct some treatment strategies using albendazole and triclabendazole in this region. These strategies should be inspected regularly by Iranian Veterinary Organization.

Authors did not have access to the data about milk and weight losses due to fasciolosis and dicrocoeliosis. It is recommended to evaluate these economic losses plus to losses of liver condemnations to better understand the problems caused by liver flukes in animals.

Conclusion

This abattoir survey generally reflected the disease situation in the Kermanshah Province and showed that the prevalence of liver fluke infections is generally lower than those reported from other regions of Iran. Furthermore, this study provides a preliminary baseline data for the future monitoring of these potentially important parasitic diseases.

More surveys are suggested to be carried out to collect more data about the liver flukes infection prevalence and risk factors for developing a prediction model in small ruminants in western Iran. The identified risk factors and the prediction model can be useful to formulate appropriate control strategies and decrease the economic loss due to condemnation of infected livers.

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Conflict of interest We declare that we have no conflict of interest.

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