Prevalence, putative risk factors for cross sectional epidemiology of *Fasciola* infection in sheep in the Nile Delta of Egypt with special highlighting on its economic consequences

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Abstract

Risk factors related to herd and farmer status, farm and pasture management, and environmental factors were examined for their association with the prevalence of Fasciola infection in sheep farms in four represented provinces of Nile Delta region (Beheira, Kafr-Sheikh, Menofia and Alexandria). The study method involved the collection of fecal samples and coprological examination using standard sedimentation technique and questionnaire survey. A total of 4920 sheep (n= 80 flocks) were sampled from total of 140 flocks which were requested to participate in this study. The sampling method has involved all age group, sex, breeds, body condition scores, diverse flock sizes, and different ecological conditions. Based on this study the overall prevalence of ovine fascioliasis was found to be 17.87%, and the prevalence was higher in baladi breed (21.86%) than Rahmani (13.58%) and barki breed (18.12%). The final logistic model showed that ovine fascioliasis was associated with lower prevalence in summer (OR 0.24; CI: 0.14-0.39), spring (OR 0.15; CI: 0.09-0.26), and winter (OR 0.41; CI: 0.29-0.59) when compared with autumn. In addition, flock size ranged 100-150 (OR 2.81; CI: 2.00-3.96) and over 150 (OR 1.91; CI: 1.42-2.57) per flock were associated with higher prevalence of Fasciola than flocks ranged less than 100. In regard to the ecological conditions, it has been investigated that Fasciola infection in sheep in the regions of relative humidity ranged 50-60 (OR 0.34; CI: 0.23-0.51) and over 60 (OR 0.61; CI: 0.45-0.84) was associated with lower prevalence than humidity less than regions of relative humidity less than 50. Referring to the economic impact of ovine fascioliasis, the total weight of infected sheep with Fasciola was significantly lower (44.17 kg) than those free (55.29) and the value of weight reduction estimated for the infected sheep was 301.55 Egyptian pound (EGP). Moreover, average treatment cost for a single sheep suffered 46.22 EGP and the mortality value for three-dead sheep was 4800 EGP. In conclusion, the results may help to formulate appropriate control strategies in Egypt and other areas with similar climatic conditions in order to channel limited resources to mitigate only those risk factors which are significant to protect the profitability of the livestock industry.

Keywords: ovine, Fasciola, economic impact, prevalence

1. Introduction

Sheep production is considered a major sector of meat supply for human consumption in Egypt and contributes to development of the rural areas. In Egypt total sheep population was estimated at 5.5 million heads, most of them allocated in Nile-Delta (Statistics of Live Stocks, 2011). Fascioliasis is a well-known parasitic disease because of its veterinary importance and the great losses it causes in livestock production (Mas-Coma et. al., 1997). Sheep, goat, cattle and buffaloes are the most important species affected by Fascioliasis in addition to large variety of 20 domestic and wild animals. Sheep Fascioliasis has extreme economic importance through mortality, decrease in meat and wool production, and decrease in growth rate, reduced lambing rate, reduced birth weight and reduced multiple birth rates (Ngategize et. al., 1993). The infection ranges from massive one with sudden death to a subclinical infection causing chronic disabilities and marked economic losses (Dalton, 1999).

Despite the substantial economic losses caused by fascioliasis, estimated at US$ 2 billion per year worldwide (Spithill and Dalton, 1998) and the cosmopolitan distribution of this parasite, little attention has been given to the study of risk factors of fascioliasis in sheep and goats. A number of epidemiological studies in Europe, Africa, Asia and Australia have identified several risk factors of fascioliasis in cattle caused by F. gigantica and/or F. hepatica (Tum et al. 2004; Durr et al. 2005; McCann et al. 2010; Bennema et al. 2009). The actual risk of infection is influenced by the number and distribution of animals, the presence of infected snails, and grazing management which allow animals to access herbage containing metacercariae (Tum et al. 2004). These factors act largely on the hosts of the parasite rather than directly on the parasite itself. If there is no clear indication of the source of infection, careful study of risk factors possibly including environmental and herd management practices, should pinpoint the source of infection and can contribute to effective control programs (Roberts and Suhardono, 1996).

Therefore, the objectives of the present study were to investigate the prevalence of Fasciola infection in sheep flocks in different provinces representing the delta region of Egypt and estimation of the economic losses attributed to fascioliasis.

2. MATERIALS AND METHODS

2.1. Study area

A cross surveillance study was conducted on four provinces located in the Nile Delta region of Egypt (Fig 1). Beheira Province located at latitude of 30° 50' 53.1564" N and longitude of 30° 20' 36.7836" E, Kafr sheikh located at the latitude of 31° 6' 22.752" N, and longitude of 30° 56' 31.11" E, Menofia located at 30° 35' 50.082" N and 30° 59' 15.4752" E. and Alexandria Province located at latitude of 30° 45' 44.2656" N and longitude of 29° 41' 46.5648" E, and These provinces constitute 75% from the total production of sheep in Egypt (El-Tahawy, 2010).

2.2. Sample and data collection

Faecal samples were collected from clinically healthy and randomly selected sheep flocks. Flocks whose owners agreed to participate in the study (n= 80) from 140 flocks were visited once between January 2015 and February 2016 and were equally distributed by autumn, winter, summer, and spring seasons. Faecal samples were stored at 4°C until analyzed (Hanson and Perry, 1994).

Criteria to participate in this study included a farm reared sheep breeds, evidence of the disease, and informed consent of the farm manager to provide the required data. Data on herd characteristics, herd management practices and farmer status were collected through a survey questionnaire at the time of sampling. Data were collected via a two page questionnaire comprising 10 closed questions. In order to avoid any misunderstanding, the investigators completed the questionnaires by interviewing the farmers at the time of the visit to the farm for sample collection.

2.3.Coproscopic examination

Fecal example gathered from the sheep was put in clean widespread jug protected with 10% formalin named with the one of a kind recognizable proof numbers. Fecal examination for Fasciola eggs was completed utilizing the sedimentation technique depicted by Hansen and Perry (1994). Two gram of fecal sample in a cone like glass was blended with 20ml of water and the blend was sieved through a tea strainer into beaker and then to centrifuge tube. The blend was centrifuged for three minutes at 1500 rpm and by expelling the supernatant, the dregs (sediment) was included a drop of methylene and very much blended. A drop of silt was taken into slide and inspected under magnifying lens, eggs of Fasciola species were recognized by their qualities yellow shading.

2.4.Risk factors identification

Seasonal fascioliasis refers to those animals diagnosed infected with Fascioliasis within these time intervals; autumn-Fascioliasis (21 September to 20 December), winter-Fascioliasis (21 December to 20 March), spring-Fascioliasis (21 March to 20 June), and summer-Fascioliasis (21 June to 20 September) and the animal don’t get infected the following season.

Body condition scores were evaluated by a manual assessment of the thickness of fat cover and prominence of bone at the tail according the methods described by Nicholson and Butterworth (1986). The tail head is scored by feeling for the amount of fat around the tail head and the prominence of the pelvic bones. The loin is scored by feeling the horizontal and vertical projections of the vertebrae and the amount of fat in-between. Assessment relies mainly on the tail head but is refined by the loin score if both are very different. On a scale of 1-5, a score of 1 is extremely thin and a score of 5 is extremely fat. Poor condition scores by tail head are unmistakable with deep cavity with no fatty tissue under skin and skin fairly supple but coat condition often rough. While loin score method described by spine prominent and horizontal processes sharp.

As to the medium body condition scoring, tail head technique depicted shallow cavity but pin bones prominent; some fat under skin and skin supple. Then again lion method demonstrated horizontal processes can be identified individually with ends rounded. Be that as it may, for good body condition scores utilizing tail head, fat cover over whole area and skin smooth but pelvis can be felt. What's more, loin technique demonstrated end of horizontal process can only be felt with pressure; only slight depression in loin.

With reference to the anthelmintic drugs given as prophylactic treatment against Fascioliasis in sheep farms, the most widely recognized medications utilized as a part of Egypt were fasciocidal drugs like albendazole and rafoxanid, and triclabendazole. sheep animals got doses of one or a mixture of these medications contrast from farm to another and the period between the doses shift between twenty one days in some farms and thirty days in other farms. Animals that received a dose of anthelmintic drugs at least once during the study period were considered to be received prophylactic and others didn't receive considered not prophylactic.

In regard to age of the farmer and his education level, age of the farmer was recorded during the time of survey and also his education level which didn't changed or progressed during the period of the study.

Duration of grazing varied between sheep flocks and grouped as 3 months, 6 months, 9 months, and 12 months. The contact of sheep flock with other either contacted or not was recorded. In addition, the type of pasture during grazing (private or public) and the source of water supply (tape water or stream)

Daily data of climate conditions (temperature and humidity) in Egypt was taken from the report of the weather underground of Egypt website http://www.wunderground.com and freemeteo.com websites database. Then, the average monthly data were calculated for each year.

2.5.Economic impact

The economic losses can be calculated through estimation of the treatment cost, reduction in weight, and mortality of the affected animals according the method described by El-Tahawy (2010). Body weight of the affected animals were compared with the healthy control animals on the basis of the price of one-kg of live body weight equal to 37 EGP. Cost of the treatment of Fasciola depends on the cost of the chosen drug and the course of the treatment and varies according to the kind of the anthelmintic drug. The cost of mortality was also evaluated.

2.6.Statistical analysis

The relationship between the prevalence of Fasciola infections and the investigated factors was analyzed by defining a binary outcome variable where positives samples (as determined by coprological examination) were coded as 1, while negative samples were coded as 0.

The Chi-square test was used to analyze the association of all examined factors as independent categorical variables with Fasciola prevalence. Variables significant at $p < 0.05$ were tested for multicolinearity and selected for inclusion in the multivariate logistic regression model. Overall fit of the logistic regression models was assessed using the Hosmer-Lemeshow good-ness-of-fit statistics. Results are presented as adjusted odds ratios (OR) with 95% confidence intervals (95% CI). In all cases, the statistical significance was considered at 5% level. Missing observations were excluded from the analysis. All statistics were performed using Epi info 7 statistical package. The economic data were analyzed by T-independent sample test between Fasciola and free-Fasciola sheep.

1. **Results and Discussion**

Table 1 depicted univariate logistic regression associated with the risk factors for ovine Fascioliasis. As shown, the prevalence of Fasciola in barki and rahmani was lower (18.12 % and 13.58%) while baladi sheep (21.86%). Seasonally, the ovine fascioliosis was higher in autumn (22.27 %) than the comparable seasons. The other prevalences within the different risk factors can be accessed in Table 1.

Multiple logistic regressions were performed after screening the risk factors for the good-fit and removing the poor-fit ones. As presented in Table 2

Barki breed have associated with higher prevalence with and odd ratio (OR 1.06; CI: 0.69-1.63; P=0.77) while Rahmani breed have associated with lower Fasciola infection with and odd ratio (OR 0.32; CI: 0.20-0.52) when compared with the reference baladi breed.

The seasonal variation of ovine Fascioliasis was also presented in Table 1. Spring, summer, and winter have associated with lower prevalence of Fasciola than autumn season. As introduced in the table, the odd ratio of spring (OR 0.15; CI: 0.09-0.26; P<0.0001), summer (OR 0.24; CI: 0.14-0.39; P<0.0001), and winter (OR 0.41; CI: 0.29-0.59; P<0.0001).

In terms of the flock size, it has been noted that the flock size ranged 100 to 150 and those over 150 sheep were associated with higher prevalence of Fasciola than those of flock size less than 100. The odd ratios presented in the table were estimated (OR 2.81; CI: 2.00-3.96) and (OR 1.91; CI: 1.42-2.57; P<0.0001, respectively).

Furthermore, the flock contact with other has a great role in the spreading of Fasciola where the odd ratio of flock contact (yes) was 2.27 (CI: 1.70-3.03; P<0.0001) when compared with non-contact flocks. As well, the duration of grazing risked the Fasciola among sheep flocks. The odd ratio of sheep flocks grazed 6 months, 9 months, and twelve months were associated with higher prevalence of Fasciola than those grazed three months (OR 1.93, 4.66, 2.91; P<0.0001, respectively). Correspondingly, sheep grazed in public pasture have associated with higher prevalence with odd ratio (OR 2.71; CI: 2.06-3.56; P<0.000) when compared to the private pasture.

In regard to the source of water either stream water or tape water, it was found that tape water shared a lower prevalence than stream water. The odd ratio depicted in the table was (0.60; CI: 0.43-0.82; P<0.001). Furthermore, sheep got prophylactic treatment were associated with lower prevalence of Fasciola than those didn't get (OR 0.14; CI: 0.10-0.19; P<0.0001).

Body condition scores have part in the prevalence of Fasciola among sheep. Medium and poor body condition scores have associated with higher prevalence of Fasciola than good one. The odd ratio estimated for both were 2.88 (CI: 1.95-4.26) and 2.85 (CI: 2.07-3.92).

The ecological condition associated with the prevalence of ovine Fascioliasis was also explored and presented in Table 2. Temperature ranged 26 to 31 was associated with higher prevalence of Fasciola than regions of less than 26 with an odd ratio (OR 1.34; CI: 1.01-1.77). However, relative humidity of the regions ranged 50 to 60 and over 60 have connected with higher prevalence of Fasciola than regions of relative humidity less than 50 with an odd ratio (OR 0.34; CI: 0.23-0.51) and (OR 0.61; CI: 0.45-0.84), respectively.

Economic impact

Table 3 presented the economic effect of Fasciola infection on the productivity of sheep flocks. Sheep-infected Fasciola exhibited lesser total body weight (47.14 kg) when compared with the total body weight of health one. In addition, the monetary losses because of weight reduction estimated 301.55 EGP. The cost of the treatment of single sheep suffered fascioliasis roughly estimated 46.22 EGP. Furthermore, the value of mortality due to death of three sheep was 4800 EGP.

Fascioliasis is a global problem for farmers and veterinarians because of its effect on meat, milk and wool production. More recently, it has become apparent that anthelmintic treatment is not always effective due to the development of drug resistance (Mitchell et al. 1998; Moll et al. 2000; Coles, 2005). Identifying the risk factors for Fasciola infection may lead to the development of appropriate control measures for reducing the incidence of infection as well as the need for treatment in order to increase the efficiency of milk and meat production of animals.

Previous studies carried out elsewhere indicated a wide range of seroprevalence for ovine Fascioliasis (Moghaddam et al. 2004; Mekroud et al. 2004). These differences are probably due to agro-ecological and climatic differences between the localities, although differences in the management systems may also have resulted in such variation (Abunna et al. 2010).

Table (1) Univariate logistic regression analysis of risk factors associated with Fascioa infection in sheep

Independent variables	Categories				Coefficient	dds ratio	95% CI	p -value	Pseudo-R2	Goodness of fit
Breed	Barki	1545	280	18.12	-1.23	0.29	0.24-0.35	<0.0001	0.072	1
	Rahmani	1678	228	13.58	-1.30	0.27	0.22-0.34	<0.0001		
	Baladi	1697	371	21.86			Reference			
Province	Beheira	1671	253	15.14	1.93	2.64	1.30-3.98	<0.001	0.036	0
	Kafr el-Sheikh	760	241	31.71	1.26	2.38	1.89-2.87	<0.001		
	Menofia	999	230	23.02	1.90	1.97	1.11-2.83	<0.01		
	Alexandria	1490	155	10.40			Reference			
Season	Spring	1223	201	16.43	-0.58	0.30	0.22-0.40	<0.0001	0.092	1
	Summer	1120	143	12.77	-0.79	0.27	0.20-0.35	<0.0001		
	Winter	1064	198	18.61	-0.49	0.35	0.12-0.58	<0.001		
	Autumn	1513	337	22.27			Reference			
Sex	Female	1976	443	22.41	1.24	1.80	1.25-2.34	<0.0001	0.084	0
	Male	2944	436	14.81			Reference			

Age	>3 years	1060	143	13.49	-1.63	0.23	0.16-0.29	<0.0001	0.014	0
	2-3 years	1730	296	17.11	-2.28	0.24	0.13-0.35	<0.0001		
	<2 years	2130	440	20.66			Reference			
Flock size	>150 sheep	1155	285	24.67	0.47	1.59	1.34-1.89	<0.0001		
	100-150 sheep	1739	296	17.02	0.50	1.64	1.37-1.98	<0.0001	0.014	1
	<100 sheep	2026	298	14.71			Reference			
Flock contact	Yes	2347	495	21.09	1.35	3.87	3.30-4.54	<0.0001	0.18	1
	No	2573	384	14.92			Reference			
Duration of grazing	12 months	1122	205	18.27	0.47	1.60	1.28-2.01	<0.0001	0.016	1
	9 months	1075	209	19.44	0.32	1.37	1.08-1.75	0.01		
	6 months	1132	286	25.26	-1.00	0.37	0.23-0.58	<0.0001		
	3 months	1591	179	11.25			Reference			
Type of pasture	Public	2268	510	22.49	1.14	3.13	2.70-3.63	<0.0001	0.174	1
	Private	2652	369	13.91			Reference			
Water supply	Tape water	2941	576	19.58	1.29	1.57	1.24-1.90	<0.0001	0.193	1
	Stream	1979	303	15.31			Reference			
Prophylactic treatment	Yes	2697	375	13.90	-1.98	0.14	0.11-0.17	<0.0001	0.149	1
	No	2223	504	22.67			Reference			
Body condition score	Poor	1131	276	24.40	0.68	1.98	1.68-2.34	<0.0001	0.061	1
	Medium	1986	457	23.01	1.43	4.17	3.38-5.15	<0.0001		
	Good	1803	146	8.09			Reference			
Education level of owner	High	2583	341	13.20	-1.87	0.16	0.12-0.20	<0.0001	0.104	0
	Basic	2337	538	23.02			Reference			
Age of owner	>50 years old	1753	239	13.63	-0.23	0.79	0.65-0.97	0.02	0.02	0
	40-50 years old	1988	241	12.12	-0.68	0.51	0.43-0.61	<0.0001		
	<40 years old	1179	399	33.84			Reference			
Temperature	>31°C	1813	357	19.69	1.36	1.42	1.19-1.71	<0.0001	0.005	1
	26-31°C	1688	288	17.06	0.12	0.80	0.95-1.34	0.18		
	<26°C	1419	234	17.89			Reference			
Humidity	>60%	1933	274	14.17	-0.36	0.71	0.59-0.84	<0.0001	0.029	1
	50-60%	1790	333	18.60	-1.11	0.34	0.26-0.42	<0.0001		
	<50%	1197	272	22.27			Reference			

N total number of samples, n number of positive samples% prevalence of *Fasciola* infection

In the present study revealed a variation of the prevalence of *Fasciola* among different governorates providing higher rate in the tested provinces than the reference one. Our findings are in the same line with the previous studies on the Delta region. Ezzat (1949) stated that *F. gigantica* flourished in the northern parts of the Nile Delta, causing serious losses in the sheep flocks. Furthermore, he mentioned that the disease was wide spread among sheep and calves in Dakhla and Kharga Oases about 90% (Ezzat, 1950). Haridy et al. (1999) recorded the overall rates of Fascioliasis among slaughtered sheep, goat, cattle and buffaloes in the Egyptian abattoirs and the overall rates were 2.02% for sheep and goats, 3.54% for cattle and 1.58% for buffaloes. The highest prevalence was reported in Beheira

Governorate while the lowest was observed in Kafr El Sheikh (El-Bahy, 1997). Furthermore, Soliman (1998) detected *Fasciola* percentages of 52.8, 47.5 and 20 % in cattle, buffaloes and sheep, respectively during their studies in Beheira Governorate. Recently, Haggag (2008) reported that the overall *Fasciola* infection rates in examined sheep in Beheira and Alexandria Governorates were 17.77% and 31.85% by using fecal examination and IHA, respectively.

In addition differences in the prevalence of *F. hepatica* between breeds of sheep noted in the present study were also observed by other investigators (Boyce et al. 1987; Khallaayoune et al. 1991). The apparent influence of breed is perhaps closely associated with the husbandry system (Sanchez-Andrade et al. 2002). Munguia-Xochihua et al. (2007) found no difference in infection rate between different breeds of sheep. On the other hand, results obtained by Mir et al. (2008) indicated that the prevalence of *Fasciola* was higher among exotic breed more than native breed. Additionally, Eguale et al. (2009) confirmed that there was a difference in susceptibility of the examined sheep breeds to infection with *F.hepatica*.

Age variation in the present study revealed that higher prevalence of Fasciola was observed in the group of sheep less than 2 years old followed by those over 3 years old and those ranged 2 to 3 years old. The probable Explanation for the lower prevalence in higher age group compared to younger age group could be due to the so called self-cure phenomenon (Fryod, 1975; Assanji, 1988) and/or high acquired immunity which increase with age. It has been reported that host may recover from parasitic infection with increasing age and hence become resistant (Winkler, 1982). Our findings in agreement with the studies of Mungui-Xochihua et al. (2007) who recorded that the greater prevalence of Fascioliasis were reported in sheep between 2-4 years. Moreover, Ghazani et al. (2008) mentioned that there were statistical difference between age more than 1 year and less than 1 year (more in less than I year). Besides, Mir et al. (2008) estimated the prevalence of Fasciola in sheep and found it higher in sheep more than 4 years old (42.8%), followed by sheep group 2-4 years old (37.7%) and sheep group 0-2 years old (18.79%).

The seasonal variation of the prevalence Fasciola infection in sheep revealed that autumn season was associated with higher rate than the comparable seasons. Other studies are near to our findings where Taylor et al. (2007) stated that the hatching of fluke eggs and the multiplication of the snail intermediate host require high rainfall and temperatures (>10°C).These conditions generally occur in the spring and autumn, when many fluke eggs hatch, snails multiply and then cercariae develop and are released on wet pastures before encysting onto herbage. The seasonality pattern in Fasciola prevalence has been also observed by Ahmed et al. (2007) who revealed that climate condition particularly rainfall, were frequently associated with differences in the prevalence of Fasciola infection because this was suitable for intermediate hosts like snails to reproduce and to survive longer under moist conditions. Furthermore, Hossain et al. (2011) concluded that the prevalence of F. gigantica was found to be significantly higher during the wet season than that of dry season.

Flock size has a significant role in the spreading of Fasciola. Our obtained results indicated that the larger size ranged 100 to 150 and over 150 have connected with higher prevalence of

Fasciola than the lower flock size less than 100. This possibility explained to the higher density of the sheep flock is considered a risk factor for a higher contact getting a higher infection with Fasciola between the sheep (Kantzoura et al., 2011 and 2012).

Table 2: Logistic regression analysis of risk factors associated with Fasciola infection in sheep (final model, including breed, season, sex, age, farmer age, type of grazing and duration, type of pasture and environment related factors)

Factor		coefficient	Odd ratio	95% CI	P-value
Constant		0.76	-	-	0.07
Breed	Barki	0.06	1.06	0.69-1.63	0.77
	Rahmani	-1.11	0.32	0.20-0.52	<0.0001
	Baladi			Reference	
Season	Spring	-1.85	0.15	0.09-0.26	<0.0001
	summer	-1.41	0.24	0.14-0.39	<0.0001
	winter	-0.88	0.41	0.29-0.59	<0.0001
	autumn			Reference	
Flock size	100-150	1.03	2.81	2.00-3.96	<0.0001
	>150	0.65	1.91	1.42-2.57	<0.0001
	<100			Reference	
Flock contact	Yes	0.82	2.27	1.70-3.03	<0.0001
	NO			Reference	
Duration of grazing	6 month	0.65	1.93	0.95-3.90	0.06
	9 month	1.54	4.66	2.99-7.28	<0.0001
	12 month	1.09	2.91	1.94-4.36	<0.0001
	3 month			Reference	
Type of pasture	Public	0.99	2.71	2.06-3.56	<0.0001
	Private			Reference	
Water supply	Tape water	-0.50	0.60	0.43-0.82	<0.001
	Stream			Reference	
Prophylactic treatment	Yes	-1.96	0.14	0.10-0.19	<0.0001
	No			Reference	
Body condition score	medium	1.05	2.88	1.95-4.26	<0.0001
	poor	1.04	2.85	2.07-3.92	<0.0001
	good			Reference	
temperature	26-31	0.29	1.34	1.01-1.77	0.03
	>31	0.13	1.14	0.84-1.56	0.37
	<26			Reference	
Humidity	50-60	-1.05	0.34	0.23-0.51	<0.0001
	>60	-0.48	0.61	0.45-0.84	<0.0001
	<50			Reference	

In regard the association between the sex and prevalence of Fasciola, our findings of higher prevalence in female than male was supported Khan et al. (2010) who assumed that sex is a determinant influencing prevalence of parasitism and females are more prone to parasitism during pregnancy and peri-parturient period due to stress and decreased immune status. Moreover, The change of physiologic condition during lactation (productive activity) and/or lack of proper nutrition for production and due to long time exposure of the animals to disease entity and their heavy grazing in submerged areas might be the cause of greater prevalence rate in females (Hossain et al., 2011).

Prevalence of Fasciola was varied between the sheep either grazed on public or private pasture. The obtained results declared that sheep grazed in public pasture have more risk for Fasciola than those grazed in private one. These results are agreement with the studies of Kantzoura et al. (2011 and 2012) who investigated that the sheep grazed on public pasture have higher odd ratio of Fasciola than those grazed in private. However, Durr et al. (2005) declared that farms that use private and permanent pastures have a significantly higher risk of getting infected with F. hepatica compared to farms where animals graze on public pastures. They postulated that private pastures have a small area compared to public pastures and animals graze on them for a long period of time. So, there is a constant shedding of eggs on these pastures. In addition, private pastures are usually irrigated and irrigation has been found to be a significant risk factor for the presence of Fasciola.

Table 3: Economic impact of Fasciola infection on sheep productivity

Criteria	Case	Mean ± Std err. Mean
Total weight (kg)	Fasciola	47.14± 1.17b
	free-control	55.29 ± 2.06a
Value of weight reduction (EGP)	Fasciola	301.55 ± 4.45
	free-control	-
Treatment cost (EGP)	Fasciola	46.22± 0.76
	free-control	-
Mortality value (EGP)	Fasciola	4800
	free-control	-

Means within the same column carrying different letters are significantly at $P<0.05$.

Moreover, in the present study the results obtained regarding the source of water and its association with the extent of the prevalence of Fascioliasis was also examined. The results depicted that stream water have share a higher prevalence of Fasciola than the tape-water. Wet pastures with mud appeared to be a significant risk factor. This is expected since this kind of environment is appropriate for the propagation (survival) of snails. Local seasonal crowding of animals along the banks of water provides an important opportunity for transmission (Njau et al. 1989). Correspondingly, Soulsby (1982) reported that the higher infection rate of sheep may be due to exposure to encysted metacercaria during their grazing along water canals beside their higher susceptibility and low immunity. Furthermore, duration of grazing has a part of the spread of Fasciola among different sheep breeds. The obtained results revealed that sheep grazing nine and twelve months have more chance to get fascioliasis more than those grazed three months. This might be explained when the duration of grazing takes place with longer period thus enhance the rate of contacts between the infected sheep with healthy one making the rate of infection gets high.

In regard the body condition scores, data obtained declared that poor and medium body condition scores have higher prevalence of Fasciola than good one. These results are supported by the findings of the high prevalence of Fasciola infection in poor body condition animals could be justified by the fact given by Devendra and Marca (1983) who indicated animals of poor body condition were vulnerable to parasitic diseases. The significant variation in the prevalence of Fasciola in relation to body condition could be further justified by the fact that Fasciola worms are known to suck blood and tissue fluid and even damage the parenchyma of the liver due to the migrating immature worms (Marquardt et al., 2000).

The variables introduced into the statistical model that concern the age and the educational level of farmers had also been investigated by Cringoli et al. (2004) but they were not found to be significant. In the current study, the age of farmers was recognized as a protective factor but the educational level as a risk factor. Perhaps, older and educated farmers may have experience in local conditions and better stockmanship skills.

The ecological conditions in the present study indicated that temperature less than 26 °C and humidity less than 50 considered as risk factors for the spreading of Fasciola among sheep flocks. Khanjari et al. (2014) reported that as with the development of the intermediate host, temperature (>9.5 °C), rainfall and soil moisture are important factors influencing the development of the parasite from egg to miracidium. In addition, studies have demonstrated that the parasite development is arrested below 10 °C or over 30°C (Boray, 1969). So the epidemiology of F. hepatica is dependent on temperature which controls the life cycle stages developing out of the mammalian host (Tinsley, 2005).

In regard to the economic impact of Fasciola on the productivity and monetary issue of sheep flocks, it has been investigated that Fasciola has a prominent role in reduction of the body weight and costed great economic losses among the sheep flocks. Our findings were supported by the studies of Ngategize et al. (1993) who estimated that the financial losses due to ovine fascioliasis as 46.5, 48.8 and 4.7% as caused by mortality, productivity (weight loss) and liver condemnation, respectively. An occurrence rate higher than 90% of F. hepatica eggs among sheep and cattle was observed in the state of Rio Grande do Sul Brazil in addition to losses of 12-13% due to noncompliance with the liver quality standards established by governmental authorities. The economic losses

Due to the condemnation of 250,000 fluke-infected livers cost U$ (140,000,000) representing 15% of the livers inspected at official meat packing plants in this state (Marques and Scrofrerneker, 2003). In Egypt, Haseeb et. al., (2002) stated that according to the report of the General Organization of Veterinary Services, the loss in meat and milk in Egypt due to fascioliasis was 30% per year which is nearly estimated by (one billion Egyptian pounds).

2. Conclusions

The current study provides an epidemiological investigation of risk factors related to herd characteristics, herd management practices, farmer status, and the climatic variables associated with parasitic infections of economic importance in small ruminants in Egypt and other areas with similar climatic conditions. The study definite that there was significant association in the prevalence of Fasciola with the cattle breed, season, body condition score, flock size, prophylactic treatment, flock contact, duration of grazing, type of pasture, and environmental conditions. Referring to the economic impact, Fasciola infection caused a great losses sheep farms through reduction in the body weight, treatment cost, and mortality value. In brief, the results may help to formulate appropriate control strategies in Egypt and other areas with similar climatic conditions in order to channel limited resources to mitigate only those risk factors which are significant to protect the profitability of the sheep productivity.

3. References

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