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Research Article

Epidemiological Study of *Haemonchus contortus* among Sheep in North Kordufan State, Sudan

Mubarak Ahmed Mohammed Mahmoud[1], Abdelhamid Ahmed Mohamed Elfadil[2], Edris Ahmed Yagoup[3], Ibrahim Abdulrahman Adam[4], Elamir Gafar Saad Mohamed[5], Shakir Bakhit Bushara[6] and Yassir A Shuaib[7]

[1]General Administration for Animal Resources Services, Ministry of Environment, Water & Agriculture, Riyadh city, Kingdom of Saudi Arabia; [2]College of Veterinary Medicine, Sudan University of Science and Technology, Khartoum, Sudan-current, consultant Epidemiologist, General Administration for Animal Resources Services, Ministry of Agriculture, Riyadh city, Kingdom of Saudi Arabia; [3]General Corporation of Veterinary Research, Elobied Veterinary Research Laboratory; [4]General Directorate of Extention and Nomads Development; [5]General Directorate of Quarantines and Meat Hygiene, Federal Ministry of Livestock, Fisheries and Rangeland, P.O. Box 293 Khartoum, Sudan; [6]Albawardi Veterinary Farm, Dammam City, Kingdom of Saudi Arabia; [7]Department of Preventive Veterinary Medicine, College of Veterinary Medicine, Sudan University of Science and Technology, P.O. Box 204, Hilat Kuku, Khartoum North, Sudan
***Corresponding author:** barakat381@yahoo.com; abdelhamidelfadil@yahoo.co.uk

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ABSTRACT

A cross sectional study was conducted from April to July 2012 to determine the prevalence of *Haemonchus contortus* infection in sheep and its associated risk factors in North Kordofan state. Floatation technique, modified McMaster technique, and fecal culture were used for identification of the egg of the parasite, faecal egg count and harvesting of larva for larval identification. The overall prevalence in the current study was 36.4%. Potential risk factors such as locality ($\chi2$=52.224, P=0.00), age ($\chi2$=8.131, P=0.017), breed ($\chi2$=19.328, P=0.000), body condition ($\chi2$=1.978, P=0.000), flock size ($\chi2$=3.582, P=0.167), source of addition to the flock ($\chi2$=3.962, P=0.138), temperature ($\chi2$=10.229, P=0.000), humidity ($\chi2$=7.327, P=0.026), housing ($\chi2$=5.486, P=0.019), other diseases ($\chi2$=1.255, P=0.000), fecal consistency ($\chi2$=30.650, P=0.000), grazing type ($\chi2$=2.322, P=0.128), and use of drugs ($\chi2$=137.6, P=0.000) showed statistically significant association ($P\leq0.25$)with the occurrence of sheep haemonchosis. However, in the multivariate analysis the risk factors found significantly associated ($P\leq0.05$) with the disease included locality of Barrah (Exp B=8.148, P=0.00), and Sheikan (Exp B=7.944, P=0.000), moderate body condition (Exp B=21.241, P=0.000), bad body condition (Exp B=313.500, P=0.000), age more than three years (Exp B=6.629, P=0.02), and flocks not used drugs (Exp B=19.361, P=0.000). This knowledge is important for the control of sheep haemonchosis in Sudan.

Key words: Prevalence, Risk Factors, Sheep, *Haemonchus contortus*, North Kordufan, Sudan

INTRODUCTION

Sheep Haemonchosis is a parasitic disease caused by *Haemonchu contortus*, a nematode species that during its adult stage lives in the hosts' abomasa. *Haemonchus. contortus* is the widely distributed in all geographic areas (Francisco *et al.*, 2007). Sheep are an important source of high quality food products for human (meat, milk). The prevalence rate of GIN in sheep flock is reported to be very high. GINs are known to cause destructive in affecting ovine flock which may lead to serious consequences if proper attention is not given (Franiso *et al.*, 2007). Production potential of livestock development programs plagued in tropical and subtropical areas due to presence of gastrointestinal helminthes including *Haemonchus*, which causes high mortality in severe cases and great economic losses due to decrease of meat, milk and wool production as the result of decrease in erythrocytes, lymphocytes, hemoglobin, PCV and body weight. A decrease in profitability up to 15% and 50% due to gastrointestinal parasitism including *H. contortus* has been reported by Gadahi *et al.*, 2009. Several epidemiological studies on the GIN infection were carried out to depict the seasonal pattern of haemonchosis in

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different agro ecological areas of the world (Chaudary *et al.*, 2007). The seasonal trend in haemonchosis is influenced by a number of abiotic and biotic factors that dictate the development and survival of pre-parasitic stages of *H. contortus* onto the herbage (Chaudary *et al.*, 2007). This situation has highlighted the need to acquire comprehensive epidemiological knowledge of haemonchosis in order to devise appropriate and cost effective strategies to control GIN parasites with timely anthelmintic treatments in study area (Chaudary *et al.*, 2007).The reports of *H. contortus* infection in sheep at the different localities in the Sudan indicated that the parasite could represent a major problem to sheep industry in the country (Fayza *et al.*, 2003).The purpose of this study was to estimate the prevalence of *H. contortus* of sheep at different flocks in North Kordufan state of Sudan, and to investigate the potential risk factors associated with *H. contortus* infection.

MATERIALS AND METHODS

Study area

North Kordufan State is considered to be the heart of Sudan for its central location. It lies between latitude 9-16°N and longitudes 27-32°E, with a total area of 244,700 km^2. The State has a population of about 2.4 million of whom 63.0%, 24.0% and 13.0% are semi-settled, pastoralists and a urban residents respectively (El-Hag *et al*., 2011). The state is boarded by North Dar Fur State in the north-west, The Northern State in the north, Khartoum state in the east, White Nile state in the south-east, East Dar Fur state in the south-west and South Kordufan State in the south (Daw El Beit, 1999). The livestock population in North Kordufan constitutes one of the major sources of the income to the national economy and rural communities. Recent official livestock population was estimated to be 960, 500 for cattle; 7,200,000 for sheep; 3,600,000 for goats; and 1,200,000 for camels. The map of Sudan showing the localities in North Kordufan is shown in (Fig. 1).

Fig. 1: Map of Sudan showing five localities in North Kordufan State included in the study. "Green circle symbol" = Umm Rawaba;"Pink circle symbol" = Sheikan; "Red circle symbol" = Barah: "Black cirle symbol" = AbuZabad: "Blue circle symbol" = EnNahud.

Study design

A cross sectional study was conducted to estimate the prevalence of Sheep Haemonchosis and the potential risk factors associated with the disease (Martin *et al.*, 1987). The multistage probability sampling method was conducted. Five localities out of nine localities of the state were randomly selected (Fig. 1). Two administration units were selected from each locality. Seven villages were selected from each unit. Finally, simple random sampling was applied to choose the animals from each flock (Thrusfield, 2007).

Sampling methods

The prevalence of sheep Haemonchosis was calculated according to (Farooq *et al.*, 2012), the following formula: prevalence = [Number of samples positive/Total number of samples examined] ×100.

Sample size

The sample size was calculated according to (Martin *et al.*, (1987) by considering 32% expected prevalence (Fayza *et al.*, 2003). And 5% accepted error at 95% confidence interval using this formula: n=1.962(P^) (Q^) / L2; where, N=required sample size; 1.962=constant; P^=expected prevalence; Q^=1-P^; L=desired absolute precision. The sample size was calculated is 335, and for easy calculation 360 samples were taken and tested**.**

Questionnaire surveys

A pre-tested structured questionnaire with the primary objective of elucidating the multifactorial background of disease was conducted in an interactive manner at all selected flocks. Owners and/or managers of all farms involved in the study were asked to provide information on risk factors which comprised; breed, age, sex, body condition score, other diseases, animal source of addition to the flock, fecal consistency (individual risk factors), flock size, housing, type of grazing, use treatments, presence of other animals, (managemental risk factors) and the months, vegetation, temperature, humidity, rainfall, type of soil (climatic risk factors) and localities (provinces). These risk factors were then divided to categories (Thrusfield, 2007). All animals included in this study were subjected to a questionnaire, which was filled out by the animal owners.

Data analysis

The data collected in the field were entered into a computer on a Microsoft Excel spreadsheet. Statistical analysis was performed using 'Statistical package for the social sciences' (SPSS), version 16 (for Windows). Associations between the outcome variable (status of Haemonhosis in the flocks) and its potential risk factors were first screened in a univariate analysis using Chi-square test. Potential risk factors with $P \leq 0.25$ (two tailed; $\alpha = 0.25$) were considered significant in the $\chi 2$ test. A multivariate model for the outcome variable was constructed using manual stepwise forward logistic-regression analysis. Risk factors with a P-value equal or less than 0.05 were considered significantly associated with haemonchosis.

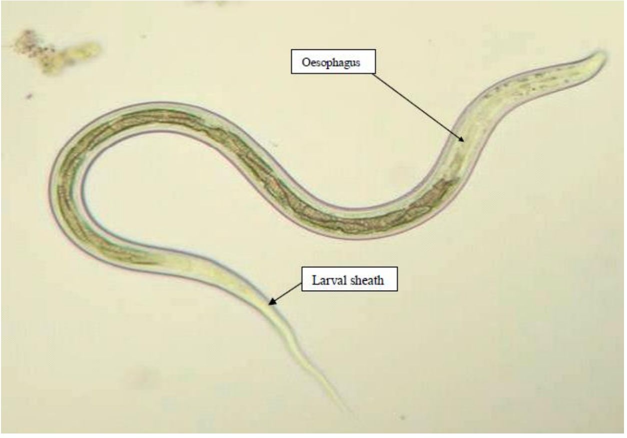

Fig. 2: Third-stage larva of *H. contortus* from coproculture.

Diagnoses of the parasite

Fresh fecal samples were taken weekly, directly from the rectum of sheep in suitable containers and carefully labeled with animal identification and analyzed for FEC according to the modified McMaster technique with saturated sodium chloride as floatation fluid in which each nematode egg counted represented 50 eggs per grams of feces (EPG) (Saddiqi, 2010). The number of the eggs (ova) of *Haemonchus. contortus* within the both grids of the chamber were counted, using light microscope with magnification power of 10X and 40 X (Tasawar *et al.*, 2010). Faecal cultures provide an environment suitable for hatching of helminthes eggs and for their development. Faeces found positive for parasite eggs but confusing for exact identification were broken up finely, using either a large pestle and mortar or a spatula and were placed in a glass jar or Petri dish. (Farooq, 2009). The faeces are placed in the incubator at 25 to 27c and left for 7 to 10 days, depending on the embryonation time of the worm egg. Each day, the humidity is checked and the beaker is thoroughly shaken. The faeces can then be put in the Baermann-apparatus, and the following day, the larvae (Fig. 2) was collected (Thienpont *et al.,* 1979). The species of parasites were confirmed later by identification of third stage larvae obtained through faecal culture as described by Maff (1979), Soulsby (1982), and Durrani *et al*., 2007). After 7 days, larvae were collected by Baermanization and stored at 4ºC in flat tissue culture flasks. (Saddiqi, 2010). The estimated species composition, based on the morphology of ensheathed and exsheathed L3, was approximately 60% *Haemonchus contortus*, 20% *Trichostrongylus spp*, 10% *Teladorsagia circumcincta*, with a very small percentage of *Cooperia spp* (Waller *et al*., 2004).

RESULTS

The result of this study showed that out of 360 animals, 131 were found to be infected with Heamoncosis, indicating that the overall prevalence rate was 36.4% among sheep in North Kordufan State (Table 1).

The highest rate of infection was in Barra (59.7%), and Sheikan (59.1%), whereas the lowest rate of infection was in Umm Ruwaba (15.4%). Regarding distribution of Haemonchosis by sex, the rate of infection within females was 37.7%, and 31.6% in males. Infection rate was 42.9% in animals more than 3 years, 32.4% in animals aged 1-3 years and 21.1% in animals aged less than 1 year. The distribution of *H. contortus* infection according to the breed of Sheep was 31.1% in Hamarri, and 59.7% in Kabashi breed. For the body condition the prevalence of Heamoncosis was 8.3% in good body condition, 65.9% in moderate body condition, and 96.6% in bad body condition. Also, the *H. contortus* infection was 43.2% in small flock, 37.3% in medium flock, and 30.8% in large flock sizes. Distribution of the infection according to months was, 40.0% in wet months, and 34.3% in dry months. The presence of *H. contortus* infection in case of the source of addition of animals to the flock was 33.2% in sheep raised on the farm, 39.5% in sheep purchased from outside locality, and 47.8% in animals purchased from same locality. The prevalence of Haemonchosis during various seasons was 40.0% in rainy season, in contrast 34.3% in dry season. The highest rate of infection was 52.9% in area with low temperature (less than 36°C), more than 33.1%, and 31.8% in areas with high temperature (more than 40°C, and from 36°C to 40°C respectively). The rates of infection is higher (48.8%) in areas with high humidity level (more than 40%) than 32.2%, 33.1% in areas with moderate and low humidity (30% to 40%, and less than 30% respectively). The prevalence of *H. contortus* of various housing was 47.5% in animals raised indoor, and 33.3% in animals raised outdoor. The highest rate of infection was 77.6% in presence of other diseases, in contrast 16.8% in animals free of other diseases. The distribution of *H. contortus* infection by fecal consistency was 75.0% in animals with a diarrhea as a symptom possibly due to another illness, 42.2% in animals with soft feces, and 28.6% in animals with normal feces. The infection rate according to various grazing type was 43.2% in seminomadic system, compared to 34.2% within nomadic system. Regarding distribution of Haemonchosis by using drugs was 12.4% in sheep have owners using drug, and 73.2% in sheep that have owner's not using drugs. The prevalence of the disease in animals grazing in good vegetation (fully covered with green grass) areas was 40.0%, in contrast 34.3% in animals grazing in poor vegetation areas (partially or non-covered with green grass). The rate of infection was 40.3% in animals raised in presence of other animals (goats), whereas 35.6% among animals raised alone. The distribution of *H. contortus* infection by soil type was 40.0% in animals raised in loam soil, and 34.3% in animals raised in sand soil. In the univariate analysis using Chi-square test, risk factors such as localities ($\chi2$=53.224, P=0.000), age ($\chi2$=8.131, P=0.017), breed ($\chi2$=19.328, P=0.000), body condition ($\chi2$=1.978, P=0.000), Flock size ($\chi2$=3.582, P=0.167), Source of addition to the flock ($\chi2$=3.962, P=0.138), Temperature ($\chi2$=10.229, P=0.006), Humidity ($\chi2$=7.327, P=0.026), Housing ($\chi2$=5.486, P=0.019), Other diseases ($\chi2$=1.255, P=0.000), Fecal consistency ($\chi2$=30.650, P=0.000), Grazing type ($\chi2$=2.322, P=0.128), and use drug ($\chi2$=137.6, P=0.000) showed statistically significant association ($P=\leq 0.25$) with the occurrence of haemonchosis. However, the other risk factors didn't show statistically significant association with the occurrence of infection. In the multivariate analysis of haemonchosis in sheep included independent risk factors

Table 1: Summary of univariate analysis for risk factors associated with sheep haemonchosis in North Kordofan state, Sudan (April 2012 to July 2012; n = 360; 37 flocks) using the Chi-square test

Risk factors	Animals tested	Animals affected (%)	d. f	$\chi 2$	P value
Locality			4	53.224	0.000
Barra	67	40 (59.7)			
EnNahud	85	27 (31.8)			
Umm Ruwaba	78	12 (15.4)			
Sheikan	66	39 (59.1)			
Abu Zabad	64	13 (20.3)			
Sex			1	0.963	0.326
Female	284	107 (37.7)			
male	76	24 (31.6)			
Age			2	8.131	0.017
<year	38	8 (21.1)			
1 - 3years	145	47 (32.4)			
>3years	177	76 (42.9)			
Breed			1	19.328	0.000
Hamari	293	91 (31.1)			
kabashi	67	40 (59.7)			
Body condition			2	1.978	0.000
Good	216	18 (8.3)			
Moderate	85	56 (65.9)			
Bad	59	57 (96.6)			
Flock size			2	3.582	0.167
1-35	88	38 (43.2)			
36-70	142	53 (37.3)			
>70	130	40 (30.8)			
Months			1	1.146	0.284
Wet	130	52 (40.0)			
dry	230	79 (34.3)			
Rainfall			1	1.146	0.284
Present	130	52 (40.0)			
Absent	230	79 (34.3)			
Source of addition to flock			2	3.962	0.138
-Raised on farm	238	79 (33.2)			
-Purchased outside locality	76	30 (39.5)			
-purchased same locality	46	22 (47.8)			
Temperature(°C)			2	10.229	0.006
>40	133	44 (33.1)			
36-40	157	50 (31.8)			
<36	70	37 (52.9)			
Humidity (%)			2	7.327	0.026
>40	84	41 (48.8)			
30-40	143	46 (32.2)			
<30	133	44 (33.1)			
Housing			1	5.486	0.019
Indoor	80	38 (47.5)			
outdoor	280	93 (33.2)			
Other diseases			1	1.255	0.000
No	244	41 (16.8)			
yes	116	90 (77.6)			
Fecal consistency			2	30.650	0.000
Diarrhea	36	27 (70.0)			
Soft	83	35 (42.2)			
Normal	241	69 (28.6)			
Grazing type			1	2.322	0.128
Semi nomadic	88	38 (43.2)			
Nomadic	272	93 (34.2)			
Use drug			1	137.6	0.000
Used	218	27 (12.4)			
Not used	142	104 (73.2)			
Vegetation			1	1.146	0.284
Good	130	52 (40.0)			
Poor	230	79 (34.3)			
Other animals			1	0.501	0.479
Yes	62	25 (40.3)			
No	298	106 (35.6)			
Soil type			1	1.146	0.284
Loam	130	52 (40.0)			
sand	230	79 (34.3)			

Statistically significant at P≤0.25 (two-sided) in univariate model.

Table 2: Final multivariate logistic regression model of haemonchosis in sheep flocks in North Kordofan, Sudan (April, 2012 to July, 2012; n = 360; 37 flocks)

Risk factors	Animals affected (%)	Exp (B)	95.0% C.I for Exp (B)		P value
			lower	upper	
Locality					
Umm Ruwaba	12 (15.4)	Ref			0.000
Barra	40 (59.7)	8.148	3.716	17.869	0.000
Sheikan	39 (59.1)	7.944	3.617	17.449	0.000
EnNahud	27 (31.8)	2.560	1.190	5.508	0.16
Abu Zabad	13 (20.3)	1.402	0.590	3.331	0.444
Age					
<year	8 (21.1)	Ref			0.089
1 - 3years	47 (32.4)	5.423	0.994	29.592	0.051
>3years	76 (42.9)	6.629	1.230	35.718	0.02
Body condition					
Good	18 (8.3)	Ref			0.000
Moderate	56 (65.9)	21.241	10.993	41.044	0.000
Bad	57 (96.6)	313.500	70.634	1391.42	0.000
Flock size					
>70	40 (30.8)	Ref			0.185
1-35	38 (43.2)	1.676	0.956	2.939	0.071
36-70	53 (37.3)	1.355	0.845	2.245	0.238
Source of addition to flock					
-Raised on farm	79 (33.2)	Ref			0.187
-Purchased outside locality	30 (39.5)	0.315	0.059	1.686	0.177
-purchased same locality	22 (47.8)	0.167	0.025	1.139	0.068
Use drug					
Used	27 (12.4)	Ref			0.000
Not used	104 (73.2)	19.361	11.191	33.493	0.000

Statistically significant at P≤0.05 in the multivariate model.

(locality, body condition, age more than 3 years and use of drugs) was found to be the only statistically significant (P=≤0.05) risk factors with sheep haemonchosis. We also noticed the presence of confounding between locality and breed, which led to the exclusion of breed from the final model (Table 2).

DISCUSSION

The Sudan with its estimated 40 million head of sheep is one of the largest sheep breeding countries in Africa. Nevertheless, little attention has been directed towards ovine haemonchosis in this country (Fayza *et al*., 2003). The results of this study indicated that *H. contortus* is widely spread in sheep of North Kordofan state, Sudan. Therefore, the overall prevalence of sheep haemonchosis in North Kordofan state, Sudan was 36.4%. This prevalence is higher than the prevalence reported in Omdurman slaughter house which was 32 % (Fayza *et al.*, 2003).

The prevalence of sheep haemonchosis in our study is much lower than the prevalence in other studies in different countries in Ethiopia (Nagasi *et al.,* 2012), (Sissay, 2007), (Abunna *et al*., 2009), (Dagnachew *et al*., 2011), in Pakistan (Tasawar *et al.*, 2010), (Asif *et al.*, 2008), (Raza *et al.,* 2009), (Qamer *et al.,* 2009), and in Benin (Attindehou *et al.,* 2012). However, the prevalence of sheep haemonchosis in our study is much higher than the prevalence in Iran (Tehrani *et al*., 2012).

The prevalence of haemonchosis by localities (provinces) has been investigated in this study, the highest prevalence of infection was in Barrah, Sheikan, then EnNahud and Abu Zabad, and this is similar to the reported results in Ethiopia (Sissay, 2007, and Dagnachew *et al.*, 2011). These variations could be attributed to the geographic location. In the present investigation, the higher prevalence of infection was in females as compared to males, this is coincide with the results of different countries in Pakistan (Raza *et al.*, 2009), in Ethiopia (Dagnachew *et al*., 2011), and in Iran (Tahrani *et al*., 2012), and disagreement with a study conducted in Pakistan (Tasawar *et al.*, 2010). Females have a high rate of infection than males, because the females remain longer for production purposes so the disease has more chance to develop.

When assessing age as risk factor, it was shown that with more than 3years of age were highly affected, compared with animals less than 3 years to a year, and animals less than a year, the difference in infection rate could be attributed mainly to the fact that aged animals have a longer exposure time to *H. contortus* in pastures than young one. These results are in agreement with the previous report of Tasawar *et al.* (2010). Our results do not coincide with the studies conducted in Pakistan (Qamer *et al.,* 2009), and Ethiopia (Sissay, 2007, and Dagnachew *et al*., 2011). In addition, there was also a significant difference between the breed of the animal and *H. contortus* infection rate. The highest infection rate was observed among Kabashi as they are highly susceptible to *H. contortus* infection. In contrast, the Hamarri breeds are relatively resistant to *H. contortus* infection hence; this could be attributed to the nature of pasture-grazing patterns of animals, immuno response for the parasite, and the topographical location of pasture. These findings are consistent with the observations reported in different breeds of sheep in Pakistan (Tasawar *et al.*, 2010).

Relationship between body condition and haemonchosis in sheep was recorded with statistical difference between bad, moderate and good body conditioned animals, which means those animals were not equally susceptible for haemonchosis. Bad body condition has the highest rate of infection than others with the good and moderate body condition, because animals in bad body condition have a little tolerance, lack immunity, and therefore more susceptible to infection. This result agrees with a study conducted in Ethiopia (Nagasi *et al.*, 2012). In the present investigation, small flock size has the highest rate of infection than medium and large flock size. The reason might be attributed to lack of attention and veterinary care of young breeders or shepherds of their flocks unlike the owners of large flocks.

The current investigation showed that infection was more prevalent during wet months than the dry months. This finding is supported by a previous study in Sudan (Fayza *et al*., 2003), and in Benin (Attindehou *et al.*, 2012). But this result disagrees with other studies conducted in Pakistan (Qamer *et al*., 2009), and Iran (Tahrani *et al*., 2012). This difference, in our opinion, might be attributed to seasonal variation, and also as a result of inhibition of *H. contortus* during the dry hot months of the year. In this study the highest rate of infection was in animals purchased same locality, compared with animals purchased from outside locality and animals raised on farm. This could be attributed to lack of veterinary care and lack of use anti-helminthes in same locality unlike other sources.

Our result showed that infection was more prevalent during rainy season, than the dry season. This could be due to increased availability of infective larvae of *H. contortus* on pasture during the rainy season. This finding is in line with finding of Fayza *et al*., (2003), and Sissay (2007). But our results do not coincide with a study carried out in Pakistan (Qamer *et al*., 2009).

When assessing temperature as the risk factor, it was shown that the animals residing in Low temperature (<36°C), area have the highest rate of infection than moderate, and high temperature areas, because an optimum temperature (25 to 27°C) is required for the hatching of *H. contortus*. Contrary to what has been reported in previous studies, the findings in this study showed that this disease was more prevalent in high humidity areas (>40%), as compared to moderate and low humidity areas. This could be attributed to the fact that, high humidity may help hatching of eggs, and moulting of larva. The statistically significant relationship between housing and haemonchosis in sheep was recorded the high rate of infection with *H. contortus* was found in animals kept indoor as compared to animals kept outdoor. This could be attributed to the fact that probability of infection may increase in animals confined in small area, and in housed animals the surrounding environment may be conductive to infection. Also a higher prevalence of infection was found in animals having other diseases compared to the animals free from other diseases. This is probably due to the fact that other diseases suppress the immune response, thus increasing the susceptibility of animals to infection. Our result showed that infection was more prevalent in animals' with a diarrhea which could be due to another illness, than the animals with soft and normal feces. This could be attributed to the fact that diarrhea results in dehydration, reduces resistance to infection and affects the immune response of the animal. In the current investigation showed that infection was a higher prevalence in semi nomadic system as compared to nomadic system. This could be attributed to the fact that nomadic animals have less chance of exposure to the parasite larvae, under normal condition. Also the prevalence of *H. contortus* infection in animals whose owners did not use drugs was a higher than the animals whose owners used drugs. This could be attributed to the fact that using drugs would definitely reduce parasitic burden. In this study the highest rate of infection was in areas of good vegetation as compared to areas of poor vegetation. This was probably due to the presence of larvae climber in the grass, thus increasing the rate of infection. In the current investigation, infection was more prevalent in sheep raised with other animals (goats), as compared to the animals that raised alone. In the present study the higher rate of infection was observed in animals raised in loam soil, than the animals in sand soil. This was probably due to the fact that loam soil is suitable for hatching eggs and larvae moults, due to its more content of moisture than the sand soil.

Thirteen risk factors were found to be significantly ($P \leq 0.25$) associated with haemonchosis in the univariate analysis. Out of these 13 risk factors, 4 were significantly ($P \leq 0.05$) associated with haemonchosis in the multivariate analysis. These 4 risk factors included localities: Barrah (Exp (B)=8.148), Sheikan (Exp (B)=7.944). This is similar to the reported results in Ethiopia (Sissay, 2007), and (Dagnachew *et al*., 2011), and body condition: moderate (Exp (B)=21.241), bad (Exp (B)=313.500). This result agrees with a study conducted in Ethiopia (Nagasi *et al.*, 2012), age: >3 years (Exp (B)=6.629). These results are in agreement with the previous report of Tasawar *et al.*, (2010). Our results do not coincide with the study carried out in Pakistan which did not show any significant difference (Qamer *et al.*, 2009), in Ethiopia (Sissay, 2007), and (Dagnachew *et al*., 2011), and use drugs: not used drugs (Exp (B)=19.361), were considered statistically significant with sheep haemonchosis.

We may notice the presence of confounding between locality and breed, which led to the exclusion of breed from the final model; this could be attributed to the fact that certain breeds were found in same localities.

Conclusions

Sheep haemonchosis was found to be an important problem in the study areas; in contrast, the prevalence of haemonchosis in this study area is mostly associated with the epidemiological factors such as origin of the animals and host factors such as age, body condition, and management factors such as flock size, source of animal addition to the flock, and use of drugs.

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REFERENCES

Abunna F, E Tsedeke, B Kumsa, B Megersa, A Regassa, and E Debela, 2009. Abomasal nematodes: prevalence in small ruminants slaughtered at Bishooftu Town, Ethiopia. The Internet J Vet Med, 7: 1937-8165.

Asif M, S Azeem, S Asif and S Nazir, 2008. Prevalence of gastrointestinal parasites of sheep and goats in and around Rawalpindi and Islamabad, Pakistan, J Vet Anim Sci, 1: 14-17.

Attindehou S, S Salifou, BC Félix, GO Bassa, NM Adamou and PL Joseph, 2012. Epidemiology of haemonchosis in sheep and goats in Benin. J Parasitol Vector Biol, 4: 20-24.

Chaudary FR, MFU Khan and M Qayyum, 2007. Prevalence of *Haemonchuscontortus* in naturally infected. small ruminants grazing in the Potohar area of Pakistan, Pak Vet J, 27: 73-79.

Dagnachew S, A Amamute and W Temesgen, 2011. Epidemiology of gastrointestinal helminthiasis of small ruminants in selected sites of North Gondarzone, Northwest Ethiopia, Ethiop Vet J, 15: 57-68.

Daw El Beit EN, 1999. Consequences of coping with Drought in North Kordofan, MSc. Thesis University of Coventry, England.

Durrani ZA, N Kamal and SM Khan, 2007.Serodiagnosis of Haemonchosis in small ruminants. University of Veterinary and Animal Sciences, Lahore, J Anim Pl Sci 17: 3-4.

El-Hag MA, FOK Abdelrahman, El-JH Faisal, WA Nimat, MA Mahmoud and KA Abdelrahman, 2011. Changes and threats facing nomads under drylands - the case of Shanabla tribe in Western Sudan, DCG Report No. 62.

Zahid F, 2009. Prevalence of gastro- intestinal helminthes in some ruminant species and documentation of ethno veterinary practices in Cholistan desert, PhD Thesis, University of Agriculture Faisalabad-38040, Pakistan.

Farooq Z, S Mushtaq, Z Iqbal and SH Akhtar, 2012. Parasitic Helminths of Domesticated and Wild Ruminants in Cholistan Desert of Pakistan. Int J Agric Biol,14: 63–68.

Fayza OA, Bushara Osman HOAY and A Majid, 2003. The seasonal prevalence of adult and arrested L4 Larvae of *Haemonchus contortus* in naturally infected sudanese desert sheep. The Sudan J Vet Res, 18: 89-92.

Francisco J Angulo-Cubillán, Leticia García-Coiradas and C Montserrat, 2007. Concepción de la Fuente y José M Alunda (*Haemonchus contortus*-sheep relationship: a Review-RevistaCientifica, FCV-LUZ/ Vol. xvII: 577-587.

Gadahi JA, MJ Arshed, Q Ali, SB Javaid and SI Shah, 2009. Prevalence of Gastrointestinal Parasites of Sheep and Goat in and around Rawalpindi and Islamabad, Pakistan. Vet World, 2: 51-53.

Getachew T, P, Dorchies and P Jacquiet, 2007. Trends and challenges in the effective and sustainable control of *Haemonchuscontortus*infection in sheep. Parasite, 14: 3-14.

Martin SW, HA Meek and P Willeberg, 1987. Veterinary epidemiology principles and methods. Iowa state University Press/AMES: pp: 45.

MAFF, 1979. Parasitological laboratory techniques, technical bulletin No. 18. ministry of agriculture, fisheries and food manual of veterinary, her majestey's stationary office, London.

Negasi W, B Bogale and M Chanie, 2012. Helminth Parasites in Small Ruminants: Prevalence, Species Composition and Associated Risk Factors in and Around Mekelle Town, Northern Ethiopia. Europ J Biol Sci, 4: 91-95.

Qamer MF, A Maqbool, KM Sarwar, A Nisar and MA Muneer, 2009. Epidemiology of haemonchosis in sheep and goats under different managemental conditions. Vet World, 2: 413-417.

Raza MA, S Murtaza, HA Bachaya, G Dastager and A Hussain, 2009. Point prevalence of Haemonchosis in sheep and goats slaughtered at Multan Abattoir. The J Anim Plant Sci, 19: 158-159.

Saddiqi HA, 2010. Evalation of some indigenous breeds of sheep for natural resistance against *Haemonchus contortus* infection. PhD thesis, University of Agriculture, Faisalabad, Pakistan.

Sissay MM, 2007. Helminth parasites of sheep and goats in Eastern Ethiopia: Epidemiology, and anthelmintic resistance and its management. PhD thesis, Swedish University of Agricultural Sciences, Uppsala, Sweden. ISSN 1652-6880, ISBN 978-91-576-7351-0.

Soulsby EJL, 1982. Helminths, Arthropods and Protozoa of Domestic Animals. 7th Ed. Bailliere Tindall and Cassel Ltd, London.

Tasawar Z, S Ahmad, MH Lashari and CS Hayat, 2010. Prevalence of *haemonchuscontortus* in sheep at research centre for conservation of Sahiwal Cattle (RCCSC) Jehangirabad District Khanewal, Punjab, Pakistan. Pak J Zool, 42: 735-739.

Tehrani A, J Javanbakht, M Jani, F Sasani and A Solati, 2012. Histopathological study of *Haemonchus contortus* in herrik sheep abomasum. J Bacteriol Parasitol 3: 144.

Thienpont D, F Rochette and OFJ Vanparijs, 1979. Diagnosing Helminthiasis Through Coprological Examination. Janssen Research Foundation Beerse Belgium, 361/52 1401.

Thrusfield M, 2007. Veterinary epidemiology, Veterinary Clinical Studies Royal (Dick) School of Veterinary Studies. University of Edinburgh, Third edition. Back well publishing, pp: 158-161.

Waller PJ, G Bernes, L Rudby-Martin, BL Ljungström and A1Rydzik, 2004. Evaluation of copper supplementation to control *Haemonchus contortus* infections of sheep in Sweden, Acta veterinaria Scandinavica, 45: 149-160.