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Table of Contents: Volume 7 Number 4 April 2015

ARTICLES

Research Articles

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Full Length Research Paper

Seroprevalence of small ruminant brucellosis and its effect on reproduction at Tellalak District of Afar region, Ethiopia

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A cross-sectional study was conducted in Tellalak district of Afar region to determine the sero-prevalence of small ruminant brucellosis and its association with major reproductive health problems. Serum samples (272 from goats and 142 from sheep) were collected from three randomly selected peasant associations along with a questionnaire survey. Animals above six months of age with no history of previous vaccination for brucellosis were randomly selected. Modified Rose Bengal Plate Test (mRBT) was used as a screening test while Complement Fixation Test (CFT) was used to confirm reactors. Overall sero-prevalence of 13.7% was observed in both goats and sheep. The prevalence in goats was much higher (15.4%) than in sheep (10.6%). The prevalence among females with a history of retained fetal membrane was significantly higher (P<0.001) than those without. Age, sex and flock size were not associated with the sero-prevalence of brucellosis. However, the presence of pregnancy was a known risk factor in both goats and sheep. Sero-positive animals were likely to abort (OR=5.1) or give rise to a weak offspring (OR=9.4). This study showed brucellosis to be widespread in the study area with a much higher potential for further spread to other sites as well as be a public health risk.

Key words: Brucellosis, reproductive problem, small ruminants, Tellalak, Afar region.

INTRODUCTION

Ethiopia has over 25 million head of sheep and 21 million goats of which 25% of the sheep and 73% of the national goat population inhabit the lowlands. Most goat populations in Ethiopia are raised under pastoral conditions (PFE, 2004; CSA, 2010). Although small ruminants represent a huge resource; production from this important asset does not realize its full potential due to a number of factors including various diseases (Singla, 1995; Ibrahim, 1998). Sheep and goats are two completely different species of animals that tend to be affected by similar bacterial agents that contribute significantly to abortions. Of all the disease problems which can affect flocks of goats or sheep, those causing abortion and reproductive failure are always the most costly (Bruce, 2004). Reproductive proficiency is one of the core profiles of economic consideration in any livestock production enterprise. Loss of a calf, lamb or kid due to abortion and its squeal frequently leads to infertility (Radostitis et al.,

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2000). Among the most common infectious agents that cause abortions in small ruminants worldwide brucellosis caused by *Brucella melitensis*.

In Ethiopia, only few studies have been conducted on small ruminants brucellosis. Reported prevalence include 1.5% in sheep and 1.3% in goats in the central highlands of Ethiopia (Teklye and Kasali, 1999), 15% in sheep and 16.5% in goats in Afar (Teshale et al., 2005), 3.2% in sheep and 5.8% in goats in Afar (Ashenafi et al., 2007), and 3.2% in goats and 1.6% in sheep (Mengistu, 2007) in Konso. Pastoralists usually consume raw milk and meat and there is a high proximity between the pastoralists and their animals which predisposes them to zoonotic diseases. In spite of higher occurrence of abortion in small ruminants, only few studies have tried to study the risk factors, the specific causative agents or it association with brucellosis. Currently, the livelihood of the pastorals is more and more dependent on small ruminants for milk, meat and source of cash. Unfortunately, the status of reproductive performance and the role of brucellosis in causing reproductive problems is not fully known. Therefore, the objectives of this study were to determine the sero-prevalence of brucellosis, to assess the association of sero-positivity to reproductive problems, and to identify the most prevalent risk factors in the study area contributing to occurrence, transmission and public health hazard.

MATERIALS AND METHODS

Study area and animals

The study was conducted in Tellalak district of Afar region, North East Ethiopia. Tellalak is a district located in the Southwest part of the region in the lower Awash basin covering a total area of 1418 km^2. The topography of the area is mainly plain land with small hills, valleys and riversides. Rainfall is bimodal consisting a main season (*karma*) and a short rain (*Sugum*) that together give an average annual rainfall of around 400 mm. In addition, Wata, Tellalak, Gewes and Awash are perennial rivers that serve as a key water source for the area. The vegetation is composed of bushes, consisting most liked forage for camels and goats. There is scattered grassy plain which also serve as good source of pasture for cattle and sheep.

During *Gill* (October to January*)* and *Hagay* season (May to July), cattle and camels migrate from the villages located in the south east part of Tellalak district to Gewane and Awash river side while the villages located in the eastern part migrate to Kewet and Mafud areas of neighboring region. Livestock move back to the area during the rainy season; however, migration of sheep and goats is usually within the same district (APADO, 2007). There are about 162,338 goats, 86,492 sheep, 83,623 cattle, and 46,612 camels in the same order of economic importance (APADO, 2007).

The study animals comprised indigenous Afar goats (also known as the Adal, Denakil or Abyssinian short-eared goat) and sheep (previously known as Adal or Denakil breed of 'fat tailed sheep') (ILRI, 2006). Tellalak district has 11 peasant associations; 3 PAs (Tellalak-Abaro with 32,680 shoats, Adalil-Dewie with 36,320 shoats, and Aware-Ared with 29,900 shoats) were purposively selected for this study based on the size of sheep and goat population and accessibility of the PAs. Goats and sheep of both sexes that are ≥6 months of age and with no previous history of vaccination were randomly selected.

Study design

A cross-sectional study was conducted to assess the sero-prevalence of brucellosis. A questionnaire survey was used to investigate risk factors and to evaluate association of brucellosis to selected reproductive disorders such as abortion, retained fetal membrane, stillbirth, and birth of weak offspring. On-spot observational study was also conducted for reproductive health problems.

Sample size determination and sampling method

Two stage cluster sampling method was employed. The primary-sampling unit was a flock defined as a household having at least one sheep or goat. The secondary sampling units were the individual animals. Since the between-cluster variance of small ruminant brucellosis in the area was unknown, a simple random sampling method was applied to calculate the number of animals to be included in the study. Win Episcope 2.0, an improved epidemiological software for veterinary medicine was employed with an infinite population and multiplying the estimated sample size by two to account for potentially large variation (Thrusfield, 2005). A 5% absolute precision, a 95% confidence interval, and an overall prevalence of 16% previously reported for the region were considered in the sample size determination. Accordingly, 414 animals consisting of 272 goats (18 Male and 254 Female) and 142 sheep (17 Male and 125 Female) were included in the study. An ownership of 20 animals per households was assumed to determine the number of clusters, hence 21 (414/20) randomly selected animal owners were included in the study.

Questionnaire survey

Information on potential risk factors of small ruminant brucellosis was collected using pre-tested questionnaire. The individual animal characterstics such as species, sex, age, breeds, pregnancy status and source of replacement stock, movement of sheep and goats in search of feed and water, dry season watering and feeding points, lambing/kidding conditions and its management together with the reproductive disorders such as history of abortion, retention of fetal membrane, stillbirths or births of weak lambs/kids, methods of disposal of fetal membranes and other periparturent reproductive problems were recorded.

Collection of blood samples

Approximately, 6 ml blood sample was collected through jugular venipuncture using sterile plain vacutainer tubes. The samples were properly labeled (date and location of collection, species, sex and age of the animals) and left for 24 h at room temperature to allow clotting and the serum was separated by gently decanting it to sterile cryovials. The serum samples were then transported using an ice box and later stored at -20°C at Kombolcha Regional Veterinary Laboratory until testing for *Brucella* antibodies.

Serological test

Modified Rose Bengal Test (mRBT)

The mRBT was undertaken at Sebeta National Animal Health Diagnostic and Investigation Institute. *Brucella abortus* antigen

Strain 99 manufactured by Lilliale Diagnostics (Badbury view, UK) was used for the test.

Complement fixation test (CFT)

All the sera that tested positive to mRBT were subjected to CFT for confirmation. CFT was carried out at the National Veterinary Institute (NVI), Department of Immunology. All the reagents required for CFT were evaluated by titration. A 2% sheep red blood cell (SRBC) suspension was prepared before being used in the test proper. The preparation of reagents and CFT procedures were performed according to the protocols of the Federal Institute for Consumer Protection and Veterinary Medicine Service Laboratory, Berlin, Germany (OIE, 2008). Sheep and goats that serially tested positive to both mRBT and CFT tests were considered to be positive for brucellosis.

Data management and analysis

Data obtained from both serological tests and questionnaire surveys were entered into Microsoft excel spreadsheet. A descriptive stastical analysis was carried out using SPSS 15.0 (SPSS 2006) to determine the seroprevalence. The individual animal level sero-prevalence was calculated on the basis of mRBT and CFT positive results divided by the number of animals tested (Thrusfield, 2005).

The results obtained from questionnaire survey were compared with those of serological tests. Pearson's Chi-square test (χ^2) and Fisher's exact test were used to study the association of risk factors and reproductive problems with the sero-prevalence of brucellosis. The degree of association between potential risk factors and sero-prevalence were determined using Odds ratio. Statistical significance was held at p<0.05.

RESULTS

Overall sero-prevalence

The overall sero-prevalence in both sheep and goats after mRBT was 17.4% (72/414). Out of the mRBT positive sera, 79.2% (57/72) further showed a positive reaction for CFT. The prevalence of brucellosis in both sheep and goats after mRBT for the different study sites was in the order of 20% Tellalak-Abaro, 25% Adalil-Dewi and 23% Aware-Ared. Summary of results of mRBT and CFT categorized by, species, age, sex, flock size and pregnancy status is given as shown in Table 1. Samples positive with both mRBT and CFT were considered as true seropositive and were taken for the subsequent data analyses. The overall true sero-prevalence of brucellosis in small ruminants was 13.7%.

Sero-prevalence among the potential risk factors of small ruminant brucellosis

The true sero-prevalence of brucellosis among the study sites is as shown in Table 2. Except for the pregnancy status, there was no stastically significant difference (p>0.05) in the true sero-prevalence between the PAs, between sheep and goats, between males and females, and between the various flock sizes. However, true sero-prevalence was significantly higher (p<0.05) in pregnant animals as compared to non-pregnant ones. The true sero-prevalence of brucellosis among the pregnant goats 82.4% (28/34) was significantly higher (P=0.001) than in sheep 17.6% (6/34).

Reproductive problems of small ruminants in the study area

The prevalence of abortion, RFM, still birth and weak offspring were 17.2, 14.5, 1.3 and 1.8%, respectively. History of previous abortion and retained fetal membrane were highly associated (P=0.00) with the highest prevalence of brucellosis (Table 3). Animals with previous history of abortion were 5 times more at risk of being sero-positive as compared to those without history of abortion while animals with RFM were about 8 times more at risk. The odds of animals with history of stillbirth contracting brucellosis was lower (OR=4.5) and not statistically significant as compared to those without stillbirth. However, animals that gave rise to weak offspring also showed positive reaction to brucellosis test and the relationship was statistically significant (P<0.05, Table 3).

Results of questionnaire survey on husbandry practices and associated risk factors

In this study, 21 individuals whose animals were sampled for blood collection were asked about awareness of brucellosis, presence of regular veterinary service, grazing system and disposal of fetal membrane, the practice of migration, method of milk consumption, and handling aborted fetus to find out the presence of associated risk factors with the occurrence of brucellosis. All households used same communal grazing area and do migrate seasonally in search of feed and water for their animals. Most of the respondents (71.2%) commonly leave the afterbirth on the ground while the remaining 28.8% just throw the afterbirth on a tree. Almost all households do not properly take care of aborted fetus. Awareness of small ruminant brucellosis was very low (19.1%) among owners and further, a good proportion (66%) of owners also did not have a regular veterinary service. Milk is commonly consumed raw.

DISCUSSION

The data collected revealed high sero-prevalence (13.7%) of small ruminant brucellosis in the study area. Previous study on brucellosis in Afar region reported a higher prevalence (16%) although the study did not address specific areas of the region (Teshale et al., 2005).

Table 1. The result of small ruminant brucellosis in Tellalak district of Afar region.

Category		No.of animals tested	mRBT positive (%)	CFT positives	Prevalence (%)
Species	Goat	272	46 (16.9)	42	15.4
	Sheep	142	26 (18.3)	15	10.6
Sex	Male	35	6 (17.1)	5	14.3
	Female	379	66 (17.4)	52	13.7
Age	(0.6-2 years)	30	7 (23.3)	6	20.0
	(≥2 years)	384	65 (16.9)	51	13.3
Flock size	1-15	65	14 (21.5)	8	12.3
	15-30	153	23 (15.0)	18	11.7
	≥30	196	35 (19.9)	31	15.8
Pregnancy	Present	125	40 (32.0)	34	27.2
	Absent	254	26 (10.2)	23	9.1

Table 2. Chi-square analysis of association between risk factors and prevalence of brucellosis.

Category		N	Prevalence (%)	χ^2 value	P- value	OR (95% CI)
PA	Tellalak and Abaro	135	14.8	1.00	0.61	0.79 (0.75-2.0)
	Adalil and Dewie	152	11.8			
	Aware and Ared	127	14.9			
Species	Goat	272	15.4	1.10	0.29	1.4 (0.75-2.6)
	Sheep	142	10.6			
Sex	Male	35	14.3	0.91	0.34	0.66 (0.26-1.6)
	Female	379	13.7			
Age	0.6-2 years	30	20.0	1.06	0.30	0.62 (0.24-1.60)
	≥2 years	384	13.3			
Flock size	1-15	65	12.3	0.76	0.69	1.24 (0.83-1.85)
	15-30	153	11.7			
	≥30	196	15.8			
Pregnancy	Present	125	27.2	11.3	0.001	2.74 (1.5-5.0)
	Absent	254	9.1			

Subsequent more detailed reports for different districts of the same region indicated lower prevalence of brucellosis over wider areas: 2.3% in Tellalak district, 8.0% in Samurobi, 1.7% in Fursi and 10% in Awash Fentale and neighboring districts (Ashenafi et al., 2007) with an overall prevalence of 4.8% for the whole of Afar region. In the presence of seasonal mobility, lack of veterinary service, and very poor understanding of the disease, higher prevalence probably indicates that the lack of awareness from the owner's side has contributed to the increase in the prevalence and spread of the disease over time. Additional reason for the difference in the prevalence might also be due to absence of vaccination against brucellosis, coupled with the traditional use of communal grazing that brings the risk population close to one another. The difference in sample size and the variation

Table 3. Chi-square analysis for posible association of reproductive problems in female with the pevalence of brucellosis.

Category		No.of animals tested	No.of positives	Prevalence (%)	χ^2-value	P- value	OR (95% CI)
RFM	Present	55	26	47.3	47.5	0.001	7.8 (4.1-14.8)
	Absent	324	24	7.4			
Stillbirth	Present	5	2	40.0	3.1	0.07	4.5 (0.73-27.6)
	Absent	374	48	12.8			
Weak offspring	Present	7	4	57.1	11.9	0.001	9.4 (2.0-43.3)
	Absent	372	46	12.4			

in degree of sensitivity between CFT and I-ELISA could also be another source of difference in the prevalence reports.

The present study indicates that the prevalence of brucellosis in goats (15.4%) was higher than sheep (10.6%). Although not statistically significant, goats were 1.45 times more at risk of being sero-positive as compared to sheep. This finding is comparable to that of Teshale et al. (2005) and Ashenafi et al. (2007) who also reported higher prevalence in goats than in sheep in Afar region, and Mengistu (2007) in Konso, southern Ethiopia. Similar findings were also reported from Nigeria (Bale et al., 2003; Ojo et al., 2007; Bertu et al., 2010). However, study by Tekelye and Kasali (1999) in the central high lands of Ethiopia, and by Samaha et al. (2008) in Egypt showed a higher prevalence in sheep as compared to goats mainly due to differences in husbandry system and in susceptibility of the sheep and goat breeds in the particular area.

The prevalence in males was higher than the female animals, but this was not statistically significant. It is difficult to draw a strong conclusion, because of the small numbers of male animals sampled in this study. The prevalence of brucellosis was higher in younger (20.0%) animals than in older (13.3%) animals. Unlike the present finding, another study (Ashenafi et al., 2007) reported a prevalence of 5.3% in adult animals and 1.6% in younger sheep and goats. It is known that sexually mature and pregnant animals are more prone to *Brucella* infection than sexually immature animals of either sex. This may result from the fact that sex hormones and erythritol, which stimulate the growth and multiplication of *Brucella* species organisms, tend to increase in concentration with age and sexual maturity (Radiostits et al., 2000). However, the fewer number of young animals sampled in the present study has clearly inflated the prevalence as compared to that in adult animals. The prevalence of brucellosis among larger flock size was higher than small flock size; however, the difference was not significant. Literature (Walker, 1999) shows that herd sizes and animal densities are directly related to prevalence of the disease and create difficulty in controlling infection in a population. In the present study, however, it perhaps shows watering and grazing site where all animals have similar chance of exposure to *brucella* organism to be more important than densities of animals in larger flock.

A total of 379 female animals were included to study association of sero-positivity with the presence of reproductive problems, and with the presence or absence of pregnancy. Male animals of both species were not included in this discussion because by chance no male animal was found with reproductive organ problems at the time of sampling serological test. There was a statistically significant difference (P=0.001) among the pregnant and non pregnant animals. This might be due to susceptibility of the reproductive tracts of pregnant animals. Allantoic factors including erythritol, possibly steroid hormones and other substances stimulate the growth of most of the *Brucella* spp. (Anonymous, 2007).

The sero-prevalence of brucellosis was also higher (P=0.000) in small ruminants having history of abortion and retained fetal membrane than those without these problems. The higher rate of infection in pregnant sheep and goat might be due to infection within the reproductive tract that provide a potential reservoir site for the organism which eventually propagated and become active as pregnancy advanced. The presence of a statistically significant association (P=0.000) between a positive reaction to brucellosis and the birth of weak offspring is a common sign of brucella infection. Often when not aborted, the offspring is delivered as a weak individual prone to early mortality.

Conflict of interest

The authors declare that there is no conflict of interest

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Full Length Research Paper

Prevalence of strongyle infection and associated risk factors in equine in Menz Keya Gerbil District, North-Eastern Ethiopia

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A cross sectional study was conducted to determine the prevalence of equine strongyles in Meneze Keya Geberial district from July 2013 to September 2013. Coprological examination using floatation technique and assessing risk factors were followed. A total of 390 equines, 204 donkeys, 174 horses, and 12 mules were included in the study. The overall prevalence was found to be 64.61% and the species specific prevalence was 62.3, 69, and 41.7% in donkeys, horses and mules, respectively. There was no statistically significant difference (p>0.05) on the prevalence of the gastro-intestinal (GI) strongyles infection among different species of equines. The age level prevalence was 64.6% in young equine and 64.6% in adult equines. Statistically significant difference (p<0.05) in the prevalence of GI strongyles infection in different sex of equine was found. No statistically significant difference (p>0.05) in the prevalence of GI strongyle infection related to age and body condition was found. In conclusion, strongyles infection is widely distributed in equine in the study area. Strategic prevention and control to strongyles infection should be devised and implemented. Further researches on determining the management practices which predisposes equines to strongyle infections should be conducted.

Key words: Ethiopia, equine, Menze Keya Geberial district, prevalence, strongyles.

INTRODUCTION

The equine population in Africa is 17.6 million, 11.6, 2.3 and 3.7 million donkeys, mules and horses, respectively (Pearson et al., 1997). Ethiopia retains a total of 8.6 million equines, 5.2, 2.8 and 0.6 million donkeys, horses and mules, respectively (Addissalem, 2005). This high number of equine in the production system shows the importance of the species in the area.

Most equines are found in the areas of high human population density where the production system is dominated by annual cropping with livestock production (Yilma et al., 1991). Horses are more populated in high land whereas mules and donkeys are relatively more in middle to lower altitude areas of the country (Gezahegn, 2000; Hassan, 2000).

Equines have significant role in transport of the agricultural products and human transport system in Ethiopia. They are used as saddle or cart or pack animals in most parts of the country, but in few regions equines

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are used for ploughing of land for crop production and threshing crops (Gizaw, 1987; Hagos, 2000).

Equines are one of the major hosts for haemoprotozoans and helminth infections (Sumbria et al., 2014). They are known to be infected by 28 genera and 75 species of nematodes, 1 genus and 5 species of trematodes and 3 genera and 22 species of cestodes (Drugde and Lyons, 1986) and more than 50 strongyles species (Lyons and Tolliver, 2009). In Ethiopia, gastro-intestinal (GI) parasite infection is one of the most important health problems of equines contributing to poor body condition, reduced power output, poor reproductive performances and short lifespan. Studies have shown high prevalence of GI parasites such as large and small strongyles, ascarids, pinworm, stomach worm, lung worm and liver fluke (Yilma et al., 1991; Yoseph et al., 2001).

Strongyles are among the most frequently encountered and highly pathogenic helminthes of equidae, responsible for death when control measures are neglected (Drudge and Lyons, 1986; Soulsby, 1982). However, the greatest losses are probably due to failure of youth equine to grow properly and less efficient performances of horse that are moderately parasitized (Radositis et al.,). Large strongyles are generally recognized as the most important of the internal parasites in the horse and the major pathogenic species in this group are *Strongylus vulgaris, Strongylus edentatus* and *Strongylus equinus*. The first two species are distributed worldwide whereas *S. equinus* is relatively uncommon (Fikru et al., 2005).

In recent study by Takele and Nibiret (2013), they reported the overall prevalence of different parasites to be 88.21% in donkeys and 77.91% in mules, where 94.1% of donkeys and 84.33% of mules harbored two or more types of parasites (mixed infection) in and around Bahir Dar, Western Ethiopia. Similarly, Asefa et al. (2011) reported a prevalence of 99.5% of strongyle infection in donkeys in Sululta and Gefersa districts of Central Ethiopia. These findings show the importance of the strongyles in Ethiopia.

Despite the significance of equines to the production system and huge population in the Menz Keya Gabriel district, there was no study on the important strongyle infection on equines. Therefore, it was important to study the epidemiology of strongyles infection and the risk factors associated to the prevalence of equine strongyle infections in Menz Keya Gebreal district. Therefore, this research was conducted with objectives to determine the prevalence and assess risk factors associated with the prevalence of GI strongyle infection in Menz Keya Gebreal district.

MATERIALS AND METHODS

Study area

The study was conducted from July to September, 2013 in Menz Keya Gerbil district. It is located at 312 km from Addis Ababa, North-Eastern Ethiopia at altitude that ranges from 1400 to 2960 meter above sea level (masl). The area receives mean annual rainfall of 1000 mm with mean minimum and maximum annual temperature of 10 and 25°C, respectively. The agro ecology of the area is 20% low land, 42% midland and 38% highland.

Study population

The study animals were equine species, donkeys, horses and mules. All animals used included local breeds of both sex and were grouped into different age groups (young and adult). The body condition score (BCS) of equines were grouped into two, poor (BCS 1 to 2) and good (BCS 3 to 5), adapted from Nicholson and Butterworth (1986).

Study design

A cross-sectional study design was followed and a simple random sampling technique was employed to select study peasant association and study animals. Body condition scoring and fecal samples were collected from study equines throughout the study period. The fecal specimen was collected directly from the rectum.

Fecal sample collection and coprological examination

The specimen directly collected from the rectum were put to universal bottles containing 10% formalin and refrigerated at 4°C if fecal examination is delayed, but in most cases fecal examination was done immediately. Each sample was labeled with code referring to the animal number, species, corresponding owner's name, date, body condition and place of collection. The collected fecal samples were examined in the parasitological laboratory of the district clinic with qualitative flotation technique, as described by Cringoli (2010) and Aymour (1992).

Sample size determination

The samples size was decided by formula of Thrusfield (2005), by assuming 50% expected prevalence, as there were no previous study, and 95% confidence interval.

$$n = \frac{Z^2 \, p \, (1-p)}{d^2}$$

where n is the sample size required, Z is taken from the level for 95% CI (1.96), P is the prevalence expected (50%), and d is the level of precision (5%).

Accordingly, the calculated sample size was 384, and this number of sample was proportionally distributed to the equine species of the district. Accordingly, 204 donkeys, 174 horses and 12 mules were included in proportionate to the total of 390 equines sampled.

Data analyses

The data were analyzed using Statistical Package of Social Sciences (SPSS) version 20 software for windows. Prevalence was obtained by dividing number of equines positive for strangles infection to the total equines examined. Pearson chi-square (χ^2) test was used to assess association of different risk factors to the

Table 1. Prevalence of GIT strongylosis among donkeys, horse and mules.

Equine species	Total sampled	No. of positives	Prevalence (%)	χ^2	p-value
Donkeys	204	127	62.3		
Horses	174	120	69	4.701	0.095
Mules	12	5	41.7		
Total	390	252	64.61		

Table 2. The prevalence of GI strongyles infection in young and adult equines.

Age category	Total sampled	No. of positives	Prevalence (%)	χ^2	p-valve
Adult	229	148	64.6		
Young	161	104	64.37	0.00	0.995
Total	390	252	64.61		

Table 3. The prevalence of GI strongyles infection by sex of equines species.

Sex	Total sampled	No. of positives	Prevalence (%)	χ^2	p-valve
Male	237	144	60.8		
Female	153	108	70.6	3.928	0.047
Total	390	252	64.61		

Table 4. Prevalence of GI strongyles infection in different body condition scored equines.

Body condition	Total sampled	No. of positive	Prevalence (%)	χ^2	p-valve
Good	236	150	63.6		
Poor	154	102	66.2	0.292	0.589
Total	390	212	64.6		

occurrence of the strongyles infection.

RESULTS

Prevalence in different species of equine

The overall prevalence was found to be 64.61% and the species specific prevalence was 62.3, 69, and 41.7% in donkeys, horses and mules, respectively. There was no statistically significant difference (p = 0.095) on the prevalence of the GI strongyles infection in different species of equines in the study area (Table 1).

Prevalence in different age groups of equine

The study animals were categorized into two age groups, young (<2 years) and adult (>2 years of age). The prevalence on age bases was 64.6 and 64.6% in young and adult equines, respectively. There was no statistically significant variation (p = 0.995) in the occurrence of GI strongyles infection with the two age groups (Table 2).

Prevalence in different sex of equines

Sex based prevalence was 70.6 and 60.8% in female and male equine species, respectively. There was statistically significance difference (p = 0.047) in the prevalence of GI strongyles infection in different sex of equine species in the study area (Table 3).

Prevalence in different body condition score of equines

Out of 154 equines with poor body condition score, 102 (66.2%) were positive for strongyles infection, whereas from 236 equines with good body condition score, 150 (63.6%) were positive for strongyles infection. There was no statistically significant difference (P = 0.589) in the prevalence of GI strongyles infection with regard to the body condition score (Table 4).

DISSCUSION

The finding of present study revealed that strongyles infection prevalence of 64.61% is relatively of high rate. This is an indication that strongyles infection is of important health constraints in equine population in all of the three species donkey, horse and mule in the study area. This finding of high prevalence of strongyles
infection is in agreement to Adam et al. (2013) who reported the animals harbouring mild strongyle infection and showed the highest incidence of 69.7% in donkeys and 84% in horses, in North Darfur State, South Sudan.

The finding of current study of prevalence of 62.3 and 41.7% in donkeys and mules, respectively, is lower than that of Asefa et al. (2011) who reported 88.21% in donkeys and 77.91% in mules in and around Bahir Dar, Western Ethiopia. This variation could be due to difference in agro-ecology and density of equine population in the areas. Similarly, the finding of the current study of prevalence of 62.3% in donkeys is lower than that of Asefa et al. (2011) who reported a prevalence of 99.5% of strongyle infection in donkeys in Sululta and Gefersa districts of Central Ethiopia. This variation could be due to the variation in agro-ecology or management practices. This relatively lower prevalence of strongyles infection in the current study could be due to the practice of use of anthelmintic therapy for equine in the study area. The age wise occurrence of strongyles infection in this study revealed no significant difference ($p>0.05$) in prevalence rate between young and adult. These finding is not in agreement to Soulsby (1982) and Desalegn (2005) who reported higher prevalence in adult and lower in foals due to the fact that foal management is good than adult equine. This could be due to the difference in management system, whereas in this study population both the young and adult were reared extensively and mixed, thus the likelihood of exposure is almost similar to different age groups.

There was statistically significant difference between different sexes of equine species in this study by current finding. This finding is not in agreement to the findings of Fikru et al. (2005) and Yoseph (1993), both reported no significant different in sex. This could be due to the difference in the management of animal difference. In this study, female equines were managed for breeding purpose, usually kept homestead whereas male equine are used for pack purpose, carrying of goods for long distance to market places, usually crossing different agro ecological area. These conditions could have increased the likelihood of exposure of the male animals to strongyles infection as compared to their female counterparts.

CONCLUSION AND RECOMMENDATIONS

The strongyles infection in equines is found to be widely prevalent and should be considered as one of the important disease of equines in the country. The management practices of equines in general and the agro-ecology of an area are of paramount importance in determining the occurrence of GI strongyles infection in equine. The local management system, where equines are allowed to graze mixed with different species of animal on small communal pasture land, usually overstocked has facilitated GI strongyle infection transmission and prevalence. Hence, the prevention and control of equine strongyles infection should take the management practices of equines and agro-ecology of an area into consideration. Based on the aforementioned conclusion, the following recommendations are forwarded:

(1) Strategic strongyles infection prevention and control should be devised on the bases of the management and agro-ecology of the areas.
(2) Further researches on management practice predisposing equines to strongyles infection should be conducted.
(3) Appropriate management and sanitary standard through strategic deworming has to be followed in combating the impact of strongyles infection in equines.
(4) It is advised that there should be equine health promotion program supported by the government.

Conflict of interest

The authors declare no conflict of interest

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Full Length Research Paper

Comparison of range of motion in Labrador Retrievers and Border Collies

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The objective of this paper was to compare the range of motion in Border Collies to that of Labrador Retrievers. Humeral circumference, thigh circumference and differences between sex and age were also compared. Twenty three (23) healthy Border Collies and 18 healthy Labrador Retrievers were used. A single investigator measured range of motion of the carpus, elbow, shoulder, hip, stifle and tarsus as well as humeral and thigh circumference under field conditions in 23 Border Collies and 18 Labrador Retrievers. Border Collies had a significantly greater range of motion (P<O.001) in all joints than Labrador Retrievers. Sex was a significant predictor of range of motion (P=0.010), but age was not (P=0.400). Range of motion significantly varied by joint (P<0.001) and the effect was different within Border Collies versus Labrador Retrievers (P=0.008). Range of motion did not vary between left and right sides (P=0.365). Considerations of range of motion were made in deciding pathology and progress based on type and breed of dog (sporting, herding, protection). Comparisons were made based on breed and from left side to right side.

Key words: Range of motion, goniometry, flexion, extension, and abduction.

INTRODUCTION

Range of motion (ROM) is the distance and direction that a joint can move between positions to its full potential such as flexion and extension. Goniometry is the measurement of angles, and this is how range of motion is evaluated in human physical therapy and animal rehabilitation (Boone and Azen, 1978; Riegger-Krugh and Millis, 2000). Limits in range of motion help quantify deficiencies and aid in documenting improvement after surgery and during animal rehabilitation (Mölsä, 2014). Normal range of motion measurements have been established via goniometry on Labrador Retrievers (Jaegger, 2002).

Seventy percent thigh circumference with the leg in extension is an indirect method of assessing changes in muscle mass in the hind limbs of canines and animal physiotherapists when evaluating orthopedic disease (Millis and Scroggs, 1999; Molsa, 2014). Antebrachial (humeral) circumference (just above the elbow around the humerus and associated musculature) is the most common indirect measurement of general front leg musculature used at some rehabilitation practices.

However, if a breed or type of breed difference exists

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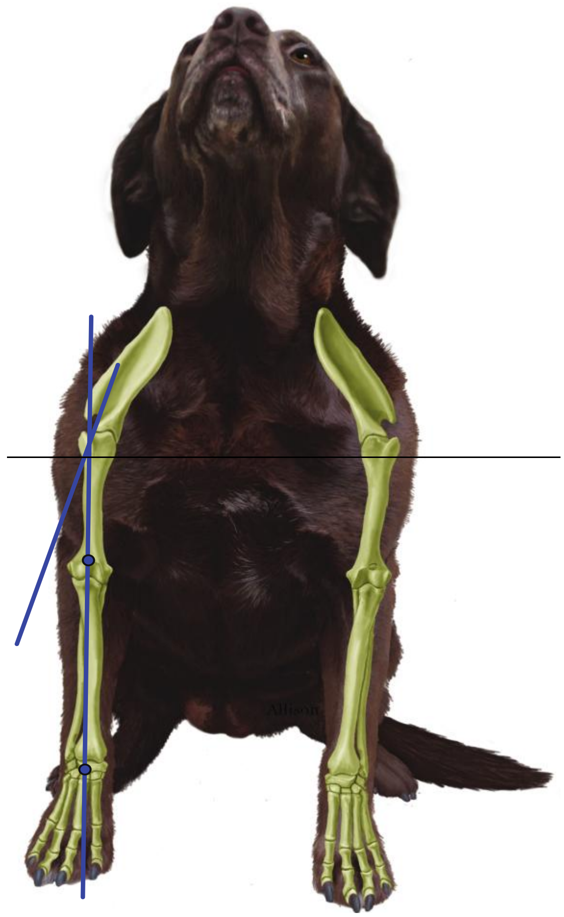

Figure 1. Axis for measuring shoulder abduction with the dog in the sitting position.

for normal values, it would be useful so that a dog is not considered abnormal when the dog has range of motion values within normal limits for that breed or type of breed.

MATERIALS AND METHODS

Dogs

Twenty three Border Collies between the ages of 0.8 and 7 years old (11 males, and 12 females) and 18 Labrador Retrievers between 6 months and 10 years of age (5 males, 13 females) were active on the day of measurement, but no dog had passive range of motion performed on them before study measurements were taken. The dogs included in this study did not have clinical sign of lameness, palpable pain or muscle tightness or laxity or a history of trauma or surgery on the legs on the day of or prior to the measurements. Radiographs and CT scans were not performed on animals included in this study, as the measurements were taken in field conditions. Sex (intact or neutered) was not a factor in selection of cases. All dogs had the same measurements taken at the same time and in the same order of location (hip flexion and extension, stifle flexion and extension, tarsal flexion and extension, 70% thigh circumference, shoulder flexion and extension, elbow flexion and extension, carpal flexion and extension and shoulder abduction).

Goniometry

The arms of a transparent plastic goniometer[1] were aligned with anatomic landmarks on the limbs (axis) and 1 degree gradations were used for measurements. All joints were measured in lateral recumbency except for shoulder abduction. Flexion and extension for the involved joints were measured per previously described methods (Millis et al., 1999) using the shafts of the bones above and below the joint as guide points for the arms of the goniometer as shown in Figure 2. Shoulder abduction was measured with the dog in a sitting position and the goniometer placed vertically along the cranial aspect of the humerus. The scapula was secured with one hand as the leg was abducted away from the center of the body starting from the zero point axis of the humeral shaft as shown in Figure 1. Care was taken to keep the shoulder and the elbow in extension.

Thigh and humeral circumference

A Gulick II tape measure[2] was applied around the femur at approximately the 70% mark while the dog was in a standing position with the leg extended (Millis and Scroggs, 1999). A Gulick

[1] Cm goniometer, MSD products, Landerzeel, Belgium
[2] Gulick II Measuring Tape, Country Technology, Inc, Gays Mills, Wisconsin

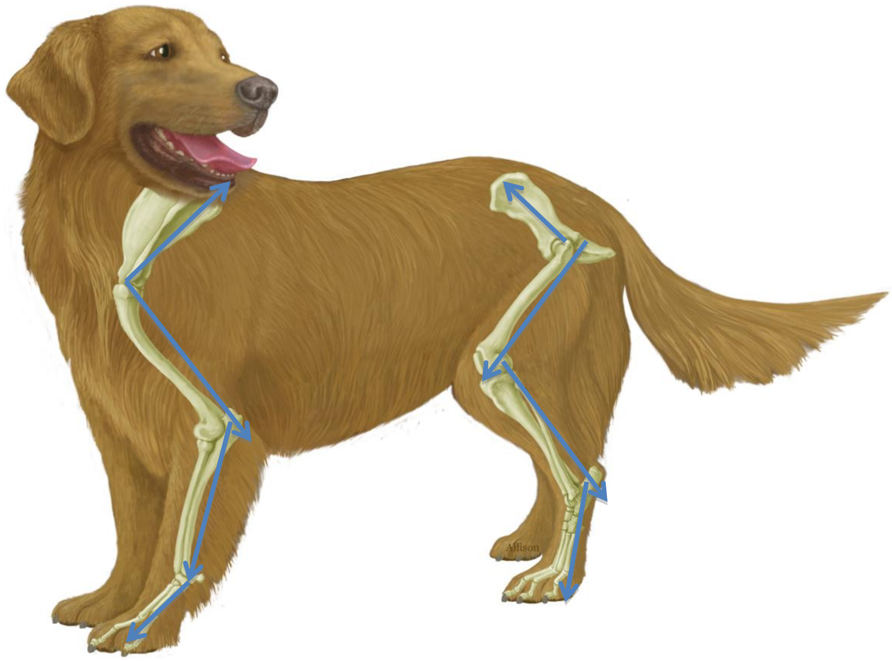

Figure 2. Axis for angles of range of motion measurement of major joints.

II tape measure was applied 1 inch above the elbow for humeral circumference while the dog was in a standing position with the leg extended. Results were obtained to the closest half-centimeter.

Statistical analysis

Data were evaluated for normality by calculating descriptive statistics, plotting histograms, and performing the Anderson-Darling test for normality. The data did not appear normally distributed and therefore was described as median and interquartile ranges (IQR) and rank-transformed prior to statistical analysis. The effect of breed on joint measurements was estimated using repeated measures ANOVA in four independent analyses. The first analyzed measurements were from the elbow, shoulder, carpus, stifle, hip and tarsus in flexion and extension for both right and left limbs. The other analysis evaluated shoulder abduction, humeral circumference (just above the elbow), and 70% thigh circumference using similar ANOVA (Analysis of Variance) models. Analysis included breed as a subject effect while joint, extension versus flexion and right versus left limbs were included as within subject effects. Age (continuous) and sex (categorical) were included in all models as between subject effects to adjust for potential confounding in the evaluation of breed differences. Statistical analyses were performed in commercial software and results were interpreted at the 5% level of significance[3].

RESULTS

Border Collies had a significantly greater range of motion in all joints (P<0.001) compared to Labrador Retrievers (Table 1). Sex was a significant predictor of ROM (P<0.001) with intact females (P=0.013) and spayed females (P=0.034) having a significantly greater ROM than neutered males (Table 2).

Age was not a significant predictor of ROM (P=0.400) based on the ANOVA models. Range of motion significantly varied by joint (P<0.001), and the effect was different within Border Collies versus Labrador Retrievers (P=0.008). Range of motion did not vary by side (P=0.365). Border Collies had significantly greater shoulder abduction than Labrador Retrievers (P<0.001), but did not vary by sex (P=0.903) or age (P=0.653) (Molsa et al., 2014. The mean shoulder abduction angle for Border Collies in this study was 69° with a range of 65 to 73° on both sides. The Labrador Retrievers in this study had a mean of 42.5° and a range of 40 to 44°. Humeral circumference in the Border Collies had an interquartile range of 14.2 to 15.4 cm on both the left and right sides. Humeral circumference in Labrador Retrievers had an interquartile range of 19 to 20 cm on both the left and right sides. 70% thigh circumference in the Border Collies had an interquartile range of 25.6 to 29.4 cm on the left and 25.7 to 28.5 cm on the right side. 70% thigh circumference in Labrador Retrievers had an interquartile range of 34 to 36.6 cm on the left and an interquartile range of 33.3 to 35.3 cm on the right side.

DISCUSSION

Border Collies may have an overall greater range of motion in their joints due to their body conformation and

[3] IBM, SPSS Statistics Version 21, International Business Machines Corp., Armonk, New York USA

Table 1. Range of motion comparison based on breed.

Location	Measurement	Collies Median (IQR)	Labradors Median (IQR)	P Value*
Elbow	Extension	180 (179, 185)	170 (170, 175)	-
	Flexion	50 (50, 60)	45 (41, 50)	-
Shoulder	Extension	175 (165, 185)	170 (165, 174)	-
	Flexion	50 (40, 50)	40 (40, 45)	-
Carpus	Extension	205 (200, 210)	200 (190, 205)	-
	Flexion	50 (50, 60)	43 (40, 50)	-
Stifle	Extension	180 (176, 190)	169 (165, 172)	-
	Flexion	50 (50, 60)	45 (40, 50)	-
Hip	Extension	170 (155, 175)	159 (151, 160)	-
	Flexion	50 (44, 50)	45 (40, 50)	-
Tarsus	Extension	180 (180, 180)	175 (175, 180)	-
	Flexion	50 (40, 60)	40 (40, 40)	-
Overall	Extension	180 (170, 190)	170 (165, 180)	-
	Flexion	50 (50, 60)	40 (40, 50)	-
Shoulder	Abduction	70 (60, 75)	45 (41, 50)	<0.001
Humerus	Circumference	15 (14, 15)	20 (19, 21)	<0.001
Thigh	Circumference	27 (25, 30)	35 (33, 37)	<0.001

IQR: Interquartile range; *Repeated measures ANOVA comparing Collies and Labradors while adjusting for sex and age.

activities (herding) that they are selectively bred for over time. According to the AKC breed standard, the Border Collie's elbows are neither in nor out. Stifles are well turned with strong hocks that may either be parallel or very slightly turned in. The Border Collie's most used working gaits are the gallop and a moving crouch (stealth) which converts to a balanced free trot, with minimum lift of feet. The trot covers the ground with minimum effort, exhibiting facility of movement rather than hard driving action. Viewed from the rear, the hindquarters drive with thrust and flexibility with hocks turning neither in nor out, moving close together, but never touching (The American Kennel Club, 2006). On the other hand, the AKC breed standard for Labrador Retrievers states that the elbows should be held neatly to the body with the legs not too close together. The hind legs are strongly bonded, muscled with moderate angulation at the stifle, and powerful, clearly defined thighs. The angulation of both the stifle and the hock joint is such as to achieve the optimal balance of drive and traction (The American Kennel Club, 2006).

Females have greater range of motion than males. These findings are consistent with results of humans (Berryman-Reese and Bandy, 2010). Increased testosterone in men allow for increased muscle mass, and increased muscling or fat surrounding joints makes for less range of motion of that joint (Berryman-Reese and Bandy, 2010; Hall, 2012).

Age was not associated with a decreased range of motion in the studied dogs. However, it has been noted in humans, that with the exception of hip extension, at least to the age 74 years, any substantial loss of joint mobility should be viewed as abnormal and not attributable to aging (Roach and Miles, 1991).

A previous study in dogs with medial shoulder instability repeated more excessive angles of abduction with a mean of 53° versus that in unaffected shoulders with a mean of 32° (Cook and Renfro, 2005). However, no Border Collies were included in the study. The mean shoulder abduction angle for Border Collies in this study was 69° with a range of 65 to 73° on both sides. The Labrador Retrievers in this study had a mean of 42.5° and a range of 40 to 44° which had previously been within the normal shoulder abduction measurement for dogs (Millis et al., 2003). Another study found that abduction, adduction and rotation around the longitudinal

Table 2. Range of motion comparison based on sex.

Location	Measurement	Intact female	Spayed female	Intact male	Neutered male
		Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)
Elbow	Extension	174 (170, 179)	180 (174, 186)	180 (170, 181)	180 (169, 185)
	Flexion	50 (45, 50)	50 (49, 60)	50 (49, 51)	50 (49, 51)
Shoulder	Extension	170 (165, 175)	175 (170, 185)	168 (160, 175)	165 (160, 171)
	Flexion	43 (40, 50)	45 (40, 50)	45 (40, 50)	40 (40, 50)
Carpus	Extension	205 (200, 210)	200 (195, 210)	200 (194, 210)	205 (200, 210)
	Flexion	50 (40, 50)	50 (49, 60)	50 (50, 56)	50 (40, 60)
Stifle	Extension	174 (165, 180)	180 (170, 190)	175 (165, 180)	178 (160, 181)
	Flexion	50 (41, 50)	50 (45, 53)	50 (40, 56)	50 (40, 60)
Hip	Extension	160 (155, 170)	160 (154, 180)	160 (155, 170)	155 (148, 166)
	Flexion	45 (40, 50)	50 (45, 50)	50 (44, 50)	48 (40, 51)
Tarsus	Extension	180 (175, 180)	180 (174, 180)	180 (175, 180)	180 (175, 180)
	Flexion	40 (40, 40)	50 (40, 60)	40 (40, 50)	45 (40, 60)
Overall	Extension	175 (170, 180)	180 (170, 190)	175 (170, 180)	175 (161, 180)
	Flexion	45 (40, 50)	50 (45, 54)	50 (40, 50)	50 (40, 50)

IQR: Interquartile range; *Repeated measures ANOVA comparing Collies and Labradors while adjusting for sex and age.

axis of the upper arm differ up to 40 degrees between breeds (Fischer, 2010).

Although body weights or body condition scores were not recorded for each of the dogs in the study, the 70% thigh and humeral circumferences for each breed had a narrow range. Measurement of thigh circumference is an indirect method of assessing changes in muscle mass (Millis and Scroggs, 1999). Humeral circumference in the Border Collies had an interquartile range of 14.2 to 15.4 cm on both the left and right sides. Humeral circumference in Labrador Retrievers had an interquartile range of 19 to 20 cm on both the left and right sides. 70% thigh circumference in the Border Collies had a range of 25.6 to 29.4 cm on the left and 25.7 to 28.5 cm on the right side. 70% thigh circumference in Labrador Retrievers was 34 to 36.6 cm on the left and 33.3 to 35.3 cm on the right side. This would indicate a very close cohort of individuals as regard to muscle mass and frame size in both breeds.

Some limitations of this study include the absence of a power analysis. However, numbers of dogs used were similar to a previous study and measurements on both sides of the body were performed (Cook et al., 2005). A second limitation may be that the measurements were performed by a single investigator. The reliability between investigators has been established in both animals and humans (Cook et al., 2005; Roach and Miles, 1991). However, having a single investigator in this study may actually be considered a strength, as there is virtually no variability in technique.

Further studies are needed to establish normal range of motion values for breeds or types of dogs (working, herding, sporting, toy). Although changes in range of motion are not specific for a disease entity, they are reliable for progression of a disease or recovery. Changes in range of motion should be used in conjunction with degree of lameness, pain, comparison of the contralateral limb, breed, sex and diagnostic modalities such as radiographs, diagnostic ultrasound, and MRI exams.

Conflict of interest

The authors declare that they have no conflict of interest.

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Full Length Research Paper

Incidence of lumpy skin disease and associated risk factors among export-oriented cattle feedlots at Adama District, Central Ethiopia

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A study on incidence of lumpy skin disease (LSD) was conducted at 20 exports-oriented cattle feedlots found in Adama district in Central Ethiopia between June and December, 2011. The 11,189 bulls in the 20 exports-oriented feedlots were clinically examined and evaluated for LSD, its incidence, mortality and morbidity. The overall incidence and mortality rate of LSD in cattle feedlots was 6.1 and 1.8% respectively. Statistically significant difference was observed among sites of feedlots operations in incidence (χ^2 = 251.4, df = 5, p < 0.05) and mortality rate (χ^2 = 167.9, df = 5, p < 0.05). The overall case fatality of the disease was 30% with significant difference among all feedlot operation sites (χ^2 = 326.7, df = 5, p < 0.05). Majority of the affected population was observed with variable degree of lameness that was accompanied with edema of limbs with the progression of the disease. The nodules became necrotic, and eventually a deep scab formed (sit-fast). The results of this study indicated that the complex epidemiological situation of the disease in Ethiopia needs more detailed investigation if improved vaccine-based control is to be achieved effectively and efficiently.

Key words: Cattle, Central Ethiopia, feedlots, lumpy skin disease.

INTRODUCTION

Lumpy skin disease (LSD) is a serious skin disease of cattle caused by lumpy skin disease virus (LSDV). It causes acute to sub-acute systemic disease characterized by mild to severe symptoms including disseminated appearance of skin lesions, 2 to 5 cm in diameter and lymphadenopathy, accompanied by high fever, which can sometimes exceed 41°C (Babiuk et al., 2008). The virus causes significant economic losses in cattle industry due to reduction in milk production, decreased weight gain, abortion, decrease draft power, temporary or permanent sterility, damaged hides and deaths thus decreasing their commercial value, (Rovid, 2008; Gari et al., 2011).

Furthermore, restrictions to the global trade of live animals and animal products, costly control and eradication measures such as vaccination campaigns as well as the indirect costs because of the compulsory limitations in animal movements cause significant financial losses

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(Tuppurainen and Oura, 2012). In outbreaks of the disease, the morbidity rate varies widely depending on the immune status of the hosts and the abundance of mechanical arthropod vectors and usually ranges from 3 to 85%. In general, mortality rate is low (1 to 3%) but may sometimes reach 40% (Coetzer, 2004; Tuppurainen and Oura, 2012).

LSD is mechanically transmitted by different types of biting and blood-feeding arthropods (Kitching and Mellor, 1986; Chihota et al., 2001; Magori-Cohen et al., 2012). This disease is mainly spread to new areas by infected animals, but it could also be transmitted by contaminated hides and other products. Outbreaks can be eradicated by quarantine, depopulation of infected and exposed animals, proper disposal of carcasses, cleaning and disinfection of the premises and insect control (Rovid, 2008). In endemic countries, the control of LSDV can be achieved through the use of attenuated live virus vaccines (Brenner et al., 1992).

LSD is now endemic in most of sub-Saharan Africa, parts of North Africa and has been reported from the Middle East (Gari et al., 2010; Salib and Osman, 2011; Body et al., 2012; Tuppurainen and Oura, 2012). Currently, LSD outbreaks occur almost in all agro-ecological zones of Ethiopia (Gari et al., 2008; Gari et al., 2010; Gari et al., 2011). Since the export of live cattle from Ethiopia is currently largely feedlot-based, the occurrence of LSD in the feedlots certainly has affected access of the country to international markets. Therefore, the objective of this study was to determine the incidence of lumpy skin disease and associated risk factors in export-oriented cattle feedlots at Adama District in Central Ethiopia.

MATERIALS AND METHODS

Study area

The study was conducted in Adama district (Nazret/Nazareth) (Figure 1) situated in East Shewa Zone of Oromia regional state located between 8°33' N, 39°16′ E, 8.55° N, and 39.27° E at an elevation of 1,712 m above sea level South-East of Addis Ababa. It is about 99 km away from the nation's capital Addis Ababa, on the famous and ever busy port highway of Ethiopia. It is a bowl-like sinking sight surrounded by small hills just in the heart of the great East Africa Rift Valley. The mean annual temperature varies between 18°C and 30°C and its mean annual rainfall is 410 to 820 mm. Natural vegetations grown in Adama district are grouped under the *Acacia* wood land and savannah vegetation.

Study design and subject

A longitudinal study design was implemented in this study. During the study period, 11,189 bulls found in 20 exports-oriented feedlots were followed for the occurrences of new cases of LSD. The bulls were originated from Borena pastoral area and they are on finishing stage for export in Adama districts. The bulls aged 3 to 5 years vaccinated earlier for LSD were examined. Bulls in each selected feedlots were closely monitored for three months for progression of the disease. Cohorts of sick bulls were isolated to observe clinical signs until recovery or death. The diagnosis of the disease was made on the basis of clinical signs suggestive of LSD.

Clinical examination

During the study period, all bulls were carefully examined for presence of characteristic clinical signs of LSD on skin and mucus membrane. Suspected cases of LSD were restrained in a crush pen and examined for physical status, temperature, superficial lymph node and skin lesions according to Radostits et al. (2007). In each feedlot, animals manifesting the characteristic signs of LSD like nodules on the skin and mucous membranes, rise in temperature were considered as infected. All cases of LSD diagnosed among feedlots, veterinarian and/ or bull attendant were further clinically examined by research team. Endemically occurring skin diseases of cattle were taken into consideration to rule-out the differential diagnoses while the clinical examination was conducted.

Data analysis

Data was classified, filtered, coded using MS Excel and were analyzed using descriptive statistics. Chi-square test was used for comparison of incidence and morbidity rate. Multivariable logistic regression analysis was used to assess the association between incidence and mortality rate with potential risks factors identified. For all analyses confidence level was held at 95% and $P \leq 0.05$ was set for significance. Statistical analyses were conducted using STATA v 12.

RESULTS

Observational clinical signs amongst the studied cattle

From the total of 11,189 bulls observed, 681(6.1%) bulls showed clinical signs and lesions suggestive of LSD. Affected animals showed severe clinical signs characterized by generalized skin nodules, enlarged peripheral lymph nodes and edema of the dependent parts (brisket and forelegs). Majority of the affected population was observed with variable degree of lameness that accompanied edema of limbs. With progression of the disease the nodules became necrotic, and eventually a deep scab formed (sit-fast) (Figure 2).

An evaluation of mortality and morbidity rates of LSD

From the total of 11,189 bulls, 681(6.1%) and 204 (1.8%) bulls were found affected and dead with LSD, respectively. Statistically significant difference in incidence (χ^2 = 2.514, df = 5, $p < 0.05$) was observed among the sites of feedlots operations, with the highest rate in Koshe (11.9 %) and lowest in Dera (1.4%) (Table 1). Mortality rates were also significantly different (χ^2 = 1.68, df = 5, $p < 0.05$) among all the sites of operations, the highest observed in Koshe (4.8%) and lowest in Dera(0.5%). The overall case fatality of the disease was 30% with significant difference among all feedlot operation sites (χ^2

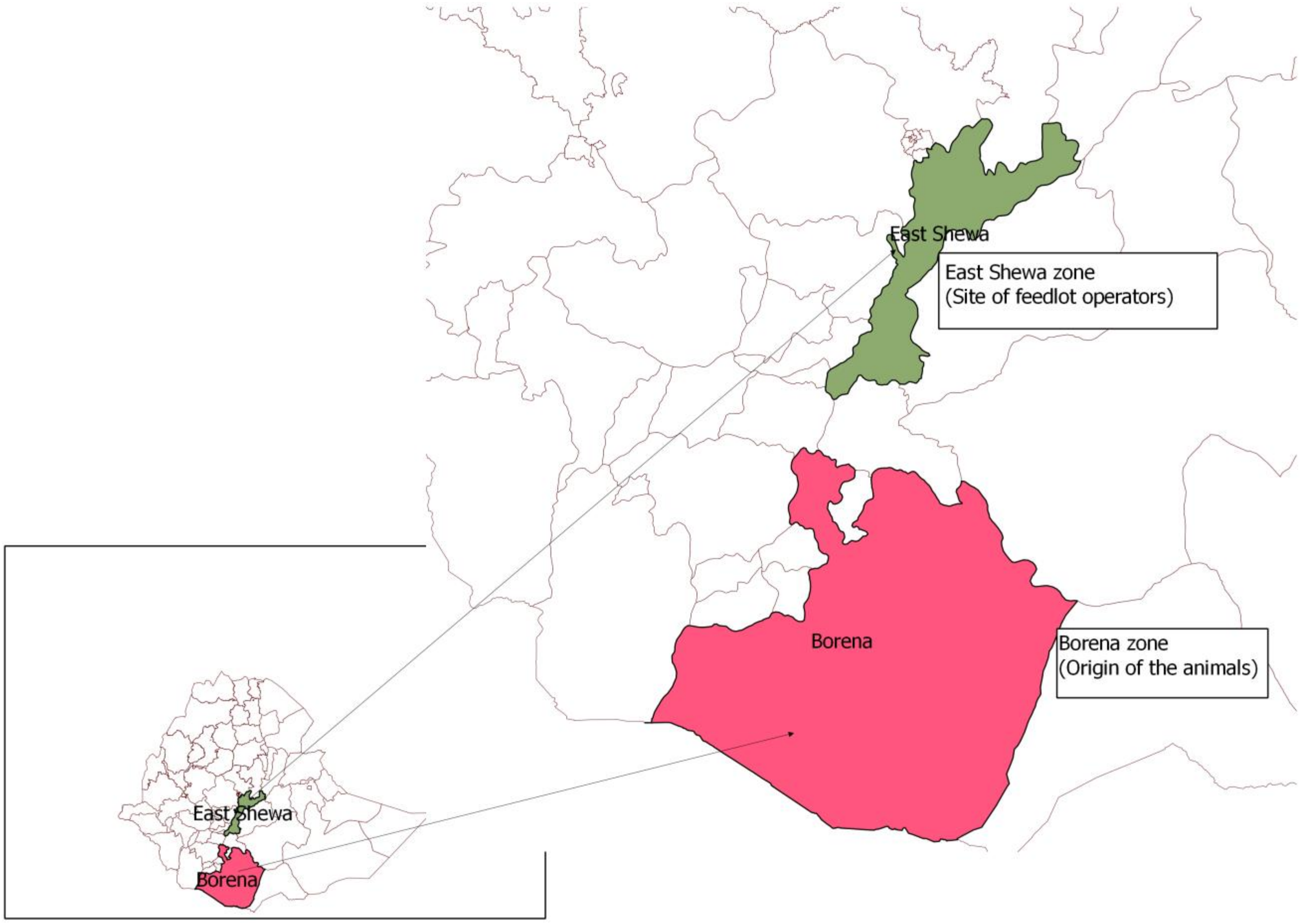

Figure 1. Study area.

Table 1. Morbidity rate of LSD in feedlots in Adama district in relation to site of operations.

Site	Number at risk	Number affected	Morbidity rate	95% CI
Boku	817	89	10.9	8.8-13
Dera	1050	15	1.4	0.7-2.1
Koshe	2263	269	11.9	10.6-13.2
Migra	1771	74	4.2	3.2-5.1
Jogo	4055	158	3.9	3.3-4.5
Wanji	1233	76	6.2	4.6-7.5
Total	11189	681	6.1	5.6-6.5

$\chi^2 = 251.4$, df = 5, $p < 0.05$.

= 326.7, df = 5, $p < 0.05$) (Table 2). The highest case fatality was recorded in Koshe (40.5%), and the lowest case fatality recorded in Jogo (15.8%).

Table 3 shows the associations of potential risk factors with infection of LSD among the bulls in the feedlots based on multivariate logistic regression analysis. The analysis showed that bulls kept in peri-urban sites were more likely infected by LSD than in urban (odd ratio (OR) = 4). Fattening of bulls in rented barn also increased the risk of LSD infection compared to privately owned barn (OR = 1.79). Provision of veterinary service with mobile veterinarians was found to be associated with LSD infections compared to veterinary service provision by own veterinarian (OR = 2.9). Bulls housed more than 500 bulls per barn were more likely at risk of LSD infection than bulls kept less than 200 and between 200 and 500

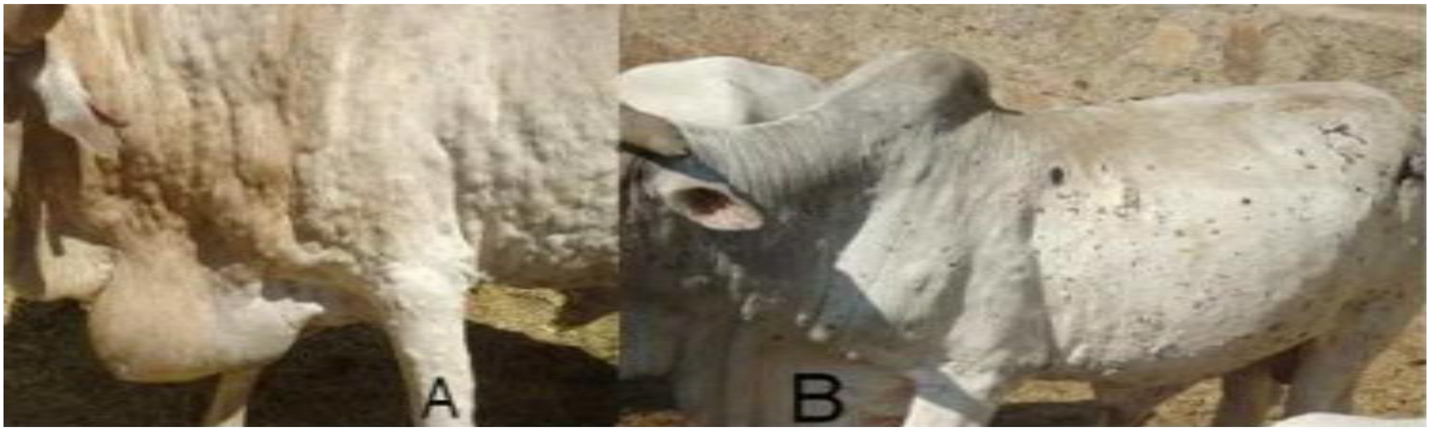

Figure 2. Characteristic clinical signs of LSD: A= Generalized skin nodules, brisket edema and Lameness; B= Necrotic nodules and deep scab formation (sit-fast).

Table 2. Mortality and case fatality rate of LSD in feedlots in Adama district in relation to site of operations.

Site	Number at risk	Number of dead	*Mortality rate	95% CI	**Case fatality rate (%)	95% CI
Boku	817	25	3.1%	1.9-4.2	28.1	18.6-37.6
Dera	1050	5	0.5%	0.1-0.9	33.3	6.3-60.4
Koshe	2263	109	4.8	3.9-5.7	40.5	34.6-46.4
Migra	1771	24	1.4%	0.8-1.9	32.4	21.5-43.4
Nahmled	4055	25	0.6%	0.4-0.9	15.8	10.121.6
Wanji	1233	16	1.3%	0.7-1.9	21.1	11.7-30.4
Total	11189	204	1.8%	1.6-2.1	30	26.5-33.4

* χ^2 = 167.9, df = 5, $p < 0.05$, ** χ^2 = 326.7, df = 5, $p < 0.05$.

Table 3. Associations of potential risk factors with morbidity rate of LSD in cattle feedlots in Adama district.

Risk factor	Number at risk	Number of affected	Morbidity rate (%)	OR	95% CI(OR)	P-Value
Location						
Peri-urban	9418	607	6.44	1	-	-
Urban	1771	74	4.17	0.25	0.17 -0.37	0.000
Barn ownership						
Own	8957	533	5.95	1	-	-
Rented	2232	148	6.63	1.79	1.34 -2.40	0.027
Carcass disposal						
Burn/buried	2205	98	4.44	1	-	-
Open space	8984	583	6.48	0.87	0.68 -1.13	0.338
Veterinary service						
Mobile veterinarian	4521	373	8.25	1	-	-
Own veterinarian	6668	308	4.61	0.34	0.28-0.41	0.000
No of bulls						
≤200	616	61	9.90	1	-	-
201-500	2354	113	5.64	1.07	0.71-1.63	0.726
>500	8219	507	6.16	1.55	1.08-2.23	0.027

Table 4. Associations of potential risk factors with mortality rate of LSD in cattle feedlots in Adama district.

Risk factor	Number at risk	Number of dead	Mortality rate (%)	OR	95% CI (OR)	P-Value
Location						
Peri-urban	9418	180	1.91	1	-	-
Urban	1771	24	1.35	0.25	0.17-0.37	0.000
Barn ownership						
Own	8957	158	1.76	1	-	-
Rented	2232	46	2.06	1.80	1.35-2.40	0.000
Carcass disposal						
Burn/buried	2205	18	0.82	1	-	-
Open space	8984	186	2.07	0.88	0.68-1.13	0.298
Veterinary service						
Mobile veterinarian	4521	129	2.85	1	-	-
Own veterinarian	6668	75	1.12	0.34	0.28- 0.42	0.000
No of bulls						
≤200	616	17	2.76	1	-	-
201-500	2354	35	1.49	1.33	0.63-2.85	0.455
>500	8219	152	1.85	2.12	1.08- 4.14	0.028

bulls per barn with odd of 1.55 and 1.45, respectively. Caracas disposal methods were not significantly associated with LSD occurrence.

The results of multivariate logistic regression analysis of potential risk factors on LSD mortality are presented in Table 4. According to the analysis, fattening of bulls at peri-urban sites increased the risk of death (OR = 4) due to LSD compared to urban sites. Bulls that finished in rented barn were also more likely at risk of death than privately owned barn (OR = 1.80). Furthermore, the risk of LSD death increased when veterinary services were provided by mobile veterinarians compared to own veterinarian (OR = 2.94). The bulls that were more than 500 in number per barn were more likely at risk of LSD deaths than those kept at less than 200 and between 200 and 500 bulls per barn with odd of 2.12 and 1.59, respectively. Carcass disposal methods were not significantly associated with LSD death.

DISCUSSION

The presence of characteristic skin nodules and outstanding features of the LSD are best indicative of the occurrence of LSD at affected feedlots. LSD infection causes a variable degree of clinical and pathological outcomes. The clinical signs observed in this study such as generalized skin nodules, edema of the dependent parts, ocular discharge and lameness were similar with the clinical signs documented elsewhere (Coetzer, 2004; Brenner et al., 2006; Kumar, 2011; Gari et al., 2010; Salib and Osman, 2011; Body et al., 2012).

The recurrent LSD outbreaks in feedlots during the rainy season might be linked with the optimum season for the development of insect population (Kitching and Mellor, 1986; Chihota et al., 2001; Gari et al., 2010). LSD vaccines (Neethling strains) were used in the feedlots as part of Sanitary and phytosanitray (SPS) requirements and rules and regulations of animal quarantine. However, vaccination of bulls started a week after the last bull purchased entered the feedlots and were registered by the quarantine service, with a time gap that was sufficient for transmission of the disease to susceptible bulls.

Furthermore, the disease was spread among the vaccinated bulls in the feedlots during epizootic period regardless of vaccination. The problems of vaccine failure and re-infection of vaccinated animals has been also reported by other authors (Hunter and Wallace, 2001; Kara et al., 2003; Brenner et al., 2009; Gari et al., 2010; Kumar, 2011). None of the isolation pens for LSD infected bulls was insect proof with very high probability of viral transmission through mechanical vectors (Kitching and Mellor, 1986; Chihota et al., 2001). It is likely that during LSD outbreak in feedlots, optimal conditions for the spread of LSDV were created through the presence of high numbers of susceptible animals in combination with the poor biosecurity practice and the high abundance of insect vectors.

The magnitude of LSD occurrence varied across sites of feedlots operation during the study period. The observed LSD incidence at animal level found in this study was 6.1% which is in close agreement with previous findings from Nekemt area of 7.02% (Regassa, 2003) and 8.1% reported by Gari et al. (2010) in different agro-ecological zones of Ethiopia. Mortality (1.8%) observed during this outbreak was similar with previous reports by Salib and Osman (2011) in Egyptian cattle. Furthermore, the observed mortality rate in the present study is in agreement with the previous reports of 2.12% in Ethiopia by Gari et al. (2010). The significant differences observed between the morbidity, mortality and case fatality rates in the six sites might be attributed to variations in availability of suitable condition for the presence of blood-feeding arthropods (Ali et al., 1990; Gari et al,. 2010) and difference in biosecurity practice used in the feedlots (Tuppurainen and Oura, 2012).

Fattening of bulls in peri-urban sites was a significant risk factor for LSD infection and death. This might be due to the fact that in peri-urban area there is relatively higher vegetation converge than in urban site which could support biting fly population. Furthermore, in peri- urban site, small holder farmers' cattle grazed around the feedlots areas could increase the risk of LSD infection and death in peri-urban than in urban areas (Gari et al., 2010). Fattening of bulls in rented barn also increased the risk of LSD infection and death. This could be due to the fact that in rented barns, there is higher probability of feedlot operators' turnover. This might compromise the biosecurity level of the barn by disposing risky material in the barn and lower probabilities of disinfecting or thoroughly cleaning of the barn between the batches. These in turn increase the probability of the virus transmission between the batches since LSDV is remarkably stable and surviving for long periods at ambient temperature, especially in dried scabs (Rovid, 2008).

Provision of veterinary service with mobile veterinarian was found to be significant risk factor for LSD infections and death compared to veterinary service provision by own veterinarian. This might be due to the fact that there is higher probability of using contaminated equipments between feedlots by mobile veterinarian. Therefore, if proper needle hygiene was not practiced, needles contaminated with virulent LSDV during the actual vaccination and treatment procedure serve as vehicle for transmission of the virus (Carn and Kitching, 1995; Magori-Cohen et al., 2012; Tuppurainen and Oura, 2012). Furthermore, mobile veterinarians are less equipped than business owner; there might be higher probability of failure in one or more steps of the cold chain of vaccine. As indicated by Tuppurainen and Oura (2012), lack of appropriate storage facilities for storage of vaccine resulted in inactivation of vaccine because of exposure to direct sunlight or high environmental temperatures during the vaccination process.

Bulls that held more than 500 bulls per barn were more likely at risk of LSD infection and death than those kept in less than 200 and between 200 and 500 bulls per barn. This might be associated with increase opportunity for transmission of the virus by arthropod vectors between bulls. In this study, carcass disposal methods were not significantly associated with LSD infection and death. This might be due to the fact that dead bodies disposed in shallow pits nearby feedlots or throw in open air where insects have easy accesses to disposed carcasses and thus facilitating the transmission of the virus to neighboring feedlots likewise.

Conclusion

The present study indicates that LSD outbreak occurred in the cattle feedlots and resulted in bull mortality and morbidity which affect livelihood of business owners and have major threat to national economies as they tend to affect the international trade. The results of this study, indicates that the complex epidemiological situation of the disease in Ethiopia needs more detailed investigation for improved vaccine-based control for it to be achieved efficiently.

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Conflict of interest

The authors declare that they have no conflicts of interest.

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Full Length Research Paper

The prevalence of gastro-intestinal parasites of carnivores in university zoological gardens in South West Nigeria

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A survey of prevalence and intensity of gastro-intestinal parasites of carnivores in three university zoological gardens in South-West Nigeria was conducted. Faecal samples collected were analysed with flotation technique using a saturated solution of zinc sulfate as the floating solution, McMaster Egg Counting Technique and Petri Dish-Filter Paper Slant technique for larval recovery. Faecal examination revealed an overall infection prevalence of 49.1%. The prevalence in University of Ibadan (UI) zoo was 23.7%, 54.8% in Obafemi Awolowo University (OAU) and 69.2% in University of Ilorin (Unillorin) zoos. The gastrointestinal helminths identified include *Ancylostoma* sp., *Ascaris* sp., *Baylisascaris* sp., *Toxascaris* sp., *Toxocara* sp., *Strongyloides* sp. and *Entamoeba* sp. was the only protozoa encountered. *Ascaris* sp., had the highest prevalence of 22.6%, followed by *Ancylostoma* sp. with a rate of 20.8%. *Baylisascaris* sp., and *Strongyloides* sp. both had a prevalence rate of 13.2% each, while *Entamoeba* sp. yielded the lowest prevalence (3.8%). Regular monitoring of parasitic diseases and the use of selective treatments would be effective for the control of the gastrointestinal helminths for the wellbeing of animals, safety of zoo keepers and tourists in the zoo.

Key words: Carnivores, gastrointestinal parasites, zoological gardens, South-West Nigeria.

INTRODUCTION

A zoological garden is a form of *ex situ* conservation, which primarily involves keeping wild animals alive outside their natural environment for aesthetic, educational, research and recreational purposes (Varadharajan and Pythal, 1999).

Nigeria is blessed with abundant wildlife species which need to be properly managed on a sustainable basis to prevent depletion (Opara et al., 2010), hence the need to adopt strict management of these resources. Repopulation of endangered species and conservation of wild animals in wildlife parks and zoological gardens are management strategies (Ajibade et al., 2010). Parasites play a major role in the lives of animals, with effects ranging from negative impacts on host population size to the evolution of host behaviours to combat parasites. Parasitic diseases constitute one of the major challenges in wild animals in captivity (Adedokun et al., 2002; Emikpe et al., 2002; Singh et al., 2006; Emikpe et al.

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Table 1. Distribution of carnivorous animals at the three zoological gardens

Carnivore/Zoo	U.I.	O.A.U	Uni-Ilorin	Total
Lion (*Panthera leo*)	8	6	6	20
Stripped Hyaena (*Hyaena hyaena*)	2	1	2	5
Spotted Hyaena (Crocuta crocuta)	-	-	2	2
Jackal (*Canis mesomelas*)	1	-	-	1
Tibetan Fox (*Vulpes* ferrilata)	1	1	2	4
Common palm Civet (*Paradoxurus* hermaphroditus)	-	2	1	3
Total	12	10	13	35

2007).

In the wild, animals might have a natural resistance against parasitic infections or live mutually with their parasites (Borkovcova and Kopriva , 2005). Change in environment and living conditions from freedom to captivity influences the animals' ecology and might increase the susceptibility to parasitic infections (Goossensa et al., 2005; Singh et al., 2006). Many of these animals are exotic to the geographical location of the parks and zoo gardens where they are kept. So also, keeping animals in captivity aggregates a number of species of animals in close proximity. Proximity provides opportunity for the transmission of diseases or parasites to species which would not normally come in contact with such pathogens (Moudgil and Singla, 2013). Severe parasitoses can lead to blood loss, tissue damage, spontaneous abortion, congenital malformations and death (Adedokun et al., 2002; Emikpe et al., 2002; Despommier, 2003; Emikpe et al., 2007).

Another possibility of parasite transmission is when animals are moved from one enclosure to another, without proper parasite treatment. Mixing different species brings additional risks of parasitic infections (Goossensa et al., 2005). Zoological garden staff members have also been reported to play an important role in the transmission of parasites amongst animals in zoos, through their shoes, clothes, hands, food or with working tools (Adetunji, 2014; Otegbade and Morenikeji, 2014). Most of these parasites are zoonotic and pose a serious threat to human health (Kashid et al., 2003).

Carnivorous animals act as definitive hosts for many intestinal parasites, some of which are responsible for several zoonotic diseases like ancylostomosis, echinococcosis, gnathostomosis and toxocarosis (Schantz and Kramer, 1995; Eslami and Hosseini, 1998). Overgaauw (1997), further suggested close interaction between humans and carnivores as reasons for endemicity of these zoonotic parasites.

Inadequate information on diseases and parasites of zoo animals is a major limiting factor in the management of zoological gardens. Investigations into prevalence, geographical distribution, systematic and biology of parasites of zoo animals are important for planning and control of parasitoses. Hence, the need for a regular program of gastrointestinal parasite surveillance and measures of control based on correct diagnosis, effective treatment and proper prophylaxis to ensure sound health of zoo animals (Ajibade et al., 2010; Moudgil et al., 2014). This study aims to establish the profile of gastrointestinal parasites in carnivores in three zoos in Nigeria.

MATERIALS AND METHODS

Study area

This study was carried out in the zoological gardens of three Southwestern Universities in Nigeria: the University of Ibadan Zoological Garden (UI Zoo), Ibadan which lies on latitude 7°26´ N and longitude 3°53´ E; Obafemi Awolowo University Biological gardens (OAU Zoo), Ile Ife (7.4667°N, 4.5667°E) and University of Ilorin Zoological Garden (UNILORIN Zoo), Ilorin (latitude 8°30 and longitude 4°35´ E). The zoological gardens have several different sections and the animals are put in sections by species. Indoor and outdoor enclosures are cleaned on a routine basis with necessary prophylaxis. Animals are regularly dewormed in some zoos to curb parasitic infections. Natural features, such as branches, climbing structures, and platforms are used for enrichment of enclosures to promote animal well-being. Carnivore species, such as lions, are housed in large closed circuit enclosures for the safety of visitors and tourists (Table 1).

Collection of samples and coprologic examination

Fresh faecal samples were collected in triplicates from the carnivores between March, 2012 and May, 2012 to examine for gastrointestinal parasites. Samples were collected in plastic vials, which were clearly marked with the time and date of collection, species of the animal, and the animal's cage number. All samples were transported to the laboratory, and examined within 48 h. The faeces were examined macroscopically for consistency, presence of blood, mucus, tapeworm proglottids and larval nematodes. Examination for parasite eggs and larvae was by standard methods. Qualitative egg identification was done by floatation technique using a saturated solution of zinc sulfate (703 g/l, specific gravity 1.18) as the floating solution, McMaster Egg Counting Technique for quantitative ova examination while larva culture was done using the petri dish- filter paper slant culture technique (modified Harada- Mori Technique) as described by Garcia (2001). Some quantity of each faecal sample was cultured for 10 days to harvest and identify helminth larvae (Soulsby, 1982). Larvae that emerged were subsequently recovered for identification using typical morphological features (Sloss et al., 1994

Table 2. Prevalence of gastro-intestinal parasites in carnivorous animals in the zoological gardens

Zoo	Animals	Faecal samples	No and % of prevalence	*Ascaris* sp (%)	*Toxascaris* sp (%)	*Toxocara* sp (%)	*Strongyloides* sp (%)	*Ancylostoma.* sp (%)	*Bayliascaris* sp (%)	*Entamoeba* sp (%)
	Lion	24	-	-	-	-	-	-	-	-
	Stripped Hyaena	6	4 (66.7)	_	-	_	_	4 (100)	_	_
U.I.	Jackal	5	5 (100)	-	-	-	-	-	5 (100)	-
	Fox	3	-	-	-	-	-	-	-	-
	Total	38	9 (23.7)	-	-	-	-	4 (44.5)	5 (55.6)	-
	Lion	18	10 (55.6)	5 (50)	3 (10)	-	2 (20)	-	-	-
	Striped Hyaena	3	2 (66.7)	_	-	_	_	2 (100)	_	_
O.A.U	Fox	4	4 (100)	-	-	2 (50)	-	-	2 (50)	-
	Civet	6	1 (16.7)	-	-	-	-	-	-	1 (100)
	Total	31	17 (54.8)	5 (29.4)	3 (17.6)	2 (11.8)	2 (11.8)	2 (11.8)	2 (11.8)	1 (5.9)
	Lion	18	12 (66.7)	-	6 (50)	3 (25)	3 (25)	-	-	-
	Striped Hyaena	6	6 (100)	4 (66.7)	-	_	2 (33.3)	_	_	_
UNILORIN	Spotted Hyaena	6	6 (100)	_	-	_	_	5 (83.3)	_	1 (16.7)
	Civet	3	3 (100)	3 (100)	-	-	-	-	-	-
	Fox	6	-	-	-	-	-	-	-	-
	Total	39	27 (69.2)	7 (25.9)	6 (22.2)	3 (11.1)	5 (18.5)	5 (18.5)	-	1 (3.7)
TOTAL		108	53 (49.1)	12 (22.6)	9 (17)	5 (9.4)	7 (13.2)	11 (20.8)	7 (13.2)	2 (3.8)

Statistical analysis of data

Descriptive statistical analysis was used to summarize the results as percentage, means and standard deviations and differences between the means were determined using the analysis of variance (ANOVA) at the 5% level of significance.

RESULTS

Study population

A total of 35 carnivorous animals of two families, *Canidae* and *Felidae* were present in the three zoological gardens (Table 1).

Prevalence of helminth parasites in the zoological gardens

Of all the faecal samples collected (108), 53 (49.1%) were found infected. The prevalence of gastrointestinal parasites in the samples examined comprises UI - 23.7%, OAU - 54.8%, UNILORIN - 69.2% (Table 2). *Ascaris* sp. was found in 12 (22.6%), *Ancylostoma* sp. in 11 (20.8%), *Baylisascaris* sp. in 7 (13.2%), *Toxascaris sp.* in 9 (17%), *Toxocara* sp. in 5 (9.4%), and *Strongyloides* sp. in 7 (13.2%). None was found infected with tapeworms.

Distribution of parasites in the zoo animals

In UI Zoo, not all the animals sampled were infected. Infections were found only in some samples collected from hyaenas and jackal and these were infected with *Ancylostoma* sp. and *Baylisascaris* sp. respectively (Table 3). In OAU Zoo, parasites were identified in most samples, with Fox having the highest prevalence rate of 100%. The foxes were infected with *Toxocara* sp. were infected with more types of parasites (*Ascaris* sp, *Toxascaris* sp and *Strongyloides* sp) even though their prevalence was not as high as

Table 3. Parasite distribution in the faecal samples of the zoo animals studied

	Animal	No. of samples collected	No. of samples with parasites (%)	Parasites discovered through Floatation Technique (No of sample)
	Lion	24	-	-
UI	Stripped Hyena	6	4 (66.7)	*Ancylostoma* sp (4)
	Jackal	5	5 (100)	*Baylisascaris* sp (5)
	Fox	3	-	-
	Total	38	9 (23.7)	-
	Lion	18	10 (55.6)	*Ascaris* sp (5),*Toxascaris* sp (3), *Strongyloides* sp (2)
	Stripped Hyena	3	2 (66.7)	*Ancylostoma* sp (2)
OAU	Fox	4	4 (100)	*Toxocara* sp (2) , *Baylisascaris* sp (2)
	Civet	6	1 (16.7)	*Entamoeba* sp (1)
	Total	31	17 (54.8)	-
	Lion	18	12 (66.7)	*Toxocara* sp (3) , *Strongyloides* sp (3), *Toxascaris* sp (6)
	Stripped Hyena	6	6 (100)	*Ascaris* sp (4) , *Strongyloides* sp (2)
UNILORIN	Spotted Hyena	6	6 (100)	*Ancylostoma* sp (5)
	Civet	3	3 (100)	*Ascaris* sp (3)
	Fox	6	-	*Entamoeba* sp (1)
	Total	39	27 (69.2)	-

that of the foxes.

In University of Ilorin Zoo, infections were found in some samples collected from all the animals except the fox. All the stripped and spotted Hyenas, and Civet sampled were 100% infected, but the lions were infected with more types of parasites (Table 3).

Intensity of gastrointestinal parasites in the carnivorous animals

There was no significant difference in the intensity of *Ancylostoma* sp (100.0 ± 0.50) and *Baylisascaris* sp (83.0 ± 0.33) discovered in UI (P>0.05), also, no significant difference in the intensity of the different parasites (*Ascaris sp* 90.0 ± 0.19, *Toxascaris sp* 66.7 ± 0.17; *Strongyloides sp* 100.0 ± 0.50) found in OAU zoo. The number of *Toxacara* sp (25.0 ± 0.25) found in OAU was significantly lower than other parasites discovered (P<0.05).

DISCUSSION

This study showed the types, prevalence and intensity of gastrointestinal parasites in carnivorous animals in three strategic zoos in South West Nigeria. *Ascaris* sp, *Toxascaris* sp, *Strongyloides* sp, *Baylisascaris* sp, *Ancylostoma* sp, *Toxacara* sp and *Entamoeba* sp were the parasites identified in different carnivores. All the parasites recovered from the various species of carnivores were also earlier reported in Nigerian captive animals (Parsani et al., 2001; Ajibade et al., 2010; Opara et al., 2010).

The observed total prevalence of 49.1% is in agreement with the studies of Atanaskova et al. (2011) in Skopje, Macedonia and Lalosevic et al. (2007) in Palic Zoo in Serbia. However, prevalence observed in the present study was lower than that reported by Ajibade et al. (2010) and Opara et al. (2010) with prevalence rates of 62.5 and 61.5% respectively. Among individual parasitic infections, the study revealed infection of 22.6% for *Ascaris* sp, 13.2% for Strongyloides sp, 20.8% for Ancylostoma sp and 3.8% for *Entamoeba* sp. The observation was in agreement with the findings of Opara et al. (2010) who recorded a higher prevalence of helminthes (82.2%)

and protozoan (17.8%) (*Entamoeba* and *Giardia* species) parasites in zoo captive animals.

This study also showed that parasitic diseases are common to zoo carnivores in countries of warm and tropical climates due to the factors that favor the development of parasites such as light, temperature and humidity (Magona and Musisi, 1999; Opara et al., 2010). Attendants cleaning the cages and enclosures of these animals could act as a vehicle (formite) for cross transmission. Also, the animals serve as potential reservoirs that could transmit gastrointestinal protozoans and helminths to zoo keepers and possibly to visitors.

This study further shows the need for a well-adjusted anthelmintic program, such as early season treatments to prevent infection in wildlife species under captivity, regular passive surveillance for parasitic infections and effective treatment programs.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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Full Length Research Paper

Epidemiological study on ectoparasite infestation of small ruminants in Sodo Zuria District, Southern Ethiopia

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A cross-sectional study was conducted to estimate magnitude of small ruminant ectoparasite infestation in Sodo Zuria district from November, 2013 to March, 2014. Out of the total 758 small ruminants, 51.5% sheep and 48.9 % goats were found infected with ectoprasite infestation (p=0.471). Standard identification of 383 ectoprasite specimens demonstrated ticks (34.6%), lice (7.1%), fleas (6.1%) and mange mites (2.8%). Tick and flea infestation were predominant in sheep (p<0.01) whereas mange mite infestations was more common in goats (p < 0.01). The tick species observed, in order of importance, were *Ripicephalus evertsi eversti, Amblyoma variegatum, Boophilus decoloratus*, *Amblyoma coherences* and *Ripicephalus pulchellus (*exclusive to sheep). The flea species observed were *Ctenocephalides felis* and *Ctenocephalides canis*. Regarding mange mites, *Sarcoptus scabie* was more frequent and affected both sheep and goats whereas *Demodex caprea* was found only in goats. Among lice species identified, *Linognatus ovilluis* and *Damalina ovis* were higher in sheep whereas *Linognatus stenopsis* was more common in goats (p<0.05). Generally, female animals were affected by ectoparasites more frequently (56 %) than males (44.4%) (p=0.001). Small ruminants older than one year (53.8%) were affected more frequently than younger animals (45.8%) (p=0.029). Ectoparasite infestation was more frequent in animals with poor body condition (59%) than those having medium (41.9%) and good (43.6%) body condition (p=0.000). Small ruminant flocks in Sodo Zuria district were widely affected by ectoparasite infestation which leads to substantial morbidity. Effort to raise awareness of farm households and improve control services is recommended.

Key words: Goats, parasites, prevalence, sheep, Wolaita zone.

INTRODUCTION

Small ruminants constitute 30% of the total livestock population in Ethiopia and represent a major contributor to food production (CSA, 2004), providing 35% of meat consumption and 14% of milk consumption (Asfaw et al., 1998). Hide and skin account for 12 to 16% of the total export in Ethiopia and small ruminants contribute a significant portion of these exports (Mahmud, 2000). However, the contribution of small ruminants to food supply, household income and export income are below the exiting potential which is attributed to several

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constraints including; diseases, poor feeding, poor managements and poor technological inputs (Chalachew, 2001).

Parasitic infections are of paramount economic importance in small ruminants and result in lowered resistance, loss of production and even mortality (Singla, 1995). Among these infections skin diseases caused by lice, sheep keds, fleas, ticks and mange mites are among the major diseases of small ruminants and causes serious economic loss due to; mortality, decreased production and reproduction as well as downgrading and rejection of skin. Moreover, ectoprasites are very important vectors for numerous microbial infectious diseases affecting livestock (Radostits et al., 2007). Some 35% of sheep and 56% of goat skin rejections in Ethiopia are due to affection by ectoparasites. The figures portray seriousness of negative economic impact posed by ectoparasites on livelihoods, the tanning industry and the national economy in the country (Chanie et al., 2010). The present study estimated the magnitude of ectoparasite infestation in sheep and goat flocks sampled from Sodo Zuria district.

MATERIALS AND METHODS

Study area

Sodo Zuria district is part of Wolaita zone in South Nations Nationalities and Peoples Region (SNNPR) - Ethiopia. The zone is located between 6 36'N to 7 18'N latitude and 37 12'E up to 38 24'E longitude. The zonal capital, Wolaita Sodo town, lies about 383 km's south of Addis Ababa. Altitudes in the zone vary between 1650 to 2500 meters above sea level. The mean annual rainfall and temperature vary between 800 to 1400 mm and 15 to 25°C, respectively. Topographically, Wolaita zone consists of rugged and undulating mountains, rolling hills, plateaus and flat steep slope that extend to the Abaya Lake and Omo River. Integrated agro-forestry crop-livestock production farming system is the basis of livelihood. The livestock resource of the area comprises 923,633 cattle (local and improved), 231,115 sheep, 118,178 goats, 4,212 horses, 38,238 donkeys, 3,031 mules, 550,489 poultry, and 53,781 bee colonies (WZAD, 2011).

Study design

A cross sectional study of randomly sampled small ruminant holdings was conducted from November, 2013 to March, 2014 in Wolaita Zuria district. The study population constituted indigenous sheep and goats kept in small flocks and managed under traditional extensive farming system.

Animals

Study was conducted on sheep and goat flocks in four agro-ecologically similar accessible Keble's: (1) Wachika Bush, (2) Offa Gandaba, (3) Tome Gerera and(4) Humbo Larena of Sodo zuria district. A total of 758 small ruminants were selected for investigation. Sample size was calculated according to Thrustfield (2005) using an expected prevalence of 55.5% (Yacob et al., 2008) and 5% desired absolute for each species. Sheep and goats were selected by simple random sampling from small ruminant holding sampling frame in respective keble's.

Examination

Species and sex of study animals was recorded. Body condition was subjectively scored as poor (sharp bony prominence), medium (bony prominence noticeable but not sharply angled) and good (bony prominence rounded and barely noticeable). Age of animals was noted as young ($\leq$ 1 year) and adults (> 1 year). Examination for ectoparasites was performed by multiple fleece parting in opposite direction to normal hair or wool resting inspection and palpation of skin for parasites and/or lesions over entire body.

Specimens

Visible ectoparasites (ticks, lice and fleas) were collected manually (hand, brush or comb) from their attachment sites. Visible ectoparasites collected from individual animals were placed in labeled universal bottles containing 70% alcohol. Skin scraping was taken from suspected cases of mange mite infestation (exhibiting scales, crusts, alopecia and/or itching). A blade was dipped in a drop of mineral oil on the side and scrapping was carried out until capillary oozing is observed (Walton and Currie, 2007). The scraped samples were placed in labeled universal bottles containing 10% formalin.

Ectoparasite identification

Specimens from each animal were transported to Wolaita Sodo Regional laboratory for ectoparasite species identification.

1. Tick specimens were placed on petridish and examined under stereomicroscope for morphological species classification as outlined by Walker et al. (2003).
2. Lice specimens were similarly examined for morphological classification as biting or suckling type and subsequent species identification according to Wall and Shearer (1997).
3. Identification of flea species was done under stereomicroscope using morphological criteria outlined by Soulsby (1982).
4. Mange mite species identification was performed under low power microscope according to keys given by Wall and Shearer (1997).

Statistical analyses

Data gathered from field and laboratory works were entered on Microsoft excel spreadsheets and analyzed using Statistical Package for the Social Sciences (SPSS-20). Distribution of ectoprasites infestation in different kebele's and across risk factors like species, age groups, sexes and body condition score was summarized in percentages and compared using Chi-square test. Statistical significance was ascribed at $p<0.05$ or less.

RESULTS

Overall, 381 (50.3%) animals were affected by ectoparasites. The frequency of ectoparasite infestation in sheep and goats was 203 (51.5%) and 178 (48.9 %), respectively ($p=0.471$). The prevalence of ectoparasite

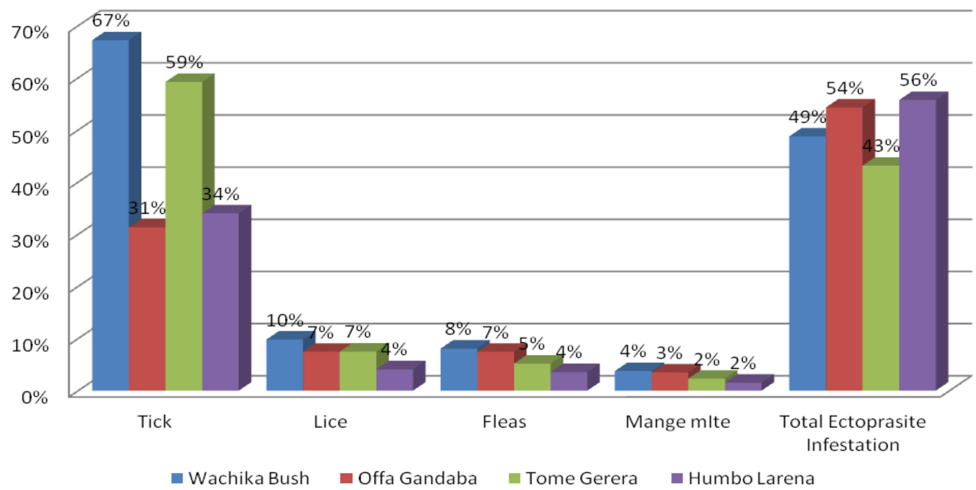

Figure 1. Prevalence of small ruminant ectoparasite infestation in different kebele's (%).

infestation in the different kebele's was comparable (Figure 1). Female animals were affected by ectoparasites more frequently 215 (56 %) than males 166 (44.4%) (p=0.001). Adult small ruminants 229 (53.8%) were more frequently affected by ectoparasites than young animals 152 (45.8%) (p=0.029). Frequency of ectoparasite infestation in animals with poor, medium and good body condition scores was 200 (59%), 44 (41.9%) and 137 (43.6%), respectively (p=0.000). Except for 2 (0.6%) cases of mixed ectoparasite infestation, tick and flea in first sample and tick and lice in second, remaining cases involving single ectoparasites including; 260 (68.2%) ticks, 53(13.9%) lice, 45 (11.8%) flea and 21 (5.5%) mange mite infestations. Distribution of small ruminant ectoparasite did not vary significantly between different kebele's (Figure 1). Tick and lice (*Linognatus. ovilluis* and *Damalina ovis*) infestations were more frequent in sheep (p<0.01). In contrast, infestation by fleas (p=0.007) and mange mites (p=0.000) were higher in goats (Table 1). Tick, flea and mange mite infestations were higher in female than male small ruminants (p<0.05) and prevalence of tick infestation was higher in animals with poor body condition score (p<0.05). Meanwhile, no statistically significant variation in ectoparasite infestation pattern was observed between the two age groups (Table 2).

DISCUSSION

Ectoparasites like mange mites, lice, keds and ticks are widely distributed in all agro-ecological zones in Ethiopia, causing serious economic losses in small holder farms (Kumsa et al., 2012). Likewise, current findings indicated that ectoparasite infestation was uniformly widespread (50.3%) in Sodo Zuria district. The problem was more frequent in sheep than goats which could be attributed to better body grooming habits in latter species (Mullen and Durden, 2002). Adults (> 1 year) and female animals were affected by ectoparasites more frequently than their respective counter parts.

In agreement, Yakob et al. (2008) reported prevalence of 53% and 15% for adult and young small ruminants in Wolaita Sodo. Maternal grooming and separate housing could be reducing exposure in younger animals. On the other hand, females are suggested to face higher parasitic challenge at pregnancy related to immuno-suppression. Observations that animals with poor body condition had higher ectoparasite infestation rate suggest negative effect on productivity. Ectoparasites induce itching or worry (reduce time on grazing) and suck blood (compete for nutrients), both of which compromise the nutritional status of host animals (Radostitis et al., 2007). The ectoparasites identified in this study were ticks, lice, fleas and mange mites in the given order of frequency. Ticks are the main ectoparasites affecting small ruminants in Ethiopia. Similar spectrum of small ruminant tick genera were reported in Wolaita Sodo (Yacob et al., 2008; Abebe et al., 2011). Ease of detecting ticks as compared to fleas which jump frequently to avoid access and mange mites which are not visible to the naked eye could be a contributing factor. The current prevalence of small ruminant lice infestation (7.1%) is comparable to 5.3% reported from Bahir-dar (Tesfaye et al., 2012) but lower than 54.6% reported from around Gondar town (Fantahun and Mohamed, 2012). Variations could reflect differences in agro-ecology, season of study and management conditions in different localities. The prevalence of fleas infestation observed in this study (6.1 %) was between the 1.2% (Abebe et al., 2011) and12.7% (Tesfaye et al., 2012) reported from different parts of Ethiopia. Meanwhile, current prevalence of small ruminant mange mite infestation (2.8 %) is in agreement with 0.4% (sheep) and 6.6% (goats) reported by Tefera

Table 1. Prevalence of ectoparasite infestation in small ruminants.

Ectoparasite		Animal		
Type	Species	Ovine	Caprine	Overall
Tick	*Rhipicephalus evertsi evertsi*	60 (37)	41 (41)	101 (38.5)
	Amblyoma varigatum	44 (27.2)	24 (24)	68 (26)
	Boohphilus decolaratus	34 (21)	23 (23)	57 (21.75)
	Amblyoma coherance	19 (11.7)	12 (12)	31 (11.8)
	Rhipicephalus puchillus	5 (3.1)	-	5 (1.9)
	Host overall	162 (41.1)**	100 (27.5)	262 (34.6)
Lice	*Linognatus stenopsis*	1(4.2)	24(80)**	25(46.3)
	Linognatus. ovilluis	16(66.7)**	5(16.7)	21(38.9)
	Damalina ovis	7 (29.2) *	1(3.3)	8(14.8)
	Host overall	24(6.1)	30(8.2)	54 (7.1)
Flea	*Ctenocephalides felis*	11(73.3)	20(64.5)	31 (67.4)
	Ctenocephalides canis	4(26.7)	11(35.5)	15(32.6)
	Host overall	15(3.8)	31(8.5) **	46 (6.1)
Mange	*Sarcoptes scabie*	3 (100)	12(66.7)	15 (71.4)
	Demodex caprea	-	6 (33.3)	6 (28.6)
	Host overall	3(0.8)	18(4.9)**	21 (2.8)

** and * Represent statistical variation at $p<0.01$ and $p<0.05$, respectively.

Table 2. Prevalence of ectoprasites according to sex, age and body condition of study animals.

Determinant		Ectoparasites			
		Tick	Lice	Fleas	Mange mite
Sex	Female	146 (38)	22 (6)	30 (7.8)	17 (4.4)
	Male	116 (31)	31(8.3)	16 (4.3)	4 (1.1)
	p -value	0.043	0.219	0.042	0.005
Age group	Young	107 (67.8)	17 (5.1)	24 (7.2)	5 (1.5)
	Adult	155 (36.4)	37 (8.7)	22 (5.2)	16 (3.8)
	p- value	0.223	0.058	0.238	0.061
Body condition	Poor	141(41.6)	22 (6.5)	25 (7.4)	13 (3.8)
	Medium	33 (31.4)	6 (5.7)	2 (1.9)	3 (2.9)
	Good	88 (28)	26 (8.3)	19 (6.1)	5 (1.6)
	p -value	0.001	0.561	0.122	0.216

(2004). Tick infestation was more frequent in sheep whereas flea and mange mite infestation were more common in goats ($p<0.01$). Differences could be attributed to better habitat provided by thicker sheep coat and easier diagnostic access in goats. The main tick species observed, in order of importance, were *R. evertsi everstí, A. variegatum, B. decoloratus*, *A. coherences* and *R. pulchellus.* The latter was exclusive to sheep. Among lice species identified, *L. ovilluis* and *D. ovis* tend to frequent sheep whereas *L. stenopsis* was more common in goats ($p\leq0.05$). *C. felis* was the flea species frequently recovered from small ruminants in this study.

Conclusion

The study demonstrated that ectoparasite infestation was a common problem facing small ruminant flocks in Sodo

Zuria district. The condition led to substantial morbidity and could render skin/hide produce unsuited for leather processing. Prevailing scenarios reflect shortfall of control strategies and significant economic loss due to small ruminant ectoparasite infestations.

Conflict of interest

The authors declare that they have no conflicts of interest.

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