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ORIGINAL RESEARCH

Small ruminant brucellosis and community perception in Jijiga District, Somali Regional State, Eastern Ethiopia

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Abstract A cross-sectional study of brucellosis in small ruminants was carried out from October 2008 to March 2009 in Jijiga District, Somali Regional State of Ethiopia. Seven hundred thirty sera samples (421 of sheep and 309 of goats) were randomly collected from purposively selected villages of the study area. Structured questionnaire format was developed, pre-tested and administered to assess the perception of the community pertaining to brucellosis in sheep and goats. Sera samples were screened by Rose Bengal Plate Test (RBPT), and all samples tested positive by the RBPT were subjected to Complement Fixation Test (CFT) for confirmation. Of 12 serum samples that were positive by RBPT, 11 were positive by CFT. Statistically significant differences were not observed between the species as well as the sex groups ($P>0.05$); however, the variation between the age groups was statistically significant ($P<0.05$). Analysis of the questionnaire survey suggests that improper handling of aborted materials, consumption of raw milk, and lack of awareness about the disease, among others, might greatly contribute to further spread of brucellosis in their livestock and exposes the community to a public health hazard. In general, the sero-prevalence in the study area was not so high; nevertheless, appropriate brucellosis control and prevention methods should be implemented to circumvent future potential for economic losses and the public health hazard of the disease.

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Introduction

The Somali Regional State of Ethiopia is well known for its large number of small ruminants. According to the report of Central Statistical Agency (CSA, 2008), the small ruminant population of Somali region is 1,162,743 sheep and 1,374,540 goats. Despite all these, the country fails to properly utilize this huge resource as diseases take a lion share among several factors that hamper the productivity of the sector. One of such diseases is brucellosis.

Brucellosis is a disease caused by bacteria of the genus *Brucella*. Nine *Brucella* species are currently recognized. Seven of them that affect terrestrial animals are: *Brucella abortus*, *Brucella melitensis*, *Brucella suis*, *Brucella ovis*, *Brucella canis*, *Brucella neotomae*, and *Brucella microti* (Scholz et al. 2008). A recent study demonstrated that the members of *Brucella* are very similar in size and gene makeup (Sriranganathan et al. 2009).

B. melitensis is the main causative agent of caprine and ovine brucellosis (OIE, 2008). In certain countries where there is no *B. melitensis*, small ruminants could get infected with *B. abortus* (Lilenbaum et al. 2007).

The disease in naturally infected sheep and goats is characterized by abortion, stillbirth, and birth of weak offspring in females and acute orchitis and epididymitis in males, and may result in infertility (Rodostits et al. 2007). Moreover, it is an important zoonosis threatening the public health in many countries of the world (Al-Majali et al. 2007; Montagnaro et al. 2008; Saegerman et al. 2008).

While brucellosis has been eradicated in most industrialized regions, its occurrence is increasing in developing countries (Benkirane, 2006; Al-Majali et al. 2007). *B. melitensis* is particularly common in the Mediterranean. It also occurs in the Middle East, Central Asia, around the Arabian Gulf, and in some countries of Central America. This organism has been reported from Africa and India (OIE, 2009).

In Ethiopia, few studies have been conducted so far on small ruminant brucellosis (Ashenafi et. al. 2007; Tekelye and Kasali, 1990; Teshale et al. 2006; Yibeltal et al. 2005); regardless, there was very little information on the status of the disease in pastoral areas of Jijiga. On one hand, the livelihood of the pastoralists in these areas mainly depends on their livestock, and hence, the disease could impose a tremendous economic loss due to reproductive wastages such as infertility, abortion, stillbirth, and the likes. On the other hand, due to their dietary habits, these communities seem to be at stake of being infected by brucellosis.

To this effect, the objectives of this study were therefore to determine the sero-prevalence of small ruminant brucellosis and to assess the perception of the community pertaining to the disease in sheep and goats of Jijiga District, Somali Regional State of Ethiopia.

Materials and methods

Study area

The study was undertaken in ten purposively selected sub-regions of the Jijiga district namely: Dhagahaleh, Domdumas, Hadaw, Lamadaga, Haroraysa, Gobiyar, Dienta, Amadle, Bufimo, and Shebelley. Jijiga town is located at about 630 km east of Addis Ababa and 105 km east of Harrar town at geographic coordinates of approximately 9°20′ North latitude and 45°56′ East longitude. Altitude within the town ranges from 1,660–1,710 m above sea level.

Study animals

The study animals consisted of small ruminants that were mainly under pastoral production system, mixed with other species (mainly with cattle and camels). The small ruminants under study comprised of the indigenous Somali goat and black head Ogaden sheep with no history of vaccination against brucellosis. Both sexes and different age groups were included in the study.

Study design

A cross-sectional study was carried out from October 2008 to March 2009 to determine the sero-prevalence of brucellosis in small ruminants and to assess the perception of the community pertaining to the disease in sheep and goats.

Questionnaire survey

A structured questionnaire format with regard to the history of previous abortion, stage of abortion, management of aborted materials and fetus, occurrence of swelling of joints and testicle, milking practice, as well as milk and meat consumption habits of the local community was developed, pre-tested, and administered to 64 heads of households. Moreover, data on species, breed, sex, age, herd size, and stock replacement were recorded. Age, educational status, and awareness of the respondents about the disease were also included.

Collecting and handling of blood

Seven hundred and thirty sera samples (421 of sheep and 309 of goats) were randomly collected from purposively selected villages of the study area. Seven to 10 ml of blood was collected from jugular vein of apparently healthy sheep and goats using plain Vacutainer tubes and needles. Individual tubes were identified using numbers and alphabets to indicate their origin. The tubes were left tilted overnight at room temperature to allow clotting. Sera were then removed from the clot and were transported to Jijiga Regional Veterinary Diagnostic and Research Laboratory in an icebox and stored at –20°C until serological testing was performed.

Serological tests

Rose Bengal plate test

For the RBPT, the procedure described by Nielsen (2002) was followed. The sera antigen was removed from the refrigerator and left at room temperature for at least 30 min before the test was performed. RBPT *Brucella* antigen from Veterinary Laboratories Agency, Addlestone, United Kingdom, and positive as well as negative control sera from National Veterinary Institute, Debre Zeit, Ethiopia, were used. Briefly, 30 μl of sera samples were dispensed on to the plate, and 30 μl of RBPT antigen was dropped alongside the sera. Using an applicator stick, the antigen and the sera were mixed and examined for agglutination. Positive and negative controls were employed for interpretation of the results. Results of RBPT were interpreted as 0, +, ++, and +++ as has been described by Nielsen (2002), with 0=no agglutination; +=barely visible agglutination (seen using magnifying glasses); ++=fine agglutination; and +++=coarse agglutination. Those samples with no agglutination (0) were recorded as negative while those with +, ++, and +++ were recorded as positive.

Complement fixation test

All the sera which were screened to be positive by the RBPT were further retested by CFT following the protocol described by Mac Millan (1990) for confirmation using standard *B. abortus* antigen for CFT (Veterinary Laboratories Agency, Addlestone, United Kingdom), Amboceptor (Biomerieux, France), 2% sheep RBC, positive and negative control antisera (National Veterinary Institute, Debre Zeit, Ethiopia). The complement was obtained from the Federal Institute for Health Protection of Consumers and Veterinary Medicine, Berlin, Germany. Sera were confirmed to be positive according to OIE (2009) as follows: At a dilution of 1:5, sera with a strong reaction of approximately 100% fixation of the complement (4+) or sera with about 75% fixation of the complement (3+); at a dilution of 1:10, sera with about 50% fixation of the complement (2+); and at a dilution of 1:20, sera with about 25% fixation at a dilution of 1:40(+).

Data analysis

Data from the field were stored into a computer on a Microsoft Excel Spreadsheet. Categorical variables were expressed in percentages. The prevalence was calculated as the number of animals tested positive by the CFT, divided by the total number of tested animals. Logistic regression analysis was performed using SPSS version 16. Odds ratio and 95% confidence interval were computed to see the degree of association of the risk factors with brucellosis sero-positivity. For all analysis, a p value less than 0.05 were taken as significant.

Results

Sero-prevalence

Seven hundred thirty sera samples were screened by Rose Bengal plate test, and all samples tested positive by RBPT were subjected to Complement Fixation Test for confirmation. Of 12 serum samples that were positive by RBPT, 11 (91.6%) were positive by CFT. Hence, out of the total sera tested, 1.5% was confirmed to be positive.

On species basis, the prevalence in goats was slightly higher than that of the sheep, and it was a bit higher in female animals than in males. Among the age groups, the prevalence of the disease was relatively higher in older animals than in younger (Table 1).

Logistic regression analysis of the association of different risk factors with sero-prevalence of brucellosis was carried out. Species, sex, and age of animals were among the potential risk factors that were assessed. Statistically significant differences were not observed between the species as well as the sex groups ($P>0.05$); however, the variation between the age groups was statistically significant ($P<0.05$; Table 2).

Questionnaire survey

The average age of the interviewees was 42.63 years while the maximum and minimum ages were 72 and 24 years, respectively. The average flock size of the interviewees was 142.26 with minimum flock size of 59 and maximum flock size of 317 animals. Most of the interviewees were illiterate.

As the pastoralists mentioned, they do not always practice stock replacement, as there is no economic rule used to determine whether to keep or replace an animal. Almost all interviewees claimed that they sell lower-producing animals to make room for higher-producing replacement animals especially for meat purposes. All the interviewees claimed that they cull their animals only for certain reasons such as poor body growth, series of abortions in females, low meat and milk production especially in goats, and diseases. Every one of the interviewee ascertained that sheep and goats usually graze mixed with other animals. All of the respondents do not have awareness about brucellosis in sheep and goats; consequently, they all have the habit of consuming raw milk and improper handling of aborted materials (Table 3).

Discussion

The overall sero-prevalence of small ruminant brucellosis in the study area was 1.5% while, on species basis, it was 1.2% in sheep and 1.9% in goats. These results were closely related with the report done by Teshale et al. (2006) in Somali region, where 1.6% and 1.7% prevalence of brucellosis was documented in sheep and goats, respectively. This might be due to the similarity in animal production and management systems as well as reasonably similar agro-ecological conditions of the districts of the region. Similarly, Tekelye and Kasali (1990) also observed prevalence of 1.5% in sheep and 1.3% in goat in the central highlands of Ethiopia, which might be attributed to the practice in animal management and production systems. In this part of the country, fewer animals are raised and are raised separately. On the other hand, the prevalence recorded in this study was relatively lower than the finding by Ashenafi et al. (2007), who observed prevalence rates of 3.2% in sheep and 5.8% in goats in the pastoral areas of Afar region. Such differences might be observed due to the variation in herding practices. In the Afar region, mixing animals from the various areas is common at communal grazing and watering areas. In the Somali region, only

Table 1 Sero-prevalence of brucellosis in sheep and goats in Jijiga District

Parameters	Number of sera tested	RBPT-positive (%)	95% Confidence interval (CI)	CFT-positive (%) [out of RBPT-positive]	Overall sero-prevalence (%)	95% Confidence interval (CI)
Species						
Sheep	421	5 (1.2)	0.79–1.59	5 (100.0)	1.2	0.79–1.59
Goats	309	7 (2.3)	2.1–2.44	6 (85.7)	1.9	1.44–2.44
Total	730	12 (1.6)	0.72–2.56	11 (91.6)	1.5	0.62–2.38
Sex						
Female	562	10 (1.8)	1.29–2.27	9 (90.0)	1.6	1.14–2.06
Male	168	2 (1.2)	0.79–1.59	2 (100.0)	1.2	0.79–1.59
Total	730	12 (1.6)	0.72–2.56	11 (91.6)	1.5	0.62–2.38
Age, years						
≤2	166	0 (0.0%)	–	0 (0.0)	0.0	–
2–4	434	7 (1.6)	1.14–2.08	7 (100.0)	1.6	1.14–2.08
>4	130	5 (3.9)	3.15–4.55	4 (80.0)	3.1	2.46–3.74
Total	730	12 (1.6)	0.72–2.56	11 (91.6)	1.5	0.62–2.38

animals belonging to a given clan are allowed to be mixed, and there is a strong clan-based segregation of animals and use of rangeland (Teshale et al. 2006).

Statistically significant difference was not observed in the prevalence of brucellosis between the two species (χ^2= 0.84, P value=0.35; Odds ratio=1.78; 95% confidence interval, 0.54–5.92). Nonetheless, our study revealed that goats are 1.78 times more at risk of being infected with brucellosis than sheep. According to Radostits et al. (2007), goats have greater susceptibility to *Brucella* infection than sheep. Moreover, goats excrete the organism for a long period of time, unlike sheep. This reduces the potential for disease spread among sheep flocks. Thus, a significantly higher sero-prevalence should have been observed in goat than sheep. Nevertheless, this difference might be observed due to the variation in sample size.

Table 2 Multivariate logistic regression analysis of the association between the various risk factors and prevalence of brucellosis in small ruminants

Parameters	Odds ratio (OR)	95% Confidence interval (CI) for OR	χ^2	*P* Value
Species				
Sheep Goats	1.78	0.54–5.92	0.84	0.35
Sex				
Female Male	1.34	2.85–6.30	0.15	0.71
Age, years				
≤2 2–4 >4	2.94	1.09–7.89	4.73	0.03

Table 3 Results of questionnaire survey on the perception of the community about brucellosis in small ruminants of Jijiga District

Parameters		Number of respondents		
		Yes (%)	No (%)	Total
History of previous abortion		64 (100.0)	0 (0.0)	64
Joint swelling				
In sheep		44 (68.8)	20 (31.2)	64
In goats		41 (64.1)	23 (35.9)	64
Testicular swelling				
In rams		33 (51.6)	31 (48.4)	64
In bucks		37 (57.8)	27 (42.2)	64
Milking practices				
In sheep		46 (72.0)	18 (28.0)	64
In goats		50 (78.1)	14 (21.9)	64
Milk consumption habits				
Sheep milk	Raw	43 (67.2)	21 (32.8)	64
	Boiled	3 (4.7)	61 (95.3)	64
	Traditional treatments	18 (28.1)	46 (71.9)	64
Goat milk	Raw	48 (75.0)	16 (25.0)	64
	Boiled	2 (3.1)	62 (96.9)	64
	Traditional treatments	14 (21.9)	50 (78.1)	64
Slaughtering animals (contact)		64 (100.0)	0 (0.0)	64
Consumption habit of meat				
Raw		0 (0.0)	64 (100.0)	64
Cooked		64 (100.0)	0 (0.0)	64
Grazing				
Separately		0 (0.0)	64 (100.0)	64
With other animals		64 (100.0)	0 (0.0)	64
Proper handling of aborted materials		0 (0.0)	64 (100.0)	64
Awareness of the community about brucellosis		0 (0.0)	64 (100.0)	64

Even though our result showed that female animals are 1.34 times more likely to be infected with brucellosis than male animals, statistically significant difference was not observed in the prevalence of brucellosis between both sexes (χ^2=0.15, *P* value=0.71; Odds ratio=1.34; 95% confidence interval, 2.85–6.30) which was in contrast to the established facts. Hirsh and Zee (1999) have reported that male animals are less susceptible to *Brucella* infection due to the absence of erythritol. However, in support of our finding, Ashenafi et al. (2007) and Yibeltal (2005) have also reported that there was no considerable difference in the prevalence of brucellosis between sexes in both species of animals. The lack of statistically significant difference between the two sexes observed in this study might be due to the smaller sample size of males.

Alternatively, statistically significant variation observed between the age groups (χ^2=4.73, *P* value=0.03; Odds ratio=2.93; 95% confidence interval, 1.09–7.89) is in accord with the work of Ashenafi et al. (2007) who reported a higher prevalence in adult sheep and goats. The present study also revealed that the predicted odds for sexually matured animals are 2.93 times the odds for younger animals. It has been reported that brucellosis is essentially a disease of sexually mature animals (Quinn et al. 2004). Young animals tend to be more resistant to infection and frequently clear an established infection, although latent infections can occur (Walker, 1999). Susceptibility increases after sexual maturity and sexually mature and pregnant animals are more prone to *Brucella* infection and brucellosis than sexually immature animals of both sexes (Radostits et al. 2007). This may result from the fact that sex hormones and erythritol, which stimulate the growth and multiplication of *Brucella* organisms, tend to increase in concentration with age and sexual maturity.

Analysis of the questionnaire survey suggests that the lack of awareness of the community about brucellosis in sheep and goats, improper handling of aborted materials, and the habit of consuming raw milk among others might greatly contribute to further spread of brucellosis in their livestock and expose the community to a public health hazard. Most of the respondents were illiterate (Table 3), and very little has been done regarding awareness creation about the disease in their community; hence, the level of the perception of the community in relation to the disease in sheep and goats might be one of the factors that attributed to these situations.

In places where brucellosis is endemic, there is a possibility that humans can get infected via contact with infected animals or consumption of their products, mostly unpasteurized milk and milk products of sheep and goats (Tabak et al. 2008). It was also observed that the prevalence of human brucellosis acquired from dairy products in some countries is seasonal, reaching a peak usually after kidding and lambing (Dahouk et al. 2007). Another study identified that living in close proximity of livestock, keeping and attending to livestock, and consumption of raw milk and fresh cheese as risk factors for having brucellosis by the Boran and Hamar people of Ethiopia (Genene et al. 2009).

Likewise, the absence of hygiene measures, such as the use of isolated lambing/kidding areas, appropriate disposal of aborted materials, and removal of foci of infection, can aggravate the spread of infection among sheep and goats as pastures and water become contaminated. Improper management of aborted materials and fetus and throwing them in the field also might allow easy access and consumption by dogs that maintain the recycling of the disease in the area. Zinsstag et al. (2007) reported that problems such as abortion, stillbirth, and retained fetal membranes are the most common reproductive wastages in small ruminants in Ethiopia, and humans may become contaminated while handling the infected materials. Further complications arise through wild animal reservoirs which may also carry and transmit the disease (Bruno et al. 2007).

All of the respondents claimed that sheep and goats usually graze mixed with other animals. Intermingling diverse species of animals may cause uninfected animals to easily get exposed to the disease from multiple sources such as abortion discharges and direct contact with infected animals. Mixed farming and especially raising sheep and/or goats along with cattle was reported by many researchers to be a risk factor for *Brucella* transmission between different animal species (Al-Majali et al. 2007; Al-Majali et al. 2008). As camels could also be infected by *B. melitensis* when they are pastured together with infected sheep, goats, and cattle, milk from infected camels might represent a major source of infection to the pastoralists (Musa et al. 2008).

It has been stated that controlling animal brucellosis in developing countries requires a considerable effort to build infrastructure that educates people about the risks of brucellosis, proper laboratory facilities, and trained personnel to collect and test samples and perform record keeping and active surveillance programs (Mohamed et al. 2010). Conversely, Schelling et al. (2007a) and Zinsstag et al. (2005) suggested that new strategies can be found for developing countries to respond adequately to existing and emerging zoonoses.

Conclusion and recommendations

The sero-prevalence in the study area was not so high; however, as none of the animals under the study were vaccinated, it seems to reveal a natural transmission of *Brucella* organisms in the area. Thus, it is recommended that further studies are required to help better understand a detailed epidemiology of small ruminant brucellosis in the region and consequently establish a successful prevention and control strategy. Since small ruminants are one of the important sources for the livelihood of these pastoralist community and their products are highly consumed, due attention should be given to this sector by the concerned bodies to circumvent the future potential for economic loss and public health hazard of the disease.

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