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Sero-prevalence of bovine brucellosis and its risk factors in Jimma zone of Oromia Region, South-western Ethiopia

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Abstract A cross sectional sero-prevalence study was conducted on 1,595 cattle in Jimma zone, Ethiopia to investigate the status of bovine brucellosis and identify potential risk factors. Sera samples were analyzed using Rose Bengal Plate Test (RBPT) and Complement Fixation Test (CFT). The overall individual and herd level sero-prevalences were 3.1% (n= 1,595) and 15.0% (n=227), respectively. The sero-prevalence of bovine brucellosis at individual animal level was significantly higher in non-pregnant (11.18%) than pregnant (2.77%) and lactating (22.35%) than non-lactating animals (2.46%). Moreover, significantly higher sero-prevalence was observed in herds of larger sizes. Individual animal sero-prevalence was also positively associated with the occurrence of abortion (26.98 and 1.54% in those with and without previous history of abortion, respectively). Generally, the sero-prevalence of bovine brucellosis found in Jimma area was not high and the sero-prevalence was closely associated with some of the risk factors considered at individual animal and herd level.

Keywords Bovine brucellosis · Ethiopia · Sero-prevalence · Risk factors

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Introduction

Although the livestock sector in Ethiopia has a significant contribution to the national economy, productivity (meat and milk) per animal is very low (Shiferaw et al. 2003). The main technical limitations on livestock development and that determine the biological efficiency of production in Ethiopia are inadequate feeding, poor animal health, low potential of the genotypes used for yield traits and the traditional low input livestock management practices.

Among the infectious diseases, brucellosis has been known to be prevalent in the country in many places causing considerable economic losses (Kelay, 2002). Brucellosis is a zoonotic disease that exists worldwide and is more or less endemic in most African countries and still exists in some southern European countries (Mangen et al. 2002; John and Arimi, 2002; Saegerman et al. 2008). The diseases causes abortion and retained fetal membrane, which have been considered as important fertility problems causing serious economic losses (Schelling et al. 2003). Mangen et al. (2002) reported that in the traditional production systems, relative additional milk and meat off-take potential, if brucellosis is controlled, would be in the range of 5–11% and 12–35%, respectively.

In Ethiopia, the prevalence of bovine brucellosis has been intensively investigated in state owned dairy farms (Bekele et al. 2000), in smallholder farms in

some parts of Ethiopia (Kassahun, 2004; Berhe et al. 2007) and in the central highlands of Ethiopia (Kebede et al. 2008). However, there was little attempt in the past to determine the status of bovine brucellosis in both indigenous and crossbred cattle populations kept in different management systems in the current study area. Thus, this study was carried out to determine the sero-prevalence of bovine brucellosis and assess the potential risk factors in Jimma Zone, South-western Ethiopia.

Materials and methods

Study area

The study was conducted in four districts (Chora-Boter, Limu-Kosa, Sokoru and Dedo) and five towns (Jimma, Limu Genet, Sheki, Tolay and Motoso) of Jimma zone. From the pastoral area Defkella, Hasanuphe and Didibo Boroda villages were involved in the study. The altitude of the zone ranges from 880 meter above sea level in Omo valley to 3,360 meter above sea level at Maygudo in Nadda-Dedo mountain chains. The average annual rainfall and temperature of the district are 1,637 mm and 11.43°C, respectively.

The study involved two management systems: extensive (mixed crop-livestock (MCL) and pastoral production systems) and semi-intensive (urban production system). Livestock are important for draught in the mixed crop-livestock farming system and also contribute for production of meat and milk. The pastoral production system is dominated by cattle. In the area, native grass pasture is the major source of feed for ruminants in the extensive management system. The average grazing time was 9 to 10 hours. The total cattle population of Jimma zone was about 2.54 million, which accounted for 5.8% of the total cattle population of Ethiopia. Local cattle are found all over the zone and there are crosses of Holstein-Friesian and zebu cattle in some places.

Study type and sampling procedure

A cross sectional study was carried out to determine the overall individual animal and herd level sero-prevalence of bovine brucellosis, and their association with different risk factors. The sampling strategy employed was two-stage cluster sampling. The primary units were villages in the mixed crop-livestock production system, pastoral communities in pastoral production system and towns in the urban production system. The secondary units were cattle herd owners in all systems. At each stage, sampling units were selected by simple random sampling method. Sample size was determined using the formula for cluster sampling (Thrusfield, 2005). Accordingly, a total of 1,595 cattle above six months of age with no history of previous vaccination against brucellosis were sampled for this study.

Data collection

Approximately 10 ml of blood sample was collected from each selected cattle and the serum was separated. The sera were stored at -20°C until analyses. All sera samples collected were screened by RBPT. The RBPT antigen was obtained from Institut Pourquier 325, Rue de la Galera 34097 MONTPEELLIER CEDEX 5, France. The method prescribed by BgVV Service Laboratory (2000) was followed to undertake RBPT. Those sera reacted positively to RBPT were further tested with CFT. The CFT test was conducted at the National Veterinary Institute Laboratory, Debre Zeit, Ethiopia, according to the protocols recommended by OIE (2004), where the test was regarded as positive (4+, 3+, 2+, or +) when the reading was as complete fixation or partial hemolysis. The test was regarded as negative (0) when there was complete hemolysis. Data related to age, sex, breed, parity, lactation status, reproductive history and health of individual animals, breeding and management practices of farms were gathered using a structured and pre-tested questionnaire format.

Data analysis

Univariate logistic regression was used to test the significance of the effect of different risk factors on individual and herd level sero-prevalence. Dummy variables were created for those explanatory variables with more than two categories. Those explanatory variables with a p-value of less than 0.25 in the univariate analysis were fitted in a multivariate logistic regression model. In both cases, the models

were adjusted for the cluster sampling method. Age of animals were categorized into <3, 3–6 and >6 years; herd size was categorized into<6, 6–10 and >10 heads of cattle and parity number was categorized as nullparous, monoparous and pluriparous. Associations between sero-positivity and occurrences of retained fetal membranes and abortion were determined by chi-square test.

Results

Overall sero-prevalence of bovine brucellosis

From 1,595 cattle sera samples collected and tested by RBPT, 53 (3.3%) were sero-positive for brucellosis. Out of those 53 brucella positive reactors, 50 (3.1%) were confirmed to be seropositive for brucellosis upon further testing by CFT. All males, animals with the age of 3 years and less and nulliparous animals tested were negative in both RBPT and CFT. From a total of 227 herds included in the study, there were 34 herds with at least one animal tested positive (15.0%). The average within herd sero-prevalence was 2.48% (standard error=7.8), while the highest and lowest within herd sero-prevalences were 62.5% and 0%, respectively.

Factors affecting individual animal sero-prevalence

The results of univariate logistic regression revealed that pregnancy status, lactation status and altitude had significant effect on individual animal sero-prevalence ($P<0.05$), while age, parity, stage of pregnancy and management system did have significant effect ($P>0.05$). The multivariate logistic regression showed that pregnancy status and lactation status significantly affected individual animal sero-prevalence ($P<0.05$); the sero-prevalence was significantly higher in the non-pregnant (11.18%) than pregnant ones (2.77%) and in the lactating (22.35) than the non-lactating ones (2.46%) (Table 1).

Factors affecting herd level sero-prevalence

Herd size, management system and altitude had significant effect ($P<0.05$) on herd level sero-prevalence using univariate logistic regression. Mating practice and sources of replacement stock had no significant effect ($P>0.05$) on herd level sero-prevalence. The multivariate logistic regression revealed that herd size had significant effect ($P<0.05$) on herd level sero-prevalence, where the herd level sero-prevalence significantly and consistently increased with the increment of herd size (Table 2).

Table 1 Influence of some risk factors on sero-prevalence of bovine brucellosis at individual animal level in Jimma Zone, South-west Ethiopia

Factor	Group	N	Positives No. (%)	Univariate			Multivariate		
				CI (95%)	OR	P-value	CI (95%)	OR	P-value
Age	3–6 years	420	10 (2.38)						
	> 6 years	925	40 (4.32)	0.92–3.75	1.85	0.086	0.42–2.21	0.97	0.935
Parity	Monoparous	475	24 (5.05)						
	Pluriparous	614	26 (4.23)	0.48–1.44	0.83	0.511			
Pregnancy status	Pregnant	1,192	33 (2.77)						
	Non-pregnant	152	17 (11.18)	2.40–8.14	4.42	0.000	2.69–10.76	5.38	0.000
Stage of pregnancy	≤ 5 months	31	3 (9.68)						
	>5 months	121	14 (11.57)	0.32–4.73	1.22	0.772			
Lactation status	Non-lactating	1,259	31 (2.46)						
	Lactating	85	19 (22.35)	3.85–33.8	11.40	0.000	4.27–35.3	12.28	0.000
Altitude	Lowland	908	35 (3.85)						
	Midland	686	15 (2.19)	0.33–0.94	0.56	0.030	0.42–8.93	1.93	0.400
Management system	Extensive	985	38 (3.86)						
	Semi-intensive	610	12 (1.97)	0.22–1.05	0.50	0.068	0.05–1.90	0.33	0.214

Table 2 Influence of risk factors on sero-prevalence of bovine brucellosis at herd level in Jimma Zone, South-west Ethiopia

Factor	Group	N	Positives No. (%)	Univariate			Multivariate		
				CI (95%)	OR	P-value	CI (95%)	OR	P-value
Herd size	< 6	139	7 (5.04)						
	6–10	55	11 (20.00)	1.72–12.91	4.71	0.003	1.21–10.11	3.49	0.021
	> 10	33	16 (48.48)	6.39–49.30	17.75	0.000	5.10–41.37	14.52	0.000
Management system	Extensive	105	24 (22.86)						
	Semi-intensive	122	10 (8.20)	0.14–0.66	0.30	0.003	0.18–1.76	0.57	0.329
Altitude	Lowland	136	27 (19.85)						
	Midland	91	7 (7.69)	0.14–0.81	0.34	0.015	0.21–2.55	0.73	0.626
Mating practice	AI	44	9 (20.45)						
	Natural	98	17 (17.35)	0.33–2.01	0.82	0.658			
	Both	85	8 (9.41)	0.14–1.13	0.40	0.085			
Sources of replacement stock	On farm	26	6(23.08)						
	Off farm	82	9 (14.52)	0.13–1.29	0.41	0.128			
	Both	119	19 (15.97)	0.22–1.78	0.63	0.387			

Association of sero-prevalence with abortion and retained fetal membranes

The results of chi-square test showed that the occurrence of abortion is positively and significantly associated with the sero-prevalence of brucellosis ($P<0.05$). The sero-prevalence was 26.98% and 1.54% in animals with and without history of previous abortion, respectively (Table 3). History of occurrence of retained fetal membranes and frequency of occurrence of abortion were not significantly ($P>0.05$) associated with sero-prevalence of brucellosis.

Discussion

The overall individual level sero-prevalence of brucellosis in cattle in this study was lower than the reports of Kebede et al. (2008) (11%) and Eshetu et al. (2005) (10%) in the central highlands and Addis Ababa, Ethiopia, respectively. Higher prevalence rates were also reported in indigenous cattle in Nigeria (32.2%) (Junaidu et al. 2008) and in crossbred cattle in Algeria (9.7%) (Aggad and Boukraa, 2006). Our finding is very close to the reports of Berhe et al. (2007) (3.19%) in extensive production systems in Tigray region of Ethiopia. Lower prevalence rate was

Table 3 Association of sero-prevalence of bovine brucellosis with abortion and retained fetal membranes in Jimma Zone, South-west Ethiopia

Risk factor	No. tested	Prevalence No. (%)	Chi-square	P-value
Retained fetal membranes			0.36	0.550
Yes	81	4 (4.94)		
No	1,263	46 (3.64)		
Previous abortion			196.19	0.000
Yes	115	34 (26.98)		
No	1,039	16 (1.54)		
Abortion frequency			2.42	0.120
Only once	100	27 (27.00)		
Two or more times	15	7 (46.67)		

reported by Kassahun (2004) for intensive (2.5%) and extensive farms (1.7%) in Southern Ethiopia. The overall herd level sero-prevalence (15%) in the present study is similar with the report of Mussie (2005) (14.96%) in extensive production system in northwestern parts of Ethiopia but higher than that of Kassahun (2004) (9.2%) and lower than the reports of Berhe et al. (2007) (42.31%) and Kebede et al. (2008) (45.9%) in Ethiopia, Aggad and Boukraa (2006) (31.5%) in Algeria and Ahmad et al. (2009) (25.8%) in Jordan. The low level of individual and herd sero-prevalence in this study could be probably an indication of less level of introduction of new breeds to the local herd for crossbreeding purposes.

In this study, there was no seropositive reactor in nulliparous animals and in those less than 3 years of age. Low levels of sero-prevalence were reported for the same group of animals by Berhe et al. (2007) (0.69%) and Kebede et al. (2008) (1.4%) in Ethiopia. On the other hand, Bayemi et al. (2009) reported that animals between one and three years of age accounted for nearly half of the seropositive animals in Cameroon in small-scale farms. This is an indication of variations in the management practices (level of intensification and hygienic practices) in farms included in the different studies.

In this study, significantly higher individual animal sero-prevalence was found in non-pregnant and lactating animals than otherwise. Similar results without significant effects were reported by Mussie (2005) in Ethiopia and Omer et al. (2000) in Eritrea. Age, parity, stage of pregnancy, management system and altitude had no significant effect. The later finding is in agreement with the reports of Berhe et al. (2007) with regard to altitude and parity number and that of Mussie (2005) in extensive systems in northwestern Ethiopia for the effects of age, pregnancy status, stage of pregnancy, parity number and management system. In contrast to our finding, significant effects of management system were reported by Berhe et al. (2007) who reported higher sero-prevalence in the transhumance system than sedentary system.

Herd size was the only factor with significant effect on herd level sero-prevalence and the sero-prevalence increased significantly with herd size. This finding is similar to the reports of Berhe et al. (2007) and Ahmad et al. (2009) and disagrees with that of Kebede et al. (2008). Our finding possibly suggests that an increase in herd size may be associated with poor hygiene of farm. Omer et al. (2000) also reported that stocking density is an important determinant of brucellosis infection.

In our study, individual animal sero-prevalence was positively associated with the occurrence of abortion, while retained fetal membranes and frequency of abortion had no significant association. This finding is in line with the results of Kebede et al. (2008) regarding retained fetal membranes and differs in the case of the effect of the occurrence of abortion. A positive association between brucellosis sero-prevalence and occurrence of abortion was also reported by Ahmad et al. (2009) in Jordan and Muma et al. (2006) in Zambia. This could be explained probably by the fact that abortion is the typical outcome of brucellosis infections (Schelling et al. 2003).

In conclusion, the observed overall individual animal sero-prevalence of bovine brucellosis in Jimma Zone was not high. However, it deserves due attention because of the public health significance of the disease. At this time, it may be appropriate to practice a test and slaughter control strategy at least in the study area before the disease spreads and attains higher level of prevalence.

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