

Serological investigation of brucellosis and its association with abortion in sheep and goats in selected districts of Jimma zone, southwestern Ethiopia

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Abstract

The occurrence of brucellosis in different species of livestock has been reported from different parts of Ethiopia, however, the serostatus and risk factors of this disease in small ruminants is not well documented in southwestern parts of the country. This study was conducted from October 2016 to October 2017 to investigate the seroprevalence and associated risk factors of brucellosis as well as its association with abortion in sheep and goats in selected districts of Jimma zone. A total of 804 small ruminants (402 sheep and 402 goats) were randomly selected and blood samples were collected for serological tests. The presence of antibody to *Brucella* was screened by Rose Bengal Plate Test and confirmed using the complement fixation test. Seroprevalence of 4.2% in sheep and 5.2% in goats was recorded in this study. An overall seroprevalence of 4.7% was recorded in small ruminants in the study areas. *Brucella* seropositivity was observed more frequently among sheep and goats with a history of abortion (6.7%) than animals that have no history of abortion (3.7%), however, the difference noted was not statistically significant. Older age (OR 3.9, CI = 1.43-9.94), pregnancy (OR 2.6, CI = 1.19-5.72), late term gestation (OR 2.4, CI = 1.54-3.78), mixed flock (OR 2.8, CI = 1.33-5.89) and larger flock size (OR 2.7, CI = 1.08-6.95) were noted to have more number of reactors. Hence, it is important to consider brucellosis as one of the diseases that needs attention and further study should be conducted to identify the circulating *Brucella* species and other causes of abortion in sheep and goats. Besides, this finding warrants the need for further investigation on its public health impact in the region.

Keywords: Brucellosis; Epidemiology; Sheep; Goat; Jimma Zone

Introduction

Ethiopia has a huge number of small ruminants with an estimated population of 30.7 million sheep and 30.2 million goats (CSA, 2017). However, the disease of reproduction is challenging to the rearing of sheep and goats in the country (ESGPIP, 2011). Infectious reproductive diseases of sheep and goats are part of the major flock health problems known to constrain the sector. These diseases usually manifest themselves through infertility, abortion, stillbirth and weak offspring (Radostits *et al.*, 2007). Several infectious agents including, bacteria, viruses and protozoa are accountable for abortion in sheep and goats. Abortion is also caused by non-infectious factors such as toxic substances, metabolic, nutritional and physical injuries. These causes also have a significant impact on the overall productivity of sheep and goats (Daniel and Marley, 2008; Mirkena *et al.*, 2011). Among infectious causes of abortion, *Brucella* is one of the known bacterial pathogens causing tremendous economic losses (FAO, 2003; Tegegn *et al.*, 2016).

Brucella melitensis and *B. ovis* are the two important *Brucella* species known to affect sheep and goats, however; *B. abortus* is also been incremented occasionally in sheep and goats (Radostits *et al.*, 2007; Akhvledian *et al.*, 2010). The disease is manifested by late-term abortions, weak lambs and kids, stillbirths, infertility and characterized mainly by the retained fetal membrane (Radostits *et al.*, 2007). *Brucella* infection in sheep and goats is a well-known disease worldwide. However, the disease is a serious problem in developing countries (FAO, 2003; Njeru *et al.*, 2016; Shirima and Kunda, 2016). The prevalence of brucellosis is affected by several risk factors such as production system, host and environmental factors (Radostits *et al.*, 2007). In sexually mature sheep and goats, brucellosis restricts to the reproductive tract and typically causes placentitis and abortion in pregnant ones. *Brucella melitensis* and *B. abortus* are zoonotic pathogens that cause disease in humans (Pappas *et al.*, 2006; Radostits *et al.*, 2007).

Many developing countries with a limited resource like Ethiopia are facing other priority diseases and have not yet performed an aspect of brucellosis intervention. The epidemiology, and control and prevention methods of brucellosis in sheep and goats were not well understood (McDermont and Arimi, 2002). As a result, brucellosis remains challenging in sheep and goat population and cause huge economic and public health problems in the country (Tegegn *et al.*, 2016; Mohammed *et al.*, 2017). Brucellosis also causes reduce the foreign cur-

rency earnings through rejection of export sheep and goats from international markets (LMA, 2005).

Ethiopia has various agro-ecological zones that have contributed to the development of different livestock production systems (Beruktayet and Mersha, 2016). Production system, breed, and environmental factors greatly influence the spread of brucellosis among the causes of abortion (Tulu *et al.*, 2018). Several sheep and goats breed in Ethiopia are reared in different agro-ecological zones and production systems. The extensive production system of the country is responsible for the mixing of different livestock species for maintenance and transmission of brucellosis (Megersa *et al.*, 2011b). Close animal-human contact and traditional raw animal product consumption make zoonosis among the main public health hazards in Ethiopia. Hence, detailed epidemiological studies for the implementation of applicable control strategies were needed (Addis and Desalegn, 2018). Several studies were done on sheep and goat brucellosis in different parts of the country (Teshale *et al.*, 2006; Asmare *et al.*, 2010; Megersa *et al.*, 2011b; Dabassa *et al.*, 2013; Sintayehu *et al.*, 2015). Nevertheless, reports from south western part of the country are very limited. Therefore, this study aimed to estimate the seroprevalence and identify the associated risk factors of brucellosis. Besides it attempts to observe the association of *Brucella* reactors with abortion in sheep and goats in selected districts of the study area.

Materials and Methods

Description of study areas

The study was carried out in Limu Seka and Chora Boter districts of the Jimma zone. Limu Seka district located about 463 km from Addis Ababa, the capital city of Ethiopia; and 109 km from Jimma town, the capital city of Jimma zone. The district covers an area of approximately 1,694 km² and is divided into 38 kebeles (the smallest administrative units). The agro-ecology of the district is characterized by highland (13%), mid-highland (55%) and lowland (32%). The altitude of the district is between 1,400-2,200 meters above sea level. Chora Boter district is located 466 km away from Addis Ababa, and 112 km from Jimma town, zonal capital. This district has 19 kebeles; and agro-ecologically it is characterized by highland, mid-highland, and lowland. The altitude of the district is between 1,100-2,200 meters above sea level and has an average temperature of 22°C. Chora Boter district has 228,846 head of cattle, 47,854 head of sheep, and 68,037 head of goats. Both districts have two distinct seasons.

The rainy season is starting in late March and ending in October, and the dry season is occurring from November to early March.

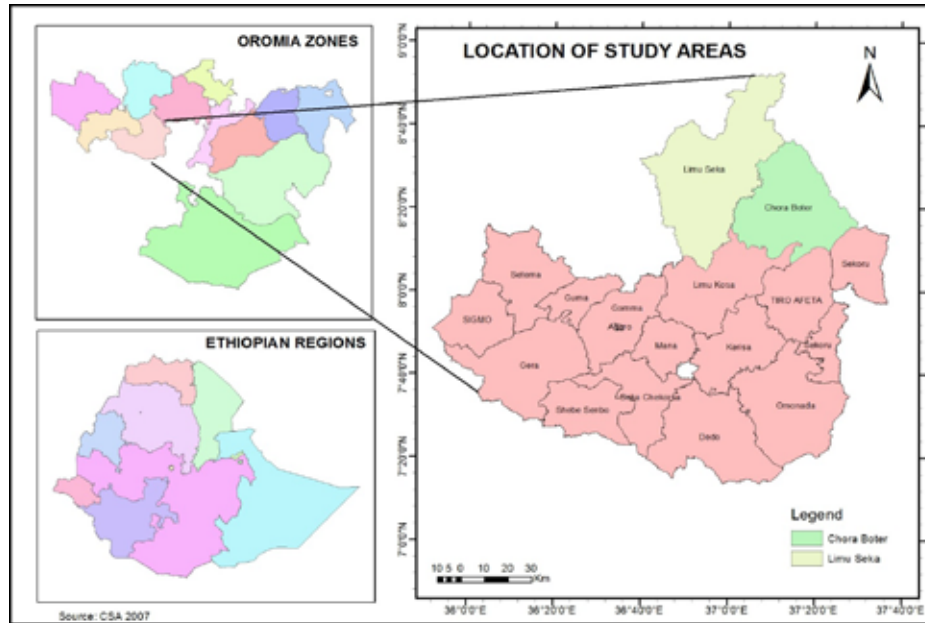


Figure 1: Map of the study areas

Study design and animals

A cross-sectional study was carried out from October 2016 to October 2017 in selected districts of Jimma zone to investigate the seroprevalence and associated risk factors of brucellosis as well as its association with abortion in sheep and goats. The target population of this study comprises female sheep and goats in study districts, namely Limu Seka and Chora Boter. Sheep and goats older than three months (to exclude maternal immunity) were randomly selected and included in the study. Age was determined using dentition and categorized as < 1 year, 1 year to 2 years and >2 years (ESGPIP, 2009). The number of sheep and goats farmers own was categorized as small (<7 sheep/goats), medium (8-12 sheep/goats) and large (>12 sheep/goats) flock sizes. Parity number was categorized as nulliparous (zero parity), monoparous (parity one) and pluriparous (\geq two parities) (Margatho *et al.*, 2019). Management systems were classified as extensive and semi-intensive based on the criteria adopted by Gizaw *et al.* (2015). Body condition scoring for sheep and goats

was conducted using the guidelines established by Langston University (Vil-laquiran *et al.*, 2007; Kenyon *et al.*, 2014) and ESGPIP (ESGPIP, Technical Bulletin No. 8) guidelines for body condition scoring and for all sheep and goats under the study their body condition grouped into three groups (poor, medium and good). Abortion was defined as loss of fetus or fetuses before 140 days of pregnancy (Margatho *et al.*, 2019). The gestation stage of abortion was categorized as first trimester (<50 days), second trimester (51-100 days) and third trimester (101-154 days) (Bokko, 2011). Properly manage abortion materials when it was buried or burned whereas improperly manage was simply leave it on the ground or give to the dogs. According to the agro-altitudinal and agro-climatology classification of Ethiopia, lowland falls between 500 and 1,500 and midland falls between 1,500 and 2,300 meters above sea level (Libeau *et al.*, 1995).

Sampling techniques and sample size determination

The multistage sampling method was used to select sampling units from different flocks. Jimma zone and districts (Limu Seka and Chora Boter) were selected purposively based on the dominant of sheep and goats production system, while peasant associations and flocks were selected randomly. The sampling frame of peasant associations were obtained from respective districts agricultural office. A total of ten peasant associations were selected from two districts using a random sampling technique where six peasant associations were from Limu Seka and four of them from Chora Boter based on sheep and goats population. Since there is no previous study on breeding sheep and goat brucellosis in study areas, the sample size was calculated using formula described by Thrusfield (2005) considering an expected prevalence of 50% and an absolute precision of 5% with 95% confidence interval. Substituted each gave 384 animals. Since two populations (sheep and goat) were included in this study, the sample size was double (768). However, a total of 804 small ruminants (402 sheep and 402 goats) were involved to increase the accuracy of the study.

Blood sample collection

Blood samples collected from the jugular vein, (3-5ml) aseptically using sterile plain vacutainer tubes and needle, were kept in a slanting position overnight (12 hours) at room temperature to separate the serum. Then sera were gently decanted into sterile screw capped tubes, labeled and transported in ice packs to Jimma University, College of Agriculture and Veterinary Medicine micro-

biology laboratory and stored at -20°C until screened and tested for antibodies against natural *Brucella* microorganisms. As there has never been a history of vaccination for brucellosis, all positive results were attributed to natural infection. Parallel to blood sample collection relevant information such as agro-ecology, management system, flock size, species composition (mixed of sheep and/goats with cattle), introducing new animals, species, management of aborted material, age (years), parity, body condition, reproduction status, abortion history and frequency, gestation period at abortion and history of retained fetal membrane were collected using separate format.

Serological test

All serum samples collected were first tested using Rose Bengal Plate Test (RBPT) at the National Veterinary Institute (NVI), Debre Zeit, Ethiopia according to the technique described by Alton (1990). The sera and RBPT reagent were taken from the refrigerator and kept at room temperature for at least 30 minutes before the test was performed. A total of 30 microliters of serum sample was dispensed onto the plate and 30 microliters of RBPT antigen were dropped on the slide with sera. The interpretation of both positive and negative control results was done according to the degree of agglutination and the reaction was read in a good light source or by a magnifying glass when micro agglutination was suspected. The RBPT results were interpreted 0, +, ++ and +++ as has been described by Dohoo *et al.* (2009), where 0 indicates no agglutination, + indicates barely visible agglutination (using magnifying glasses), ++ indicates fine agglutination and +++ indicates coarse clumping. Those serums identified with no agglutination (0) were regarded as negative, while those with +, ++ and +++ were considered as positive. The whole positive serums were confirmed using the complement fixation test (CFT) using standard *B. abortus* S99 (KT153, UK). This test was also done at NVI. The preparation of the reagent was evaluated by titration and performed according to protocols recommended by OIE (2009). Sera with a strong reaction, more than 75% fixation of complement (3+) at 1:5 dilution or at least with 50% complement fixation (2+) at 1:10 dilution and above were considered as positive and lack of fixation/complete hemolysis was considered as negative (OIE, 2004).

Data management and analysis

Data obtained from this study were recorded, coded and stored in Microsoft Excel for Windows 2010 and transferred to STATA version 11.0. Seroprevalence of brucellosis was calculated by dividing the number of seropositive samples

to the total of sheep and goats samples. Association between brucellosis and presumptive risk factors was analyzed using the logistic regression analysis. The variables with p-value less than or equal to 0.25 in univariable logistic regression, after checking for multicollinearity using collinear matrix index and interaction effect using cross-product terms were taken forward for multivariable modeling. The model fitness was observed using the Hosmer-Lemeshow test. The model validate was also evaluated by using the ROC curve. For all statistical analysis, confidence intervals (CI) of 95% and p-value of 0.05 were used.

Results

Out of the total 804 sheep and goats sampled, 6.3% (n=51) of sheep and goats were tested positive on screening using RBPT. Further, confirmation using CFT identified an overall 4.7% (38/804) prevalence of *Brucella* antibodies in sheep and goats. Seroprevalence of 4.2% (17/402) and 5.2% (21/402) were recorded in sheep and goats, respectively. More seropositivity of *Brucella* antibody was observed among sheep and goats with the history of abortion (6.7%) than animals that have no history of abortion (3.7%). However, there was no difference ($p>0.05$). Likewise, sheep and goats from a large flock size category were almost three times more likely to be infected with *Brucella* organisms than small flock size (OR=2.8, $p<0.05$). Similarly, a statistically significant difference in seroprevalence of brucellosis was observed in animals herded with cattle ($p<0.05$). Mixed (sheep and/goats with cattle) species were almost three times more likely to be infected with *Brucella* organisms than those having close contact with cattle (OR=2.8). However, agro-ecology, species, introducing of a new animal, management system and properly manage of aborted material were not able to explain seroprevalence of brucellosis (Table 1).

Table 1. Univariable logistic regression of environmental-related putative risk factors in study areas

Variables	Categories	Total animals examined	Total animals positive (%)	OR (CI; 95%)	p-value
Agro-ecology	Lowland (Ref.)	176	8 (4.55)	-	0.143
	Midland	628	30 (4.78)	1.7 (0.837-3.430)	
Management system	Extensive (Ref.)	691	32 (4.63)	-	0.218
	Semi-intensive	113	6 (5.31)	0.6 (0.269-1.349)	
Flock size	Small(<7) (Ref.)	228	6 (2.63)	-	0.024
	Medium(8-12)	241	7 (2.90)	0.9 (0.429-1.912)	
	Large(>12)	335	25 (7.46)	2.8 (1.154-6.956)	
Species composition	Single species (Ref.)	419	11 (2.63)	-	0.005
	Mixed	385	27(7.01)	2.8 (1.37-5.72)	
Introducing new animals	No (Ref.)	457	19 (4.16)	-	0.893
	Yes	347	19 (5.48)	1.1 (0.541-2.024)	
Proper manage of aborted material	Yes (Ref.)	247	8 (3.24)	-	0.190
	No	527	30 (5.39)	0.6 (0.266-1.302)	
Species	Sheep (Ref.)	402	17 (4.23)	-	0.507
	Goat	402	21 (5.22)	0.8 (0.416-1.542)	

Ref. = Reference; OR=Odd Ratio; CI=Confidence Interval

Similarly, *Brucella* seropositivity was significantly varied among sheep and goat age groups with older age categories are 2.7 times more likely to be *Brucella* seropositive than younger age category (OR=2.7, p<0.05). The univariable logistic regression analysis shown that *Brucella* seroprevalence was a statistically significant difference with gestation stages, with the odd of seropositivity being 1.3 times higher in animal aborted in the third trimester than those have no history of abortion (OR=1.3, p<0.05).

Table 2. Univariable logistic regression of host-related putative risk factors in study areas

Variables	Categories	Total animal examined	Total animal positive (%)	OR (CI; 95%)	p-value
Age					0.006
	<1 year (Ref.)	236	5 (2.12)	-	
	1-2 years	217	11 (5.07)	1.6(1.42-3.45)	
	>2 years	351	22 (6.27)	2.7(1.15-6.66)	
Parity					0.136
	Nulliparous (Ref.)	168	6 (3.57)	-	
	Monoparous	207	8 (3.86)	0.7(0.32-1.77)	
	Pluriparous	429	24 (5.59)	1.6 (0.68-3.71)	
Body condition					0.569
	Good (Ref.)	135	4 (2.96)	-	
	Medium	463	24 (5.18)	0.6(0.19-1.64)	
	Poor	206	10 (4.85)	0.6(0.18-1.95)	
Reproduction status					0.087
	Non-pregnant (Ref.)	342	11 (3.22)	-	
	Pregnant	462	27 (5.84)	1.9(0.91-3.82)	
Abortion history					0.064
	Absent	536	20 (3.7)	-	
	Present	268	18 (6.7)	0.5 (0.28-1.03)	
Abortion frequency					0.104
	None aborted	536	20 (3.7)	-	-
	Once (Ref.)	199	15 (7.5)	0.5 (0.24-0.95)	
	≥2	69	3 (4.3)	0.9 (0.25-2.95)	
Gestation period at abortion					0.008
	None aborted (Ref.)	536	20 (3.73)	-	
	First trimester	41	1 (2.43)	0.2 (0.09-0.68)	
	Second trimester	68	4 (5.88)	0.3 (0.14-0.82)	
	Third trimester	159	13 (8.18)	1.3 (1.41-2.60)	
Retained placenta					0.922
	Absent (Ref.)	673	29(4.31)	-	
	Present	131	9(6.87)	1.0 (0.37-2.48)	

Ref. = Reference; OR=Odd Ratio; CI=Confidence Interval

In multivariable logistic regression analysis, explanatory variables with a p-value of less than or equal to 0.25 in the univariable logistic regression were included. This model showed that older sheep and goats were identified to be *Brucella* seropositive with the odds of positivity 3.9 (OR=3.9, CI; 1.43-9.94) times more likely than the younger ones. Similarly, this result also shows that sheep and goats that were from a mixed (sheep and/ goat with cattle) species were more likely to be *Brucella* antibody seropositivity than those having no contact with cattle (OR=2.8, CI; 1.33-5.89). Furthermore, sheep and goats from large flock sizes were also found to be at higher risk of *Brucella* infection, than those from small flock size (OR=2.7, CI; 1.08-6.95). Likewise, sheep and goat aborting at the third-trimester stage were higher *Brucella* seropositivity (OR=2.4, CI; 1.54-3.78) than those have no history of abortion. Moreover, reproduction status is statistically significantly different in *Brucella* antibody seropositivity with pregnant sheep and goats are 2.6 times more likely to harboring *Brucella* infection than non-pregnant ones (OR=2.6, CI; 1.19-5.72). Hosmer-Lemeshow test (0.5) indicates that the model was fit data well. ROC curve (0.76) indicated the model was good predicting ability.

Table 3. Final multivariable logistic regression model for brucellosis antibody seropositivity in study areas

Variables	Categories	Total animals examined	Total animals positive	Adjusted OR (CI; 95%)	p-value
Age(years)	<1 year (Ref.)	236	5 (2.12)	-	-
	1-2 years	217	11 (5.07)	1.6 (1.36-3.86)	0.040
	>2 years	351	22 (6.27)	3.9 (1.43-9.94)	0.007
Species composition	Single species (Ref.)	419	11 (2.63)	-	-
	Mixed species	385	27 (7.01)	2.8(1.33-5.89)	0.007
Flock size	Small (<7) (Ref.)	228	6 (2.63)	-	-
	Medium (8-12)	241	7 (2.90)	1.8 (1.35-2.66)	0.039
	Large (>12)	335	25 (7.46)	2.7 (1.08-6.95)	0.034
Gestation period at abortion	None aborted (Ref)	536	20 (3.73)	-	-
	First trimester	41	1 (2.43)	0.3 (0.11-1.03)	0.056
	Second trimester	68	4 (5.88)	0.5(0.18-1.27)	0.141
	Third trimester	159	13 (8.18)	2.4(1.54-3.78)	0.037
Reproduction status	Non-pregnant (Ref.)	342	11 (3.22)	-	-
	Pregnant	462	27 (5.84)	2.6(1.19-5.72)	0.017

Ref. = Reference; OR=Odd Ratio; CI=Confidence Interval

Discussion

In the present study, an overall 4.7% seroprevalence of brucellosis was recorded in female sheep and goats in study areas. The seroprevalence detected in this study is in line with the findings of Mengistu (2007), Wesinew *et al.* (2013) and Deddefo *et al.* (2015), who reported seroprevalence of 5.1%, 4.8%, and 4.6%, respectively. However, this result is higher than the findings of Tsehay *et al.* (2014) and Melese (2016), who reported a seroprevalence of 3.6% in eastern and 3.7% in southern Ethiopia, respectively. Higher seroprevalence

than the current study is reported by Yohanis (2012) 9.6% and Muluken (2016) 7.5% in the Afar region. Seroprevalence of 5.2% in goats and 4.2% in sheep was estimated in the present study. This result is in agreement with the findings of Feyisa *et al.* (2007), Yohanis (2012) and Deddefo *et al.* (2015), who reported 5.8% in goats and 4.9% sheep, and 4.9% in goats and 4.4% in sheep, respectively. However, the current result is higher than the findings of Teshale *et al.* (2006), who reported a seroprevalence of 1.7% in goats and 1.6% in sheep. Similarly, Mengistu (2007) reported 3.2% and 1.6% seroprevalence of brucellosis in sheep and goats, respectively. This variation may be due to differences in environmental factors, breed of sheep and goats, management and production system.

A statistically significant difference was observed in the *Brucella* seropositivity of sheep and goat among different age groups ($p < 0.05$). The odds of *Brucella* seropositivity in older sheep and goats were almost four times (OR=3.9) more likely than in the younger category. This could be explained by the fact that sexually mature animals are more susceptible to *Brucella* infection than sexually immature animals since sex hormones that encourage growth and multiplication of *Brucella* organism, probable increase in concentration with age and sexual maturity (Quinn *et al.*, 2004; Radostits *et al.*, 2007). Significantly higher seropositivity in older small ruminants than younger can be attributed to the practice of leaving younger around home premises when adult small ruminants were taken to a communal grazing area. This decreases the risk of younger's being exposed to infection from common grazing and watering points (Kiputa *et al.*, 2008). This finding is in line with the reports of Megersa *et al.* (2011a), Yohanis, (2012) and Muluken (2016), who reported a significant association between age and *Brucella* seropositivity in sheep and goats.

Reproductive status of sheep and goat is significantly associated with *Brucella* seropositivity where pregnant sheep and goat were about three (OR=2.6, $p < 0.05$) times more likely than in non-pregnant ones. This could be explained by the fact that susceptibility to *Brucella* infection is increased after sexual maturity and especially with pregnancy. This is due to *Brucella* organisms prefer uterus in which allantoic fluid factors such as erythritol could stimulate the growth of *Brucella* and elevate in the placenta and fetal fluid from about the second trimester of pregnancy (Coetzer and Tustin, 2004; Radostits *et al.*, 2007). This finding is in line with the report of Yohanis (2012), who stated that brucellosis was associated with the reproduction status of sheep and goats. Gestation period at abortion is significantly associated with *Brucella* seropositivity whereby seropositivity about two (OR=2.4, $p < 0.05$) times more likely in

the third-trimester stage than those have no history of abortion. This can be explained by the presence of higher concentration erythritol produced naturally by the developing fetus favors the multiplication of *Brucella* organisms, where it causes degeneration and necrosis of the cotyledons leading to abortion from the last months of gestation (Smith *et al.*, 2002; Coetzer and Tustin, 2004). Besides, in highly susceptible nonvaccinated pregnant sheep and goat, abortion occurs in the last month of pregnancy is a cardinal feature of *Brucella* infection (Radostits *et al.*, 2007). This finding was supported by the reports of Muluken (2016), and Coetzer and Tustin (2004), who indicated a significant association between seropositivity of *Brucella* infection and gestation stage in sheep and goats.

Species mix is also associated with *Brucella* seropositivity where sheep and goats kept together with cattle is almost three (OR=2.8) times more likely to be positive for *Brucella* antibody than a single species flock. Cross-species infection with other *Brucella* species, especially *B. abortus*, has been documented in sheep and goat as a cause of *Brucella* infection (Glenn and Karen, 2005). Multiple livestock species herding together, especially keeping of goat and sheep along with cattle has been reported as an important determinant risk factor of *Brucella* seropositivity (Abbas and Agabu, 2002). Keeping sheep in contact with *Brucella* infected goat, also a potential risk factor for brucellosis spread among sheep flocks (Radostits *et al.*, 2007). However, this finding is not supported by the reports of Coelho *et al.* (2013), who stated herding of small ruminants with cattle were not risk factors for brucellosis. This difference in *Brucella* seropositivity of species composition recorded in the different study areas may be associated with the differences in agroecology, management system and breed used in each study.

Flock size is associated with *Brucella* seropositivity in sheep and goat with large flock size was about three (OR=2.7) times more odd of brucellosis than small flock size. Flock size has previously been reported as an important determinant for transmission of *Brucella* organism between susceptible and infected animals (Omer *et al.*, 2000) and because of one positive animal was at least available in large flock size compared with small flock size (Al-majali, 2005). This finding also related to a higher density of animals per flock. Keeping a large flock allows greater contact among animals. This makes a higher bacteria load in the environment and as a result, the probability of brucellosis transmission will be increased. Moreover, grazing in the communal pasture may facilitate the contact between infected and none infected flocks (Kaba-

gambe *et al.*, 2001; Coelho *et al.*, 2013). The association of flock size with the seropositivity in the present finding is confirmed with previous results (Kagambage *et al.*, 2001; Al-majali, 2005; Coelho *et al.*, 2007; Coelho *et al.*, 2013; Tegegn *et al.*, 2016;).

In the current study, no statistically significant difference ($p>0.05$) was detected in seroprevalence of *Brucella* antibody between aborted and none aborted sheep and goats. This suggests that brucellosis may not be associated with abortion in sheep and goat in study areas. This could be true as abortion in sheep and goat has multiple causes, infectious (*Toxoplasma gondii*, *Leptospira spp*, *Listeria spp*, *Salmonellae spp*, *Coxiella burnetti*) and non-infectious (heat stress, nutritional deficiencies, trauma, toxic substances, etc) other than brucellosis. It is known that only seropositivity does not certainly associate with abortion in all conditions. It is important to identify the actual causes in the aborting sheep and goats and/ or in the aborted fetus or placental tissues to confirm the pathogen is accountable for abortion (Morris *et al.*, 2018). This result is in line with the reports of Gebremedhin (2015) and Wubishet *et al.* (2017), who reported that the risk of *Brucella* seropositivity was not associated with abortion. However, this result is inconsistent with some previous studies in Ethiopia (Tassew and Kassahun, 2014; Asmare *et al.*, 2013) that stated brucellosis was associated with abortion in sheep and goats. This variation may be due to differences in agroecology, breed, management and husbandry condition in the area. This can also be differences between the study areas regarding conditions that could favor the transmission of various causes of abortion (Radostits *et al.*, 2007).

Conclusions

In the present study, the high seroprevalence of brucellosis was recorded in sheep and goat. Older age, mixed flock, pregnancy, late term gestation, and larger flock size have been noted as the most important factors for recovering higher proportion of *Brucella* reactors in sheep and goats. The present study also indicated that the presence of higher brucellosis in sheep and goat with the history of abortion than those have no history of abortion. Hence, it is important to carry out further study to identify the circulating *Brucella* species using molecular tools and other potential causes of abortion in sheep and goats. Besides, this study warrants the need for further investigation on *Brucella* infection public health impact in the study area.

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Conflict of interests

The authors have not declared any competing of interests

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