Veterinary and Animal Science 7 (2019) 100047

Contents lists available at ScienceDirect

Veterinary and Animal Science

journal homepage: www.elsevier.com/locate/vas

Sero-prevalence and community awareness on the risks associated with Livestock and Human brucellosis in selected districts of Fafan Zone of Ethiopian-Somali National Regional State

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ARTICLE INFO

Keywords:
Camel
CFT
Husbandry practices
Pastoral community
RBPT
Ruminants

ABSTRACT

A cross-sectional study was conducted to estimate the sero-prevalence, potential risk factors for transmission and spread of brucellosis in livestock and human in Jigjiga and Gursum *Woredas* of Fafan Zone in Ethiopian-Somali. Two *Kebeles* were purposively selected from each *Worada* based on accessibility and willingness of livestock owners. For serology, a total of 268 cattle, 108 sheep, 172 goats, 183 camels, 211 humans were included. For questionnaire, 99 volunteers were recruited. Blood samples were collected from livestock and human. The serum was subjected to Rose Bengal Plate Test (RBPT) and Complement Fixation Test (CFT) to detect *Brucella* antibody. Out of the total 731 livestock examined, 3.0% were positive for *Brucella* antibodies using RBPT. Highest sero-prevalence was recorded in camels (4.9%) followed by goat (2.9%), cattle (2.6%), and sheep (0.9%). Using CFT, 0.4% of animals were found positive for brucellosis. A sero-prevalence of 1.7% was recorded in goats using CFT but no in other animal species. From the 211 human serum samples, 5 (2.4%) were positive for *Brucella* infection using RBPT. One (0.4%) was confirmed by CFT. Questioner survey revealed, almost all respondents (98%) were not aware about zoonotic risks of brucellosis. Cattle and camel milking were mainly performed by housewives. Although 97-99% of respondent had habits of cooked meat consumption, the majorities (99%) consume raw milk. In the pastoral community, the observed sero-prevalence of human brucellosis along with the practices of animal husbandry and animal food consumption habits, might give an insight that brucellosis could pose a public health hazard.

1. Introduction

Brucellosis is a contagious infectious bacterial disease affecting domestic animals (OIE, 2008), maintained in wildlife population (Dwight & Yuan, 1999) and with risk of zoonosis in human (Mantur, Amarnath, & Shinde, 2007; OIE, 2008). In livestock it results reproductive losses due to abortion, placentitis, stillbirth, birth of weak offspring, epididymitis, and orchitis (Dwight & Yuan, 1999; OIE, 2008; Radostits, Gay, Hinchcliff, & Constable, 2007). Cattle are a major reservoir of *B. abortus*. Sheep, goats, pigs, equines and camels are occasionally infected but rarely act as a source of infection for cattle (Radostits et al., 2007).

Many developing countries with limited resources, including Ethiopia, are facing other priority diseases that are more spectacular and have not yet fully launched programs featuring any aspects of brucellosis intervention. The epidemiology of the disease in livestock and humans as well as cost-effective prevention measures is not well understood (McDermott & Arimi, 2002). Hence, brucellosis remains challenging widespread in domesticated and wildlife animal population and presents enormous economic and public health problems in developing countries (Acha & Szyfres, 2001; Memish & Mah, 2001). The true incidence of human brucellosis is unknown and the estimated burden of the disease varies widely, from < 0.03 to > 160 per 100,000 population (Pappas, Papadimitriou, Akritidis, Christou, & Tsianos, 2006). Occupationally, 11% among animal health workers and 7% among hospital patients (Franc, Krecek, Häsler, & Arenas-Gamboa, 2018; McDermott, Grace, & Zinsstag, 2013) are at risk of acquiring *Brucella* infection.

Franc et al. (2018) reported an average prevalence ranging from 0 to 88.8%, 0 to 68.8%, 0.4–20% and 0–12.9% in sheep and goats, cattle, camels and other species (pigs and dogs), respectively in Africa and Asia. An overall true *Brucella* sero-prevalence of 5.3% in goats, 2.7% in sheep, and 2.9% in each of camels and cattle were reported in Ethiopia (Tadesse, 2016). Bekele, Mohammed, Tefera, and Tolosa (2011)

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https://doi.org/10.1016/j.vas.2019.100047
Received 6 July 2018; Received in revised form 20 November 2018; Accepted 2 January 2019
Available online 03 January 2019

reported brucellosis in sheep and goats at Jigjiga district. A huge and diverse livestock species of Ethiopia are maintained under different agro- ecological zones, predominately extensive animal husbandry practices. These provide ample opportunities for inter-mixing of different animal species at communal grazing areas and water points nearly in of 80% the rural community (Samui, Oloya, Munyeme, & Skjerve, 2007), which are mainly characterized by poor sanitary condition. Such species composition and mixing could attributed to risk of widespread host for the establishment and transmission of pathogen owning to high stock density and multi-species composition under lack of controlling measures in Ethiopian livestock industry (Benkirane, 2006; Megersa et al., 2011; Samui et al., 2007).

Thus, the economic and public health impact of brucellosis remains of particular concern in developing countries mainly among the vulnerable sector in rural pastoral populations. The risk is presumed to be high in nomadic pastoral societies, where close and frequent contact between man and animals is unavoidable part of ecology (Hamdy & Amin, 2002). However, little information is available on the prevalence of brucellosis at the livestock and human interface in such kind of society. Therefore, the objectives of this study were to estimate the seroprevalence of livestock and human brucellosis and to assess the community awareness on the risks of zoonotic brucellosis in selected districts of Fafan Zone, Ethiopia.

2. Materials and methods

2.1. Ethical considerations and clearance

Ethical clearance was obtained from the Ethiopian Somali Regional State Health Research Ethical Review Committee. Additionally, verbal consent was obtained from the owner of the animal. Full cooperation and voluntary participation of all participants was obtained by assuring them the confidentiality of their involvement.

2.2. Description of the study areas

The study was conducted in two districts namely Jigjiga and Gursum that are found in Fafan administrative Zone of Somali Regional State at about 600 km east of Addis Ababa, Ethiopia. The altitude of the zone ranges from 500 to 1650 m above sea level and lies between approximately 9020′ North e and 45,056′ East (Fig. 1). The climate is semi-arid type which is characterized by high temperature. The mean annual rainfall in the area ranges from 600 to 700 mm. Agro-pastoralism is the dominant production system in Fafan Zone. The Zone is estimated to have human population of 430,634. The livestock population of the zone is 503,871 cattle, 1134,856 sheep, 1365,265 goats, and 290,649 camels (CSA, 2015).

2.3. Study population

The study populations were apparently healthy livestock species (cattle, sheep, goats, and camels) and human found in selected rural *Kebeles* of the study districts. Animal included were local breeds (indigenous), both sexes, age groups of greater than six months, and with no previous vaccination history against brucellosis. In the study districts, livestock were managed under typical pastoral community characterized by clan-based segregation with often mixing of animals from different houses within a clan. Human that has close contact with sampled animals were considered for the study.

2.4. Study design

A cross-sectional study type was employed to estimate the seroprevalence of brucellosis in target population and to assess awareness of community on risks associated with brucellosis.

2.5. Sampling methods

From the seven *Woredas* of Fafan Zone, two were randomly selected based up on lottery system. Similarly, two *Kebeles* were selected from each *Woredas*. The selected *Kebeles* were Hadew and Shebele from Jigjiga, while Fafan and Bombas from Gursum districts. Households keeping livestock in and around the study area were sampled based on accessibility, population of the study livestock and willingness of the owners to be involved in the study. From each household, 50-70% of the herd was randomly selected for sampling. Individuals for questioner interview were recruited based on their willingness and participation in animal management practices related with risk of brucellosis.

2.6. Sample size determination and distribution

The sample size was determined based on the formula recommended by Thrusfield (2005) using 95% confidence interval and desired precision of 0.05 (5%) considering an expected prevalence of 3% (Hunduma & Regassa, 2009), 1.2% and 1.9 % (Bekele et al., 2011) and 4.2% (Teshome, Molla, & Tibbo, 2003) for cattle, sheep, goat and camel. Using the same formula, sample size for human was calculated with expected prevalence of 16.5% (Ahmed, Ali, Mesfin, Deressa, & Girmaye, 2008). Accordingly, the sample size was 45 cattle, 18 sheep, 29 goats, 62 camels, and 211 human. However, to increase precision, the sample size was increased by 6 fold for cattle, sheep, and goat and by 3 fold for camel. Thus, a total of 731 animals (268 cattle, 108 sheep, 172 goats, and 183 camels) were included for the study based on proportional allocations of the sample size for each *Kebele* (Table 1).

For questionnaire survey sample size was calculated using the formula given by Arsham (2002); $N = 0.25/SE^2$, where: N = sample size, SE (standard error) = 5%. Thus, the required sample size for the questionnaire survey was 100. However, only 99 volunteers were included.

2.7. Sample collection and laboratory analysis

2.7.1. Blood sample collection

Before withdrawal of blood from the jugular vein, the site was disinfected using 70% alcohol. Blood volume of 7 ml to 10 ml from cattle and camel; and 4 ml to 5 ml from sheep and goats was collected. Each sample was labeled with specific identification number and transported to Jigjiga Regional Veterinary Diagnostic and Research Laboratory in an ice box for processing and RBPT. The serum was separated by allowing the blood to clot overnight at room temperature and the purified serum was harvested into sterile screw capped cryovials.

In the case of sample collection from human, 4 ml to 5 ml of blood was withdrawn from the radial vein by health professionals at nearby health center using plain vacationer tube and needle. The serum was then separated by allowing the blood to clot for one hour and the serum was collected into sterilized screw caped cryovials.

2.7.2. Serological test

Primary screening of serum samples for *Brucella* antibody was performed using RBPT at Jigjiga Regional Veterinary Diagnostic and Research Laboratory according to the standard procedure described by Nielsen (2002). The results were read by examining the degree of agglutination in good light source and when necessary using magnifying glass. Any visible agglutination was considered positive. For interpretation of the results, both positive and negative control sera were used as recommended by OIE (2004). Due to the absence of reagents required for CFT at the regional laboratory, the RBPT positive samples were stored at -20^0C until transported to National Veterinary Institute (NVI), Bishoftu, Ethiopia for confirmatory test using CFT. The serum from human blood was subjected to RBPT at respective health centre. The CFT was preformed and interpreted according to OIE (2004).

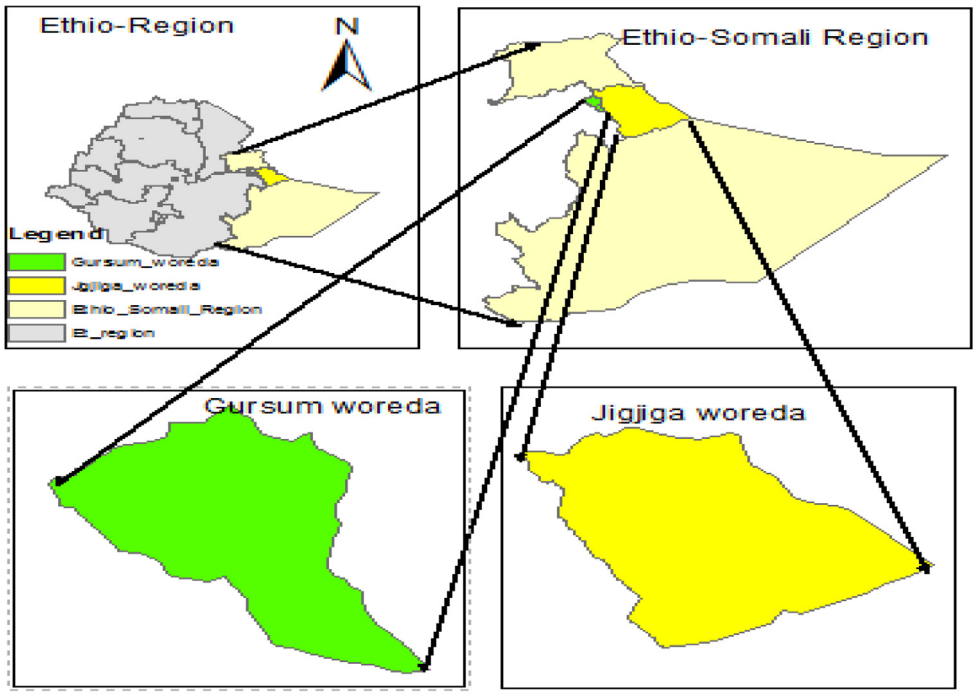

Fig. 1. Map of the study area.

Table 1
Livestock and human sample distribution in the selected study areas.

Study population		Jigjiga *Woreda* №.		Gursum *Woreda* №		Total №
		Hadew kebele	Shebele kebele	Fafan kebele	Bombas kebele	
Animal	Cattle	50	60	90	68	268
	Sheep	30	16	38	24	108
	Goat	44	38	56	34	172
	Camel	50	35	52	46	183
	Total	174	149	236	172	731
Huma	Human*	58	55	45	53	211
	Human**	25	25	24	25	99

* studied for sero-prevalence of brucellosis.
** studied for knowledge of zoonotic diseases and zoonotic brucellosis as well as livestock management and product utilization.

2.8. Questionnaire survey

Questionnaire interview format was prepared and administered to gather information from randomly selected households' individuals using local language. The questionnaire format was focused on the knowledge and awareness related with the transmission of brucellosis from livestock to human. Factors like livestock management practices, milk source and milking practices, milk consumption practices, meat sources and meat consumption practices of community were considered. In addition, the presences of reproductive disorders in livestock were considered.

2.9. Data management and analysis

The data from the field and laboratory were entered into Microsoft Excel 2013© and analyzed using SPSS version 20 software program. Categorical variables (species, sex, age, and *Kebeles*) and data on management system were expressed in frequency and proportions. Brucellosis prevalence was calculated based on results from RBPT positive per sampled animal or human. Similar, calculation was made from CFT positive animal or human.

3. Results

3.1. Seroprevalence of livestock brucellosis

Out of the 731 animals examined, 22 (3.0%) were positive for brucellosis upon screening using RBPT, while 3 (0.4%) were confirmed using CFT (Table 2). Based on RBPT, the highest prevalence was recorded in camels (4.9%). The study also showed that brucellosis was higher in females (3.9%). Regarding the *Kebeles*, the highest prevalence was observed in Bombas (4.1%). Based on CFT, the prevalence was similar in most of variable categories but it was higher in goats (1.7%) than other livestock species (0%).

3.2. Seroprevalence of human brucellosis

Out of the 211 serum samples, 5 (2.4%) and 1 (0.4%) were found positive for *Brucella* antibody by RBPT and CFT, respectively (Table 3). The RBPT revealed that Fafan and Bombas were the *Kebeles* with relatively higher prevalence of human brucellosis with a proportion of 4 and 3.8%, respectively. Meanwhile, the prevalence was higher in female (4.4%) and in adult (3.9%).

Table 2
Sero-prevalence of brucellosis in livestock animals in the study area.

Variables of study		№ of examined animals	№ (%) sero-positive with:	
			RBPT	CFT
Sex	Male	245	3 (1.2)	1 (0.4)
	Female	486	19 (3.9)	2 (0.4)
Age	Young	322	9 (2.8)	2 (0.6)
	Adult	409	13 (3.2)	1 (0.2)
Species	Cattle	268	7 (2.6)	0 (0.0)
	Camel	183	9 (4.9)	0 (0.0)
	Sheep	108	1 (0.9)	0 (0.0)
	Goat	172	5 (2.9)	3 (1.7)
Kebele	Hadew	174	4 (2.3)	1 (0.6)
	Shebele	149	4 (2.7)	0 (0.0)
	Fafan	236	7 (3.0)	2 (0.8)
	Bombas	172	7 (4.1)	0 (0.0)
Total		731	22 (3.0)	3 (0.4)

Table 3
Sero-prevalence of humans brucellosis in the study area.

Variables of study		№. of tested individuals	№ (%) sero-positive with: RBPT	CFT
Gender	Male	98	0 (0.0)	0(0.0)
	Female	113	5 (4.4)	1(0.9)
Age	Young	106	1(0.9)	0(0.0)
	Adult	105	4(3.8)	1(1.0)
Kebele	Hadew	58	1(1.7)	0(0.0)
	Shebele	75	1(1.3)	0(0.0)
	Fafan	25	1(4.0)	1(0.4)
	Bombas	53	2(3.8)	0(0.0)
Total		211	5 (2.4)	1 (0.4)

Table 4
Knowledge status of community on the presence of zoonotic diseases and zoonotic brucellosis by studied demography/parameters.

Demography/parameters of studied community		Total № interviewed	№ (%) individuals knowledgeable on: Presence of zoonotic diseases	Zoonotic risk of brucellosis
Gender	Male	91	11 (12.1)	2 (2.2)
	Female	8	2 (25.0)	0 (0)
Age	Young	52	6 (11.5)	1 (1.9)
	Adult	47	7 (14.9)	1 (2.1)
Kebele	Hadew	25	2 (8.0)	0 (0)
	Shebele	25	1 (4.0)	0 (0)
	Fafan	24	6 (25.0)	1 (4.2)
	Bombas	25	4 (16.0)	1 (4.0)
Total		99	13 (13.1)	2 (2.0)

3.3. Questionnaire survey

Of the 99 respondents, 13 (13.1%) were knowledgeable on the presence of zoonotic diseases but only 2 (2.0%) were aware of zoonotic risks related to animal brucellosis (Table 4). Large proportion of respondents from Fafan (25%) and Bombas (16%) *Kebeles* were aware of zoonotic diseases. However, very low proportion (4 - 4.2%) were aware of the zoonotic risks brucellosis.

With regard to livestock management, almost all (99-100%) of studied community keep animals at day and night time separately, while high proportion (57.6%) practiced mixing of their livestock during grazing. Milking of camel and cattle was mainly performed by house wives, while only low (5.1-6.1%) proportion of husband was involved. The majority (91-98%) of respondents use all studied animals as sources of milk and nearly all (97-99%) of interviewed individuals had habit of raw milk consumption as well as used cooked meat as a source of food. Only 3% of respondents indicated the presence of abortion/ stillbirth in the herd (Table 5).

4. Discussion

4.1. Livestock brucellosis

Brucellosis creates a serious economic problem for both the intensive and extensive livestock production system in the tropics and is considered a threat to public health. This is particularly important in the pastoral community where the livelihood is closely linked with the livestock population. In the present study, RBPT revealed that the overall prevalence of livestock brucellosis in studied districts of Ethiopian-Somali was 3.0%. Our study revealed that brucellosis was observed in both sexes with estimated prevalence of 1.2 and 3.9% in male and female, respectively. The similarity in the prevalence of brucellosis among sex category is not in line with the reports of Tesfaye (2003) and Tolosa (2004) who reported only female positive

Table 5
Livestock management and product utilization associated with risk of brucellosis transmission in animal and human.

Livestock management and product utilization	Parameters of the study			№	Risk of brucellosis acquiring (%)*
Livestock management	Keeping animal at day time		Mixed	1	1.0*
			Separate	98	99.0
	Keeping animal at night time		Mixed	0	0*
			Separate	99	100
	Mixed grazing with other animal		Present	57	57.6*
			Absent	42	42.4
Milk source and milking practices	Animals used for milk source	Cattle	Yes	97	98.0*
			No	2	2.0
		Sheep	Yes	92	92.9*
			No	7	7.1
		Goats	Yes	91	91.9*
			No	8	8.1
		Camel	Yes	89	89.9*
			No	10	10.1
	Responsible personnel for milking*	Sheep	Wife	27	27.3
			Others**	72	72.7
		Goats	Wife	29	29.3
			Others**	70	70.7
		Cattle	Wife	92	92.9
			Husband	6	6.1
		Camel	Wife	91	91.9
			Husband	5	5.1
Milk consumption practice	Raw milk consumption		Yes	98	99.0*
			No	1	1.0
	Milk treatment method		Boiled	1	1.0
			Raw	98	99.0*
Meat source and consumption practices	Meat consumption method	Cattle	Cooked	98	99.0
			Raw	1	1.0*
		Sheep	Cooked	98	99.0
			Raw	1	1.0*
		Goats	Cooked	98	99.0
			Raw	1	1.0*
		Camel	Cooked	96	97.0
			Raw	3	3.0*
Reproductive disorders in the herd	Abortion/ stillbirth		Present	3	3.0*
			Absent	96	97.0

* Suspected risk of *Brucella* transmission, acquiring, infection;
** Husband, children and neighbors.

reactors in Tigray region and Jimma Zone of the country, respectively. In addition, the similarity in the prevalence of brucellosis in young's (2.8%) and adults (3.2%) using RBPT is not in line with the expected high occurrences in sexually mature than immature animals of either sex (Radostits et al., 2007). The variations in sero-prevalence of brucellosis might occur due to agro ecological differences of study areas, sample size, animal management, the diagnostic test used and production systems. The similarity in the proportion of infection between male and female animals indicates similar exposure risk of both sexes. This is supported by the present finding where no sex based segregation of livestock during grazing in the field. Radostits et al. (2007) suggested that herd size and management condition determine the rate of transmission of *Brucella* infection among susceptible hosts.

The present study revealed that sero-prevalence of cattle brucellosis was 2.6% using RBPT which concurs with the proportion reported by previous studies in the country. Thus, Adugna, Agga, and Zewde (2013), Asmare, Asfaw, Gelaye, and Ayelet (2010), Gumi et al. (2013), Hailu, Mohamed, Mussie, and Moti (2011), and Asmare et al. (2007) reported prevalence of 1.4%, 0.9%, 1%, 1.7%, and 2.5%, respectively. However, a relatively high prevalence (4.63%) was reported by Hailemelekot, Kassa, and Assfaw (2007) in the country.

The proportion of RBPT based *Brucella* positive goats (2.9%) and sheep (0.9%) recorded in this study are relatively lower than prevalence reports of 5.8% (in goats) and 3.2% (in sheep) by Ashenafi, Teshale,

Ejeta, Fikru, and Laikemariam (2007) in Afar region. In agreement with the present finding, Mengistu (2007) reported a prevalence of 3.2% in goats in southern region of the country.

The current finding on the prevalence of camel brucellosis (4.9 %) is higher than the previous reports of 0.4-2.5% (Bekele et al., 2011), 0.9% (Gumi et al., 2013), 0.53% (Gessese, Mulate, Nazir, & Asmare, 2014), and 2.8% (Teshome et al., 2003) using RBPT in different parts of the country. However, the present finding is similar with previous reports from Kenya (Njeru et al., 2016) and Somalia (Ghanem et al., 2009) at a proportion of 3.9% (by RBPT) and 3.1% (by I-ELISA), respectively.

Using CFT, the overall 0.4% *Brucella* antibody positive livestock indicates the public health risk of pastoral communities in study area. Corbel (2006) also suggested possible cross transmission of the diseases among susceptible hosts sharing common environment. Similarly, Njeru et al. (2016) from Kenya and Ghanem et al. (2009) from Somalia reported the risk of brucellosis transmission in human and animal who share similar environment. The prevalence was the same in male (0.4%) and female (0.4%), indicating similar risk of infection for both sexes in the pastoral community settings. The prevalence was also similar in young's (0.6%) and adults (0.2%) indicating again similar risk of infection of both age categories. Agreeably, Asfaw, Molla, Zessin, and Azage (1998) reported CFT based confirmation in males at proportion of 0.1% in bovine species. On the other hand, Hailemelekot et al. (2007) reported relatively higher proportion in males (2.1%) under extensive management system. Complement fixation test confirmed the presence of *Brucella* infection only in goats with proportion of 1.7%. This finding in goats is closely related with the 9%, 1.3%, 1.7%, and 1.6% report of Bekele et al. (2011), Muhie (2005) and Sori (2006), Tekleye and Kasali (1990), respectively in Ethiopia.

4.2. Human brucellosis

The overall prevalence of human brucellosis in studied districts of Ethiopian-Somali revealed 2.4% using RBPT but 0.4% using CFT for *Brucella* antibody indicating public health importance the disease among pastoral communities in the area. Corbel (2006) suggested possible cross transmission of the diseases among susceptible hosts including humans who's sharing common environment with infected animals. Similarly, Njeru et al. (2016) from Kenya and Ghanem et al. (2009) from Somalia reported prevalence of brucellosis in human and animal who share similar environment. This is also supported by the observed exposure risks related to animal husbandry, occurrence of reproductive disorders, and consumption of raw milk in this finding.

The sero-prevalence obtained by CFT is lower than the 2.2%, 1.2%, 3.4%, and 3.8% reported by Mekonnen, Shewit, Moses, Mekonnen, and Belihu (2011), Tibesso, Ibrahim, and Tolosa (2014), Tolosa (2004), and Hailemelekot et al. (2007), respectively in different parts of the Ethiopia. It was also lower than the 4.6% reported in Eritrea (Omer, Asfaw, Skjerve, Teklegiorgis, & Woldehiwot, 2002). Based on RBPT, our study showed that only females were reactive to brucellosis. This may be linked with the observed disparity in the role of gender with regard to milking of livestock risking for exposure. In accordance to this, 91-93% house wives were responsible for milking of cattle and camel cows. The present RBPT sero-reaction to brucellosis among theses livestock was higher in the area. This is also true for the higher prevalence in adults (3.8%) than young (0.9%).

Although, 99-100% of studied community keeps animal at day and night time in a separate, 57.6% use communal grazing. Moreover, abortion/ stillbirth was reported in 3% of the herd which have risk of transmission while contact (Hamdy & Amin, 2002; Radostits et al., 2007). Surprisingly, almost all (99%) of interviewed individuals consume raw milk which is one of the sources of human infection from animals shedding the pathogen (Mantur et al., 2007; OIE, 2008; Radostits et al., 2007). However, the majorities (97-99%) practiced consumption of cooked meat, which reduces the risk of getting infected with *Brucella*. Overall, the lack of community awareness about brucellosis; and the habit of raw milk consumption among others might greatly contribute for further spread of brucellosis (Njeru et al., 2016).

5. Conclusion

The present study revealed the occurrence of brucellosis in both livestock and human at a low proportion in Ethiopian-Somali pastoral communities. This could be due to the clan-based segregation of animals as a mitigation measure of the risk of brucellosis transmission amongst animals and humans. Although the causes of abortion and stillbirth in herd are multi-factorial, the low presences of such cases found concomitant with that of prevalence of brucellosis in the area. However, the risk of acquiring *Brucella* infection is very high, particularly due to the consumption of raw milk and involvement of family members as well as neighbors on milking. Thus, public awareness among pastoralists on the transmission and health hazard of brucellosis needs to be addressed through community trainings. Further epidemiological studies with isolation and identifications of *Brucella* biotypes involved at the interface of livestock and human might give a clear picture on the role of livestock in zoonotic brucellosis.

Conflict of interests

The authors declare that they have no competing interests.

Acknowledgements

The Authors would like to acknowledge Ministry of Livestock and Fishery for the financial support, Haramaya University for facilitating Budget use, Somali Regional State of Ethiopia Livestock and Pastoralist Development Bureau, Jigjiga Regional Veterinary Research and Diagnostic Laboratory Office for allowing access to laboratory facilities, National Veterinary Institute (NVI) for allowing access to laboratory facilities, Somali Regional State Health Bureau and Research and Diagnostic Laboratory Office for processing of human samples, and Dire Dawa Plant and Live Animal Export Quarantine Staffs for the kind help and facilitation during the field work.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.vas.2019.100047.

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