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Research Article

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Brucellosis in camel and human: Seroprevalence and associated risk factors in Amibara district of Afar region, Ethiopia

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Abstract

Background: Brucellosis is an important neglected zoonotic disease caused by infection with bacteria of the genus *Brucella* affecting different mammalian species including man. A cross-sectional study was conducted to estimate the seroprevalence of brucellosis in camels and human and its associated risk factors in Amibara district of Afar region, North east Ethiopia from October 2019 to May 2020

Result: A total of 250 camel and 120 human sera were serially tested using the Rose Bengal Plate Test (RBPT), and Complement Fixation Test (CFT). The overall seroprevalence of camel brucellosis in the current study was 7.6% (95% CI: 4.9-11.56) using RBPT and 3.2% (95% CI: 1.63-6.2) by combined RBPT and CFT. In Human twelve (10%) of the collected sera were positive by RBPT among which only four of them (3.33%) were positive by CFT. The risk factors analysis indicated that, age, body condition, number of parity and abortion history were significantly associated with brucella seropositivity in camel ($P \leq 0.05$). In human, occupation and non-protective handling of dystocia cases showed apparent association with brucella seropositivity.

Conclusion: The results of the present study indicated that, brucellosis is a common health problem in camel and human in Amibara district of Afar region. The public health importance of this disease is associated with raw milk consumption and close contact with the animals having history of recent abortion. Therefore, controlling the risk factors, establishing brucella diagnostic service in human clinics and hospitals, continuous social training with feedback assessments and overall implementing of One Health approach framework to attain optimal health for people and domestic animals in area are recommended to safeguard the health of society.

Keywords: *Amibara, Afar, Abortion, Brucellosis, Camel, Cattle, Human, Seroprevalence.*

Introduction

Brucellosis is an important zoonotic disease caused by infection with bacteria of the genus *Brucella* affecting different mammalian species including man (CFSPH, 2018). It is an economically important disease which severely hinders livestock productivity (Yasmin and Lone, 2015). Domestic animals such as cattle, camel, sheep, goat, pig and dog as well as human are greatly affected by this disease (B Lopes et al., 2010) whereas it is also documented in wildlife and marine animals (Godfroid, 2002). Domestic carnivorous animals may acquire brucellosis by consuming contaminated fetuses, meat, placenta or milk (Woldemeskel, 2013). Currently 11 *Brucella* species are recognized with high genetic similarity although each has different host preference (C Mathew et al., 2015).

The species of *Brucella* bacteria with great zoonotic and economic importance are *B. abortus*, *B. melitensis*, and *B. suis* (C. Mathew et al., 2015). All these *Brucella* organisms can enter the body of animals through inhalation, ingestion and mucous membrane or broken skin (Corbel, 2006). Brucellosis has a worldwide distribution (De Massis *et al.*, 2019) where Africa is one of the endemic areas. In Ethiopia, it is found to be one of the endemic disease of livestock which results in significant loss of productivity through abortion, late first calving age, long calving interval time, low herd fertility and comparatively low milk production (Abebe et al., 2017a); Megersa *et al.*, 2011). According to Muma *et al.*, (2007) and Schelling *et al.*, (2003) report, cows infected with *Brucella* are three to four times more likely to abort than unexposed cows. Additionally, this disease posed a barrier to export and import of animals, constraining livestock trade and is an impediment to free animal movement (Yilma et al., 2016).

In human, brucellosis is a debilitating disease that lacks pathognomonic symptoms (Ducrottoy *et al.*, 2017), representing a major public health hazard, which affects social wellbeing and stability in many countries (Njeru et al., 2016). The disease spread when people consume unpasteurized contaminated milk, raw liver (Gutema and Tesfaye, 2019) and contact with infected tissues and discharge (Bosilkovski, 2015). There is an increased incidence of brucellosis in veterinarians, slaughter house workers and laboratory personnel (Esmaeili et al., 2016). Based on the nature of the disease and ease of transmission, the pastoral society are usually at great risk of contracting

brucellosis due to their habit of consumption of raw milk and close physical contact with animals (Abbas and Agab, 2002). However, because of the difficulty to access pastoral communities, the occurrence and the control of brucellosis is poorly understood both in humans and animals in the pastoral settings of the Sub-Saharan Africa (McDermott and Arimi, 2002). In pastoral regions of Ethiopia, brucellosis in animals and humans has been reported by different authors where the prevalence was quite varying (Yohannes *et al.*, 2013). According to (Zerfu *et al.*, 2018), the incidence rates of brucellosis in humans of pastoral and sedentary system origins were estimated at 160 and 28 per 100,000 persons in a year, respectively.

Even though, many studies have made on the seroprevalence of camel and human brucellosis, there is no clear understanding of the geographic pattern of the disease. Additionally, the public health implication of brucellosis in the pastoral areas of Afar region has not been extensively studied and evaluated by diagnostic techniques rather than relying on survey works (Zerfu *et al.*, 2018). Hence, the availability of recent finding could aid in instituting proper control and prevention measures against this disease for animal owners and communities of the areas at large. Therefore, the present study was made to estimate seroprevalence of brucellosis in camels and exposed individuals and to investigate potential risk factors in Amibara district of Afar Region; Ethiopia.

Materials and Methods

Description of the study area

This study was conducted in Amibara district of Gabirasu zone (Zone 3 of Afar region of Ethiopia) located in the Middle Awash Valley (Figure 1). Amibara district is about 250km to the North East of Addis Ababa and has 19 kebeles with total population of ~63,378, of which 35,374 were men and 28,004 women. The altitude of Amibara district is 740m above sea level. Fourteen years climatic data on monthly basis showed that the average maximum and minimum temperature of the area is 34°C and 19°C, respectively, and its annual total rainfall is about 571 mm (Chekol and Mnalku, 2012). The livestock population of the Amibara district is composed of 103,959 cattle, 122,526 goats, 48,043 sheep, 3,888 donkeys and 39,995 camels (CSA, 2007).

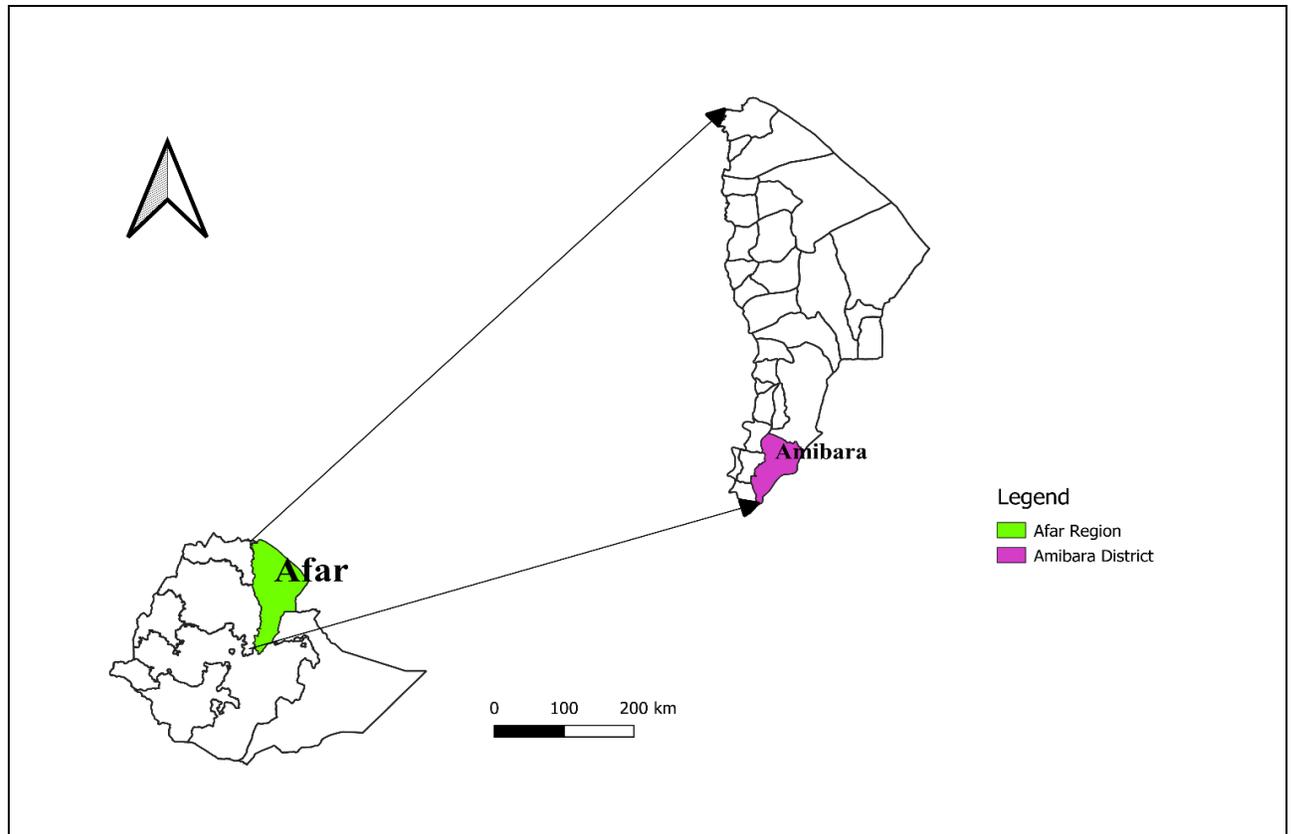


Figure 1: Map of Afar Regional State and proposed study district

Source: Diva GIS

Study Population

In the present study, the target study populations were herds of *camelus dromedarius* in the hands of pastoralists with no history of vaccination. Camels older than six months of age were included into the study as the disease wasn't common in the animals less than 6 months of age due to maternal antibody. Camels age was classified into ≤ 4 years, 4-10 years and >10 years as young, adult and old age group respectively according to (Gizaw *et al.*, 2017). To collect human sample, the target study groups were the owners of the sampled camels. Maximum of four individuals were recruited into the study from each house hold based on their interest.

Study design and sampling techniques

A cross-sectional study design was used from October 2019 to May 2020 in order to determine seroprevalence of brucellosis in both camel and the owners of the sampled camel. Study kebeles were selected purposively based camel population and accessibility.

To select camel herds in the proposed kebeles, convenience sampling techniques was used based on the willingness of herd owners to cooperate and accessibility during the period of study. Then each herd was stratified into subgroup based on age and sex to ensure equal representation of all the subgroup. From each subgroup, individual animals were selected by systematic random sampling technique.

Sample size determination of study animals

The sample size for serological study of brucellosis in camel was estimated based on the previous study report by (Hadush *et al.*, 2013) and (Gizaw *et al.*, 2017) in Afar region. Therefore, the minimum required sample size was calculated using the formula described by (Thrustfield, 2007), with defined precision of 5 % and level of confidence interval of 95%. So, by considering previous seroprevalence of camel brucellosis as 4.1%, the minimum required sample size was calculated to be 61. However, in order to increase precision and reduce standard error, the minimum sample size obtained by calculation was increased by four-fold. Therefore, about 250 camels were considered for this study from selected kebeles of Amibara district.

Sample size determination of human participant

To select human participant, purposive sampling techniques was employed. Accordingly, all the owners of sampled camels were recruited into the study in which maximum of four individuals were selected from each house hold based on their interest. Consequently, 120 individuals were included into the present study.

Blood sample collection from animals

Blood samples were collected from each camel preceded by proper restraining to avoid unexpected personal injury and to minimizing unnecessary stress that might be happen to the animals. After disinfecting the site of jugular vein, 10 ml of blood sample was collected into sterile plain vacutainer tube from each camel. Then, the samples were labeled by using code describing herd number, sex, body condition and kebeles. Then the samples were taken to

laboratory and sera separated after maintaining at room temperature in slanted position for 24hrs and centrifuging at 1500 rpm for 5 minutes in WARC. Finally, the serum was gently decanted into sterile cryovials (1.8ml), labeled and stored at -20⁰c until it gets transported to National Veterinary Institute (NVI), serology department, Bishoftu, Ethiopia

In human, about 5-7 ml of peripheral blood sample was collected from each respondent preceded by verbal agreement. Nurses working in Melka Werer Health station collected blood samples from the participants. Then the sera were separated from the blood after allowing staying in slanted position at room temperature for 24hrs and centrifuging at 1500 rpm for 5 minutes. Finally, the serum from each sample was decanted into the cryovials (1.8 ml) labeled, packed and stored in WARC Animal health research laboratory at -20⁰C.

Questionnaire survey

In the present study, the owners of the sampled camels and interested individuals were interviewed using semi-structured questionnaire. The questionnaire focused on the knowledge attitude and practice of the society about zoonotic transmission of brucellosis from camel to human.

Laboratory Diagnosis

Rose Bengal plate test

In this study, camel sera were screened for brucellosis by RBPT at National Veterinary Institute (NVI) of Ethiopia. But human sera were screened by RBPT at WARC and positive to RBPT were further confirmed by CFT at NVI. RBPT was conducted according to the procedures described by the World Organization for Animal Health (OIE, 2018). *B. abortus* antigen (Lillidale Diagnostics, Holt wimborne, Dorset, BH21 7DG, United Kingdom) and their positive and negative control sera were used to detect the Brucella antibodies following the manufactures' instructions. Agglutinations were recorded as 0, +, ++ and +++, according to the degree of agglutination (Nielsen, 2002). A score of 0 indicates the absence of agglutination; + indicates

barely visible agglutination; ++ indicates fine agglutination, and +++ indicates coarse clumping. The presence of agglutination at any degree was considered as positive reaction while the absence of agglutination was considered as negative.

Complement Fixation Test (CFT)

Serum samples reactive to RBPT were further tested by CFT for confirmation using standard *B. abortus* antigen S99 (New Haw, Addlestone, Surrey, KT15, and 3NB-UK). Preparation of the reagent is evaluated by titration and was performed according to the protocol recommended by World Organization for Animal Health(OIE, 2008). Sera with strong reaction, more than 75% fixation of complement (3+) at a dilution of 1:5 or at least with 50% fixation of complement (2+) at a dilution of 1:10 and above was considered as positive and lack of fixation/complete hemolysis was considered as negative result. Only samples that gave signals for both RBPT and CFT were considered positive since no single test is appropriate in all epidemiological situations due to problems of sensitivity and or specificity of the tests as recommended by OIE and other reports(Tumwine *et al.*, 2015).

Data Analysis

Risk factors believed to be associated with the occurrence of brucellosis, serological results and questionnaires data were recorded in a Microsoft Excel® Spread Sheet and analysis was done using R-Software version 4.0.0. Prevalence was calculated by dividing the number of positive animals and humans to the total number of animals and humans tested. Fisher's exact test was used to calculate associations of risk factors with brucella seropositivity. In the current study, the numbers of outcomes of interest were less than 10% of the total sample size of camel and human. Thus, Firth's bias reduced logistic regression model was used to measure the association of potential risk factors with brucella seropositivity (Puhr *et al.*, 2017). Odds ratio (OR) was used to measure the degree of association between risk factors such as herd size, age, sex, body condition, parity number, abortion history and RFM with animal level seroprevalence. P-value less than 0.05 were considered statistically significant in all analysis.

Ethical consideration

The protocol for field studies and collection of animal materials was approved by animal research ethical review committee of the College of Veterinary Medicine and Agriculture (CVMA) with certificate reference number of VM/ERC/03/01/12/2020. Pastoralists were also informed the aim of the study and their agreement was sought before commencement of questionnaire data collection. For collection of blood sample from the human participants, the work had earned recognition and written consent was obtained from Afar Regional Health Bureau by reference number of QAPB011/3934.

Result

Seroprevalence of camel brucellosis and associated risk factors

Of the 250 camel samples tested, 19 were positive by RBPT and 12 confirmed by CFT. Thus, the overall seroprevalence of camel brucellosis in the current study is 7.6% (95% CI: 0.049-0.1156) using RBPT and 3.2% (95% CI: 0.0163-0.062) by combined RBPT and CFT. In table 1, the result of sex wise brucellosis seroprevalence and the association of abortion with brucella infection in camel were indicated. As a result, abortion history showed statistically significant associated with brucella seropositivity ($P \leq 0.01^*$) which means abortion in camels is mainly due to brucellosis. It was also indicated that, female animals having a history of abortion were 36.2 times more tested positive for brucellosis than non-aborted animals (OR=36.2, 95%CI=7.52-351.9).

Table 1: The overall seroprevalence and association of abortion with brucellosis in camel

Variables	Number tested	N_o of RBPT positive (%)	N_o of CFT Positive (%)	P-value	OR (95% CI)
Sex				0.814	0.7(0.075-91.85)
Male	9	1	0(0)		
Female	223	18	8(3.2)		
Abortion History**				$\leq 0.01^*$	36.2(7.52-351.9)
Yes	37	15(42.1)	7(19.23)		
No	204	4(3.4)	1(0.284)		

** Only female animals were considered, * significant,

Association of potential risk factors with brucella seropositivity in camel was indicated (Table 2). As a result, no statistically significant difference of brucella seropositivity was observed between both sexes of camel ($p > 0.05$). Additionally; age ($P \leq 0.004$), history of abortion ($P \leq 0.005$), body condition ($P \leq 0.003$) and number of parity ($P \leq 0.001$) were found significantly associated with brucella seropositivity in camel. However, herd size and placental retention were not stand significantly with brucellosis in camels ($P > 0.05$).

Table 2: Association of risk factors with brucella seropositivity in camel

Variables	Number tested	Seropositive	Prevalence (%)	χ^2	P-value
<i>Sex</i>				0.309 ^a	1
Male	9	0	0		
Female	241	8	3.43		
<i>Age</i>				10.7 ^b	$\leq 0.004^*$
Young	34	0	0		
Adult	165	2	1.21		
Old	51	6	11.764		
<i>Body condition</i>				10.26 ^b	$\leq 0.003^*$
Poor	53	6	11.3		
Medium	158	2	1.266		
Good	39	0	0		
<i>Herd size</i>				0.926 ^b	0.6357
<20	42	2	4.76		
20-50	92	2	2.17		
>50	116	4	3.45		
<i>Number of Parity**</i>				11.2 ^b	$\leq 0.001^*$
Null	32	0	0		
Less than or =3	160	2	1.25		
Greater than 3	49	6	12.24		
<i>Abortion History**</i>				29.96 ^a	$\leq 0.005^*$
Aborted	37	7	18.92		
No Abortion	213	1	0.47		
<i>Placental retention**</i>				0.134 ^b	1
Yes	4	0	0		
No	229	8	3.5		

^bFishers exact test value, ^a- Chi- square value, *Significant; ** Only female considered

Multivariable analysis of risk factors associated with brucellosis in camel

Based on the multivariable Firth's bias reduced logistic regression analysis, only history of abortion independently associated with brucellosis in camel ($P \leq 0.002$). Briefly, camels having history of abortion were 49.6 times more tested positive for brucellosis than those with no history of abortion. Camels with number of parity greater than 3 were 2.75 times more at risk of contracting brucellosis than young camels (Table 3).

Table 3: Multivariable Firth bias reduced logistic regression analysis of factors associated with brucellosis Seropositivity in camel

Variables	Number tested	seropositive	Adjusted OR	(95% CI)	P-value
Parity Number					
Null	32	0	1	1	-
Less than or =3	160	2	0.15	(-5.31,3.233)	0.357
Greater than 3	49	6	2.75	(-195, 6.00)	0.511
Abortion History					
Yes	36	7	49.6	(2.148,6.34)	$\leq 0.002^*$
No	205	1		1	-

1: Reference

Serological results of human brucellosis

Of 120 human sera tested by RBPT, 12 were found reactive among which only 4 confirmed by CFT to be brucella seropositive. In this study, occupation of the study participant showed statistically significant association with brucella seropositivity in human ($P \leq 0.03$) based on fisher exact test (Table 4).

Table 4: socio-demographic characteristics and Brucellosis seroprevalence among the study participants

Variables	No- tested N(%)	RBPT +ve		CFT +ve		χ^2	P-value
		n	%	n	%		
Gender							0.19
Male	95(79.2)	8	8.4	2	2.1		
Female	25(20.8)	4	16	2	8		
Age						5 ^b	0.057
13-19 years	6(5)	1	16.67	1	16.67		
20-59years	79(65.8)	6	7.6	1	1.26		
Above 60 years	35(29.17)	5	14.3	2	5.71		
Educational status						3.7 ^b	0.786
Degree	1(0.83)	0	0.0	0	0.0		
Diploma	3(2.5)	0	0.0	0	0.0		
High school	10(8.33)	0	0.0	0	0.0		
Elementary	16(13.34)	2	12.5	1	6.25		
Read and write	9(7.5)	1	11.1	0	0.0		
Illiterate	81(67.5)	9	11.1	3	3.7		
Occupation						6.925 ^b	≤0.03*
Pastoralist	90(75)	7	7.78	2	2.22		
Government	22(18.34)	2	9.09	0	0.0		
Others	8(6.67)	3	37.5	2	25		
Marriage						2.6 ^b	0.484
Married	102(85%)	11	10.78	3	2.94		
Divorced	1(0.833)	0	0.0	0	0.0		
Single	17(14.17)	1	5.88	1	5.88		
Family size						1.694 ^b	0.375
1-2	30(25)	4	13.33	2	6.67		
3-5	58(48.33)	6	10.34	1	1.72		
Above 6	32(26.67)	2	6.25	1	3.12		

^bfisher exact test value, N₀-tested= Number of tested individuals

Multivariable analysis of risk factors associated with brucellosis in human

Following computation of univariable firth's bias-reduced logistic regression analysis, all socio-demographic risk factors were insignificantly associated with brucella seropositivity in human. Moreover, individuals with non-permanent work were 18.8 times more at risk of contracting brucellosis when compared with governmental employee and also showed statistically significant association ($P \leq 0.03^*$, 95% CI: 1.324, 2730.32) with brucella infection (Table 5).

Table 5: Multivariable firth's bias reduced logistic regression analysis of factors associated with brucellosis seropositivity in human

Variables	No of tested	seropositive	Adjusted OR	(95% CI)	P-value
Occupation					
Government	22	0	1	1	-
Others	8	2	18.85	(1.324, 2730.32)	$\leq 0.03^*$
Pastoralist	90	2	1.42	(0.11, 197.86)	0.817

No of tested=Number of Individuals tested, OR=Odds Ratio, 1: Reference

Results of questionnaire survey

Questionnaires were administered to all 120 participants to gather information regarding their knowledge about zoonotic diseases and management of their livestock. As a result, 80% of the respondents have no information of disease transmission from wild to domestic animals (Table 6). Additionally, 76.47% of the respondent herds their animals by mixing with different domestic animal species whereas majority of them keep their animals in national park and practice inappropriate disposal of the aborted fetus and placental membrane which are the major predisposing factors for the occurrence of brucellosis in cattle and camel (Table 6).

Table 6: Frequencies and percentages for the questionnaire survey of respondent of camel brucellosis in the study area

Variables	Response category	frequency	%
Do you think that diseases can get transmit from animal to human?	Yes	24	20
	No	96	80
How do you herd your animals?	(N=102)		
	Mix at gazing point	78	76.47
	Mix at watering point	7	6.86
	All separately	22	21.57
	All together	13	12.74
Do you Keep animals in Nation park*	(N=90)		
	yes	80	88.89
Frequent occurrence of abortion**	(N=102)		
	Yes	68	66.67
	No	34	33.33
Which animals frequently abort**	(N=102)		
	Cattle	15	14.7
	Camel	9	8.82
	Small ruminant	54	52.94
	No Animal Abort	24	23.53
Disposal of placental membrane and aborted fetus	(N=102)		
	dispose properly	5	4.9
	Throw it on open field	83	81.37
	Report to CAHWS	14	13.72

*Only pastoralist considered, ** only respondents having animals considered.

Additionally, consumption of raw meat and milk, knowledge of brucellosis and other zoonotic diseases were considered and didn't stand significantly ($p>0.05$) with brucella seropositivity in human. Even though there is no statistically significant association, all seropositive individuals were consumers of raw milk which elucidated that, raw milk consumption is more associated with brucella infection in the area. In the current study, 90% of the respondent didn't know about brucellosis and it comprise of 10 positive animals and all reactive individuals.

Table 7: Association of knowledge and practice of the camel owners with Brucella seropositivity

Variables	Respondents	Positive Animals owned	Positive respondents	Fisher value	P-value
	n (%)	(%)	n (%)		
Do you drink raw milk?				-	1
yes	110(91.7)	12(2.79)	4(3.63)		
No	10(8.3)	0(0)	0(0)		
Do you consume raw meat?				-	0.572
yes	27(22.5)	3(0.69)	1(3.7)		
No	94(78.33)	9(2.08)	3(3.2)		
Do you know zoonotic diseases:				-	0.318
Yes	34(28.33)	8(1.85)	2(5.88)		
No	86(71.67)	4(0.93)	2(2.32)		
Do you know brucellosis				-	1
yes	12(10)	2(0.46)	0(0.0)		
No	108(90)	10(2.32)	4(3.7)		
Do you use PG during handling dystocia case				-	≤0.05*
yes	12(10)	2(0.46)	2(16.67)		
No	108(90)	10(2.32)	2(1.85)		
How do you shelter camels?				9.08 ^b	≤0.03*
All separately	82(68.33)	10(2.32)	1(1.22)		
All sheltered together	2(1.67)	0(0.0)	1(50)		
Some sheltered together	24(20)	2(0.46)	2(8.33)		
No idea	12(10)	0(0)	0(0)		

CAHWS: Community Animal Health workers, ^bfisher exact test value, ^a chi-square value, *Significant.

In the present study, 91.7% of the respondent drink raw milk among which 3.63% of them tested positive for brucellosis (Table 7).

DISCUSSION

Brucellosis is an infectious bacterial disease affecting all domestic and wild animals with significant economic and public health importance. In the current study, the animal based seroprevalence of camel brucellosis in Amibara district of Afar Region was 7.6% by RBPT and 3.2% by combined RBPT and CFT. Thus, the current study revealed that the overall seroprevalence of camel brucellosis was 3.2% (8/250).

This finding is comparable with the earlier reports of 3.1% in Yabello District of Borena Zone by (Admasu and Kaynata, 2017)), 3.37% in Mehoni district of south eastern Tigray by (Habtamu *et al.*, 2015), and 3% in southern lowland of Ethiopia by (Jara *et al.*, 2020). However, it is lower when compared to 5.7% in three camel rearing regions(Afar, somali and borena) by (Teshome *et al.*, 2003), 7.6% in Awash-Fentale and Amibara districts of Afar region by (Zewold and Mekonnen, 2012) and 5.4% in four districts of Afar regional state by (Bekele *et al.*, 2013). The current study result is also lower than some reports in other African and Middle East countries when compared with a prevalence of 30.5% in Sudan by (Mokhtar *et al.*, 2007), 7.61% in Egypt by (Hassanain and Ahmed, 2012) and 19.4% in Jordan by (Dawood, 2008). 21.74%(5/23) herd level seroprevalence of camel brucellosis was recorded in the present study which is similar with the reports of (Hadush *et al.*, 2013) in Afar region of North eastern Ethiopia.

In the present study, higher number of brucella seropositivity was seen in adults and older camels than in younger animals as it is a disease of sexually matured and pregnant animals which agree with the findings of (Abebe *et al.*, 2017b). In animals, sexually maturity and pregnancy favors the occurrence of brucella infection due to increased production of erythritol sugar as the animals become sexually matured specially during pregnancy which enhance the multiplication of pathogen(Gizaw *et al.*, 2017).

Herd size of the camels was also considered in the present study to see the distribution of the infection in small, medium and large herd group since the probability of contact between animals increases as herd size increases which results in more chance of infection particularly during calving and abortion.

However, no statistically significant difference, ($p>0.05$) of brucellosis seropositivity observed in different herd size of camels based on fisher exact test even though it disagree with finding of (Gizaw *et al.*, 2017). Nutrition plays a crucial role in boosting immunity against various infectious diseases. Underfed animals are expected to have poor body condition which is manifested by decreased immunity, recurrent occurrence of infection and susceptibility to non-infectious organisms under normal condition (Kamili *et al.*, 2006) ; (Radostits *et al.*, 2007). Taking this into account, body condition of the camels was considered during this study to see the status of brucellosis in different body condition scores. As a result, statistically significant higher seropositivity of brucellosis was observed in camels with poor body condition score than camels with medium or good body condition score ($P\leq 0.01$) whereas similar findings was also reported by(Abebe *et al.*, 2017b).

Human brucellosis is a widespread disease in pastoral areas of different African and Asian countries (Abbas and Agab, 2002). In the present study, an overall human brucellosis seropositivity of 3.33% was identified by combined RBPT and CFT. This finding is fairly in agreement with the findings of (Tolosa *et al.*, 2007) in Jimma University hospital, (Kassahun *et al.*, 2006) in Addis Ababa, (Eshetu *et al.*, 2018) in Eastern Ethiopia and (Tibesso *et al.*, 2014) in Adami Tullu who reported 3.6%, 4.8%, 4.8% and 2.15% respectively. However, the result of the present study is lower than the finding of (Vancelik *et al.*, 2008) in Turkey and (Sharma *et al.*, 2016) in India who reported 5.4% and 4.96% respectively.

However, it is higher than the finding of (Rahman *et al.*, 2016) in Bangladesh and (Haileselassie *et al.*, 2011) in western who reported 2.0%, 1.2% respectively. In pastoral and agro-pastoral area, prevalence of brucellosis in human is greatly influenced by status of the disease in animals (Omer *et al.*, 2002). Brucellosis occurrence fluctuates extensively, not only between countries but also within a country(Khan and Zahoor, 2018). So, the possible justification for the variation of the current human brucellosis sero-prevalence from previous report was due to the difference in the sample size, difference in the life style of the society, type of diagnostic protocol employed and socio-economic status of the study population.

One research work conducted in Malaysia showed that, males are at greater risk of contracting brucellosis since they commonly involved in the handling of livestock and consume uncooked animal product specially in pastoral area(Tay *et al.*, 2015). However, the finding of the current study indicated that, gender is not significantly associated with brucellosis seropositivity and didn't much with the report of the above research finding in Malaysia. This may be due to small sample size of the present study and shared responsibility among male and female of Afar pastoralist.

More than 90% of peoples in Afar region rely on pastoral activity and they spend almost all their entire life with their animals. The main source of their food is also animals' origin specially milk which is commonly consumed without boiling. In the current study, 96.4% of the respondents drink raw milk which agree with the findings of (Ntirandekura *et al.*, 2018) who reported drinking unpasteurized milk and eating non-inspected meat to be among possible factors which could contribute to transmission of brucellosis in humans. Non-significant association of educational background with brucellosis seropositivity of the respondent encountered in the current study ($p>0.05$) because of low basic infrastructure in the area aligned with mobile life style of the society.

However, study conducted in Kenya shows a high level of knowledge of brucellosis in pastoral communities where respondents reported brucellosis to be a zoonotic disease and abortion as its common symptom (Obonyo and Gufu, 2015) This might be due to the difference in the educational access and coverage in pastoral area of the two countries. Even though, association of raw milk consumption and brucella seropositivity is statistically not significant, all of the seropositive individuals were consumers of raw milk. 78.33% (n=94) of the present study participant told that, they do not consume raw meat which is mainly concerned with cultural issue. This shows, the rate of brucella infection in the present study area is greatly associated with drinking of raw milk and contact with infected animals than consumption of uncooked meat. During handling of dystocia cases, majority of the respondents (98.2%) reported that they used hand pulling techniques without using protective gloves (90%). Study conduct by (Eshetu *et al.*, 2018) indicated , brucellosis were 5.11 times more in those who had assist animals during parturition compared to those who did not.

Regarding the management of aborted fetal membrane/aborted fetus and discharge, 83(81.37%) of the respondent told that, they throw it on the field. Additionally, it was also encountered that, pastoralist leave died camel calf at home to show the mother she camel every morning by considering that, the activity will instinct milk letdown. So, these activities can be the major predisposing factors for widespread occurrence of brucellosis both in camels, other domestic animals and the owners. However, 4.9% of the respondent practiced proper disposal of the aborted fetal materials. In this study, about 90% of the respondent had never heard about brucellosis and 65% of them need to acquire detailed information about it. Finally, the major symptoms of brucellosis were reported to respondents and about 99.1% of them were interested in giving blood samples for screening of brucellosis.

CONCLUSION AND RECOMMENDATIONS

Brucellosis is one of the most important bacterial diseases of domestic and wild animals with significant economic and public health importance. Both animals and human can contract brucellosis through direct contact with infected animals and their excreta, ingestion of infected materials and sometimes through aerosol transmission. The results of the present study indicated that, brucellosis is a common health problem in camel and human in Amibara district of Afar region. The public health importance of this disease is associated with raw milk consumption and close contact with the animals having history of recent abortion.

Therefore, based on the present finding, the following recommendations are worth mentioning:

- A comprehensive active assessment and surveillance studies are required to understand the distribution of brucellosis and its transmission dynamics at domestic-wild life interface and its zoonotic significance.
- Working to control risk factors, establishing brucella diagnostic service in human clinics and hospitals and implementation of One health approach framework to attain optimal health for people and animals.
- Enhancing the awareness level of the pastoral society about the public health and economic importance of brucellosis through training and workshop.

- Detailed studies on isolation and characterization of circulating strain and biotypes in the area need to be conducted.

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