

Full Length Research Paper

The traditional livestock breeding practices of Somali pastoralists and small ruminant brucellosis seroprevalence survey in selected villages of Gardo District of Puntland State of Somalia

Abdiqani Ahmed Farah* and Abdullahi Farah

Department of Veterinary Medicine, East Africa University, Gardo, Somalia.

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A cross-sectional study was carried out to define the seroprevalence of brucellosis in target animals and the perception of the community on the disease in sheep and goat. Study was undertaken in four purposefully selected sub-regions of the Gardo district of Karkaar region of Somalia, namely: Kubo, Xabaal-reer, Guud-cad, and Cambaaro of Gardo. The small ruminants studied comprised of the 225 indigenous Somali Caprine and 180 black head Somali Ovine in pastoral production systems. Among another thing in dealing with the disease, the overwhelming of them (85%) buy drugs off the shelf, while the rest (15%) seek help from veterinarians or Community-Based Animal Health Workers (CAHWs). In addition, caprine and ovine RBPT positive males and females were compared and found that at 95% CI there are no significant differences between each species' gender RBPT positives, respectively. For the Four hundred and two sera samples screened by RBPT tested 34 (9.35%) were confirmed to have been positive. According to species basis, the prevalence of caprine over ovine is not significantly different (8.2 and 8.9%, respectively). Further Logistic regression analysis was performed, and statistically significant differences were not observed between the gender of the Caprine species tested. However, the female ovine is significantly lower (6.2%) than that of male (16%) with P-value of 4.4×10^{-2} and odd ratio of 0.35 (0.50–4.01). The result in this study is higher than the similar ones recorded conducted in the neighboring countries thus, warrants further confirmatory tests.

Key words: Brucellosis, Karkaar region, sero-prevalence, small ruminant, ovine and caprine.

INTRODUCTION

Somalia's terrain is made up of dry and semi-arid rangelands, and pastoralism is the most suitable usage

for the area. Livestock, mainly consisting of sheep, goats, cattle, and camel not only provides the majority of the

*Corresponding author. E-mail: a.farah@eauqardho.edu.so

ORCID ID: <https://orcid.org/0000-0002-3605-6722>

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country's GDP but also serves as the main source of income for pastoralists (Mohamud et al., 2022). Somalia by a long way has a large livestock population in East Africa, with an estimated 7.1 million camels, 5.3 million cattle, 30.9 million goats and 13.6 million sheep. On that note, livestock is the backbone of the Somali economy contributing around 80% to the agricultural GDP and 45% to the national GDP. The Somali state of Puntland is well known for its large number of small ruminants. The main animal species within livestock enterprises in the Northeastern Puntland state of Somalia are sheep, goats, and camels (Muigai et al., 2016; ILRI, 2023). In light of the above, Nomads and semi-pastoralists, who are dependent upon livestock for their livelihood, make up a large portion of the population (Land governance in IGAD region, 2024).

Although it varies, depending on the location, pastoralists derive all their income from the animals and consume the products themselves (Mohamud et al., 2022). Nomadic pastoralists lifestyle depends on mobility thus, migrate with their flocks to graze their animals in the pasture. Like any other pastoralist in the region, Somali pastoralism is directly linked to zoonotic infections, which are diseases that can spread from animals to human due to the close interaction pastoralists have with their animals (Desta, 2016). Even though Somalia depends heavily on livestock production, it nevertheless confronts several difficulties, including a shortage of veterinary services, frequent droughts, climate change, deforestation, urbanization, and disease outbreaks. Never-the-less, the community and nomadic grounds are essential as a source of pasture and organic feed; even in terms of pasture and water resource utilization, their animals recover more quickly and can withstand shocks since nomads effectively tend to their herds (Desta, 2016).

Despite this, the nation underutilizes this enormous resource since, among other things, illnesses account for a large portion of the factors affecting the sector's production. The brucellosis is one of these illnesses. Bacteria belonging to the genus *Brucella* are the cause of the disease brucellosis. There are no proper studies that has been done in Somali, but weighing the neighboring Ethiopia, which has the same style of herding, particularly Somali region of Ethiopia study done on brucellosis showed that seroprevalence of 5.71% in camels (Balcha and Fentie, 2011), 0.48 and 3.09% in sheep and goats, respectively in pastoral areas of Ethiopia (Tsehay et al., 2014).

The primary cause of caprine and ovine brucellosis is either *Brucella melitensis* (OIE, 2008), or *Brucella abortus* (Lilenbaum et al., 2007). The disease naturally infect sheep and goats and is characterized by abortion, stillbirth, and birth of weak offspring in females and acute orchitis (swelling or pain in one or both testicles, usually from an infection or virus) and epididymitis (swelling or pain in the back of the testicle in the coiled tube that stores and carries sperm) in males, and may result in

infertility (Rodostits et al., 2007).

Despite being ignored, brucellosis poses a risk to the public's health as well as a burden on farmers' animals health. Therefore, it is critical that nations take the required steps to contain and eradicate the bacterial disease (Djangwani et al., 2021). While brucellosis has been eradicated in most industrialized regions, its occurrence is increasing in developing countries (Benkirane, 2006; Al-Majali et al., 2007). The *B. melitensis* is particularly common in the Mediterranean. It also occurs in the Middle East, Central Asia, around the Arabian Gulf, and in some countries of Central America. This organism has been reported from Africa and India (OIE, 2009). In Ethiopia, few studies have been conducted so far on small ruminant brucellosis (Ashenafi et al., 2007; Tekelye and Kasali, 1990; Teshale et al., 2006; Zinsstag et al., 2005) regardless, there was very little information on the status of the disease in pastoral areas of Jijiga. On one hand, the livelihood of the pastoralists in these areas mainly depends on their livestock, and hence, the disease could impose a tremendous economic loss due to reproductive wastages such as infertility, abortion, stillbirth, and the likes. On the other hand, due to their dietary habits, these communities seem to be at stake of being infected by brucellosis. To this effect, the objectives of this study were therefore to determine the sero-prevalence of small ruminant brucellosis and to assess the perception of the community about the disease in sheep and goats of Jijiga District, Somali Regional State of Ethiopia.

The zoonotic effect of brucellosis on the health of consumers and nomadic people is serious in developing nations, especially Somalia, which has a large number of pastoral areas with poor veterinary and health infrastructure and facilities, a low number of medical experts, and a low supply of medicinal inputs (Desta, 2016). Thus, the study's goal is to contribute to highlighting the necessity of a robust inter-sectoral collaboration among veterinary, medical, and public health institutions at the federal government and federal member state level in terms of a one-health approach, even though brucellosis is not a significant public health concern in Somalia (Hassan-Kadle, 2015).

MATERIALS AND METHODS

Study animals, areas, and design

The study was undertaken in four purposefully selected sub-regions of the Gardo district, namely: Kubo, Xabaal-reer, Guud-cad, and Cambaaro. Gardo is a city in the northeastern Karlaar region of Somalia and the administrative capital of about 1000 km north-eastern Mogadishu and 220km south-west of Bossaaso (latitude: 9° 29' 59.99" N, longitude: 49 above sea level), where the main economic activity is pastoralism. The small ruminants under study comprised of the 225 indigenous Somali Caprine and 180 black head Somali Ovine, 405 of small ruminants in total, that are mainly in pastoral production systems (Mason, 1996) with no history of vaccination against brucellosis. Both sexes and different age

groups were included in the study. A cross-sectional study was carried out from October 2023 to March 2024 to determine the seroprevalence of brucellosis in target animals and to assess the perception of the community about the disease in sheep and goats. A structured questionnaire format about the history of the herd such as animals' grazing and drinking manner, production system, breeding system, Knowledge about brucellosis, Handling method of aborted fetus and Placenta in the cantonment, delivery or calving, and how the respective herder or owner manages health problems in their flock was developed.

Serological Rose Bengal plate test (RBPT)

The process outlined by Nielsen (2002) and Nielsen and Yu (2010) was adhered to for the RBPT. Before the test was run, the sera antigen was taken out of the refrigerator and allowed to come to room temperature for at least half an hour. RBPT Brucella antigen from Guutale laboratories at Gardo district, and positive as well as negative control sera from Bossaso animal quarantine laboratory were used. Briefly 40 µl of sera samples were dispensed on to the plate, and 40 µl of RBPT antigen was dropped alongside the sera. Using an applicator stick, the antigen and the sera were mixed and examined for agglutination. Positive and negative controls were employed for interpretation of the results. Results of RBPT were interpreted as 0, +, as has been described by Nielsen (2002) and Nielsen and Yu (2010), with 0 = no agglutination; + visible agglutination. Those samples with no agglutination (0) were recorded as negative while those with + were recorded as positive.

Data analysis

Data from the field were analyzed on a Microsoft Excel Spreadsheet, the categorical variables were analyzed in percentages and nonparametric inferential such as χ^2 test in excel, SPSS, and r platforms. The structured questionnaire with regard to the history of herd were analyzed in a descriptive percentages and frequencies, then presented in table format: Odds ratio and lower and upper 95% confidence interval, and χ^2 were computed to see the degree of association of the risk factors with brucellosis seropositivity. For all analysis, a *P value* less than 0.05 were taken as significant and presented in table format.

RESULTS

Interviewee's response

The structured questionnaire with regard to the history of the herd was analyzed in percentages and presented in table format (Table 1). Out of the 40 respondents, their respective herd sizes were as follows: 17.5% had been less than or equal to 50, 30% were between 51 and 100, 40% had been between 101 and 150, and lastly 12.5% of the herd size were greater or equal to 200. As for animals grazing and drinking together habit, 87.5% grazed and drunk together, while 12.5% did the custom otherwise. Production system of the herds observed were 75% extensive in which the sheep and goats are grazed in the open field, leaving them for the whole season, while 25% had been semi-intensive, in which limited free-range grazing and feeding in stalls were combined (Shivakumara and Kiran, 2019). In addition, the 65% of

breeding system of the respective herds observed share from the neighboring hamlets or households, 10% of the respondents rear their own, while 25% of respondent's breeding was communal. When asked their acquaintance on the brucellosis matter, 29 (72.5%) responded positively, while 11 (27.5%) did have prior knowledge on the disease. When asked handling method of aborted fetus and Placenta in the particular cantonment, the response was contrasting one as 67.5% leave the fetus in the herd, 27.5% throw away further afield, while only 5.0% burn it. When asked the respondents on calving habits, 17.5% assist animals whilst in labor, whereas 82.5% of them do not assist animal in calving. As far as the managing health issues of respondent's flocks, the overwhelming of them (85%) buy drugs off the shelf and treat the animal with it, while the rest (15%) seek help from veterinarians/CAHWs (Table 1).

Small ruminant brucellosis sero-survey in selected villages of Gardo district

The small ruminants under study comprised of the 225 indigenous Somali caprine and 180 black head Somali ovine that are mainly in pastoral production systems. As far as the number female and male tested is concerned two-sample Assuming Unequal Variances t-Test was carried out and the female species of both ovine and caprine tested is highly significantly bigger in number than their male counter parts with a P-value of 1.23×10^{-5} at 95% CI (Figure 1a).

By the same token male and female caprine and ovine as well were statistically tested and found that there is a significant difference between the genders respectively with a P-value of 1.28×10^{-2} and 1.28×10^{-3} at 95% CI respectively when analyzed in two-sample assuming unequal variances t-Test (Figure 1b and c). In addition, caprine and ovine RBPT positive Male and Female were compared and found that at 95% CI there are no significant difference between each species gender (Figure 1d and e). This finding indicates that the gender of species, irrespective of their number, the rate of infection is the same.

In Figure 1a, b, c, d, and e male and female number was tested for both species. The female species of both ovine and caprine tested are highly significantly bigger in number than their corresponding gender with a p-value of 1.23×10^{-5} at 95% CI (Figure 1a). Also, the female caprine tested were significantly higher than their counter part with a P-value of 1.28×10^{-2} at 95% CI.

Also, the female ovine tested were significantly higher than their opposite sex part with a P-value of 1.28×10^{-3} at 95% CI (Figure 1b and c). In addition, caprine RBPT positive Male and Female and Ovine Male and Female RBPT positive were tested if there is significant difference between each species, found that there is no significance difference between the gender of each species (Figure 1d and e).

Table 1. The interviewee's responses: The traditional livestock breeding methods used by Somali pastoralists, both men and women, as well as their understandings on the matter.

Variable	Scoring	Response frequency (n = 40) (%)
Herd size		
≤50	1	7 (17.5)
51-100	2	12 (30.0)
101-150	3	16 (40.0)
≥200	4	5 (12.5)
Do your animals graze and drink together with other animals?		
Yes	1	35 (87.5)
No	2	5 (12.5)
Production system		
Extensive	1	30 (75.0)
Semi intensive	2	10 (25.0)
Breeding system		
From neighboring	1	26 (65)
Individual	2	4 (10)
Communal	3	10 (25)
Know about brucellosis		
Yes	1	29 (72.5)
No	2	11 (27.5)
Handling method of aborted fetus and Placenta in the cantonment		
Leave them in the herd	1	27 (67.5)
Throw away	2	11 (27.5)
Burn	3	2 (5.0)
Do you Assist animals while delivery calving		
Yes	1	7 (17.5)
No	2	33 (82.5)
How do you manage health problems in your flock?		
Buy drug and treat	1	34 (85)
Consult veterinarians/CAHWs	2	6 (15)

Seroprevalence

As aforementioned, four hundred and two sera samples were screened by RBPT, and all samples tested 34 (9.35%) were confirmed to have been positive. According to species basis, the prevalence on caprine over ovine is not significantly difference 8.2 and 8.9%, respectively, with a p-value of 0.710. Among the four sub-districts (Kubo, Xabaal-reer, Guudad, and Ambaaro) at Gardo District regarding Karkaar region with reference to Puntland State of Somalia, the prevalence of the disease among the species within a specific district as well as among districts are not significantly different when tested (Table 2).

Logistic regression analysis was performed to test the sero-prevalence of brucellosis according to sex of animal

risk factor (caprine and ovine) in sub-districts of Gardo in Karkaar region. Statistically significant differences were not observed between the gender of the caprine species tested with a p-value of 7.98×10^{-1} with an odd ratio and 95% CI of 0.875 (0.314–2.46). However, the variation between the ovine species was statistically significant as that of the female ovine is significantly lower (6.2%) than that of the male (16%) with P-value of 4.4×10^{-2} with an odd ratio and 95% CI of 0.35 (0.50 – 4.01) (Table 3).

DISCUSSION

Questionnaire survey

The minimum herd size the respondents rear was less

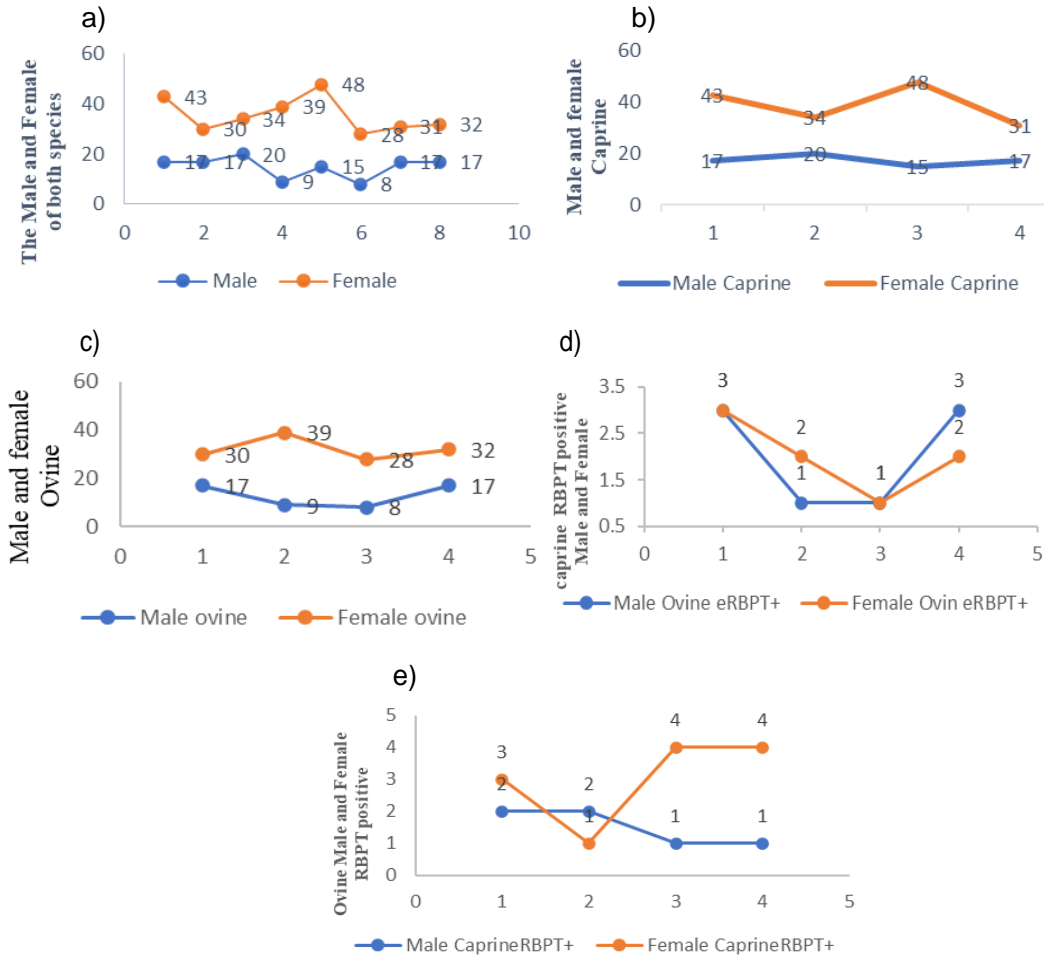


Figure 1. a) The Male and Female of both species, b) Male and female Caprine, c) Male and female Ovine, d) caprine RBPT positive Male and Female, and e) Ovine Male and Female RBPT positive.

than 50 and maximum of 101 up to 150 and reflects the regular herd size of a nomadic family in the Karkar region year in year out. The further enquiries made ascertained that it's the unpredictability of the rainy seasons in a semi-arid region Karkaar geographically falls. The extreme drought episodes are becoming more common and have a substantial impact on pastoral livelihoods as it affects the sustainable size of their herd and its rebuilding (Narbat, 2022; Hassan, 2017). As far as the observed grazing and drinking habit of the region's pastoralist, almost 90% of respective individual or family encampment releases their folk after milking in the morning to be herded together in mixed groups of the hamlet. After enquiring the reason behind these herding practices common in Somalia might be due to the shortage of village herders (Robinson, 2010). Furthermore, a vast majority of respondents (75.0%) raised animals in an extensive mode of farming with the animals spending all or a significant portion of the day outside and getting most of their nutrition from pasture in the grasslands and mountains. This type of farming might

be regarded as natural. The rest of the respondents, 25.0% precisely, raise their animal in a semi-intensive which involves extensive management, but usually with controlled grazing of fenced pasture. It consists of provision of stall feeding, shelter at night under shed and 3 to 5 h daily grazing and browsing on pasture and range. Goat and sheep raised under semi-intensive farming, which combines both methods, are allowed access to pasture areas and a certain degree of confinement. This system uses natural resources for grazing while offering a regulated environment in an effort to achieve a balance between sustainability and productivity. In this method the feed cost somewhat increased and dairy goats with sheep are semi-extensively reared and grazed on communal lands that hardly support the minimum nutritional needs mainly due to overstocking and subsequent land degradation (Kasapidou et al., 2021; Islam et al., 2010; Escareno et al., 2012). The breeding system of the overwhelming pastoralist is from neighboring, individual, and communal respectively. Therefore, the primary ways to obtain breeding animals

Table 2. Results of small ruminant brucellosis seroprevalence (RBPT) in selected villages of Gardo District in the Karkaar region.

Sub-districts of Gardo district for Karkaar region	Species	Sex	No. Tested	RBPT Positive (%)	X ²	(P value)
Kubo	Caprine	Female	43	3 (6.9)	0.366	0.5454
		Male	17	2 (11.7)		
	Ovine	Female	30	3 (10)	0.280	0.0943
		Male	17	3 (18)		
Xabaal-reer	Caprine	Female	34	1 (3)	1.196	0.274
		Male	20	2 (10)		
	Ovine	Female	39	2 (5.1)	0.447	0.503
		Male	9	1 (11.1)		
Guud-cad	Caprine	Female	48	4 (8.3)	0.043	0.8348
		Male	15	1 (6.7)		
	Ovine	Female	28	1 (3.6)	0.945	0.331
		Male	8	1 (12.5)		
Ambaaro	Caprine	Female	31	4 (12.9)	0.579	0.489
		Male	17	1 (5.9)		
	Ovine	Female	32	2 (6.3)	1.574	0.210
		Male	17	3 (17.6)		
Total	Caprine		225	18 (8.2)	0.138	-
	Ovine		180	16 (8.9)		
SUM			405	34 (8.4)		
Average RBPT Positive Prevalence				2.13 (9.35)		

were through birth into the herd, from a neighbor, or from the hamlet's own herd. The aforementioned habits, which are prevalent among the Karkar pastoralists and their surroundings, carry implications regarding their potential. In most cases, for the aforesaid habit to materialize, various techniques were employed to regulate mating, such as castration, culling, separating male and female animals, purposefully mating the best males to the best females, and regulating the size of mating groups (Marshall et al., 2019). The Somali pastoralist, with respect to breeding issues, has differing opinions about whether a certain feature in livestock was influenced by environment, genetics, or a combination of the two. In summary, both the men and women, although there is opportunity for capacity improvement, such as on inbreeding, Somali pastoralists often use sound breeding procedures (Muigai et al., 2016; Wilson, 2011). When engaged the individuals in the surveyed four sub-districts of Gardo on their awareness on diagnostic tests and vaccines of bovine brucellosis, Though the animals in

question were never been vaccinated on the bacteria, almost two third (72.5%), of them had an inkling in one way or the other (OIE, 2004; Renukaradhya et al., 2002). Handling method of aborted fetus and Placenta in the particular cantonment almost two third leave the fetus in the herd and that high frequency is major causes and potential risk factors in goat and sheep. This habit of almost two-thirds of the fetus left in the herd warrants some sort of preliminary or otherwise conducted survey to be conducted to first estimate the frequency of small ruminant abortions, identify their major causes and potential risk factors in goat and sheep flocks, and determine where *Brucella* species fits into the issue, Consequently, illustrate how the flock's abortion rate and possible predictive variables are related (Alemayehu et al., 2021). In the issue of handling method of aborted fetus and placenta, in this case sheep and goats, entails pregnant animal's signs of approaching birth and whether it gives birth naturally and without human intervention. However, occasionally, an animal may experience birth

Table 3. Seroprevalence of Caprine and Ovine brucellosis in sub-districts of Gardo in Karkaar region based on sex of animal.

Species	Sex	Number of sera tested	RBPT-positive-cum. (%)	95% CI and odd ratio	χ^2	p-value
Caprine	Female	156	12 (7.6)	0.875 (0.314 – 2.46)	0.065	7.98×10 ⁻¹
	Male	69	6 (8.7)			
	Total	225				
Ovine	Female	129	8 (6.2)	0.36 (0.13– 1.01)	4.06	4.4×10 ⁻²
	Male	51	8 (16)			
	Total	180				

complications and require pastoralist aid. Taking everything into account, the herders seemed familiar in monitoring birth progress of their animal. A tool they developed over the years as livestock is the mainstay of livelihood (Infonet, 2013). Finally, how they managed health problems in their flock was asked, and they either buy off the shelf drugs, or consult veterinarians or CAHWs. Usually from time to time the department of veterinary, together with the NGO's undertake a campaign of screening the nomadic hamlets, and only 15% of the respondents seek further consultation on the matter. It is a mellowed practice for pastoralist to keep a sick animal to remain at the home-base (Farah et al., 2004).

Small ruminant brucellosis sero-prevalence (RBPT)

Initially, brucellosis was detected in all four selected sub-regions of the Gardo district, namely: Kubo, Xabaal reer, Guudcad, and Cambaaro. The overall average seroprevalence of small ruminant brucellosis in the study area was 2.13 (9.35%) by the RBPT while on species basis it was in sheep 2 (10.5%) and 2.25 (8.2%) in goats (Table 2). This confirms findings from a different, comparable study conducted on small ruminants in the pastoral Eastern Ethiopian region of Afar, which showed that the RBPT's total seroprevalence fraction of small-ruminant brucellosis in Afar was 9.37% (Ashenafi et al., 2007). While comparatively that of the neighboring Jijiga District, Somali Regional State, Eastern Ethiopia considerably lower in the range of 1.5 to 1.2% respectively. The findings are also six-fold higher than the results catalogued in Somali region by Teshale et al., (2006), where 1.6 and 1.7% prevalence of brucellosis was documented in sheep and goats correspondingly. This could be explained owing to the dissimilarity in animal production and management systems as well as reasonably variations in land suitability for extensive grazing of the studied regions. Following the result surveyed in sheep and goat, observations has been made for the gender of the two small ruminants being tested for brucellosis, and RBPT positive prevalence for

male and female caprine was found to have been 8.58 and 7.78%, respectively (Table 4a).

Additionally, it was discovered that the prevalence of RBPT positive tests in male and female ovine was 14.8 and 6.3% respectively (Table 4b). The result is not that far off the overall sero-prevalence of small ruminant brucellosis result in Table 2. Also, a study made by Tekelye and Kasali (1990) in the central highlands of Ethiopia where they reported a prevalence of 1.5% in sheep and 1.3% in goats that is almost eight-fold lower than that of Karkar region of Puntland where extensive pastoralism is the dominant trade with a limited rain fed agricultural practice (Swalim, 2009). The study location appears to have a moderate prevalence and natural transmission of *Brucella* organisms, as none of the study animals got vaccinated (Ashenafi et al., 2007). In a matter of further testing on the findings, logistic regression analysis was performed to also check the sero-prevalence of brucellosis according to the sex of animals (caprine and ovine) in sub-districts of Gardo in the Karkaar region. Only the variation between the ovine species was statistically significant, as that of the female is significantly lower (6.2%) than that of the male (16%) with P-value of 4.4X10⁻², that has confirmed the preceding analysis. However, the statistically significant difference between the two ovine sexes observed in this study might be due to the disparity of the sexes (male and female) sample sizes.

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings, brucellosis is a prevalent and pervasive infection that affects goats and sheep among all four sub-districts in the Karkaar pastoral area. The result in this study is also to some extent higher than the similar ones recorded in the above-referred studies done in Jijiga District, Somali Regional State, Eastern Ethiopia, and the pastoral region of Afar, Eastern Ethiopia (Bekele et al., 2011; Teshale et al., 2006; Ashenafi et al., 2007) and the difference could be due to dissimilarities in the sample size and the tests used, thus, warrants further confirmatory test such as isolation and identification of

Table 4. Sero-prevalence of positive RBPT in males and females (a) caprine and (b) ovine.

Animal	Male	RBPT Positive	%RBPT Positive	P-value	Female	RBPT Positive	%RBPT Positive
Caprine	17	2	11.70	1.21×10 ⁻¹	43	3	6.90
	20	2	10		34	1	3
	15	1	6.70		48	4	8.30
	17	1	5.90		31	4	12.90
Average	17.25	1.5	8.58		39	3	7.78
Ovine	17	3	18	1.000	30	3	10
	9	1	11.10		39	2	5.10
	8	1	12.50		28	1	3.60
	17	3	17.60		32	2	6.30
	Average	12.75	2		14.8	32.25	2

the *Brucella* responsible for infection in Karkar region. Otherwise, the economic potential biotypes of Puntland's enormous population of small ruminants, as well as that of semi-arid and arid regions of Somalia in general, as an important export commodity, will be severely hampered by the bacterial infection.

Since there is close contact between humans and their livestock, which very often have intimate enclosures, brucellosis is a significant health risk for both animals and humans. It can also be transmitted to humans through the ingestion of contaminated dairy products, as the habit of pasteurizing the milk of sheep and goats is not common on the land. It can also be transmitted to humans via inhalation of the organism or by direct contact with infected animal secretions (Galinska and Zagorski, 2013; CFSPH, 2023). As the infection affects people of all ages and both sexes who come into touch with infected animals or their products, the pursuit of strict control and prevention programs are recommended. Also, the need for more extensive studies in the country and Puntland in particular, and also more research on the transmission and zoonotic effects of the bacteria is needed. In addition, the lack of data and insufficient publication has created a big gap in the estimation of the annual prevalence of brucellosis in the country in general and in Puntland state in particular. To solve this problem, research institutions ought to conduct more studies on brucellosis and then publishing their findings for an efficacious prevention and control approach.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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