Research Article

Seroprevalence and Risk Factors of Bovine Brucellosis in the Benadir Region of Somalia

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Abstract | Brucellosis is a widespread zoonotic disease that poses a serious threat to both animal and human health, particularly in regions where livestock farming is a key source of livelihood. In Somalia's Benadir region, cattle rearing is common, yet there is limited data on the prevalence and risk factors of brucellosis. This study aimed to assess the seroprevalence of brucellosis and identify potential risk factors in three selected districts located in Mogadishu Somalia Wadajir, Daynile, and Dherkenley. A cross-sectional survey was conducted involving 208 randomly selected cattle, and data were collected from 22 cattle herders through structured questionnaires. Blood samples were analyzed using competitive ELISA (c-ELISA) to detect antibodies against *Brucella* species. The overall seroprevalence was 9.13% (19/208). Among the districts, Wadajir had the highest prevalence at 15% (7/48), which was significantly higher ($p < 0.05$) than the rates in Daynile and Dherkenley, both recording 7.5% (6/80). Hierarchical cluster analysis and principal component analysis revealed two main patterns of risk. The first was associated with older cattle (over three years of age) and uncontrolled breeding practices, such as mating with neighboring herds. The second involved medium-sized herds (typically 20–30 animals), managed under semi-intensive systems, where cattle were grazed together with other species factors that accounted for 82.2% of the observed variation. These findings suggest that herd management practices, particularly breeding control and grazing methods, play a critical role in the spread of brucellosis. The study highlights the urgent need for targeted interventions, including regular screening of cattle, culling of seropositive animals, improved biosecurity and breeding practices, and enhanced awareness among livestock owners. Addressing these risk factors is essential for reducing transmission, protecting public health, and improving livestock productivity in Somalia's pastoral and semi-pastoral systems.

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Introduction

Brucellosis is one of the global zoonotic diseases associated with significant economic implications in many developing countries in sub-Saharan Africa, such as Somalia (Schelling *et al*., 2003). Although brucellosis is among the top seven zoonoses according to the World Health Organization (WHO), its impact on both humans and livestock has been neglected (Stear, 2005). Since most sub-Saharan African countries heavily rely on agriculture for food security and income generation, approximately half a million cases of brucellosis in humans are reported annually (Okuni *et al*., 2020; Mufinda *et al*., 2017). However, bovine brucellosis has been shown (Ducrotoy *et al*., 2014) to be one of the most important zoonotic diseases, particularly in Africa. In Somalia, brucellosis remains a "neglected zoonotic disease" despite its public and animal health concerns. Several factors have contributed to the persistent and widespread prevalence of bovine brucellosis in sub-Saharan Africa. According to (Mersinaj *et al*., 2013) and Peck and Bruce (2017), these factors either influence the spread and maintenance of the disease within farms and herds or are linked to disease transmission between different farms and herds. For example, the acquisition of infected cattle for upgrading or replacement is among the factors that influence the spread and maintenance of diseases within farms and herds, while the type of animal production systems, climate, deforestation, governance issues, and human-wildlife conflicts are among the factors linked to the transmission of the disease between different farms and herds.

Brucellosis is caused by bacteria that belong to the genus Brucella, which is species-specific. A total of 12 species in the genus *Brucella* have been identified, including *B. abortus*, *B. canis*, *B. melitensis*, *B. neotomae, B. ovis*, and *B. suis*, as reported by Stear (2005); Godfroid *et al*. (2011), and Foster *et al*. (2007) identified *B. ceti* and *B. pinnipedialis* in aquatic mammals (Scholz *et al*., 2008) reported *B. microti* in common voles, and *B. inopinata* in humans (Scholz *et al*., 2010) also reported *B. inopinata*. Additionally, *B. papionis* (Whatmore *et al*., 2014; *B. vulpis* Scholz *et al*., 2016) were recently identified in baboons and red foxes, respectively. According to (Fero *et al*., 2020), the most common *Brucella* species causing brucellosis infections in humans and animals on farms are *B. abortus*, *B. canis*, *B. melitensis*, and *B. suis*. In most mixed herds of livestock, the occurrence of *B. abortus* and *B. suis* was high in cattle (Akinseye *et al*., 2016). Associated economic losses due to brucellosis in animals include abortions in the last trimester, reduced milk production, mastitis in female animals, epididymitis and orchitis in male animals, and infertility in both male and female animals (de Figueiredo *et al*., 2015; Asgedom *et al*., 2016). The primary transmission of brucellosis to humans is through the consumption of contaminated milk (Lima *et al*., 2018), while direct contact with infected animals and indirect contact with fomites were reported as other potential sources of transmission (Lemos *et al*., 2009). The major causal agents of brucellosis among humans are *B. abortus*, *B. melitensis*, and *B. suis* (Stear, 2005; Ducrotoy *et al*., 2018) Specific antibodies in serum for the diagnosis of brucellosis since there is no serological test with 100% specificity and sensitivity.

Animal export alone is a major foreign exchange earner as well as a significant contributor to the GDP in Somalia. As of 2015, Somalia exported 5.3 million livestock (Pal *et al*., 2017). Besides exporting, especially animal milk, in Somalia, milk plays a major role in boosting national food and nutritional security. Given the fact that the majority of Somalia's population relies on milk, there are also accumulating studies that partly link brucellosis infection as a key threat regarding possible transmission to humans. Hence, this calls for urgency in awareness dissemination as well as possible mitigation measures against brucellosis in Somalia.

Materials and Methods

The geographic description of the Benadir region

Benadir region is within latitude 2.046934 and longitude 45.318161 in Somalia. In this pastoral intensive region, the annual temperature ranges between 28.7°C - 37°C. This region is inhabited by approximately 2.3 million people and occupies an area of about 96,878 km. Geographically, this region is near the equator and experiences dry conditions characterized by 427mm and 430mm of minimum and maximum rainfall annually, respectively. Besides, Benadir region is in the east of Somalia, near the Indian Ocean while south of the Juba River, as it extends from the Gulf of Aden in the north.

Estimation of the cattle brucellosis prevalence in the Benadir region, Somalia

Methodological gaps in sampling design: The selection of only 3 out of 17 districts and 9 households is stated to be purposive in the collection of cattle blood samples to determine the prevalence of brucellosis in cattle in the Benadir region of Somalia, but the rationale is insufficient. The sample size may not adequately represent the region. Using a 16% prevalence from the Benadir region (Somalia) requires stronger justification, considering ecological and epidemiological differences between the districts, whereby Benadir Livestock Professional Association (BENELPA) assistance was involved in the development of the sampling frame as well as locating the households with herds of cattle.

The inclusion criteria (cattle >6 months without vaccination history) were good, but need clarity on how vaccination status was verified. Following the sample size determination formulae (Degefa *et al*., 2011), it is supposed to collect blood samples from 206 indigenous breeds of cattle of different ages and sexes. Additionally, in this formula:

$$n = z\, 2\, pq / L2$$

Where n is the required sample size, Zα is the normal deviation that provides 95% confidence intervals (1.96), p is the prior estimate of the prevalence of the disease, q is obtained as 1-p, and L is the allowable error of the estimate (0.05). Sixteen percent as p was used, similar to what was adopted in Marsabit County in Kenya, owing to their close production systems, as indicated (Khan and Zahoor, 2018). Fortunately, from this study, 208 blood samples were successfully collected for further analysis.

Herein, 208 indigenous breeds of cattle were individually restrained, and whole blood samples were collected from 5 ml of blood by jugular venipuncture of each animal using a 10 ml syringe and 21G needle and allowed to clot overnight at room temperature. Subsequently, the serum was separated from clotted blood by transferring it to other tubes and transported to a laboratory for processing at the Department of Public Health Pharmacology and Toxicology, University of Nairobi. The serum in sterile vials was stored at 20 °C as it waited for subsequent analysis.

In each of the collected and processed samples, the presence of Brucella antibodies in serum samples was determined by the Rose Bengal Test (RBT) (Ducrotoy *et al*., 2016), and the positive samples were further confirmed using Competitive Enzyme-linked Immunosorbent assay (c-ELISA) (Abubakar*et al*., 2012). A similar procedure using RBT, as Mohamud *et al*. (2020) was adopted with slight modifications.

Determination of factors associated with brucellosis in cattle in Benadir Region, Somalia

Administration of a semi-structured questionnaire: A total of 22 respondents randomly distributed within the three districts within Benadir region were interviewed to gather data on socioeconomic characteristics, cattle production practices and management, awareness of zoonosis, particularly brucellosis, and possible management practices. A face to face interview approach was used during data collection.

Data analysis

From the collected data, which had qualitative and quantitative data, SPSS software was used for its analysis. Herein, a hierarchical cluster analysis, principal component analysis, and frequency tables based on Bias Corrected accelerated bootstrapping at a 95% confidence interval were not statistically significant, $P<0.05$.

The brucella seroprevalence was determined from the positive serum samples among the total samples. The processed data were presented as a percentage of either positive or negative seroprevalence among the 208 blood samples collected from Wadajir, Daynile, and Dherkenley districts within the Benadir region of Somalia. An analysis of variance (ANOVA) was used to determine significant differences in the means of the seroprevalence of brucellosis among the three districts within the Benadir region of Somalia, at $P<0.05\%$ significance level using Tukey's least significance difference.

Serological tests detect antibodies against brucella

A survey in Wadajir, Daynile, and Dharkenley districts within the Benadir region of Somalia that incorporated sample collection confirmed the presence of brucellosis based on RBT and c-c-ELISA tests. The presence of positive prevalence of brucellosis was significantly ($p<0.05$) high within the Benadir region of Somalia. The 208 samples of serum from cattle randomly distributed within the Benadir region recorded an overall 9.13% (19/208) of positive brucellosis. Notably, among the three districts, only two of them Daynile and Dharkenley had an equal number of samples, each with 80, whereas Wadajir had 48. Therefore, this study confirmed the presence of brucellosis within the Benadir region of Somalia, which is characterized by intensive pastoralism activities (Table 1).

Table 1: *Prevalence of Brucellosis in cattle in three districts in the Benadir region of Somalia.*

Overall prevalence	Number of samples (N)	Prevalence (%)	P-value
Positive	19	9.13%	0.007
Negative	189	90.87%	
Total:	108	100.00%	

Across the three districts within the Benadir region of Somalia, the prevalence of brucellosis was higher in Wadajir than in both Daynile and Dherkenley. In all three districts, the prevalence of positive and negative was significantly different ($p<0.001$). Wadajir recorded a 14.58% (7/48) prevalence of brucellosis from a sample size of 48, whereas both Daynile and Dharkenley had 7.5% (6/80) each from a sample size of 80. Among all the districts assessed for brucellosis in Benadir region, Somalia, the smallest sample of serum of cattle was gathered in Wadajir district owing to a financial challenge and no consent among the herdsmen (Table 2).

The mean prevalence of brucellosis was shown to be significantly ($p<0.05$) different within the three regions. Herein, Wadajir, having 14.58% (7/48), had a significantly ($p<0.05$) highest mean prevalence of brucellosis than other districts. Both Daynile and Dharkenley had mean prevalence that was not significantly different (Table 3).

All the samples were collected from Wadajir, Daynile, and Dharkenley districts of Somalia. The samples were subjected to Rose Bangle Test and Competitive Enzyme-linked Immunosorbent assay for confirmatory tests on Brucellosis. N represents the number of samples assessed.

All the samples were subjected to rose bangle test and competitive enzyme-linked immunosorbent assay for confirmatory tests on Brucellosis. N represents the number of samples assessed.

Means in the same column not having a common letter are significantly different based on the Tukey's LSD test ($P<0.05$).

Risk factors associated with characterization of cattle breeds, rearing practices, and animal health welfare

From the assessment of Brucellosis in cattle within Benadir region in Somalia, within Deynile, Dherkenley, and Wadajir Districts, it aggregates into two clusters based on dissimilarities. The first cluster featured the general age of the cattle herds and the breeding systems practices. On the other hand, the second cluster aggregated variables about the rearing practices and animal health awareness, and management. Hence, such variables include production systems, livestock management, grazing and drinking water of animals, management of health problems, cattle quantity, and awareness of brucellosis among cattle. From the results, the first cluster aggregated variables on cattle well-being, particularly on the breeding systems that determine the subsequent generation and age concern of the existing flock. The second cluster is more of cattle-rearing practices and animal health welfare. Hence, with this comprehension, it follows that the management of brucellosis needs to embrace the aforementioned facets (Table 4 and Figure 1).

Breeding systems adopted among cattle

As a distinct cluster with general age and different types of breeding systems (cluster one), the highest percentage of respondents had cattle herds > 3 years, mainly bred through natural crossing with neighbors cattle herds. Owing to the non-normal distribution

Table 2: *Brucellosis prevalence in Wadajir, Daynile, and Dharkenley districts in the Benadir region of Somalia.*

		Wadajir			Daynile			Dharkenley		
		Prevalence of brucellosis	N	P value	Prevalence of brucellosis	N	P value	Prevalence of brucellosis	N	P value
Brucel-losis	Positive	14.58%	7	<0.001	7.5%	6	<0.001	7.5%	6	<0.001
	Negative	85.42%	41		92.5%	74		92.5%	74	
Total		100.00%	48		100.00%	80		100.00%	80	

N, Number of Samples; All the samples were subjected to Rose Bangle Test and Competitive Enzyme-linked Immunosorbent assay for confirmatory tests on Brucellosis. N represents the number of samples assessed.

Table 3: *Mean prevalence of brucellosis within the three districts in Benadir region of Somalia.*

Districts within Benadir region	Mean prevalence of brucellosis (%)
Wadajir	14.58b
Daynile	7.50a
Dharkenley	7.50a
LSD	6.25
P-value	<0.001

Means in the same column not having a common letter are significantly different based on Tukey's LSD test (P<0.05).

Table 4: *Agglomeration Schedule for all the variables assessed for clustering.*

Stag-es	Cluster Combined		Coeffi-cients	Stage Cluster First Appears		Next stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	5	6	0	0	0	3
2	2	9	1	0	0	4
3	5	8	3.667	1	0	4
4	2	5	9.6	2	3	7
5	3	7	16.1	0	0	8
6	1	4	23.1	0	0	7
7	1	2	36.214	6	4	8
8	1	3	72.444	7	5	0

of the data, however, 87% and 43% were further corroborated with the BCA 95% confidence interval for the cattle general age and type of breeding system, respectively, which were all positive. As anticipated, from this seemed old cattle herds of over three years and majorly crossed with Possessive cattle, occurrence and transmissions of brucellosis are more likely (Table 5).

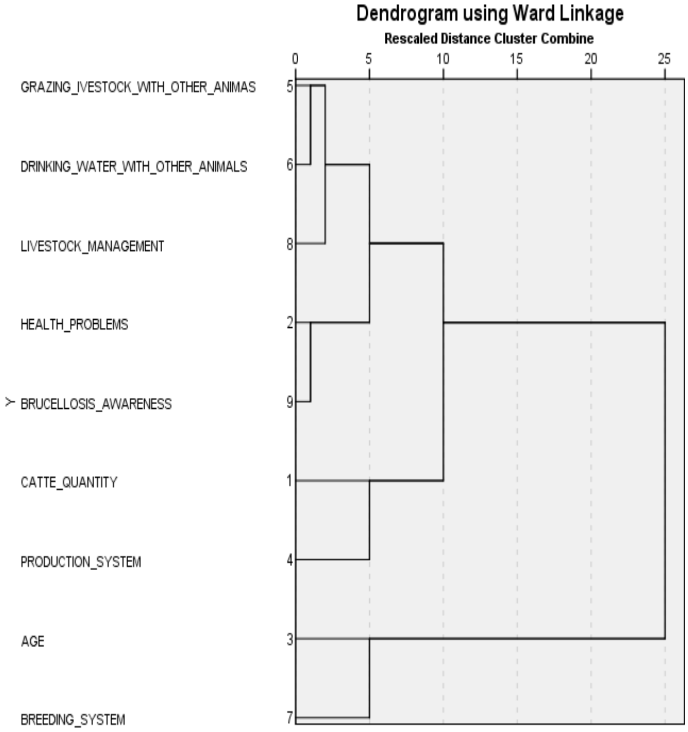

Figure 1: *Dendrogram showing the two clusters from the assessed variables.*

Cattle rearing practices, health awareness and their management

As of cluster two featuring seven components that aggregate the cattle rearing practices and animal health welfare, the principal component analysis revealed 82% of the total cumulative variance was due to three components, namely; herds of cattle, type of production system, and grazing livestock with other animals. Partly, if left unchecked, these components had immense contributions in either spreading or minimizing brucellosis infections among cattle. As it is true that the majority are pastoralists, with many herds of cattle, how the animals interact with other animals, the potential for brucellosis infection, and

Table 5: *Frequency distribution of cattle ages and breeding systems.*

					Bootstrap for percent[a] BCa 95% confidence interval			
Variables		N	%	Valid %	Bias	Std. Error	Lower	Upper
General age	> 1 to > 2 year	2	12.5	12.5	-0.4	7.8	6.3	18.8
	> 3 years	14	87.5	87.5	0.4	7.8	75	100
	Total	16	100	100	-11.4	31.8	.	.
Type of breeding systems	Communal	3	18.8	18.8	-0.1	9.9	.0b	43.6
	Individual	4	25	25	0.2	10.9	6.3b	50
	From neighboring	7	43.8	43.8	-0.3	12.4	25	62.5
	Artificial Insemination	2	12.5	12.5	0.1	8.5	.0b	31.3
	Total	16	100	100	0	0	.	.

[a]. *Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples. N represent frequency whereas % denotes percentage. BCa represented the Bias Corrected accelerated.*

Table 6: *Principal component analysis of cattle rearing practices, health awareness, and their management.*

Component	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
Herds of cattle	2.43	35	35	2.43	35	35
Type of production system	1.99	28	63	1.99	28	63
Grazing livestock with other animals	1.34	19	82	1.34	19	82
Livestock drinking water with other animals	0.59	8	91			
Management of livestock during watering, grazing and sleeping	0.45	6	97			
Aware of brucellosis disease	0.20	3	100			
Management of health problems among the herds	0	0	100			
Extraction Method: Principal Component Analysis.						

Table 7: *Frequency distribution of characteristics of production systems among cattle herds.*

					Bootstrap for percent[a] BCa 95% confidence interval				
Variables		N	%	Valid %	Bias	Std. Error	Lower	Upper	N
Size of cattle herds	10 to 20	5	26.3	26.3	26.3	0.2	10.2	10.5	42.1
	20 to 30	10	52.6	52.6	78.9	-0.2	11.4	36.8	68.4
	30 to 40	2	10.5	10.5	89.5	0.2	6.9	.0[b]	26.3
	> 40	2	10.5	10.5	100	-0.2	6.8	.0[b]	26.3
	Total	19	100	100		0	0	.	.
Type of production system	Intensive	6	31.6	31.6	31.6	0.4	10.4	15.8	47.4
	Semi-intensive	9	47.4	47.4	78.9	-0.2	11.7	31.6	63.2
	Extensive	4	21.1	21.1	100	-0.3	9.4	5.3[b]	42.1
	Total	19	100	100		0	0	.	.
	Yes	9	47.4	47.4	47.4	-0.7	11.2	31.6	63.2
	No	10	52.6	52.6	100	0.7	11.2	36.8	68.4
Grazing	livestock with other animals	Total	19	100	100	0	0	19	0

Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples. Some results could not be computed from jackknife samples, so this confidence interval is computed by the percentile method rather than the Bca method. N represent frequency, whereas % denotes percentage. BCa represented the Bias Corrected accelerated.

the type of production system highly contribute to the avenue for infection and spread of brucellosis. From this, it seemed that, though the infection spread among cattle, human interventions through managing cattle while grazing partly encourage the spread and infection of brucellosis. While Table 6 presents PCA results with clear loadings, the accompanying text provides only superficial interpretations (Table 6).

Characteristics of production systems among cattle herds

Within the Benadir region, Somalia, the majority 52% (10/19) of the respondents had 20 to 30 cattle that are dominantly reared under a semi-intensive production system, as denoted by 47% (9/19) of respondents. Similarly, there was almost a 50% split in respondents who grazed cattle herds with other animals to those that do not. These computations of the size of cattle herds, type of production system, and grazing livestock with other animals were further corroborated by the Bca 95% confidence interval, which was all positive (Table 7).

Characteristics of brucellosis infection among cattle

Among the three districts Dherkenley, Deynile, and Wadajir within the Benadir region of Somalia, the majority of 68% (15/22) of respondents were aware of brucellosis among cattle as was further confirmed by the Bca 95% confidence interval that was all positive (Table 8).

The awareness of brucellosis partly came from the fact are pastoralists as well as from eminent signs such as abortion and retained placenta.

Table 8: *Frequency distribution of Characteristics of brucellosis infection among cattle.*

					Bootstrap for percent[a] BCa 95% confidence interval				
Variables		**N**	**%**	**Valid %**	**Bias**	**Std. Error**	**Lower**	**Upper**	**N**
	Yes	15	68.2	68.2	68.2	-0.1	9.9	50	86.4
Aware of brucellosis among	No	7	31.8	31.8	100	0.1	9.9	18.2	45.5
Cattle									
	Total	22	100	100		0	0	.	.

Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples.

Table 9: *Frequency distribution of abortions, their signs and management among cattle herds.*

		Frequency	Percent	Valid %	Cumulative %
	0 % Abortions	5	22.7	22.7	22.7
	< 5% Abortions	1	4.5	4.5	27.3
Percentage of abortion cases	> 5 to 15% of Abortions	9	40.9	40.9	68.2
	> 15 to 30% of Abortions	7	31.8	31.8	100
	Total	22	100	100	
	Abortion as a sign of brucellosis	14	53.80%	66.70%	
	Retained placenta as a sign of brucellosis	9	34.60%	42.90%	
Signs of brucellosis among cattle	Orchitis/hygroma as a sign of brucellosis	3	11.50%	14.30%	
	Total	26	100.00%	123.80%	
	Burn	10	45.5	55.6	55.6
	Throw away	5	22.7	27.8	83.3
Management of the aborted fetus	Give to dogs	3	13.6	16.7	100
	Total	18	81.8	100	
	Missing System	4	18.2		
	Total	22	100		
	Burn	10	45.5	50	
	Throw away	6	27.3	30	
	Give to dogs	4	18.2	20	
Management of retained placenta					
	Total	20	90.9	100	
	Missing System	2	9.1		
	Total	22	100		
	Leave them among the herd	9	40.9	40.9	
Management of animals that had	Separate from the herd	13	59.1	59.1	
aborted or had retained placenta					
	Total	22	100	100	

Further, abortion cases as among the signs of brucellosis were present. For instance, 40% (9/22) of the respondents had reported between >5 to 15% of abortion cases among cattle. This was followed by 31% of respondents who reported brucellosis cases of between > 15 to 30%. Based on multiple response analysis, a common symptom of brucellosis – abortion – was highly reported by most respondents, and was nearly followed by the retained placenta. About half of the respondents burn either an aborted or a retained fetus as a management approach. However, of cattle that aborted or with a retained fetus, over half of them are separated from the flock (Table 9).

Discussion

Somalia, which is more of a pastoral country, heavily relies on livestock production, for instance, cattle, that contribute to food and nutrition security and income generation (Ntirandekura *et al*., 2020). Of concern, a zoonosis with the potential of infecting animals and human beings, such as brucellosis, presents immense challenges along the cattle or dairy value chain. For instance, brucellosis causes abortion in domestic animals and undulant fever in humans. This study confirmed the presence of brucellosis among cattle within Wadajir, Daynile and Dharkenley districts in Somalia. Husbandry system and environmental factors, herd size, type of breed of animal (dairy or beef), characteristics of the animal, management practices, and biology of the disease are risk factors associated with brucellosis. This study had identified 20-30 animals as the common herd size, as reported by 52.6% of the respondents. In this study, the management of brucellosis in cattle was managed through burning of the aborted fetus [55.6% (10/18)], burning of the retained fetus [50% (10/20)] and separating of the animals that had aborted or retained fetus from the healthy animals [59.1% (13/22)]. This study revealed a higher seroprevalence of brucellosis of about 15%, especially in Wadajir in the Benadir region of Somalia, compared to previous studies that had less than 10%. For instance, Afrah *et al.* (2020) reported a 10% seroprevalence of bovine brucellosis in Somalia. Elsewhere, Mohamud *et al.* (2020) reported an overall prevalence of 0.2% in dairy cows and further cautioned on its versatility and potential to negatively affect the dairy industry.

Although this study did not explore the diversity of brucellosis causal agents, Esmaeili *et al.* (2016) and Mukherjee *et al.* (2015) reported ten brucellosis species, namely *Brucella melitensis*, *Brucella abortus*, *Brucella suis*, *Brucella canis*, *Brucella neotomae*, *Brucella ovis*, *Brucella microti*, *Brucella inopinata*, *Brucella ceti*, and *Brucella pinnipedialis*. On the other hand, brucellosis in human beings is caused by gram-negative bacteria of the genus Brucella, which currently includes 12 species, of which only four are particularly pathogenic for humans: *Brucella abortus*, *Brucella canis*, *Brucella suis,* and *Brucella melitensis* (Yagupsky *et al*., 2020; Franc *et al*., 2018).

Whereas brucellosis is either directly or indirectly transmitted through contact with diseased animals, the lack of vaccination and immunization in the pastoral community presents a major factor that perpetuates brucellosis transmission and outbreaks in rural areas (Kashiwazaki *et al*., 2012). Serological tests, Rose-Bengal Test, 2-Mercaptoethanol test and ELISA are generally used for the detection of Brucella infection in livestock. Besides, Deka *et al.* (2018) attributed the low incidence of brucellosis in rams follows the good and controlled management practices and screening for breeding. Adequate seroprevalence monitoring is essential and needs to be further corroborated with the institutionalization of control measures for brucellosis.

Pastoral communities, for instance, in Somalia, experience several challenges such as zoonosis diseases. However, these challenges are partly linked to how herdsmen are handling the animals during feeding, drinking, or upon the occurrence of an infection. Of concern, Somalis are one of the most livestock-producing populations, and they contribute greatly to the family in cash profits (Ntirandekura *et al*., 2020). This study confirms the presence of brucellosis based on the symptoms from the respondents and further corroborates the laboratory findings, where a prevalence of 9.13% (19/189) was established. Additionally, the level of awareness of its management among the respondents was determined. Owing to the pastoralism culture dominated by livestock sharing water, pasture, and shelter facilities influences the direct contact among animals and hence contributes to the transmission of brucellosis. However, according to Ebrahim *et al.* (2016), abortion among cows majorly presents a major source of dissemination of brucellosis. Besides, a high level of awareness of brucellosis among respondents as confirmed by its symptoms, could partly contribute to brucellosis being endemic in many countries in Africa (Ogugua *et al*., 2023).

According to (Cárdenas *et al*., 2019), abortion, infertility, stillbirth or weak birth, epididymitis, and orchitis in males were among the symptoms of brucellosis in cattle. However, from this study, abortion and retained placenta were the common signs reported by most respondents, whereas orchitis was the least reported as being associated with brucellosis infection. Despite the knowledge of symptoms of brucellosis in most herdsmen, their management is relatively poor. For instance, in this study, about half of the respondents interact with animals that have aborted or with retained placenta, while other healthy herds partly contribute to its dissemination. Transmissions of brucellosis owing to their practices are eminent given that animals infected with brucellosis can experience 1-3 abortions and fortunately followed by normal birth without symptoms but continued excreting infectious vaginal fluid.

In this study, the majority of the respondents had 20-30 cattle, whereby it was a deliberate led or partly their justification for adopting a semi-intensive production system. A herd size of > 20 animals was 9 times more likely to have brucellosis than a herd with < 20 animals. Therefore, from this study, it is no exception from the occurrence of high brucellosis infection of 9.13% (19/189) owing to its large herd sizes. The sharing of bulls and grazing and watering areas partly contributes to the dissemination and transmission of brucellosis. In most pastoral communities, the majority of breeds are local, which could partly contribute to the increase in brucellosis infections owing to their low immunity and susceptibility to diseases. About half of the respondents use their neighbour's herds for breeding, despite all the breeds being local.

Cattle rearing is a key source of food and income generation in Somalia, but is limited by infectious zoonosis such as brucellosis. This study showed a high seroprevalence of about 15% in Wadajir and 8% each in Daynile and Dharkenley, which was higher compared to previous studies that had reported 2-6% and 10% (Afrah *et al*., 2020) in Somalia. This apparent difference could be attributed to the pastoralist culture and poor management approaches upon the occurrence of zoonosis; however, further explorations are recommended. High spread and inability to maintain brucellosis within farms and herds are among factors reported by Mersinaj *et al*., (2013); Peck and Bruce (2017) as making the disease persistent and widely spread.

Awareness of brucellosis among respondents was high, yet the management approaches against or upon occurrence are poor. The awareness type on brucellosis was mostly on the signs, such as abortions and retained placenta, but not on how it is transmitted. Despite brucellosis being endemic in most sub-Saharan Africa (Ogugua and Onunkwo, 2023), in Somalia, surveillance strategies were few to none, as indicated by Marcotty *et al*. (2009). Given the limited resources against an economically devastating disease such as brucellosis, the majority of the respondents are desperate for veterinary services, forcing them to either self-medicate or seek traditional healers. Conversely, some developed countries had successfully eradicated brucellosis among domesticated animals using sustained S19, RB51, and 45/20 vaccines (Pascual *et al*., 2022).

Conclusion

This study provides important insights into the seroprevalence and associated risk factors of bovine brucellosis in the Benadir region of Somalia. The overall seroprevalence of 9.13% indicates that brucellosis remains a significant health concern for both livestock and humans, particularly in areas where cattle play a central role in livelihoods and food security. The significantly higher prevalence in Wadajir district, compared to Daynile and Dherkenley, suggests that localized management practices and environmental factors may contribute to disease transmission. Brucellosis was present in Dherkenley, Deynile, and Wadajir districts in the Benaadir region of Somalia. The associated symptoms of brucellosis – abortion and retained placenta – were common among the local breeds.

Risk factor analysis revealed two dominant patterns linked to the spread of brucellosis: The presence of older cattle combined with uncontrolled breeding practices, and semi-intensive herd systems involving medium-sized cattle populations and co-grazing with other species. These findings underscore the role of herd demographics and management practices in influencing disease dynamics. The management of herds upon sick, for instance, brucellosis infection, is relatively poor. Therefore, apart from high awareness of brucellosis, it is important to further address the management of sick animals, either preventive or curative, as well as backed up by active seroprevalence monitoring.

To mitigate the impact of bovine brucellosis in the region, there is a clear need for comprehensive control strategies. These should include routine serological screening, culling of infected animals, improved breeding practices, biosecurity measures, and educational outreach to herders on disease prevention. Strengthening veterinary services and implementing region-specific interventions will be essential for reducing transmission, safeguarding animal health, and protecting public health from this zoonotic threat.

Declaration of competing interest

We declare that we have no financial and personal relationships with other people or organizations that can inappropriately influence our work, and there is no professional or other personal interest of any nature or kind in any product, service, /or company that could be construed as influencing the content of this paper.

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Novelty Statement

This study represents one of the first comprehensive assessments of the seroprevalence of bovine brucellosis in the Benadir region of Somalia, a geographic area with limited documented epidemiological data on this zoonotic disease. By combining serological screening with in-depth analysis of associated risk factors, this research fills critical knowledge gaps regarding the distribution and determinants of bovine brucellosis in a context characterized by pastoral and agro-pastoral livestock systems under challenging socio-economic conditions.

The findings will provide novel insights into how local husbandry practices, environmental factors, and animal movement patterns contribute to the maintenance and spread of brucellosis in Somali cattle populations. This evidence is crucial not only for enhancing disease control strategies and improving livestock productivity in the region but also for mitigating public health risks linked to this neglected infectious disease.

Moreover, by focusing on the Benadir region—an area previously underrepresented in veterinary epidemiological literature—this study furnishes foundational baseline data essential for formulating region-specific brucellosis surveillance and intervention programs tailored to Somalia's unique livestock management and socio-political landscape.

Autho's Contribution

The authors collectively designed the study, conducted fieldwork and laboratory analyses, performed data analysis, drafted and critically revised the manuscript, and approved the final version for submission.

Generative AI or AI-assisted Technology Statement

The authors declare that no Genrative AI was used in the creation of this manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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