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SEROPREVALENCE OF BOVINE BRUCELLOSIS AND ASSOCIATED RISK FACTORS IN ASOSSA, BAMBASI AND HOMOSHA WOREDAS OF ASOSSA ZONE, WESTERN ETHIOPIA

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Abstract: Across-sectional study was conducted in Asossa, Bambasi and Homosha District from July 2022 to November, 2023 with the objectives of estimating, the sero- prevalence of bovine brucellosis. Of 384 serum sample examined, 9/384 (2.34%) were positive for bovine brucellosis. The high seroprevalence of the bovine brucellosis (9.75%) was recorded in Homosha woreda while the low prevalence of the disease (0.09%) was recorded in Bambasi woreda and it was significantly high ($p<0.004$). The highest seroprevalence (5.12 %) of brucellosis was recorded in animals less than 9 years old whilst the lowest prevalence (1.97 %) was recorded in animals 3-≥5 years of old and the association was not significant among the age groups. Slightly, higher prevalence was registered in female animals (2.56%) than in male animals (0 %), which was not found to be statistically significant ($p>0.05$).The highest prevalence of brucellosis (3.33%) was found in animals with poor body condition while the lowest (2.20 %) was recorded in animals with medium body conditions respectively, and it was non-significant ($p>0.05$).Cattle Brucellosis was recorded across the study kebeles with the highest prevalence of (14.28%) in Gumu kebele whereas in Dabus, Mender (47, 48, 41, 43, 42), Sonka, Womba, Megele(49), Komoshiga (27 and 28), Nebar-komoshiga, Selga (24), Amba14, and Megele (33) kebeles, the lowest brucellosis prevalence (0%) was recorded in the present study and the prevalence of brucellosis was not significant across the study sites. In Gumu, Dunga, Mutsakosa, Megele(39), Komoshiga (26), (14.28%, 5%, 9.09%, 2.27%, 3.03%) brucellosis prevalence was recorded in the studied kebeles respectively, but the association was not significant ($P>0.05$). Therefore, based on the findings, appropriate recommendations were forwarded to reduce the impact of the zoonotic diseases in the study area. Evidence of brucellosis in various cattle and the associated human population illustrates the need for a coordinated One Health approach to controlling brucellosis so as to improve public health and livestock productivity.

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Key words: *Asossa, Bovine, Bambasi, Brucellosis and Homosha, Serum*

1. Introduction

In rapidly changing societies such as Ethiopia, it is imperative that decision makers at all levels appreciate the current and future impact of the livestock sector on public health, the environment and livelihoods. This allows decision makers to take actions now that will ensure sustainable development of the livestock sector in the coming decades – a development that benefits producers, consumers and society in general – with limited negative effects on public health and the environment. Good quality data are essential for formulating policies and programmers that support sustainable development of the livestock sector. However, livestock stakeholders, particularly the Ministries in charge of animal and public health, often face what is referred to as "the zoonotic disease and antimicrobial resistance (AMR) information trap". As there is little robust evidence to quantify the negative impacts of zoonotic disease and AMR on society, stakeholders find it hard to sufficiently demonstrate the returns of programmes and investments that tackle zoonoses. This in turn makes it difficult to secure resources to tackle zoonotic disease and AMR, and create the necessary partnerships between the government and the governed to address issues that cross all sectors of society (FAO, 2018).

Brucellosis is another infectious bacterial disease caused by members of the genus Brucella. Brucellosis caused by Brucella melitensis and Brucella abortus belongs to the world's major zoonoses (Seifert H.S.H., 1996), causing great economic losses in the ruminant production systems and representing a serious health issue for the farming community. In livestock, they cause abortion, late first calving age, long calving interval time, low herd fertility and comparatively low milk production (Asfaw Y *et al.*, 1998). Carpal hygroma is also a common clinical manifestation in

cattle. It is a true zoonosis in that all human cases are acquired from animals and, more specifically, from domestic ruminants as far as B. abortus and B. melitensis are concerned. (Seifert H.S.H., 1996).

Brucellosis is a highly infectious, chronic disease in livestock and humans caused by Brucella. The major clinical signs in cattle are repetitive abortions, and the main symptoms in humans are a profuse undulant fever with muscle and bone pain. The disease can be detected through cell staining, serological tests or bacterial culture. Brucellosis transmission from cattle to humans is usually from ingesting unpasteurized dairy products or raw meat, and direct contact with infected blood or other secretions. Animal to animal transmission is usually from direct contact with infected bodily secretions. The economic consequences of brucellosis are a significant reduction in livestock productivity due to decreased milk production because of appetite loss, loss of young, as well as the impact of severe trade restrictions imposed on affected farms and countries (FAO, 2018).

Brucellosis in goat and sheep is normally caused by Gram-negative coccobacillary rod brucella melitensis although brucella abortus may also cause clinical brucellosis. Brucella ovis is a cause of eppididymitis of rams but it has also been associated with abortion and infertility. B. melitensis infection cause a fulminating disease in man (undulant or Malta fever) which is characterized by intermittent fever, malaise, fatigue, night sweets, muscle and joint pains whereas, B. abortus causes a mild disease. Osteomyelitis is a common complication in human brucellosis. Brucellosis has been reported to been an important cause of reproductive losses in small ruminants in some sub-Saharan countries. In central Ethiopia, about 1.5% of sheep have been reported to brucellosis-seropositive (Kusiluka and Dominic, 1996).

The source of infection is the infected doe or ewes, lambs and Brucella species tend to be abundant in the placenta, placental fluid, uterine exudates and aborted fetuses. The bacteria may persist in the uterus for about 5 months after abortion. Inhalation is the most important route of infection in goat and sheep but infection may also be acquired through ingestion of infected material and by penetration of the bacteria through the conjunctiva mucosa. In utero transmission may occur. The infective discharge can contaminate the environment very rapidly causing grazing animals to ingest massive numbers of the organisms. B. melitensis is known to be the most pathogenic of the Brucellaspp and is more contagious than B. abortus (Kusiluka and Dominic, 1996).

Treatment of the affected animals in usually not undertaken and such should be culled in order to reduce the sources of infection. Regular testing of animals, restriction of movement of animals and personnel between herds and purchase of animals with known health and reproductive records can prevent introduction and reduce the spread of the disease. Pasteurization of milk is recommended in order to reduce incidence of the disease in man. All the infected materials should be in controlled and the contaminated premises disinfected and a test and slaughter policy can only be effective it is preceded by a well organized educational program to the life stock owners and assurance compensation. Vaccination with a life attenuated B. melitensis Rev1 strain vaccine conferce strong immunity but it causes abortion if used in pregnant dogs and ewes. It is recommended that kid and lamps should be vaccinated at 3 to 8 months while adults should be vaccinated two months before breeding. Formailin- killed ajuvant vaccine 53H38 has been in use in pregnant animals elsewhere (Kusiluka and Dominic, 1996).

In general, the present study were conducted in Asossa, Bambasi and Homosha woredas' of Asossa zone and It was used to investigate the sero prevalence of bovine brucellosis.

Therefore, the **Objective** of the present study was;

- To determine the seroprevalence of the bovine brucellosis.

2. Material and methods

2.1 Study Areas

The study area is located in the Benishangul-Gumuz regional state of Asossa zone, where mixed farming system is dominant, in which about 92.5% of the population is involved in agriculture as a major means of subsistence. The region is found to be 687 km away from the capital city of the country, Addis Ababa, in the west and it was located at 9º 30′- 11º 30′ latitude North and 34º 20′- 36º 30′ longitudes East and its altitude range is 700-1560 meter above sea level (MoARD, 2007).

The study was conducted in Asossa, Bambasi and Homosha Districts of Asossa zone from July to November, 2021. Asossa zone has 214 peasant association, stretching over an area of 18,340.55 kilometer square, with human population of 270,980. Annual rain fall is between 900-1500 mm with uni modal type of rain fall that occurs between April and October. Annual temperature ranges between 25- 35^0c. The livelihood of the society largely depends on mixed livestock and crop production having livestock population of 77,688 Cattle, 167281 Goat, 9651 Sheep, 27638 Equines, 279098 Poultry and 66019 beehives (CSA, 2016).

2.2 Study Design

A cross - sectional study on bovine brucellosis from July to November, 2023 was conducted.

2.3 Study population, Data collection and Transportation

384 Bovine blood samples were collected from 20 kebeles of Assosa, Bambasi and Homosha woredas. 10ml of blood samples were collected from jugular vein of cattle using sterile plain vacuitainer tubes from each selected kebeles. The samples were properly labeled, kept in icebox and transported to the Asossa, Regional Veterinary Laboratory. After arrival, blood sample were centrifuged at 1500 × g for 10 min to obtain the serum. Sera were decanted into cryovials, identified and stored at deep freeze (−20˚C) until it was processed or being transported in cold chain using ice packs.

2.4 Sample size Determination and sample method

Using Thrusfield's (2007) derivation, the sample size for the bovine serum sample, assumption and estimations of brucella species was determined. As the objectives of study was cross sectional study, because no published work was encountered, 50% was used for expected prevalence, confidence level of 95% (Z=1.96), and a 5% level of precision, a design effect of two and 10% error was inferred. The following formula was used:

$$n = \frac{1.96^2 * P_{exp}(1-P_{exp})}{d^2}$$

Where n = sample size required; P_{exp}=expected prevalence; d = level of precision;

n= $(1.96)^2(0.5)\ (0.5)/(0.05)^2$=**384.** So, **384** serum samples was collected for brucellosis cases, from randomly selected cattle.

3. Data analysis

All the collected secondary data source of (rabies, brucella, and anthrax) and serum samples were entered into a Microsoft excel spread sheets program. Processed, coded data were transferred to Intercool STATA version 11.0 for analysis. Descriptive statistics were used for estimation of animal health workers, health extensions and kebele leaders, retrospective questionnaire information on communicable animal disease in the selected kebeles. Pearson's chi-square ($\chi 2$) was used to evaluate the association of different variables with the prevalence of brucellosis infection. In all of the statistical analysis, a confidence level of 95% is used and P-value of less than 0.05 (at 5% level of significance) was considered as statistically significant.

4. Result

4.1 Brucellosis prevalence in the study woredas

Out of the total cattle examined (N=384), 9 /384 (2.34%) were found to be infected with brucellosis. 1.46%, 0.09%, and 9.75% seroprevalence of brucellosis was recorded in Asossa, Bambasi, and Homosha woredas respectively as indicated in Table 1. The high prevalence of the bovine brucellosis (brucella abortus) (9.75%) was recorded in Homosha woreda whereas the lost prevalence of the disease (0.09%) was recorded in Bambasi woreda. So the association of the factors with brucellosis was significantly high ($p<0.004$).

Table 1: Prevalence of Brucellosis in the Asossa, Bambasi and Homoshaworedas

Variable	Categories	N	Positive	Prevalence	Chi2	P –value
Woreda	Asossa	205	3	1.46	11.01	0.004
	Bambasi	138	2	0.09		
	Homosha	41	4	9.75		
		384	9	2.24		

Nb: N= examined animals

Table 2: Prevalence of brucellosis with different potential risk factors

Risk Factors	Categories	N	Positive	prevalence	Chi2	P –value
Sex	Male	33	0	0	0.86	0.35
	Female	351	9	2.56		
Age	3-≥5yr	253	5	1.97	1.48	0.47
	>5 – 7yr	92	2	2.17		
	>9yr	39	2	5.12		
Bcs	Good	127	3	2.36	0.14	0.92
	Medium	227	5	2.20		
	Poor	30	1	3.33		

NB- N= examined animals

The highest prevalence (5.12%) of brucella abortus was recorded in animals >9 years old whilst the lowest prevalence (1.97%) was recorded in animals 3-≥5 years of old and the association was not significant among the age groups (Table 2).

Slightly, higher prevalence was registered in female animals (2.56 %) than in male animals (0 %), which was not found to be statistically significant (p> 0.05) (Table 2). The highest prevalence of brucellosis (3.33%) was found in animals with poor body condition while the lowest (2.20 %) was recorded in animals with medium body conditions respectively, and the difference was insignificant (p>0.05) as indicated in Table 2.

Table 3. Origin based Prevalence of Bovine brucellosis in selected kebeles

Kebele	No. examined	Positive	Prevalence	Chi2	P value
Gumu	21	3	14.28	23.27	0.22
Dunga	20	1	5		
Mutsakosa	22	2	9.09		
Dabus	22	0	0		
M47	15	0	0		
M48	15	0	0		
Sonka	16	0	0		
M41	12	0	0		
M43	10	0	0		
M42	11	0	0		
Womba	10	0	0		
M49	5	0	0		
Komoshiga27	8	0	0		
Komoshiga28	8	0	0		
Megel39	44	1	2.27		
N/komoshiga	12	0	0		
Selga 24	8	0	0		
Komoshiga26	66	2	3.03		
Amba14	33	0	0		
megel33	26	0	0		
Total	384	9	2.34		

Nb. M: mender, k: komoshiga

In this cross sectional survey, 384 serum samples were collected from 20 kebeles of three woredas, that was, 8 kebeles of Assosa districts, 10 kebeles of Bambasi districts and 2 kebeles of Homosha districts. 3/205 (1.46%), 2/138(1.44%), 4/41(9.75%) brucellosis prevalence were recorded from Asossa (8 kebeles), Bambasi(10 kebeles) and Homosha (2 kebeles) respectively as indicated in Table 3 . Comparably, in this survey high prevalence of brucellosis (9.75%) was reported in Homosha (Dunga and Gumu) kebeles whilst the low prevalence (1.44%) was registered in Bambasi distrcts of 10 kebeles as reported in Table 3.

Cattle Brucellosis was recorded across the study kebeles with the highest prevalence of (14.28%) in Gumu kebele whereas in Dabus, Mender (M47, M48, M41, M43, M42), Sonka, Womba, Megele(49), Komoshiga (27, K28), Nebar komoshiga, Selga(24), Amba14, and Megele(33), the lowest brucellosis prevalence (0%) was recorded in present study and the prevalence of brucellosis was not significant across the study sites (Table 3). In Gumu, Dunga, Mutsakosa, Megele39, Komoshiga 26, (14.28%, 5%, 9.09%, 2.27%, 3.03%) brucellosis prevalence was recorded in the studied kebeles respectively as shown in Tables 3. However, the association is not significant (P>0.05).

5. Discussion

5.1 Bovine brucellosis seroprevalence

The present study showed that, overall sero-prevalence of bovine brucellosis was 2.24% (9/384). This finding is in line with the earlier report of Hagos A *et al.* (2016) who reported, 2.4% of overall sero prevalence of bovine brucellosis in and around Alage District of Ethiopia; which was statistically significant (p<0.05). Similarly, the present survey was consistent with the previous findings of Jergefa T *et al.* (2008) who showed that, 2.9% of overall seroprevalence of bovine brucellosis at the individual animal level, in three agro-ecological areas of central Oromiya, Ethiopia.

Similarly, the present findings were consistent with the earlier result of Bedaso M *et al*.(2020) reported that, the overall animal level prevalence of 2.4% in cattle, 3.2% in sheep and goats, and 2.6% in humans occupationally linked to livestock production systems, in Borena, Southern Ethiopia.

However, there were reports with a relatively lowers ero-prevalence rate of bovine brucellosis in other parts of the country; 1% (Kang'Ethe EK, 2007) in the Benishangul - Gumuz region of north-western Ethiopia, and 1% (Degefu H *et al*., 2011) in Nairobi, Kenya. It is comparable with other previous reports from different part of Ethiopia; 1.38% (Gumi B*et al*., 2013) in Jijjiga zone of Somalia regional state, 1.4% (Poester MA *et al*., 2013) in Bishoftu and Asella, central Ethiopia, 1.5% (Tolosa T *et al*., 2008) in Addis Ababa, 1.66% (Berhe G *et al*., 2007) in Sidama Zone, Southern Ethiopia, 1.49 % (Dinka H and Chala R., 2009) in Tigray region, and 1.4 % (Haileselassie M., 2011) in Southeastern pastoral livestock of the country.
On the other hand, there were reports with a relatively higher sero-prevalence rate of bovine brucellosis in other parts of the country; 11.2% (Berhe G.,2005) in pastoral and agro pastoral areas of East Showa Zone, 3.5% (Megresa B *et al*., 2012) in Southern and Eastern Ethiopia, Oromia region, 3.1% (Thrus field., 2018) in Jimma zone of Oromia region, 4.9% (Jergefa T *et al*., 2009) in Western Tigray, Northern part of the country, 8.0% (Shiferaw Y *et al*., 2003) pastoral region of the country; 2.9% (Tibesso G *et al*., 2014) in three agro ecological areas of central Oromia, 3.19% (Tolosa T *et al*., 2008) in the extensive cattle production system of Tigray region, and 4.3 % (Matope G *et al*., 2011) in Adami Tulu, central Ethiopia. However, most of these reports were from the area were herds were managed under extensive system, where cattle from different owners were mingled at communal grazing and watering points. Hence, the low prevalence observed in the present serological investigation could possibly be due the using of AI services, culling of infected animals and, and the prevailing management systems differences among intensive, semi-intensive and extensive production system (Mc Dermott JJ *et al*., 2013; Matope G *et al*., 2010). Similarly, relatively higher sero-prevalence were reported in other African countries; 24.5% (Mai HM *et al*.,2012) from Sudan; 24.0% (Sarba EJ *et al*., 2016) from Nigeria, 5.5% (Angere TEE *et al*.,2004) from Zimbabwe. The observed disparity could be attributed to various factors including differences in testing protocols, cattle rearing systems, and herd size.
With regard to associated risk factors, 0.09%, 1.46%, and 9.75% brucellosis in cattle were detected in Bambasi, Asossa and Homosha districts respectively during the study period. So, the high prevalence of bovine brucellosis (9.75%) was recorded in Homosha woreda whereas the lost prevalence of the disease (0.09%) was recorded in Bambasi woreda. So the association of the factors with bovinebrucellosis was significant ($p<0.004$). The present findings were in line with the previous findings of Bedaso M *et al*.(2020) who reported, 1.6%, 6.8% and 2.9% of brucella seropositivity of cattle in Dubuluk, Eleweye and Gomole districts respectively, in Borena, Southern Ethiopia.
In the present study, it is well known that sexually mature cows are more susceptible to Brucella abortus infection, which could be explained by the fact that susceptibility increased during sexual maturity and pregnancy due to the influence of sex hormones and placental erythritol on the pathogenesis of brucellosis (Radostitis *et al*.,1989).The highest sero-prevalence (5.12%) of brucellosis was recorded in animals greater than>9 years old while the lowest prevalence (1.97%) was recorded in animals 3-≥5 years of old, and hence, the association was not significant among the age groups. As compared to the present results, Bedaso M *et al.* (2020) indicated, 1.2 % of brucella seropositive in cattle age of < = 5 years old and 5.1% brucella sero positive in age of greater than > 5 year of cattle species, in Borena, Southern Ethiopia. In contrast to this findings, Hagos A *et al*. (2016) indicated that, the presence of significant associations between age and sero-positivity of brucellosis. This finding was supported by a previous report from Ethiopia (Asmare *et al*., 2010). Growth stimulating factors for *Brucella* organisms become abundant when the animal becomes sexually matured (Radostits *et al*., 2007). Besides, higher prevalence of brucellosis in older cattle can be attributed to the constant exposure of the cattle over time to the agent. Hagos *et al*. (2016) said that, very high seropositivity (33.3 %) was observed in cows which gave birth above 2 years interval. This is supported by earlier reports from Ethiopia (Musa *et al*., 1990 & Hileselassie *et al*.,2008). The possible reason could be the effects of the disease on reproductive tract causing retained fetal membrane that usually leads to uterine infection and hence poor conception rate. Comparably, Begna B *et al*., (2020) reported that, a higher sero-prevalence (1.27%) in older age category (greater than 2 years) and sero negativity in younger age category (6 months - 2 years), in and Around Adama Town, Oromia Regional State, Central Ethiopia; This finding was inconsistent with report of (Swell MM *et al*., 1990; Abebe *et al*., 2008).

In the present study, slightly, higher prevalence was registered in female animals (2.56 %) than in male animals (0 %), which was not significant ($p> 0.05$).However, Hagos A *et al*. (2016) indicated that, a significant association between sex and seroprevalence

of brucellosis was observed. 94.7 % of the seropositive animals were female. This result was in agreement with earlier studies in Ethiopia where absence of male sero reactors was reported (Berhe *et al.*, 2007; Tolosa , 2004), which was comparable with present findings.

6. Conclusion

Overall 9/384 (2.34%) sero prevalence of bovine brucellosis was recorded in the 20 kebeles. The highest brucella prevalence was recorded in Homosha woreda (9.75%) and lowest prevalence was seen in Bambasiworeda (1.44%), significant association was observed ($p<0.00$). Sex, body conditions, and age were not significantly associated in this study. 14.28 % bovine brucellosis prevalence was registered whist relatively 5%, 9.09%, 2.27%, 3.03% prevalence were recorded in Dunga, Mutsakosa, Megel- 39, Komoshiga-26 respectively in the studied kebeles of the woredas.

7. Recommendation

Based on the conclusion, the following points are forwarded

- On the identified risk factors, the best control and prevention measures should be designed;
- For assessed cases brucellosis strategic prevention and control measures should be scheduled before their occurrence ;
- Vaccination programs should be scheduled based on seasonal occurrence of the kebeles;
- Human and animal health workers should be strengthen their link on one health approaches for best disease control strategy;
- Strategic control measures on brucellosis, should be implemented in one health approach.
- Awareness creation should be conducted continuously as community for farmers and professionals in general.

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8. Reference

[1]. Adedeji AO, Okonko IO, Eyarefe OD, Adedeji OB, Babalola ET, Ojezele MO, Nwanze JC, Amusan TA. (2010): An overview of rabies - history, epidemiology, control and possible elimination.African Journal of Microbiology Research;4(22):2327–38.

[2]. Asfaw Y., Molla B., Zessin K.H. &Tegegne A. (1998): A cross-sectional 3. study on bovine brucellosis and test performance in intra and peri-urban dairy production system in and around Addis Ababa. Bull. Anim. Hlth. Prod. Afr. 46, 217-224.

[3]. Aga AM, Hurisa B, Urga K. (2016): Current situation of rabies prevention and control in developing countries: Ethiopia perspective. J Infectious Diseases & Preventive Medicine;4(1):1–6.

[4]. Barecha CB, Girzaw F, Kandi V, Pal M. (2017): Epidemiology and public health significance of rabies. Perspectives in Medical Research; 5(1):55–67.

[5]. BogleK, Motschwiller E. (1986): Incidence of rabies and post-exposure prophylaxis in developing countries.Bulletin of the World Health Organization; 64(6):883–887.

[6]. Colin J. Carlson1,2,15, Ian T. Kracalik3,4,15, Noam Ross5, Kathleen A. Alexander6, Martin E. Hugh-Jones7, Mark Fegan8, Brett T. Elkin9, Tasha Epp10, Todd K. Shury 11, Wenyi Zhang12, Mehriban Bagirova13, Wayne M. Getz14 and Jason K. Blackburn 3,4. The global distribution of Bacillus anthracis and associated anthrax risk to humans, livestock and wildlife https://doi.org/10.1038/s41564-019-0435-4.

[7]. Endalew Yizengaw, TamyalewGetahun, Wondemagegn Mulu1, MulatAshagrie, Ibrahim Abdela and MekuanintGeta, (2018): Incidence of human rabies virus exposure in northwestern Amhara,

[8]. FAO, (2018): Zoonotic diseases spotlight Ethiopia: The case for an expert elicitation protocol on zoonoses ASL 2050, USAID

[9]. Getahun B, Abyot B, Bewket S, Lucy B, and Ahmed A: Human and animal anthrax in Ethiopia: A retrospective record review 2009-2013. *Ethio. Vet. J*. 2016, **20** (2):75-85.

[10]. InglesbytV*et al*. (1999): Anthrax as a biological weapon.Medical and public health management. *Journal of the American Medical Association*, 281:1735.
[11]. Knobel DL, Cleaveland S, Fèvre EM, Meltzer M. (2005): Re-evaluating the burden of rabies in Africa and Asia. Bulletin of the, vol. 83: World Health Organization; p. 360–8.
[12]. Mattos CCDE, Mattos CADE, Smith JS, Miller ET, Papo S, Utrera A, Osburn B.(1996): Genetic characterization of rabies field isolates from Venezuela.*JClinMicrobiol*;**34**(6):1553–8.
[13]. Seifert H.S.H., (1996): Tropical Animal Health. Kluwer Academic 15. Publishers.
[14]. MOARD (2010): Federal Democratic Republic of Ethiopia Ministry of Agriculture and Rural Development Country Position Regional Policy Framework on Animal Health, for Trade and Poverty Reduction Addis Ababa, January 2010. P. 11.
[15]. WHO, (2008): Anthrax in humans and animals – 4th ed.1.Anthrax – etiology. 2.Anthrax – pathology. 3.Anthrax – prevention and control. 4.Animals. 5.Zoonoses. i.World health organization. ii. Food and Agriculture organization of the united nations. iii. World Organisation for Animal health. iSBn 978 92 4 154753 6 (n 13LM classification: WC 305).
[16]. World Health Organization (WHO),(2005): Expert consultation on rabies. First report; technical report series 931. Switzerland: Geneva; 2005. p. 1–123.
[17]. World Organization for Animal Health (OIE), (2016): Frequently asked questions on rabies.
[18]. Thrusfield, M. (2007): Veterinary Epidemiology. 3rd edition. Blackwell Science Ltd. UK. ,Pp 233-250.
[19]. Hagos A *et al*., (2016): Seroprevalence of bovine brucellosis and associated risk factors in and around Alage district, Ethiopia, vol.5, Article no.851.
[20]. Poester FP, Samartino LE, Santos RL. Pathogenesis and pathobiology of brucellosis in livestock. Rev Sci Tech. 2013; 32: 105-115.
[21]. Tolosa T, Regassa F, Belihu, K. Sero-prevalence study of bovine brucellosis in extensive management system in selected sites of Jimma Zone, Western Ethiopia. Bulletin of Animal Health and Production in Africa. 2008; 56.
[22]. Berhe G, Belihu K, and Asfaw Y. Seroepidemiological investigation of bovine brucellosis in the extensive cattle production system of Tigray region of Ethiopia. *Int J App Res Vet Med*. 2007; 5: 65.
[23]. Kang'Ethe EK, Ekuttan CE, Kimani VN, Kiragu MW. Investigations into the prevalence of bovine brucellosis and the risk factors that predispose humans to infection among urban dairy and non-dairy farming households in Dagoretti Division, Nairobi, Kenya. East African Medical Journal. 2007; 84: (11 Suppl): S96-S100.
[24]. Degefu H, Mohamud M, Hailemelekot M, Yohannes M. Sero-prevalence of bovine brucellosis in agro pastoral areas of Jijjiga zone of Somali National Regional State, Eastern Ethiopia. Ethiopian Veterinary Journal. 2011; 15.
[25]. Gumi B, Firdessa R, Yamuah L, Sori T, Tolosa T, Aseffa AE. Sero-prevalence of Brucellosis and Q-Fever in southeast Ethiopian pastoral livestock. Journal of Veterinary Science and Medical Diagnosis. 2013; 2.
[26]. Dinka H, Chala R. Sero-prevalence study of bovine brucellosis in pastoral and agro-pastoral areas of East Showa Zone, Oromia Regional State, Ethiopia. American-Eurasian J Agric. & Environ. Sci. 2009; 6: 508-512.
[27]. Haileselassie M, Kalayou S, Kyule M, Asfaha M, Belihu K. Effect of Brucella infection on reproduction conditions of female breeding cattle and its public health significance in Western Tigray, northern Ethiopia. Veterinary Medicine International. 2011; 21: 7.
[28]. Megersa B, Biffa D, Abunna, F, Regassa A, Godfroid J, Skjerve E. Seroepidemiological study of livestock brucellosis in a pastoral region. Epidemiol Infect. 2012; 140: 887-896.
[29]. Thrusfield M. Veterinary epidemiology 4th edition. John Wiley and Sons, Pp.276. 2018.
[30]. Jergefa T, Kelay B, Bekana M, Teshale S, Gustafson H, Kindahl H. Epidemiological study of bovine brucellosis in three agro-ecological areas of central Oromiya, Ethiopia. Revue Scientifiqueet Technique. 2009; 28: 933.
[31]. Shiferaw Y, Tenhagen BA, Bekana M, Kassa T. Reproductive performance of crossbred dairy cows in different production systems in the central highlands of Ethiopia. Tropical Animal Health and Production. 2003; 35: 551-561.
[32]. Tibesso G, Ibrahim N, Tolosa T. Sero-prevalence of bovine and human brucellosis in Adami Tulu, Central Ethiopia. World Applied Sciecnce Journal. 2014; 31: 776-780.
[33]. Matope G, Bhebhe E, Muma JB, Oloya J, Madekurozwa RL, Lund A, et al. Sero-prevalence of brucellosis and its associated risk factors in cattle from smallholder dairy farms in Zimbabwe. Tropical Animal Health and Production. 2011; 43: 975-982.

[34]. Mai HM, Irons PC, Kabir J, Thompson PN. A large sero-prevalence survey of brucellosis in cattle herds under diverse production systems in northern Nigeria. Biomedical Veterinary Research. 2012; 8: 144.
[35]. Sarba EJ, Getaneh AM, Borena BM, Ambecha HA, Berecha MS, Eteya WT et al. Sero-prevalence and associated risk factors of Brucellosis in dairy cattle in selected towns of West Shewa, Ethiopia. Bulletin of Animal Health and Production in Africa. 2016; 64: 387-395.
[36]. Angara TEE, Ismail AA, Agab H, Saeed NS. Sero-prevalence of bovine brucellosis in Kuku Dairy Scheme, Khartoum North, Sudan. 2004.
[37]. Matope G, Bhebhe E, Muma JB, Lund A, Skjerve E. Herd-level factors for Brucellaseropositivity in cattle reared in smallholder dairy farms of Zimbabwe. Preventive Veterinary Medicine. 2010; 94: 213-221.
[38]. T.Jergefa, B. Kelay, M. Bekana, S. Teshale, H. Gustafson & H. Kindahl (2008): Epidemiological study of bovine brucellosis in threeagro-ecological areas of central Oromiya, Ethiopia. *Rev. sci. tech. Off. int. Epiz.*, 28 (3), pp934-943
[39]. Hagos A, Delesa D. &Reta. D (2016): Seroprevalence of bovine brucellosis and associated risk factors in and around Alage district, Ethiopia,*vol*. **5**, Act: 851 (2016).
[40]. Bedaso M., Gobena A., Zerihun A., Stefan B,, AdrianM. W., James L. N. Wood.,(2020): Brucellosis in ruminants and pastoralists in Borena, Southern Ethiopia. pp1-17.PLoSNegl Trop Dis 14(7): e0008461. https://doi.org/10.1371/journal.pntd.0008461.
[41]. Deressa A, Ali A, Beyene M, Newaye Selassie B, Yimer E. The status of rabies in Ethiopia: A retrospective record review Journal of health development. 2010:24:127-132.
[42]. JemberuWT, MollaW, Almaw G, AlemuS. Incidence of rabies in humans and domestic animals and people's awareness in north Gonder zone, Ethiopia. PLOS Negl Trop Dis. 2013,7: e2216.
[43]. EshetuyY, Bethelehem N, Girma T, Yared M, Yosef B, Badeg Z et al.situation of rabies in Ethiopia ; a retrospective study 1990-2000. Journal of health development 2002, 16;105-112.
[44]. Bingham J. Canine rabies ecology in southern Africa .Emerg infect Dis. 2005:1:1337-1342.
[45]. JooYS, Lee JH, Lee KK, Bang HA, Lee WC. Retrospective study of extensive vaccination program for canine rabies control and public health in koreaJPN J infect Dis. 2011: 64:513-515.
[46]. Tang X, Luo M, Zhang S, Fooks AR, Hu R, TuC. Pivotal role ofdogs in rabies transmission, china. Emerginfect Dis. 2005:11:1970-1972.
[47]. PitzpatrickMC, HampsonK, Cleaveland S, Meyers LA, Townsend JP, Galvani AP. Potential for rabies control through dog vaccination in wildlife- abundant communities of Tanzania PLOS Negl Trop Dis. 2012:6: e1796.
[48]. Assefa D, Abrham A, Mekoro B, Bethelehem N, Eshtu Y, Kedir H, The status of rabies in Ethiopa. A retrospective record review. Journal of health development. 2010: 24:127-132.
[49]. Aworth M, Nwoshu C, Ajumobi O, Okewole P, Okolocha E, Akansi B, A retrospective study of rabies cases Reported at Vomchrisrian Hospital, plateu state Nigeria. 2006-2010. *Journal of veterinary*. 2011:32:366-370.
[50]. Sitali DC, Twmbo MC, Chison M, Bwalya MJ, Munyeme M. Lay perceptions, beliefs and practices linked to the persistence of anthrax outbreaks in cattle in the western province of Zambia. OnderstepoortJ. *Vt. Res*. 2018; **85** (1):1-8.
[51]. Munang'andu HM, Banda F, Simudaala VM, Munyeme M, kasanga CJ, Hamududu B. The effects of seasonal variation on anthrax epidemiology in the upper Zambezi floodplain of western Zambia. *JVet.Sci*. 2012; 13(3);293-8.
[52]. Opare C, Nsire A, Awumbilla B, Akanmori B. Human behavioral factors implicated in outbreaks of human anthrax in the tamale municipality of northern Ghana. Acta Trop. 2000; **76** (1) 49-52.
[53]. Sitali DC, Mumba C, Skjerve E, Mweemba O, Kabonesia C, Mwinyi MO, et al. Awarness and attitudes towards anthrax and meat consumption practices among affected communities in Zambia; a mixed methods approach. PLOS Negl Trop Dis. 2017; 11 (5); e0005580.
[54]. Pieraci EG, Hall AJ, Gharpure R, Haile A, Walelign E, DersssaA et al. Prioritizing zoonotic diseases in Ethiopia using a one health approach. One health. 2016; 2: 131-5.
[55]. Rajkumar K, Bhattacharya A, David S, Balaji SH, Hariharan R, Jayakumar M, et al. Socio-Demographic study on extent of knowledge, awareness, attitude, and risks of zoonotic diseases among livestock owners in puduchery region. *Vet. World*. 2016; **9** (9):1018.
[56]. Wilkinson A, Parker M, Martineau F, leach M, Engaging communities; anthropological insights from the West African Ebola Epidemic. *Philos*

Trans R SocLondSer B Biol Sci. 2017; **372**(1721);20160305.

[57]. Jones CL, Jenesen JD, Scherr CL, Brown NR, Christy K, Weaver J. The health belief model as an explanatory framework in communication research; exploring parallel, serial, and moderated mediation. Health commun. 2015; **30**(6);566-76.

[58]. EspinoF, KoopsV, Manderson L, Community Participation and Tropical Disease Control in resource- poor settings; in; World Health Oganization; 2004.

[59]. Parker M, Polman K, Allen T, Neglected Tropical Diseases in Biosocial Percepctive. *J bio soc Sci*. 2016; **48** (S1); S1-S15.

[60]. Phelan JC, link BG, Tehranifar P. Social conditions as fundamental causes of health in equalities; Theory, evidence, and policy implications, J health SocBehav. 2010:**51** (1-suppl) S28-40.

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