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Prevalence and risk factors associated with bovine tuberculosis in the southern zone of Nasarawa State, north-central Nigeria

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Abstract

A cross-sectional study was conducted on 500 grazing cattle under a pastoral production system in the southern zone of Nasarawa state, North-Central Nigeria to determine the prevalence and risk factors associated with bovine tuberculosis using a Single intradermal Comparative Tuberculin Test (SCITT) from April 2019 to February 2020. The total number of animals with bTB was 46 (9.2%) and the results were significantly higher in older animals between 5-6years (OR: 7.4; CI: 1.54-35.4; *P*=0.000) and in those animals that were ≥ 7 years (OR: 5.7; CI: 1.24-25-9; *P*=0.00) old and likely at risk of having more bTB. Additionally, the prevalence was significantly higher in female animals (OR:3.7; CI:1.5-8.8; *p*=0.003), also a significant prevalence was observed as the herd size increased from 31-80 (OR:1.95; CI:0.75-5.0; *p*=0.000) as well as from 81-171 (OR:5.5; CI: 2.14-14.4; *p*=0.000). Moreso, the prevalence was significant with the location of the animals, as areas with grazing reserves appeared to have more odds and more likely to have bTB: Awe (OR:9.6; C I:.2-4.4); Doma (OR:6.9; I:1.5-30.1; *p*= 0.01); Keana (OR:4.5; CI:0.96-21.6; *p*=0.01); Obi (OR:3.5; CI:0.7-17; *p*=0.01). The major risk factors for bovine tuberculosis in this study were sex, age, herd size, and location, contributing largely to the spread of bTB in the study area.

Keywords: Bovine tuberculosis; Grazing reserves; Prevalence; Tuberculin test

Introduction

Bovine tuberculosis (bTB) is a chronic bacterial disease, characterized by the formation of granulomas in tissues, especially of the lungs, lymph nodes, liver, intestines, and kidneys (Shitaye *et al*., 2007; Hlokwe *et al.,* 2013; Ahmad *et al*., 2017). Bovine TB is one of the most important diseases that affect reproduction in animals. Human infection due to *Mycobacterium bovis* has been reported in many countries of the world (Tschopp *et al*., 2016a; Dejene *et al*., 2016; Sichewo *et al*., 2020; Cadmus *et al*., 2010; Ofukwu *et al*., 2008; Adesokan *et al*., 2012). *Mycobacterium bovis* is primarily the cause of bovine tuberculosis which to a lesser extent also caused by *M.caprae* (Alveraz *et al*., 2014). *M. bovis* belongs to the *Mycobacterium tuberculosis* complex (MTBC), comprising of *M. tuberculosis, M. bovis, M.*

africanum, M. canetti, M. caprae, and M. pinipedi, where *M. bovis* primarily infects cattle but with a zoonotic characteristic.

In Africa, bTB represents a major challenge in livestock production, and the impact of the disease is exacerbated by poverty, and the inadequate strategies in control and eradication programs have resulted in a significant public health threat (Asseged *et al.*, 2000), resulting in African region having the heaviest burden of TB followed by South- East Asia (WHO, 2016). The disease transmission dynamics of bTB suggest that transmission occurs mainly within the cattle population and less frequently between cattle and humans and possibly between humans, making it difficult for the continent to achieve an efficient national control strategy (Sanou *et al*., 2014). It is important to obtain information to monitor the disease transmission pattern and its spread among the cattle population (Cosivi *et al*., 1998).

Nasarawa, north-central Nigeria has a large concentration of cattle population due to the enactment of laws banning open grazing of cattle in Benue state. The incessant farmer-herder clashes in Plateau state also made an unprecedented influx of cattle population into the state, coupled with a proficient cattle market located in Lafia and other parts of the state. Therefore, the need to study the epidemiological dynamics of bTB. Pastoralists and their cattle reside mainly in the two most important grazing reserves located within the southern zone providing forage and water for the animals cum shelter for the pastoralists. It is important to monitor the spread and transmission dynamics of bTB among the cattle population in order to provide an updated data on the prevalence of the disease using the single intradermal comparative tuberculin test (SICTT). This study aims to determine the prevalence and risk factors associated with bTB in cattle in the southern zone of Nasarawa state, north-central Nigeria.

Materials and Methods

Study area

The southern zone of Nasarawa state comprises five Local Government Areas: Awe, Doma, Keana, Lafia, and Obi. The zone shares a boundary with Plateau and Taraba states to the east and Benue state to the south (Figure 1). This part of the state is vital for crop cultivation and cattle pastoralism because of the available grazing reserves in Awe, Doma, Keana, and Obi local government areas. River Azara and Doma Dam are both tributaries to River Benue, and the river banks provide lush forage and water for animals and human activities throughout the year. The proficient cattle market in Lafia derives its stocks of slaughter animals from pastoral communities around these grazing reserves. The cattle breeds within the zone are mostly Bunaji and Sokoto Gudali of a lesser population (ILCA, 1979). They are managed under a pastoral production system with less intervention, especially in veterinary care by the government and its agencies.

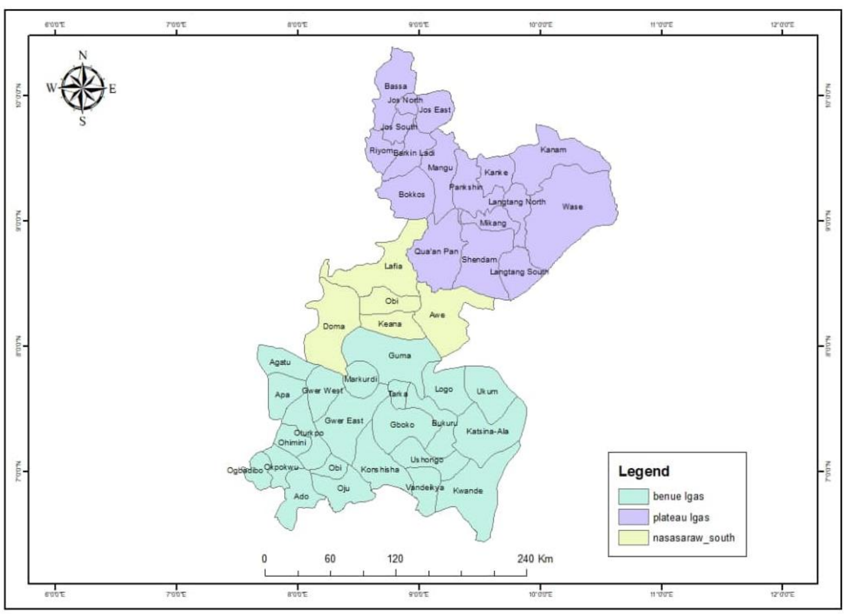

Figure 2: Map of the southern zone of Nasarawa state showing Benue and Plateau boundary

Study population

A total of 500 apparently healthy grazing animals under a pastoral production system were sampled in the study area. About 100 cattle from each local government area were randomly selected for the study.

Study design

A cross-sectional study was conducted using a single intradermal comparative tuberculin test (SICTT) in some selected herds in the southern zone of Nasarawa state, comprising five local government areas: (Awe, Doma, Keana, Lafia, and Obi), between 2019 and 2020, using purified protein derivatives of avian and bovine tuberculin procured from CZ

Veterinaria, S.A, La Relva Spain.

Sample size determination

The sample size was determined based on the assumption of 50% prevalence, at 95% CI and a degree of absolute freedom of 0.05 following the method of Thrusfield (2005). The total sample size was calculated, and the total number of required animals for all five study sites was 384, and for better precision, the sample size was increased by 20% using Thumb's rule, and the sample size was put at 500, a method reported by Martin *et al.* (1987).

Herd selection

A herd in this study is defined as a group of cattle kept by a pastoralist with 15 to 20 animals, and only herds with at least 20 cattle were selected. A multistage sampling technique described by Martin *et al.* (1987) was used in each local government area to select areas with a large, medium, and small concentration of pastoralists and their animals. All the cattle were tested in each of the randomly selected herds. In the first stage, the areas with small cattle populations in the local government area were selected and inoculated, followed by areas with medium cattle populations. In the last stage, areas with large cattle populations were randomly selected and inoculated.

Cattle selection

All the 500 animals were code numbered with a permanent marker at the medial part of the horn, towards the base. The coding was done in such a way that it could easily be discerned after 72 hours. The selected animals were carefully examined clinically and information about the individual animal was obtained; location, breed, sex, age, reproductive status (Pregnant or non-pregnant), lactation status (wet or dry), as well as body condition score (good, medium, poor), were recorded.

Tuberculin skin testing

Tuberculin skin testing was performed using aliquots of 0.1 ml of 500 IU/ml bovine purified protein derivative (PPD) and 0.1 ml of 500 IU/ml avian PPD (CZ: Veterinaria, S.A, La Relva Spain).

Bovine and avian PPDs were injected by veterinary staff intradermally at two sites approximately 12 centimeters apart at the border of the anterior and middle third of one side of the neck. This was done after shaving the two sites using a razor blade. The skin thickness was measured manually using a vernier caliper before and 72 hours after the PPD injection. An animal was considered bTB positive if the reaction at the bovine site minus the reaction at the avium site was greater than 4 mm cut-off, according to the recommendations of the OIE (2009) World Animal Health Organization, as described by Dejene *et al.* (2016).

Statistical analysis

Data were analyzed using Statistical Package for Social Sciences (IBM, USA) Version 20.0. Odds ratio (OR) and 95% CI were used to measure the likelihood and strengths of association between variables and bTB (*M. bovis*). Tables were constructed using Microsoft Excel 2010. Values of $p<0.05$ were considered significant in this study.

Results

The individual animal prevalence of bTB was 9.2% (46 reactors out of 500 animals) whereas the herd level prevalence was 50% (22 out of 44 herds) (Table 1).

The binary logistic regression analysis of the risk factors showed that the odds of bTB infection among cattle increased as the animals get older 5-6years (OR: 7.4; CI: 1.54-35.4; *P*=0.000 Table 2) and 7 years (OR: 5.7; CI: 1.24-25-9; *p*=0.00), the odds of bTB in older animals increases as the animals get older, however, the prevalence also increases. The prevalence in female animals (OR:3.7; CI:1.5-8.9; *p*=0.03. Table 2) is thrice the odds of having cases of bTB, compared to male animals, and as the herd size increases, the odds of having more cases increased. There is also a significance in the likelihood of having more bTB among cattle grazing within the study area with grazing reserves more likely to show more prevalence of bTB: (Awe: OR:9.6; CI: 2.2-43.4; *p*=0.01); (Doma: OR:6.9; CI:1.5-30.1; *p*=0.01) and (Keana: OR:4.5; CI:0.96-21.6; *p*=0.01). There was significance in the prevalence of bTB between animals with medium BCS (OR: 0.05; CI: 0.02-0.1; *p*=0.00) and those with poor BCS (OR:0.02; CI:0.005-0.017; *p*=0.00), within the study area.

Forty-four herds of cattle were sampled in this study and 50% (22 out of 44 herds) were reactive to SCITT. This study establishes that study areas with large populations of grazing animals, especially in those areas with grazing reserves recorded higher prevenances, Awe 16 (17.39%); Doma 13(11.40%); Keana 9 (9%); Lafia 1 (1.06%) as well as in Obi 7 (7%) in this order of population of animals within the grazing reserves (Table 1).

Table 1: Summary of Herd-level and Individual animal prevalence in cattle in the southern zone of Nasarawa state from April 2019 to February 2020 (n=500)

LGA		Total screened	Number positive	Prevalence%	No. Negative (%)
Awe	Individual				
	Animal prevalence	92	16	17.39	76 (82.6)
	Herd prevalence	8	6	75	2 (25)
Doma	Individual				
	Animal prevalence	114	13	11.40	102
	Herd prevalence	11	9	81.8	2(18.81)
Keana	Individual				
	Animal prevalence	100	9	9	91(91)
	Herd prevalence	8	3	37.5	5(62.5)
Lafia	Individual				
	Animal prevalence	94	1	1.06	93(98.9)
	Herd prevalence	8	1	12.5	7(87.5)
Obi	Individual				
	Animal prevalence	99	7	7	93(93)
	Herd prevalence	9	3	42.9	6(66.7)

Table 2: Binary logistic regression analysis of tuberculin reactivity and risk factors among cattle in the southern zone of Nasarawa state, north-central Nigeria from April 2019 to February 2020 (n=500)

Variables	No. of cattle tested	No. of positive responses (%)	OR (95% CI)	P-value
Sex				
Male	160	6(3.8)	1.00**	0.003
Female	340	40(11.8)	3.7(1.5-8.9)	
Age				
<2years	67	2(2.9)	1.00**	0.001
2-4years	286	21(7.3)	2.8 (0.6-12.3)	
5-6years	57	9(15.8)	7.4 (1.5-35.4)	
≥7	90	14(15.6)	5.7 (1.2-25.9)	
Breed				
Bunaji	493	1(14.3)	1.00**	0.000
Sokoto Gudali	07	45(9.1)	1.7 (0.19-14.0)	
Herd size				
1-15	1-15	5 (4.2)	1.00**	0.000
16-30	16-30	4 (4.0)	0.8 (0.22-2.92)	
31-80	31-80	11 (5.7)	1.9 (0.75-5.05)	
81-171	81-171	20 (21.7)	5.5 (2.14-14.44)	
BCS				
Good	35	3 (8.6)	1.00**	
Medium	356	23 (6.5)	0.05 (0.02-0.1)	0.000
Poor	109	20 (18.3)	0.02(0.005-0.071)	
Reproductive status				
Pregnant	79	3(3.7)	1.00**	0.03
Non-pregnant	03	1(1.2)	0.9 (0.4-1.7)	
Lactation status				
Dry	234	28 (11.9)	1.00**	0.001
Wet	106	11(10.4)	1.7 (0.2-14)	
Location				
Lafia	94	1(1.06)	1.00**	
Awe	92	16(17.4)	9.6(2.2-43.4)	0.01
Keana	100	09(9)	4.5(0.96-21.6)	
Obi	99	07(7.0)	3.5(0.7-17.1)	
Doma	115	13 (11.40)	6.9(1.5-30.1)	

Reference categories**

Discussion

In this study, the overall individual animal-level prevalence of bTB in the study area was 9.2%, and the risk factors of bTB in the southern zone were age, sex, herd size, location as well as breed of the cattle were significant factors that increased the odds of having bTB among individual animal-level in the study area and these corroborate with the reports of other studies (Dejene *et al*., 2016; Tschopp *et al*., 2016a; Gumi *et al*., 2012; Boukary *et al*., 2011).

Our findings in the present study established a significant prevalence between the sex of the animals and bTB, with the female animals having three times the odds of having more cases than the male animals and because female cattle are kept longer in the pastoral herds than the males for reproduction, they tend to be latently infected at younger ages and become chronically ill as they get older and hence, more reactive to SICTT. These findings corroborate the reports of Dejene *et al*. (2016) in Ethiopia and Ahmed *et al.* (2019) in Nigeria, whose findings also reported a similar outcome of older cattle having higher odds of bTB.

Accordingly, these findings suggested a significant likelihood between age and prevalence of bTB with older cattle between 5-6 years and ≥ 7 years having more likely odds of bTB infection, and the results showed that bTB being a chronic infection which often manifests in older cattle than younger ones and this is in agreement with the published findings of Egbe *et al*. (2016); Dejene *et al*. (2016); Ahmad *et al*. (2017) and Mekonnen *et al*. (2019), whose findings reported higher prevalence in older cattle than cattle of younger age. Our findings are also in tandem with reports in southwestern Nigeria (Cadmus *et al*., 2006) and Ethiopia (Dejene *et al*., 2016).

In the currecnt study, there was a significant association between breed and prevalence of bTB amongst the cattle sampled. Bunaji outnumbered other breeds and there was likely to have more cases of bTB than Sokoto Gudali. This could suggest a population resilience of the Bunaji breed of cattle in the study area as compared to Sokoto Gudali that are more populated in some part of the northeastern and northwestern part of the Nigeria (N*i*MET,2022). The results of this study is in agreement with the reports of Ibrahim *et al*. (2018) whose study suggested more odds of having BTB in white Fulani than in *Bokoloji* breeds within northeastern and northwestern Nigeria and elsewhere in Africa due largely to their population density. Diguimbaye-Djaibe *et al.* (2006) reported a higher prevalence of bTB in Red Bororo than in Zebu cattle in the Chad Republic. Additionally, Awah-Ndukum *et al*. (2012), confirmed higher prevalence of bTB infection in Cameroon, in Red Bororo than in Sokoto Gudali and Bunaji cattle breeds. The disease probability dynamics of bTB in cattle and their pastoralists is not only motivated by the search for pasture and water but equally to avoid areas affected by livestock disease or to engage in livestock trade, which has dramatically exacerbated the transmission of bTB within a country and across the borders (Pokam *et al*., 2019).

In this study, location was significant in the prevalence of bTB. In Awe, the odds of transmission of bTB infection in other study areas were nine times more likely than in cattle within Lafia, in epidemiological terms, the odds of disease could persist where animals graze nearby and this could exacerbate cattle-to-cattle transmission and a spillover host may likely shed *M. bovis* to the environment (Pokam *et al.*, 2019), in location, where cattle share grazing field (Michel & Van Helden, 2019) or animal movement from one location to the other could insidiously promote the dissemination of bTB into wider locations (Mekonnen *et al*., 2019).

The results of this study showed a significance between body condition score (BCS) and the prevalence of bTB. This study recorded more prevalence in animals with medium BCS and in those animals with good BCS and the results did not agree with reports of Delafosse *et al*. (1995), whose findings showed more prevalence in animals with medium and poor BCS. Additionally, this study was not in agreement with the reports established by (Yohanna *et al*., 2008; Ibrahim *et al*., 2018) whose findings established that animals with poor BCS are more susceptible to developing clinical bTB or bTB-positive animals develop poor BCS as a result of being infected with bTB.

This present study has established that there is no significant association between pregnant animals and the prevalence of bTB, with pregnant animals less likely at risk than non-pregnant ones. However, pregnant animals were reactive to the SICTT compared to non-pregnant animals. A report by Ghebremariam *et al.* (2016) in Eritrea suggested that physiological statuses such as pregnancy and lactation were significantly linked to reactivity in SICTT with pregnant and lactating animals having more reactors. It is intriguing to note that the physiological status of animals did not contribute to tuberculin sensitivity Elias *et al.* (2008), and Kazwala *et al*. (2001) maintained that the reactivity status of pregnant cows to tuberculin was not significantly different from other animals, which was in tandem with the results of these findings.

Additionally, herd size was found significant with the prevalence of bTB, with herd size having more animals more likely to be at risk. This study showed that, as the herd size increases, the prevalence of bTB also increased and the odds of bTB infection also increase and this is in tandem with reports (Tschopp *et al*., 2012; Cadmus *et al*., 2009a; O'Reilly & Daborn, 1995; Yohanna *et al*., 2008; Cadmus & Adesokan, 2009b) in Nigeria and elsewhere in Africa. In this study, we identified that, in the pastoral system, herd size is a factor of economic benefit to the cattle pastoralists without minding the cost-benefit dynamics of disease control economics, herd health as well as risk factors associated with bTB and may have likely influenced the outcome of the disease, Sichewo *et al*. (2020). Moreover, larger herds are more likely to have at least one cow with bTB which could likely influence the risk factors within the herds (Dejene *et al*., 2016).

This study established that lactating animals were likely to have more prevalence of bTB, with wet cows odds of having bTB than dry cows and this is in line with the work of Kazwala *et al.* (2001), whose report showed more prevalence of bTB among dairy cattle tested using SICCT. Additionally, Tschopp *et al.* (2009); Tschopp *et al*. (2010) maintained that reactors to tuberculin tests among dairy cattle are higher between calving and service with a high percentage of reactors as compared to non-reactors. Boland *et al*. (2010) maintained that milk yield was significantly lower for bTB reactors compared to the non-reactor cows.

In conclusion, this study established that bTB prevalence increases in female animals more than in males and increases as the cattle get older with the location of the animal having a very important risk factor for bTB within the zone. Herd size is a very important risk factor contributing to the prevalence of bTB in cattle because the increased contact between animals in the pastoral grazing system predisposes cattle herds to bTB transmission. Thus, findings from this study provided useful information on the epidemiological data on bTB infection in cattle in the southern zone of Nasarawa state.

To improve the epidemiological information, further research should be undertaken to track grazing animals in the grazing field to identify their bTB status to reduce the impact of the risk factors and older cattle within the herds should be culled off to reduce the chronic manifestation of bTB in cattle.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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