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Original Article

Occurrence of bovine tuberculosis among cattle herds from nomadic peri-urban settlements and cattle slaughtered at the municipal abattoir of Bauchi, North-Eastern Nigeria

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ABSTRACT

Objective: This study was designed to determine the prevalence of bovine tuberculosis (bTB) at the municipal abattoir and cattle herds in peri-urban nomadic settlements of Bauchi state of Northeastern Nigeria.
Materials and Methods: A total of 2440 cattle slaughtered at the municipal abattoir from June to September were examined for lesions characteristic of bTB and eighty-six (n=86) cows selected from two cattle herds located at temporary nomadic settlements in Bauchi metropolis were also screened for bTB using purified protein derivative (PPD) tuberculin skin test. During the study period, total of 2,440 cattle were slaughtered comprising majority of females (n=1656) and males (n=784) as well as of different breeds including majority of White Fulani (n=1864) followed by Red Bororo (n=508) and Sokoto Gudali (n=68).
Results: The results revealed that out of the 2,440 slaughtered cattle inspected for tuberculous-like lesions, 51 had lesions suspected to be lesions characteristic of tuberculosis, while 48 were positive for Ziehl-Neelsen. Prevalence rate of 1.96% based on microscopic examination and 2.0% based on suspected gross lesion were recorded. The prevalence was 0.77% for males, 1.2% females, 1.84% for adults, 0.12% for calves and 1.8% for white Fulani (Bunaji), 0.12% for Red Bororo (Rahaji) and 0.04% for Sokoto Gudali (Bokoloji). In addition, screening of 86 cows showed that 8.1% were positive for tuberculosis using tuberculin test.
Conclusion: The outcome of this study showed that bTB is still endemic in Bauchi state and this can pose a significant public health challenge. Thus, it is recommended that the government should intensify the test-and-slaughter policy as well as put in place an effective monitoring and surveillance control programs for bTB to mitigate the risks posed to public health by this zoonotic disease in the study area.

KEYWORDS

Bauchi state; Northeastern Nigeria; PPD

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INTRODUCTION

Bovine tuberculosis (bTB) is a chronic devastating zoonotic disease of humans and animals with a soaring influence on health, productivity and the economy (Sa'idu et al., 2017). In humans, infection with bTB occurs through ingestion or inhalation of contaminated milk and milk products, contaminated meat and meat products and infected aerosols (Bilal et al., 2010; Danbirni et al., 2017). Studies have shown that a large proportion of humans (82%) and cattle (85%) population in African countries live in agric-economic zones where bTB is endemic or inadequately controlled (Ayele et al., 2004). In Nigeria, the prevalence of bTB from 1976 to 2010 ranges from 2.5%-17%. However, several studies which involves abattoir surveys, tuberculin test, acid fast test and molecular characterization of few isolates obtained from a small number of herds have been reported (Ibrahim et al., 2010; Danbirni et al., 2010, 2013, 2017; Ejeh et al., 2013; Abubakar et al., 2013).

The disease is caused by *Mycobacterium bovis* and it is characterized by the formation of granulomatous tissue especially in the lymph nodes, lungs, kidney and intestines. The disease has an exceptionally wide host range and cattle is known to serve (Wedlock et al., 2002) as a maintenance host and a source of infections to humans as well as other animals (Morris et al., 1994). When established in the body of the wildlife reservoir host, the disease is difficult to eradicate (O'Reilly and Daborn, 1995). Across countries, cities and continents the distribution of the disease varies. In Europe, majority of the countries have been declared free from tuberculosis, this however did not include places like Ireland, Wales, England, Spain and certain parts of Europe were the disease is still endemic due to difference in climatic conditions and the presences of wildlife reservoir host (Lahuerta-Marin et al., 2016).

In humans, infection with *M. bovis* manifest as extra pulmonary tuberculosis, particularly in children (Wedlock et al., 2002). Transmission of the pathogen has been reported to be influenced by a myriad of factors which included the characteristics of the bacteria, the persistence of the bacteria in the environment, the presence of a potential susceptible host, the chances of exposure to infected animals and the accessibility and the effectiveness of control strategy such as removal of infected animals and suspected tuberculous lesions found in slaughter house and veterinary hospitals during post mortem (O'Reilly and Daborn, 1995; Skuce et al., 2012).

A significant number of human tuberculosis occurred as a result of infection with *M. bovis*, for instance studies have shown that about 5-10% of human cases were due to infection with *M. bovis* (O'Reilly and Daborn, 1995; Cosivi et al., 1998; Humblet et al., 2009). However, even with that, there is paucity of information with regards to the true prevalence of *M. bovis* infections in humans in both developed and developing countries. This is because in most developing countries including Nigeria, most of the cases of human tuberculosis are not identified by bacterial culture isolation and identification (Dankner and Davis, 2000; Vordermeier et al., 2012). Thus, leading to under reporting or over reporting of the prevalence of *M. bovis* in these regions.

Additionally, bTB is mostly seen in low and middle-income countries as well as densely populated areas. This is because, in most developing countries especially in Africa and Asia, there are no standard and effective eradication programmes aimed to stall the spread of the disease. In Nigeria and other African countries, there is paucity of information with respect to the true prevalence of bTB and its zoonotic implications to humans (Caffrey, 1994; Raufu and Ameh, 2010).

Furthermore, bTB is becoming increasingly important in Nigeria especially in the rural communities, where humans and animals abode in the same micro-environment. This is because of the exponential growth in population density where livestock production plays an important role in the socioeconomic development of the people as well as increased contact with wild life reservoir host (Okeke et al., 2014).

The lack of effective isolation and identification of *M. bovis* in humans and animals, in addition to the absence of effective surveillance and control measures have resulted in under reporting the impact of bTB. However, a number of studies have reported the occurrence of both human pulmonary and extra-pulmonary cases of tuberculosis that is associated with *M. bovis* infection (Ayele et al., 2004). Additionally, several authors have also reported the isolation of *M. bovis* and *M. africanum* from tissue samples obtained from the abattoir (Sa'idu et al., 2017). Thus, indicating that despite the lack of effective identification, control and prevention strategies put in place, bTB is endemic in Nigeria. This study was designed to determine the occurrence of bTB among cattle herds from nomadic peri-urban settlements and cattle slaughtered at the municipal abattoir of Bauchi, North-Eastern Nigeria.

MATERIALS AND METHODS

Study area: This study was carried out in Bauchi metropolitan, Bauchi state **(Figure 1)**. Bauchi state is one of the 6 states of the Northeastern region of Nigeria. It is located between Latitudes $9^{0}3'$ and $12^{0}3'$ and Longitude $8^{0}5'$ and 11^{0}E. Bauchi state has a land area of 49,119 Km^2 that covered 5.3% total land area in Nigeria. The state shares border with Kano and Jigawa to the North, Taraba and Plateau to the south, Gombe and Yobe to the east and Kaduna to the west. The state has a population of about 4,653,066 with 20 local government areas. The state has two vegetation zones namely Sahel savannah and Sudan savannah. In the southern part of the state, rains start during April, and nature of raining is heaviest (1300 mm/annum) and longer. On the other hand, the northern parts of the state receives the rain (700 mm/annum) during June-July.

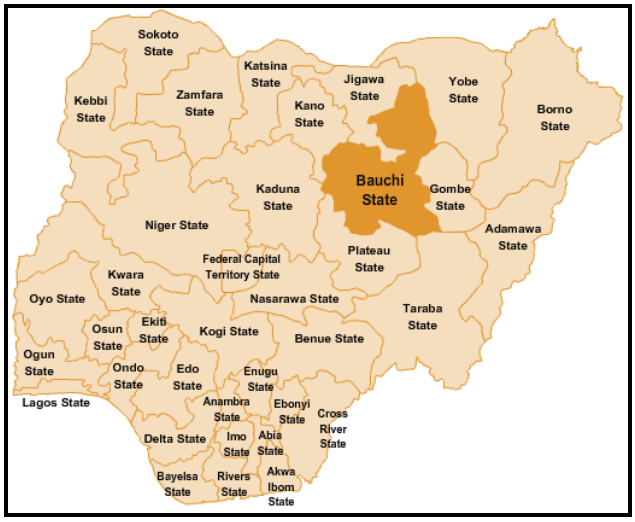

Figure 1. Map of Nigeria showing Bauchi State (Source: Google Maps, Accessed 14th February, 2018)

Sample collection: A total of 2,440 slaughtered cattle inspected for tuberculous-like (TB-like) lesion in Bauchi central abattoir were used in this study. The organs were selected based on postmortem physical examination of the carcass as recommended by the World Organization for animal health (OIE, 2009). Fifty one (51) suspected TB-like lesions were aseptically collected and preserved in a normal saline solution before transporting to the laboratory. Additionally, eighty-six (n=86) cattle were randomly selected from two cattle herds located in a temporary settlement of nomadic Fulani community at Gubi and Kagadama wards of Bauchi local government area. The population of cows in each herd was n=34 and n=52, respectively. These cows were screened for tuberculosis using purified protein derivative (PPD) tuberculin skin test.

Tuberculin testing: The test animals were humanely restrained and the injection sites on the caudal area of the tail was aseptically shaved and disinfected to inject the PPD tuberculin. An amount of 0.1 mL of the PPD tuberculin was injected into the sites and observation was carried out 72 h after injection for the presence or absence of swelling and skin discoloration. When a reaction at the injection site is present, the animal is considered 'responder' or 'suspect' and will go through the second round of testing. However, in the absence of swelling or "suspect" cattle, the whole herd would be quarantined until the animals are screened negative through the second tuberculin skin test using comparative cervical test (CCT).

The comparative cervical test (CCT) is performed on the "responders" 10 and 60 days after the caudal fold test. Briefly, the test animals were restrained and two sites, 12 cm to 15 cm apart, on the lateral side of the mid neck were shaved to measure a skin-fold thickness using a caliper. The skin thickness was measured with calipers before the PPD tuberculin was injected. After 72 h, the thickness of the skin at the injection sites was measured, using digital calipers as described by Khan and Khan (2007).

Preparation of smear: The samples were placed in a sterile Petri dish and scalpel blade was used to incise the suspected samples into two halves. Then forceps was used to candy the inner surface of halves and press firmly on to the surface of the sterile slide and make a good impression smear and then fix the smear by using heat from the Bunsen burner.

RESULTS

The outcome of this study revealed that more than 65% of the cattle slaughtered at Bauchi Abattoir were females and from the white Fulani breed. The result of this study also showed that 2.1% (n=51/2440) of the cows slaughtered at Bauchi municipal abattoir had TB-like lesions and 1.96% (n=48/2440) were positive for Ziehl-Neelsen stain (**Table 1**). Additionally, a prevalence rate of 1.96% was recorded based upon microscopic examination of samples, while only 2% were based on gross lesions of tuberculosis. According to sex, the prevalence of bTB in female was slightly higher 1.2% than in males, which was 0.77% (**Table 1**). Similarly, the prevalence of bTB was also higher in adult cattle (1.84%) than in calves (0.12%) (**Table 1**). Breeds associated

Table 1. Distribution of Bovine Tuberculosis (bTB) among slaughtered cattle on the basis of temporal (monthly distribution), breeds, sex and age in the Bauchi municipal abattoir, Northeastern Nigeria (n=2,440)

Variables	No. Slaughtered	No. Suspected Tuberculous lesions	No. +ve Ziehl Nielsen	Prevalence (%)
Months				
June	786	11	10	1.27
July	794	15	14	1.76
August	780	22	21	2.69
September	80	3	3	3.75
Breeds				
White Fulani (Bunaji)	1864	45	44	1.8
Red Bororo (Rahaji)	508	4	3	0.12
Sokoto Gudali (Bokoloji)	68	2	1	0.04
Age				
Calves	2424	47	45	1.84
Adults	16	3	3	0.12
Sex				
Male	784	20	19	0.77
Female	1656	31	29	1.18
Overall	**2440**	**51**	**48**	

n=number of samples, bTB=Bovine tuberculosis

Table 2. Prevalence distribution of tuberculosis skin test responders by breed, age and sex among nomadic Fulani herds in peri - urban area of Bauchi state, Northeastern Nigeria (n=86).

Variables	No. Tuberculin tested	No. suspected	Prevalence (%)
Breeds			
White Fulani (Bunaji)	59	5	5.8
Red Bororo (Rahaji)	19	2	2.3
Sokoto Gudali (Bokoloji)	8	0	0.0
Age			
Adults	77	6	6.9
Calves	9	1	1.1
Sex			
Male	18	3	3.4
Female	68	4	4.6
Overall	**86**	**7**	**8.1**

n=number of animals sampled

bTB showed that the prevalence of bTB was higher in white Fulani (Bunaji) (1.8%) than in red Bororo (Rahaji) (0.12%) and Sokoto Gudali (Bokoloji) (0.04%) (**Table 1**). Out of 86 tuberculin skin tested cattle, 7 responded positively to the tuberculin PPD, and the prevalence of bTB during tuberculin testing was 8.1% (**Table 2**).

DISCUSSION

bTB remains as a major public health problem worldwide. The disease constitutes a significant threat to human health in many developing countries, where the disease is endemic in domestic stock, wildlife reservoirs and likely contact with humans, particularly those infected with HIV (Skuce et al., 2012). In this study, two thousand four hundred and forty thousand (n=2440) carcasses slaughtered at Bauchi municipal abattoirs June to September were examined for TB-like lesions. Additionally, eighty-six (n=86) cows from two randomly selected herds were screened for tuberculosis using tuberculin test with purified protein derivative (PPD). The finding from this study showed that 2.1% (n=51/2440) of the total cattle slaughtered during the four-month study period in Bauchi municipal abattoir had TB-like lesions, whereas 1.96% (n=48/2440) were positive for Ziehl-Neelsen **(Table 1**). Additionally, 8.1% (n=7/86) of cows screened for tuberculosis were positive for tuberculin test (responders) (**Table** 2). It was also observed that the prevalence of TB-like lesions was slightly higher in female cattle (1.2%) as compared to male cattle (0.77%) (**Table 1**).

Similarly, the prevalence of TB-like lesions was higher in adult cattle carcasses examined (1.84%) as compared to carcasses from younger animals (0.12%) (**Table 1**). This finding was however not in agreement with the work of Ahmad et al. (2017), where the authors reported a 6.1% prevalence of TB-like lesions after sampling cattle carcasses (n=3690) in Zamfara, Northwestern Nigeria. Interestingly however, the authors also reported higher prevalence of TB-like lesions in female and adult cattle carcasses than in young and male cattle carcasses, which agrees with the findings of this study. The difference in the prevalence of TB-like lesions could be attributed to one of many factors including the sample size, difference

in the seasons during which sample was collected, the criteria for selection of lesions as well as the location of the abattoirs in Zamfara Northwestern Nigeria. For instance, even though both states are located in the northern region of Nigeria and share almost similar climatic conditions, Zamfara state however shares boundary with Niger Republic. And because of the porous nature of the borders, coupled with the nomadic lifestyle of the herdsmen, there is free transboundary movement of animals in and out of the country. Thus, increasing the chances of infection with tuberculosis.

This was confirmed in a study conducted by Boukary et al. (2011) using comparative intradermal tuberculin test to determine the prevalence of bTB in a population (n=393) of cattle. The authors reported an overall apparent and true prevalence of 3.6% and 0.8% respectively. In addition, also reported the presence of animals coughing in the herd (OR=4.7; 95% CI:1.12–19.71; *P* value=0.034) and the lack of adequate quarantine (OR=4.2; 95% CI:0.96–18.40; *P* value=0.056) as major risk factors of bTB in cattle. The authors reported that bTB was not only endemic in Niger republic but also there was high potential of transmission to humans. This finding is of significant public health importance because; consumption of offal and other organs collected from infected cow carcasses can lead to infection with tuberculosis. In many instances, due to poor implementation of compensation policy by government to butchers following carcass condemnations, meat and meat products from these infected animals ended up in the retail markets for public consumption. The plausible explanation for the high prevalence of TB-like lesions observed in carcasses of females (1.2%) and adult cattle (0.77%) slaughtered, is because cows use for calving are usually kept for longer periods in a herd than males (0.77%). Furthermore, calving stress can also lower the immunity of the female cows, thus predisposing these animals to increased chances of coming down with tuberculosis (Ahmad et al., 2017).

In comparison with other similar studies conducted in Nigeria, the prevalence of TB-like lesions observed in this study is also lower than the 4.5% (Cadmus and Adesokan, 2009), 4.4% (Damina et al. 2011) and 19.6% (Okeke et al., 2014) reported from similar studies carried out in Southwestern and North central Nigeria. However, the 2.1% prevalence of TB-like lesions reported in this study was higher than the 1.1% prevalence of TB-like lesions reported by Raufu and Ameh (2010) in the same agro economic zone. Similarly, when the findings of this study were compared to similar studies carried out in other African countries, the prevalence of TB-like lesions recorded in this study was found to be lower than reports of similar studies carried out in Ethiopia 6.12% (Aylate et al., 2013), Ghana 2.5% (Asante-Poku et al., 2014), while higher than the 1.0% prevalence of TB-like lesions reported in Cameroon by Koro et al. (2013). This could be due to the difference in breeds, farming system, the endemicity of the disease, and the indicators of carcass examination used, as well as disease control strategies used in these countries.

In this study, it was also observed that the prevalence of TB-like lesions was higher in the month of August (2.69%) and September (3.75%) than in the months of June (1.27%) and July (1.76%). During these periods (August and September) there is peak rainfall in the area and coupled with high humidity and high temperature. These climatic conditions create a favorable environment for the *M. bovis* to thrive and be transmitted to susceptible hosts. Similarly, the prevalence of TB-like lesions in white Fulani (Bunaji) breed (1.8%) was higher than observed in the Red Bororo (Rahaji) and Sokoto Gudali (Bokoloji) breeds of cattle (**Table 1**). This finding was also reflected in the screening of the 86 cows for tuberculosis using tuberculin test, where the results showed high "responders" amongst the white Fulani breeds of cattle (5.8%) as compared with the red Bororo (2.3%) and Sokoto Gudali breeds (0%) (**Table 2**). The finding is also in agreement with the report of Ahmad et al. (2017), where the authors reported that the prevalence of TB-like lesions was higher in white Fulani than in Red Bororo and Sokoto Gudali breeds. This could be attributed to the high population density of white Fulani cattle in the area than Sokoto Gudali and red Bororo.

CONCLUSION

The findings from this study showed that bTB still poses a significant public health challenge in the Bauchi State of Northeastern Nigeria. Thus, necessitating the implementation of thorough preventive strategy for prevention and control of the disease. In addition, detection of the organism at molecular level will help in determining the actual prevalence of the disease in a herd than the conventional tuberculin test. Similarly, conventional control methods, based on test-and-slaughter policies that have helped in the eradication of the disease in most developed countries of the world can be instituted. Furthermore, diagnostic assays should be available in the near future to distinguish between vaccinated and infected livestock.

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CONFLICT OF INTEREST

The authors declare that there is no conflicting interest with regards to the publication of this manuscript.

AUTHORS' CONTRIBUTION

SMJ and NNA conceived and supervised the research, AAB and SMJ drafted the first manuscript, TMH and MDG reviewed the manuscript.

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