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Article

Seroprevalence of foot and mouth disease (FMD) among sedentary cattle in northern Plateau, Nigeria

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Abstract: This study was aimed to determine the seroprevalence of foot and mouth disease (FMD) in cattle and identifying the potential risk factors associated with the disease among sedentary cattle in northern part of Plateau state, Nigeria. Two hundred and seventy cattle aged from 6 months to ≥3 years old were randomly selected and identified and whole blood collected from the jugular vein using plain evacuated tubes. Whole blood was processed and separated and sera were screened for foot and mouth disease virus (FMDV) 3D non-structural proteins using blocking enzyme linked immunosorbent assay (ELISA). Overall, 55.9% (95%CI: 49.96-61.77) FMD seroprevalence was obtained from the study area. Seroprevalence was highest in Riyom (82.5%), followed by Barkin Ladi (66.2%), Jos South (55.5%) and Bassa (41.2%) (x^2 = 17.21, P<0.05). Risk factors for age, management system and location were significant associated (P<0.05) with seroprevalence of FMD. However, there was no significant association with sex (P>0.05). The prevalence odd ratio of FMD was more in Riyom than in Jos South, Barkin Ladi and Bassa (P<0.05). Prevalence odd ratio of FMD was more in extensively managed system relative to intensively managed system, more in adult cattle aged >2 years old. This study has indicated that FMD is an important disease among sedentary cattle in Northern Plateau, however little is currently known about the economic impact of the disease on the local farmers and their livelihoods. As a control measure, efforts should be improved on animal movement during outbreaks while prophylactic control using vaccination should be considered as another option using vaccines containing virus representative of the region.

Keywords: FMD; Northern Plateau; seroprevalence; cattle; prevalence odd ratio

1. Introduction

Foot and Mouth Disease (FMD) is an important Transboundary animal disease (TAD) of economic importance to the livestock industry caused by a virus of the genus Aphthovirus, family Picornaviridae. There are seven distinct serotypes of the virus namely: A, O, C, SAT-1, SAT-2 SAT-3 and Asia 1. Infection with one serotype has been demonstrated not confer immune protection against another. Within serotypes, many subtypes have been be identified by biochemical and immunological tests (OIE, 2009). The disease is characterized by high fever, loss of appetite, salivation and vesicular eruptions on the feet, mouth and teats of lactating cows (Thomson, 1994). Morbidity is usually high in infected herds with rare mortality among adult animals. Myocarditis may occur in young animals resulting in death. Recovered animals remain in poor physical condition over a long period of time leading to economic losses for the livestock industries (Sangare, 2002).

FMD is endemic in most parts of sub-Saharan Africa, with the exception of few countries in southern Africa, where the disease has been controlled by the separation of infected wildlife reservoirs from susceptible livestock using physical barriers in combination with prophylactic mass vaccination campaigns and other zoosanitary measures. Largely due to the endemicity of the disease, and its associated low mortality among adult animals, disease outbreaks are often not perceived as important among pastoralists, thus in most cases outbreaks go unreported. However, a number of developing countries have realised that FMD is one of the trans-boundary diseases that should be controlled to ensure economic stability and access to lucrative international export markets for livestock and livestock products (Sahle, 2004).
FMD was first officially reported in Nigeria in 1924 as sporadic outbreaks, with serotype O as the cause of the outbreak (Libeau, 1960). Subsequently, other serotypes (A, SAT 1 and SAT 2) were later identified to cause outbreaks in livestock across the country (FAO, 2010a; FAO, 2010b, Ehizibolo *et al.,* 2014; Fasina *et al.,* 2013, FAO, 2014a, FAO, 2014b, FAO, 2014c). Each of these serotypes was associated with trade cattle entering Nigeria from neighbouring countries which share land borders with Nigeria. As in most developing countries, the national disease reporting system has been plagued with some weakness in Nigeria; as such there is poor documentation of outbreak cases (Abegunde *et al.,* 1988). However, FMD may continue to gain more national recognition and importance as the Nigerian livestock husbandry systems becomes more intensive and the traditional pastoral Fulani herds begin to settle in response to increased demand for animal protein and food security. It will be necessary to develop efficient control strategies for FMD and other important livestock diseases in Nigeria (Abegunde *et al.,* 1988). Although FMD is often reported seasonally by pastoralists within the study area, little information exists about the prevalence and serotypes that circulates within this study area. Therefore, the objective of this study was to determine the seroprevalence of FMD in this study location and also identify the associated risk factors for foot and mouth disease transmission among cattle herds.

2. Materials and Methods

2.1. Study area

This study was performed in northern Plateau, a region comprising of six Local Government Areas (Jos-North, Jos-South, Jos-East, Bassa, Barkin Ladi and Riyom, 09° 52N and 80° 54E North Central Nigeria), where FMD is perceived to be endemic. Plateau State has a near temperate climate with an average temperature of between 18°C and 22°C. Harmattan winds cause the coldest weather between December and February. The warmest temperatures usually occur in the dry season months of March and April. The mean annual rainfall varies from 131.75 cm in the southern part to 146 cm on the Plateau. The highest rainfall is recorded during the wet season months of July and August.

2.2. Study population and sampling technique

Cattle were selected from northern parts of Plateau, from a list of four local government areas namely; Jos South, Riyom, Barkin Ladi and Bassa during August - September 2010. The four local government areas were selected from the existing six local government areas of the state based on geographical location, proximity to livestock market, and availability of cattle population. From each location, cattle were randomly selected from the various unvaccinated herd, to be included in the study. About 270 cattle were included in the study. The sample size was calculated to estimate the herd level seroprevalence of 12.08% with absolute error at the 95% confidence interval. The calculated sample size was 153 cattle, but this was increased to 270 to account for inadequate sampling and poor sample qualities.

$$n = \frac{Z^2 \ P_{exp} \ (1 - P_{exp})}{d^2} \quad = 153 \text{ minimum samples}$$

Where:
n = required sample size
P_{exp} = expected prevalence 12.08%
Z^2 = confidence interval at 95% = 1.96
d = desired absolute precision 5% (Thrusfield, 1995)

2.3. Study design

A cross-sectional seroprevalence survey was conducted and information from the cattle owners and risk factors such as age, sex, location, and management system were collected. About 5ml of whole blood from apparently healthy cattle were collected from the jugular vein of 270 randomly selected cattle from different unvaccinated herds using plain evacuated tubes (Becton, Dickinson and Company, USA). The samples were transported to the National Veterinary Research Institute in Vom centrifuged at 1450 x g for 10 minutes for serum separation and were stored at -20°C until use. Sera were tested for antibodies to FMD 3D-non-structural proteins using a solid phase ELISA assay.

2.4. Serological analysis

The sera were screened using the FMDV 3D-ELISA kit (PrioCHECKS® Prionics Lelystad Netherland) (Sorensen *et al.,* 1998). Test sera and the negative, week positive and strong positive reference sera were added to 96-well microtiter plates, pre-coated with 3D-antigen. Overnight (16 hours) incubation at 37°C was observed. Plates were washed 6 times with washing buffer. Peroxidase conjugate of anti-ruminant antibody was added to the plate and incubated for 1 hour. This was washed and tetramethyl benzidine (TMB) substrate was added. This reaction for color development was kept at room temperature for 15 min. The reaction was stopped with 1M Sulphuric acid. Optical density of test samples were read at 450 nm on a MultiSkan spectrophotometer (Thermo Scientific, USA) and results were expressed as index derived by dividing the absorbance value of test serum by cut-off control value, according to manufacturer's instruction. Samples with Percentage Inhibition (PI) ≥50% were classified positive and samples with percentage inhibition PI<50% were considered negative respectively.

$$PI = 100 - \left(\frac{OD_{450} \text{ test sample}}{OD_{450} \text{ max}} \right) x\ 100$$

2.5. Data analysis

Animals were divided into three age categories: <1 year, 1-2 years and >2 years of age. The Chi square test was used for univariate analysis. This test was used to assess the association between being seropositive for FMD and different locations, age groups, sex and management system. The confidence level of test was set at 95% and P<0.05 was considered significant. Basic statistics was analysed using Medcalc statistical software Version 11.5.0 for biomedical research.

3. Results

Overall seroprevalence of 55.9% (95%CI: 49.96-61.77) was obtained for FMD among cattle in the study area (Table 1). Considering the different local government areas that were sampled, and number of samples collected (Riyom (n=40), Bassa (n=51), Barkin Ladi (n=15) and Jos South (n=164), the highest prevalence recorded in Riyom 82.5% (33/40) was statistically significantly different (x^2 = 17.21, P<0.05) from the prevalence in Barkin Ladi 66.7% (10/15), Bassa 41.2 (21/51) and Jos South, 55% (87/162) (Table 1).

A higher seroprevalence of 58.2% (95%CI: 51.07-65.08) was observed in females than in males 50.62% (95%CI: 39.80-61.39) (Table 2). However, the difference in prevalence of FMD between the two sex groups was found to be statistically insignificant (x^2 = 0.56, P >0.05).

Age specific seroprevalence revealed higher prevalence in adult (>2 years) of 81% (95%CI: 72.43-87.80), than in cattle aged 1-2 years 41.67% (95%CI: 33.09-50.64) and in calves <1 year old 40% (95%CI: 27.17-53.96). The difference in prevalence among the different age groups was found to be statistically significant (P<0.05) (Table 3). Based on cattle management systems, seroprevalence was highest in extensive management system 63.59% (56.85-69.95) than intensive husbandry system. The difference was statistically significant (x^2=19.8, P<0.05) (Table 4).

3.1. Prevalence odd Ratio (POD)

The Prevalence Odd ratio of FMD in Riyom LGA 4.17(95%CI: 1.64-11.02) was higher than in Barkin Ladi 1.77% (95%CI: 0.53-6.26) and Bassa 0.62% (95%CI: 0.31-1.23) which was statistically significant (P<0.05, Table 1). The Prevalence Odd ratio was higher in females 1.39% (95%CI: 0.8-2.42) than in Males. However, the difference was not statistically significance. (P = 0.212, Table 2).

In relation to age categories of sampled cattle, the Prevalence Odd ratio age group was higher in cattle aged >2 years 6.39%(95%CI: 2.82-14.66), than in cattle aged 1-2 years, 1.83% (95%CI: 0.86-3.92) and calves <1 year old. The difference in cattle aged >2 years was found to be statistically significance (P<0.05, Table 3)
The relative risk of FMD in extensive management system was higher 3.89% (95%CI: 2.05-7.43) than in intensive system of management and it was found to be statistically significance (Table 4).

Table 1. Seroprevalence of FMD in cattle of different location.

Location	**Number of samples (N)**	**Seroprevalence (%) 95%CI**	**Prevalence OR**	**P-value**
Jos South	164	53.05 (45.39-60.60)	1	
Riyom	40	82.50 (68.42-92.01)	4.17 (1.64-11.02)	0.0007
Barkin Ladi	15	66.67 (40.79-86.62)	1.77 (0.53-6.26)	0.3109
Bassa	51	41.17 (28.34-54.99)	0.63 (0.31-1.23)	0.1386
Total	**270**	**55.93 (49.96-61.77)**		

X^2 = 17.21, P<0.05

Table 2. Seroprevalence of FMD by gender.

Gender	**Number of samples (N)**	**Seroprevalence (%) 95%CI**	**Prevalence OR**	**P-value**
Female	189	58.20 (51.07-65.08)	1.39 (0.80-2.42)	0.2118
Male	81	50.60 (39.80-61.39)	1	
Total	**270**	**55.93 (49.96-61.77)**		

X^2 = 0.56, P>0.05

Table 3. Seroprevalence of FMD in different age groups.

Age category	**Number of samples (N)**	**Seroprevalence (%) 95%CI**	**Prevalence OR**	**P-value**
<1 year old	50	40 (27.17-53.96)	1	
1-2 years	120	41.7 (33.09-50.64)	1.83 (0.86-3.92)	0.0895
>2 years	100	81 (72.43-87.80)	6.39 (2.82-14.66)	0.0005
Total	**270**	**55.93 (49.96-61.77)**		

$\chi 2 =$40.55, P<0.05

Table 4. Seroprevalence of FMD in different farming System.

Farming system	**Number of samples (N)**	**Seroprevalence (%) 95%CI**	**Prevalence OR**	**P-value**
Extensive	206	63.59 (56.85-69.95	3.89 (2.05-7.43)	0.0005
Intensive	64	31.25 (20.82-43.34)	1	
Total	**270**	**55.93 (49.96-61.77)**		

$\chi 2 =$19.81, P<0.05

4. Discussion

FMD is an endemic livestock disease in Nigeria. It is evident from the study result that FMD is widely distributed among the cattle herds within the study area. Since the sampled animals had no history of previous vaccination against FMD, this prevalence could have only resulted from field infection with FMDV. The prevalence estimates ranged between 41.2% and 82.5% indicating extensive FMD transmission in all the study area. Uncontrolled animal movement within this region could be the main cause of this rapid spread among susceptible herds. These results are in agreement with the previous findings in this region (Abegunde *et al.*, 1988) who reported a seroprevalence of 33.66% among pastoralist herds. However, in a similar study in Plateau a seroprevalence of 29% was also reported in cattle which signify that FMD is an important disease in this region (Ehizibolo *et al.*, 2014).
At location levels, a higher seroprevalence was observed in Riyom (82.5%) than the other locations with Bassa (41.2%) having the least. This variation may be due to the fact that Riyom is a cattle route and a location where

most pastoralists settle their herds during critical periods of the years for pasture and water. In contrast, Bassa is situated within a communal area where contacts with other herds have been observed to be minimal.

Sex distribution indicated higher seropositivity among female cows, which is consistent with previous studies (Olabode *et al.*, 2013). However, no significant difference (P>0.05) was observed in seroprevalence of FMD between female and male cattle in this study. This finding was consistent with the previous findings elsewhere, where sex appeared not to have a significant association with the seroprevalence of FMD in cattle (Rufael *et al.*, 2006; Geleye *et al*., 2009; Esayas *et al.*, 2009; Megersa *et al.*, 2009).

However, significant difference was observed between three age categories (X^2 = 40.55, P<0.05). The relative high positivity observed in adult cattle might be due to high frequency of exposure to risk factors as reported previously (Rufael *et al.*, 2008; Megersa *et al.*, 2009 Molla *et al.*, 2010). However, this is contrary to a study in which other authors reported that cattle aged 6 months to 2 years are prone for infection with FMDV (Ishola *et al.*, 2011; Olabode *et al.*, 2013) They might have acquired the infection from multiple circulating virus serotypes and could have produced antibodies against all serotypes of FMDV. The relative low seroprevalence in younger animals might be due to low frequency of exposure to risk factors as well as the fact that most farmers keep their calves around the household during grazing with less contact with other herds (Mohamoud *et al.*, 2011).

Furthermore, significant difference in seroprevalence was recorded in different management system (X^2 = 19.81, P<0.05). It was found to be higher in extensively managed system 74% than intensively managed system 44%. This variation may be due to the fact that extensively managed cattle have to travel long distance in search of good pasture and surface water (Rufael, 2006) leading to high contacts with other cattle and wildlife reservoirs of different origin, which is a predominant factor for transmission of disease. This finding is in agreement with a previous study conducted in Ethiopia where production system was the major risk factor for FMD seropositivity (Megersa *et al.*, 2009).

The study further revealed that the prevalence odd ratio of contacting FMD is higher in Riyom than in other location in the study area. Although, the Prevalence odd ratio is higher in females than in males, however, it is of no statistical importance. The Prevalence odd ratio of contacting FMD is higher in Adult than in young animals. It was revealed that the Prevalence odd ratio of FMD infection is higher in extensive managed than intensively manage cattle.

5. Conclusions

The study has proven the endemicity of foot and mouth disease within northern Plateau and the highly contagious nature of the disease among pastoralist herds; we therefore, recommend strict control of animal movement along with application of strict zoosanitary measures and vaccination using vaccines containing antigens representative of the locally circulating virus serotypes.

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Conflict of interest

None to declare.

References

Abegunde AA, CD Ezeokoli, JU Umoh and PB Addo, 1988. Epidemiology of Foot and mouth disease in Nigerian cattle. Viral Diseases of Animals in Africa. OAU/STRC Scientific Publication Lagos Nigeria, pp. 203-212.

Ehizibolo D, A Perez, C Carrillo, S Pauszek, M Alkhamis, I Ajogi, J Umoh, H Kazeem., and SA Metwally, 2014. Epidemiological analysis, serological prevalence and genotypic analysis of foot-and-mouth disease in Nigeria 2008-2009. Transbound. Emerg. Dis., 61: 500-510

Esayas G, A Gelagay, A Tsegalem and A Kassahun, 2009. Seroprevalence of foot and mouth disease in Bench Maji zone, Southwestern Ethiopia. J. Vet. Med. Anim. Health., 1: 5-10.

FAO, 2010a. World Reference Laboratory for Foot-and-Mouth Disease (WRLFMD) Genotyping Report, 7 July 2010, FMD type O, Nigeria, 2009. WRLFMD/2010/000022

FAO, 2010b. World Reference Laboratory for Foot-and-Mouth Disease (WRLFMD) Genotyping Report, 5 July 2010, FMD type A, Nigeria, 2009. WRLFMD/2010/000022

FAO, 2014a. World Reference Laboratory for Foot-and-Mouth Disease (WRLFMD) Genotyping Report, 10 July 2014, FMD type O, Nigeria, 2011-2014. WRLFMD/2010/00016

FAO, 2014b. World Reference Laboratory for Foot-and-Mouth Disease (WRLFMD) Genotyping Report, 10 July 2014, FMD type A, Nigeria, 2011-2013. WRLFMD/2010/00016

FAO, 2014c. World Reference Laboratory for Foot-and-Mouth Disease (WRLFMD) Genotyping Report, 10 July 2014 FMD type SAT 2, Nigeria, 2011-2012. WRLFMD/2010/00016

Fasina FO, DR Connell, OA Talabi, DD Lazarus, GA Adeleke, TP Ousanya and JA Hernandez, 2013. Foot-and-mouth disease virus strains and examination of exposure factors associated with seropositivity of cattle herds in Nigeria during 2007-1009. Prev. Vet. Med., 109: 334-42.

Gelaye E, A Gelagay, A Tsegalem and A Kassahun, 2009. Seroprevalence of foot and mouth disease in BenchMaji zone,Southwestern Ethiopia. Journal of Veterinary Medicine and Animal Health Vol. 1 (1) pp. 005-010. Available online at http://www.academicjournals.org/JVMAH

Ishola OO, YS Wungak, BO Olugasa, LD David and PS Ekong, 2011. Serological survey of foot and mouth disease in cattle in Jos south local government area of Plateau state. Vom J. Vet. Sci., 8: 16-21.

Libeau J, 1960. Foot and mouth disease in Africa South of the Sahara- the present position. Bull Epiz Dis Afr., 8: 152-158.

Megersa B, B Beyene, F Abunna, A Regassa, K Amenu and T Rufael, 2009. Risk factors for foot and mouth disease seroprevalence in indigenous cattle in Southern Ethiopia: the effect of production system. Trop. Anim. Health Prod., 41: 891-8.

Mohamoud A, T Esaya and D Hailu, 2011. Seroprevalence of bovine foot and mouth disease (FMD) in Awbere and Babille districts of Jijiga zone, Somalia Regional State, Eastern Ethiopia. Afr. J. Microb Res., 5: 3559-3563.

Molla B, G Ayelet, Y Asfaw, Y Jibril, G Ganga and E Gelaye, 2010. Epidemiological study on foot-and-mouth disease in cattle: Seroprevalence and risk factor assessment in South Omo zone, South-western Ethiopia. Trans. Emerg. Infect. Dis., 57: 340-347.

OIE 2009. Manual of diagnostic tests and vaccines for terrestrial animals (mammals, birds, bees). *5nd ed. OIE*, Paris, France pp. 111-128.

Olabode HO., HM Kazeem, MA Raji and ND Ibrahim, 2013. Seroprevalence of foot and mouth disease virus antibodies in trade cattle (*Bos indicus*) in Kwara state of Nigeria. Vet. World, 6: 828-832.

Rufael T, 2006. Participatory appraisal and seroepidemiological study of Foot and Mouth Disease in Borena Pastoral areas. FVM AAU, MSc Thesis.

Rufael T, A Catley, A Bongale, M Sahle and Y Shiferaw, 2008. Foot and mouth disease in the Borana pastoral system, southern Ethiopia and implications for livelihoods and international trade. Trop. Anim. Health. Prod., 40: 29-38.

Sahle M, 2004. An epidemiological study on the genetic relationships of foot and mouth disease viruses in East Africa. *PhD Thesis University of Pretoria*, South Africa.

Sangare O, 2002. Molecular epidemiology of foot-and-mouth disease virus in West Africa. *PhD thesis, University of Pretoria*, South Africa.

Sorensen KJ, KG Madsen, ES Madsen, JS Salt, J Ngindi and DKJ Mackay, 1998. Differentiation of infection from vaccination in Foot and mouth disease by the detection of antibodies to the non-structural proteins 3D, 3AB and 3D in ELISA using antigens expressed in baculovirus. Arch. Virol., 143: 1461-1476.

Thomson G, 1994. Foot and Mouth Disease. In: Infectious diseases of livestock with special reference to Southern Africa; Coetzer,J.A.W., G.R. Thomson, G.R.and Tustin, R.C. (eds). Cape Town, London, New York: *Oxford University Press* pp. 825-992.

Thrusfield M, 1995. Sampling in: Veterinary Epidemiology, 2nd ed. London: Blackwell Science Ltd. pp. 179-228.