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Seroepidemiological Investigation of Foot and Mouth Disease in Cattle Managed under Extensive Husbandry System in Tigray, Northern Ethiopia

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Abstract: A cross-sectional multi-stage study was carried out to determine the seroprevalence of Foot and Mouth Disease (FMD) in cattle from October 2008 to June 2009 in selected zones of Tigray, northern Ethiopia. The overall seroprevalence of FMD in cattle was 15.4% (60/390) (95% Confidence interval (CI): 11.8 to 19). Among the assessed risk factors in this study, location (x^2= 10.9, P=0.012), age (x^2 = 9.3, P = 0.009) and breed (x^2 = 15.1, P = 0.002) were significantly associated with prevalence of FMD when tested using a chi-square. However, during univariate analysis, location was the only significant risk factor in which cattle from southern (Odds ratio (OR) = 6; 95% CI: 1.7 to 21.5) and western (OR = 3.9; 95% CI: 1.1 to 13.1) zones were more at risk to be infected with FMD than cattle from central and eastern zones of the region. The study revealed relatively high seroprevalence of FMD in the study area which suggests government and other development partners should introduce regular vaccination program and animal movement should be restricted during the FMD outbreak in the study area. Moreover, the study warrants further molecular characterization of the circulating virus serotypes to apply effective control and prevention measures.

Key words: Foot and Mouth Disease · Seroprevalence · ELISA · Tigray Region · Ethiopia

INTRODUCTION

Animal diseases are still a major constraint on economic growth, reduction of poverty and food security. Foot and mouth disease is among the most significant diseases which is a highly contagious, multi-species animal disease with a devastating impact on national economics and trade [1]. The disease is caused by foot and mouth disease virus (FMDV), exhibits complex epidemiology, existing in seven immunologically distinct serotypes (O, A, C, Asia1, SAT1, SAT2 and SAT3) and in numerous divergent strains within the serotypes which can manifest continuous genomic and antigenic evolutions. The causative agent of FMD has a wide host range in ungulate animals, a multiplicity of modes of transmission and spread and also it has the capacity to persist in the infected animals, animal products and in the environment. It exhibits high morbidity in herds and flocks and can also cause high morbidity in young livestock. Foot and mouth disease imposes very serious impediments to international trade in live animals and animal products [2, 3].

Foot and mouth disease is widespread disease in cattle of Ethiopia; prevalence varies from 8.01% to 53.6% depending on the environmental conditions and the husbandry system [4-8] and posing a major threat to cattle in many parts of the country, thereby causing considerable economic losses through morbidity, mortality and trade restriction. Five of the seven serotypes of FMDV (O, A, C, SAT2, SAT1) are widely distributed in Ethiopia [4,6,9,10] whereas serotypes SAT3 and Asia1 are recently identified in and around Mekelle, Tigray region [11]. Moreover, FMD causes considerable losses of milk yield and live weight among dairy and fattening stocks, respectively. Losses also occur in small-scale mixed farming systems when outbreaks affect

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draught oxen during cropping season [12, 13]. Incidence of FMD has been reported recently in two different areas of Tigray Region and resulted in heavy losses [11, 13].

Currently, in Ethiopia there is no government strategy in FMD control through vaccination and animal movement control [14]. Lack of vaccination strategies (quality, coverage and timing) and free animal movement without certification (including lack of awareness of the intermediary cattle dealers) are thus the main factors that could increase the spread of FMD along the cattle market chain [8]. Despite the wide spread and enormous economic importance of FMD in Ethiopia, the extent to which the disease is recognized as a problem is often dependent on the efficacy of the means for diagnosing it and observing its occurrence [15]. Therefore, the main objective of this study was to determine the seroprevalence of FMD and to know its distribution in different zones of Tigray, northern Ethiopia.

MATERIALS AND METHODS

Study Area and Animals: This study was conducted in western, southern, central and eastern zones of Tigray, northern Ethiopia where cattle are used for household round activities. Tigray is bordered by Eritrea to the north (independent from Ethiopia since 1993), Sudan to the west, the Afar region to the east and the Amhara region to the south. Geographically, the region extends from 120° 13' to 140° 54' N latitudes and from 36° 27' to 40° 18' E longitudes. Cattle production in the Region is mainly characterized by extensive type of management system, which includes sedentary and transhumance cattle husbandry systems. Sedentary farming is a feature of the highlands while transhumance prevails in the northwestern and southeastern lowlands. The main cattle breeds raised in Tigray region are Arado (distributed throughout the region), Barka (mainly western zone of the region) and Raya Azebo (mainly southern zone of the region); the former is the dominant breed of cattle in the present study districts. According to Mesfin [16] and CSA [17], cattle and human populations of the four zones are presented, respectively in Table 1.

Study Design and Sample Size Determination: A cross-sectional multi-stage sampling, with zone as highest and animal as lowest sampling stages, district and peasant association in between the two stages, was carried out from October 2008 to June 2009. Selection of the study unit at each stage was based on a mixed design of convenience and random samplings. Zones and districts were conveniently selected based on geographic localities and dominance of cattle population, whereas peasant associations were randomly selected following a randomization of peasant associations. Four zones and sixteen districts were selected accordingly. Lists of peasant associations were prepared with the assistance of district agricultural offices. Sample size was calculated by using the cluster sampling formula described by Bennett *et al.* [18]. We assumed an intra-class correlation coefficient (*rho*) of 0.2 and standard error of 5% with the expected prevalence of 50%. Fifteen animals were randomly selected per peasant association and the risk factors (sex, age, breed, location and altitude) of each animal considered in this study were recorded. The total sample size calculated for 26 peasant associations was n = 390 cattle.

Table 1: Cattle and human populations of the respective zones

Zone	Cattle population	Human population
Western	1,148,649	1,093,403
Southern	725,144	1,006,504
Eastern	354,921	755,343
Central	809,230	1,245,824

Sample Collection: Blood samples were collected from the jugular vein of cattle using 10 ml sterile vacutainer tubes and an identification code was given to the sample. The blood samples were allowed to stand overnight at room temperature to allow serum separation. The sera were transported using an icebox from the collection site to the National Animal Health Diagnostic and Investigation Center (NAHDIC), Sebeta, Ethiopia for further processing and transferred in to a sterile cryovials and labeled with specific laboratory code. The sera then were stored at -20°C till laboratory examination was performed.

Laboratory Test: Serum samples were examined for antibodies to 3ABC non structural proteins of FMD virus. The SVANOVIR® Foot and Mouth Virus 3ABC-Ab ELISA Kit was designed to detect FMDV specific antibodies in Bovine serum samples. The kit procedure is based on a solid phase indirect ELISA as documented in OIE [2].

Data Management and Analysis: The collected data from the study areas were recorded in database based on Microsoft® Excel for Windows 2007. The total prevalence was calculated by dividing the number of 3ABC ELISA positive animals by the total number of animal sampled.

Chi-square (x^2) test was used to test for the association of risk factors with that of FMD infection. Statistically significant risk factors for x^2 were also analyzed using univariate analysis. In all the analyses, confidence level was held at 95% and $P < 0.05$ was set for statistical significance.

RESULTS

The sera from 390 cattle were tested for the presence of non-structural FMDV proteins (antibodies) using 3ABC ELISA. The overall seroprevalence of FMD in cattle was 15.4% (60/390) (95% CI: 11.8 to 19). Among the assessed risk factors in this study, location (x^2= 10.9, P=0.012), age (x^2 = 9.3, P = 0.009) and breed (x^2= 15.1, P = 0.002) were significantly associated with prevalence of FMD (Table 2) when tested using a chi-square. Sex and altitude were not significantly associated with prevalence of FMD. However, during univariate analysis, location was the only significant risk factor in which cattle from southern (OR = 6; 95% CI: 1.7 to 21.5) and western (OR = 3.9; 95% CI: 1.1 to 13.1) zones were more at risk to be infected with FMD than cattle from central and eastern zones of the region. The results of logistic regression analysis of the potential risk factors are presented in Table 3.

Table 2: Association of risk factors with seroprevalence of FMD in cattle of the study area

Risk factor	No. sampled	No. of positive (%)	Chi-square (x^2)	P-value
location			10.9	0.012*
Central zone	60	3 (5%)		
Western zone	195	33 (16.9%)		
Southern zone	75	18 (24%)		
Eastern zone	60	6 (10%)		
Altitude			0.8	0.368
Lowlands (<1500 masl)	105	19 (18.1%)		
Highlands(>1500 masl)	285	41(14.4%)		
Age in years			9.3	0.009*
<2	44	5 (11.4%)		
2 - 4	93	6 (6.5%)		
>4	253	49 (19.4%)		
Sex			0.6	0.439
Female	283	46 (16.3%)		
Male	107	14 (13.1%)		
Breed			15.1	0.002*
Holstein	13	2 (15.4%)		
Zebu	329	49 (14.9%)		
Barka	18	8 (44.4%)		
Zebu X Barka (cross)	30	1 (3.3%)		

*Statistically significant; masl =meters above sea level

Table 3: Univariate analysis of selected risk factors to seroprevalence of FMD in cattle of the study area

Risk factor	No. sampled	No. of positive (%)	OR (95% CI)	P-value
Location				
Central zone	60	3(5%)	1	
Western zone	195	33 (16.9%)	3.9(1.1 -13.1)	0.030*
Southern zone	75	18 (24%)	6(1.7-21.5)	0.006*
Eastern zone	60	6 (10%)	2.1(0.5- 8.9)	0.307
Age in years				
<2	44	5 (11.4%)	1	
2-4	93	6 (6.5%)	0.5(0.2-1.9)	0.329
>4	253	49 (19.4%)	1.9(0.7 -5.0)	0.210
Breed				
Holstein	13	2 (15.4%0)	1	
Zebu	329	49 (14.9%)	1.0(0.2- 4.5)	0.961
Barka	18	8 (44.4%)	4.4(0.7-25.8)	0.101
Zebu X Barka (cross)	30	1 (3.3%)	0.2(0.02-2.3)	0.192

*Statistically significant

DISCUSSION

Foot and mouth disease imposes very serious impediments to international trade in live animals and animal products [2, 3]. Moreover, it is prevalent in the cattle feedlots of Ethiopia and resulted in bulls mortality and morbidity which affected livelihood of actors in the value chain and have major threat to national economies as they tend to affect the international trade [8] and is ranked as the number one cattle disease after 1985 as compared to 1984 and before [12].

The overall seroprevalence recorded for FMD in this study was 15.4% and it is indicative of its importance in the study area. The seroprevalence of FMD reported in this study was comparable to the prevalences documented for cattle in the Bench Maji zone, Southern Ethiopia [19] (12.05%), Somalia Regional State, Eastern Ethiopia [20] (14.05%) and central Ethiopia [8] (14.5%). However, the seroprevalences documented in this study was higher when compared to the previous reports of Molla *et al.* [21] (8.18%), Megersa *et al*. [22] (9.5%) and Abunna *et al*. [7] (8.01%) in different regions of the country. On the other hand, the seropositivity finding of this study was lower than the overall seroprevalences of Rufael *et al*. [4] (26.5%) and Mekonnen *et al*. [5] (24.6 %) reported in Southern Ethiopia; Borana Pastoralists, Borana and Guji Zones, respectively. This difference in prevalences of FMD could be due to the difference in environmental conditions and farming systems. The movement of animals, the increasing of climate change, the intensification of livestock agriculture (increasing demand for animal protein and a shift from cereal-based to more animal protein-based diets), growth in human travel and growing world population (growing demand for meat and meat products) among the factors that account for the incidence and spread of FMD [23].

In this study, cattle from southern (OR = 6; 95% CI: 1.7 to 21.5) and western (OR = 3.9; 95% CI: 1.1 to 13.1) zones were more at risk to be infected with FMD than cattle from central and eastern zones of the region. The possible reason for this might be due to the fact that southern and western zones have relatively higher cattle population and transhumance cattle husbandry systems; this may lead to unlimited movement of animals for search of watering points and grazing areas. In most parts of the country, animals to local market destinations are often transported on foot and subsequently result in dissemination of the infection. Previous studies [7, 24] indicated that extensive movement of livestock and the high rate of contact between animals at marketing and common grazing places as well as at watering points increase the rate of infection. Rufael *et al*. [4] have also observed peaked outbreaks during the dry seasons, which attributed to herd movement to grazing areas. In the present study relatively higher seroprevalence was recorded in Barka breeds which could be due to the fact that Barka breeds inhabited in the western zone of the region and they are transhumance (highly movable in nature). Moreover, in this result higher seroprevalence was documented in older animals. In line with this, Rufael *et al*. [4] and Abunna *et al*. [7] have also reported lower prevalence of FMD in young animals from southern and eastern Ethiopia. The low exposure in immature age groups was as a result of keeping young animals around homestead and around camps separately from the adult animals.

The study suggests relatively high seroprevalence of FMD in the study area. This is because of uncontrolled animal movement and irregular vaccination program against FMD have been existed in the area. Therefore; the government and other development partners should introduce regular vaccination program for disease control and animal movement should be restricted during the FMD outbreak in the study area. Moreover, the relatively high prevalence of FMD in the study area warrants further molecular characterization of the circulating virus serotypes to apply effective control and prevention measures.

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