



Sero-epidemiology of Foot and Mouth Disease and Farmers Perception on Vaccinating Cattle against the Disease in Sidama Region, Southern Ethiopia

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ABSTRACT

Foot and mouth disease (FMD) is a severe, highly contagious viral disease of livestock that has a significant economic impact. A cross-sectional study was conducted from September 2019 to June 2020 in three selected districts of Sidama region, Southern Ethiopia with the objectives of determining the sero-prevalence of cattle against foot and mouth disease virus (FMDV), identifying potential risk factors and assessing farmers' perception on vaccination against FMD. Purposive and systematic random sampling techniques were employed to select the districts and study animals, respectively. A total of 510 cattle were tested for FMDV antibodies using 3ABC-ELISA. The overall cattle and herd level sero-prevalence were 15.5% and 24.7%, respectively. Among the considered risk factors age, herd size and season were significantly associated with the sero-positivity of FMDV ($P < 0.05$). Out of 120 farmers interviewed 84.2% had never vaccinated their cattle against FMDV. Inaccessibility (83.7%) and unaffordable cost (72.1%) of the vaccine were mentioned as leading causes for the low vaccination practice in the current study areas. Majority of the respondents (68.3%) don't perceive vaccinating cattle against FMDV as one of the preventive measures. In districts with lower perception of farmers on vaccinating their cattle against FMDV, higher sero-prevalence of the disease were recorded. The present serological and questionnaire survey indicated that the presence of FMD sero-positive animals in the current study areas. Therefore, an integrated strategy for disease control has to be designed and implemented which could include enhancing farmers' perception about use of vaccination in preventing FMD and government provision of vaccines at affordable cost to the farmers.

INTRODUCTION

Ethiopia is one of the countries that possess a huge number of livestock populations in the Africa continent estimated to be 56.5 million

cattle, 30.7 million sheep and 30.2 million goats were found in the country (CSA, 2017). The livestock sector contributes about 40% of the agricultural Gross Domestic Product (GDP) and nearly 20% of total GDP, and 20% of national

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foreign exchange earnings in 2017 (World Bank, 2017). Within the cattle population, FMD occurs endemically resulting in several outbreaks every year (Ayelet *et al.*, 2012). FMD is caused by FMD virus (FMDV), has seven recognized serotypes (O, A, C, SAT 1, SAT 2, SAT 3 and Asia 1), with distinct immunologic, antigenic and genetic properties. They also differ in distribution across the globe (FAO, 2007).

Five of the seven serotypes of FMD (O, A, C, SAT 2, SAT 1) were identified in Ethiopia (Rufael *et al.*, 2008; Ayelet *et al.*, 2009; Negussie *et al.*, 2010). Serotype C was not identified after 1983; however, a serotype C-specific antibody in cattle was reported (Rufael *et al.*, 2008). Morbidity has been reported to reach as high as 100% in susceptible animal populations but it is rarely fatal except in young animals (Kahn and Scottline, 2005). Infected animals show a spectrum of responses to FMD ranging from unapparent infection to severe disease and death (OIE, 2008).

Foot and mouth disease is endemic with high prevalence in Africa, the Middle East, and Asia and is also present in parts of South America (Rweyemamu and Astudillo, 2002). The disease is endemic in Ethiopia and remains largely uncontrolled due to the absence of prophylactic vaccination except for a few dairy herds containing imported breeds (Sahle, 2004; Megersa *et al.*, 2009). Serological surveys reported a sero-prevalence that ranges from 5% to 72.1% at the animal level in different parts of the country (Bayissa *et al.*, 2011, Sulayeman *et al.*, 2018; Shazali *et al.*, 2021).

In terms of livestock exports from Africa, FMD is often perceived as a major hindrance to

international trade (Thomson *et al.*, 2004). In part, this perception is based on the assumption that disease freedom is required before export is possible, and has resulted in costly and an elaborated FMD control measures such as disease-free zones in Southern Africa and elsewhere (Bruckner, 2004). Commodity based approaches can provide an acceptable level of risk for exported livestock or livestock products according to international standards (Thomson *et al.*, 2004), but in the case of FMD, they still require an understanding of FMD status in cattle entering the market chain.

Recommended control measures for FMD include animal movement restrictions, a vaccination programme, animal quarantine, environmental sanitary controls, outbreak investigation, serological surveillance and slaughtering of sick animals (Chaosuancharoen, 2012). However, it is a global problem since the result of the increasing movement of human and livestock and livestock products (Perry, 2007). This is mainly due to lack of vaccination, free livestock movement among different regions in the countries and across international borders, the existence of multiple FMD virus serotypes, and involvement of wildlife (Sahle, 2004; Rufael *et al.*, 2008).

Studies undertaken in Ethiopia revealed that the disease is still endemic and occurs in different parts of the country (Sulayeman *et al.*, 2018; Shazali *et al.*, 2021). There is no national control strategy; no legislation exists for making FMD notifiable to the veterinary authorities or for animal movement restrictions to be imposed. Therefore, livestock is at risk from endemic strains as well as from antigenic variants prevailing in neighboring countries (Sahle, 2004). There is a difference in the epidemiology

and economic impacts of FMD in the livestock production systems (Jemberu *et al.*, 2014) in different parts of the country. Unidentified farmers' perceptions about risk of the disease, lack of vaccination strategies and presence of free animal movement without certification are the main factors that could increase the distribution of FMD along the cattle market chain.

Despite this fact, there is no published information regarding the status of FMD and farmers' perceptions and practices on vaccinating their cattle against the disease in Sidama region. Therefore, this study was aimed to generate current information on the seroprevalence status of FMD and associated risk factors and assesses farmers' perception on

vaccination against FMDV in selected districts of Sidama region, Southern Ethiopia.

MATERIALS AND METHODS

Description of the study area

The study was conducted in three purposively selected districts of Sidama region, namely Hawassa zuria, Boricha and Wondo Genet. Sidama region is located northeast of Lake Abaya at an altitude of 1500 to 2500 m.a.s.l. The region has geographic coordinates of latitude, north, 5 45 to 6 45 and longitude, east, 38 to 39. Mean annual rainfall of this area varies between 1200 mm and 1599 mm, with 15°C-19.9°C average annual temperature (CSA, 2015) (Figure 1).

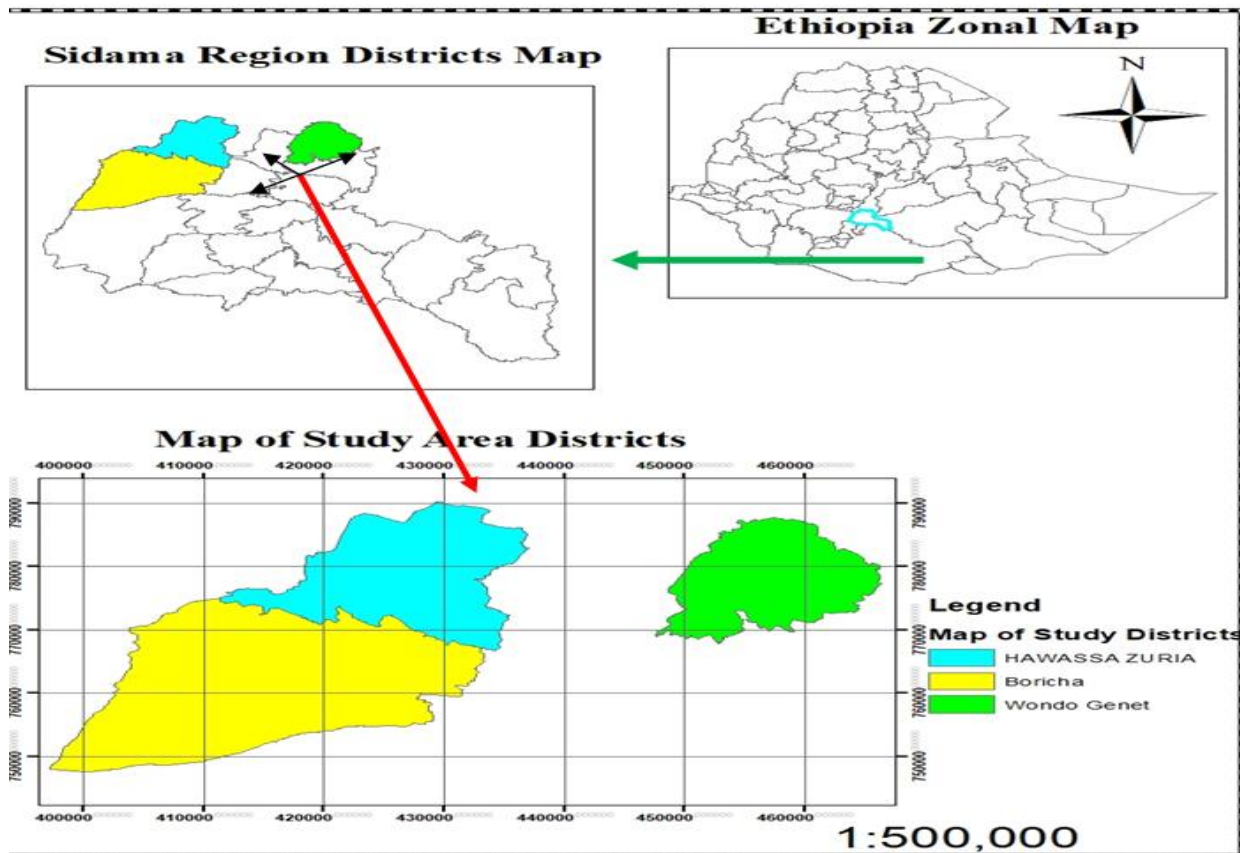


Figure 1: Map showing the study areas

Study design and sampling strategy

A cross-sectional study design was implemented for sero-prevalence study of antibodies against FMDV in the study areas. Hawassa Zuria, Boricha and Wondo Genet districts were selected purposively based on their transport accessibility, geographical location and abundance of cattle. From each district 30% of kebeles (the smallest administrative units in Ethiopia) were selected using simple random sampling. From each kebele, 20% of privately owned herds were selected randomly and finally, individual animal from each herd were also selected using simple random sampling to attain the required sample size. Breed, age, sex, districts, herd composition and size, season, vaccination history and management were recorded as the potential risk factors for the occurrence of the disease.

Sampled animals were categorized based on their breed (local and cross), sex (female and male), herd composition (cattle only and cattle mixed with small ruminants), vaccination history (previously vaccinated and non-vaccinated) and management types (intensive and semi-intensive). Ages (young, adult and old) were categorized based on their dental eruption status (Berecha *et al.*, 2011) and herd sizes were also classified as large farms size, with more than 50 animals, medium (20 to 50 animals) and small (< 20 animals) (Edao *et al.*, 2018).

Study animal population

Local and cross breeds of cattle kept under intensive and semi-intensive system were included. According to Pace and Wakeman (2003), the age groups of cattle were

categorized as (3.5years) Young, (3.5years 5.5years) Adult and (> 5.5years) Old.

Sample size determination

The sample size required for the study was calculated based on the following formula (Thrusfield, 2005).

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

Where, n= required sample size, Z= statistic for level of confidence = 1.96, P_{exp} = expected prevalence, 95% confidence level and d^2 = absolute desired precision of 0.05.

Accordingly, based on the above formula and 9.5% expected prevalence (Megersa *et al.*, 2009), the sample size computed for animal level prevalence was 132. To increase the precision, calculated sample size was made four fold to 528, but due to shortage of sample collection materials 510 cattle were considered and then proportionally allocated to the respective districts based on the total cattle population in each districts.

Serum sample collection

From each cattle, 10 ml of blood was collected and kept at room temperature overnight. Then serum was separated and transferred into cryovial and transported to Hawassa University Veterinary microbiology laboratory for storage at $-20\text{ }^{\circ}\text{C}$. At the end of sampling, all the sera were transported in cold chain to National animal health diagnostic and investigation center (NAHDIC), and tested.

Serological diagnostic tests

Sera collected from bovine species was tested

by FMDV 3ABC-Ab ELISA (ID Screen[®]) for the detection of antibody to poly protein called 3ABC which is a useful indicator of FMD virus infection regardless of the serotype involved (Haas, 1997; Mackay *et al.*, 1998). Antibody to 3ABC (nonstructural protein) is found only in virus infected cattles but not in vaccinated animals (De Diego *et al.*, 1997).

Briefly, the test was carried out stepwise as per the manufacturer's manual. First, all reagents were kept at room temperature and homogenized by vortex. The test was carried out in 96 well micro plates. Then 50µl of dilution buffer¹⁸ were added in to each well, 30µl of positive control were added in to wells A1 and B1, and the same volume of negative control were also added to wells C1 and D1, the rest wells were filled by 30µl of test sera. Then incubated at 37°C for 2hours, after incubation the wells were emptied with washing 5 times with 300µl of wash solution along with paying great attention to avoid drying of wells between washing. After washing 100µl of the conjugate 1X were added in to each wells and incubated for 30min at 21°C. After incubation the wells were emptied and washed 5 times with 300µl of wash solution, then 100µl of the substrate solution was added in to each wells and incubated at 21°C for 15 minutes in dark. After adding a 100µl of Stop Solution to each well, the result (OD reading) was recorded using a photometer at wavelength of 450 nm within 2 hours after the addition of the stop solution.

Questionnaire survey

Data concerning farmers' perception towards vaccinating their cattle was collected by using pre-tested semi-structured questionnaire. It was administered by interviewing individuals

selected by systematic random sampling. Before the interview, the objective of the survey was explained and verbal consent was obtained from the respondents. The interviews were conducted in local languages (Sidaamu Afoo or Amharic). The questionnaire mainly focused on demographic characteristic of the interviewee and perception towards vaccinating their cattle against FMD. A total of 120 farmers, 40 farmers from each three districts were interviewed for the questionnaire survey.

Data management and statistical analysis

Data generated from the laboratory investigations and survey was recorded and coded using a Microsoft excel spread sheet (Microsoft Corporation) and analyzed using STATA version 13.0 for Windows (Stata Corp. College Station, TX, USA). The association between explanatory and outcome variables was analyzed at individual cattle level by using univariable and multivariable logistic regression. Variables with a p-value less than or equal to 0.05 (in univariable analysis) were included in the multivariable logistic model. Further selection of variables in the final model was based on stepwise backward elimination procedure. Odds ratio was used to assess the strength of association between exposures variables associated with sero-positivity of the disease.

RESULTS

FMD sero-prevalence and risk factors

Based on the total 510 sampled cattle, overall sero-prevalence of FMD was 15.5% and 24.7% at the individual animals and herd levels, respectively. Comparatively higher sero-

prevalence (32.4%) was recorded in Hawassa zuria district (p=0.02; OR=2.67%; 95%CI=1.14-5.33) (Table 1).

Table 1: Individual cattle level and herd level sero-prevalence of FMD

Districts	Farmers associations	Individual cattle		Herds	
		Tested	Positive (%)	Tested	Positive (%)
HawassaZuria	Labu-koromo	68	9(13.2)	27	8(29.6)
	Udo-wotate	65	16(24.6)	22	7(31.8)
	Galo-argisa	64	12(18.7)	22	8(36.4)
Sub total		197	37(18.8)	71	23(32.4)
Boricha	Konser-fulasa	50	16(32)	31	11(35.5)
	Fulasa-aldada	48	5(10.4)	24	5(20.8)
	Hanja-chefa	52	7(13.5)	36	7(19.4)
	Aldada-dela	58	5(8.6)	27	3(11.1)
Sub total		208	33(15.8)	118	26(22)
Wondo Genet	Watara-qachama	56	5(8.9)	13	2(15.4)
	Abayye	49	4(8.2)	20	4(20)
Sub total		105	9(8.6)	33	6(18.2)
Total		510	79(15.5)	222	55(24.7)

Risk factors

The major exposure variables that were considered to predict the response of the

outcome variable includes, breed, age, sex, districts, herd composition and size, season, vaccination history and management types.

Table 2: Logistic regression analysis of FMD and its potential risk factors for sero-positivity of cattle.

Risk factors	Category	No examined	Prevalence (%)	Univariable			Multivariable		
				OR	95% CI	P-value	OR	95% CI	P-value
Districts	Wondo genet	105	9(8.6)	Ref.	-	-	-	-	-
	Hawassa zuria	197	37(18.8)	2.67	1.14 – 5.33	0.02	0.63	0.37 – 5.23	0.63
	Boricha	208	33(15.8)	2.01	0.92 – 4.37	0.04	1.38	0.16 – 2.48	0.51
Age	Young	58	3(5.2)	Ref.	-	-	-	-	-
	Adult	67	5(7.5)	1.47	0.33 – 6.47	0.03	1.38	0.31 – 6.23	0.67
	Old	385	71(18.4)	4.14	1.26 – 13.6	0.02	3.60	1.04 – 12.47	0.04
Herd size	Small	262	31(11.8)	Ref.	-	-	-	-	-
	Medium	229	46(20.1)	1.87	0.14 – 3.07	0.01	2.18	1.27 – 3.76	0.005
	Large	19	2(10.5)	0.87	0.19 – 3.97	0.46	1.03	0.21 – 5.03	0.97
Managt. type	Intensive	78	6(7.7)	Ref.	-	-	-	-	-
	Semi-intensive	432	73(16.9)	2.44	1.02 – 5.82	0.04	2.65	0.34 – 20.97	0.35
Season	Wet	38	14(36.8)	Ref.	-	-	-	-	-
	Dry	472	65(13.7)	0.27	0.13 – 0.56	0.000	0.18	0.07 – 0.42	0.000

Most of the recorded variables showed a high degree of association with sero-positivity to FMDV infection. The final multivariable logistic regression model (Table 2) revealed that age, herd size and season were significantly

associated with the sero-prevalence of the disease (P<0.05). Old cattle were 3.6 times at a higher risk of FMD than young cattle.

Farmers’ perception and practices related to FMD

Out of 120 respondents 64(53.3%) and 56 (46.7%) of them responded that their production

is dairy cattle and mixed production type (Table 3). Bovine pasteurellosis, blackleg, lumpy skin disease, anthrax and FMD were listed in order of vaccination practice by the respondents (Figure 2).

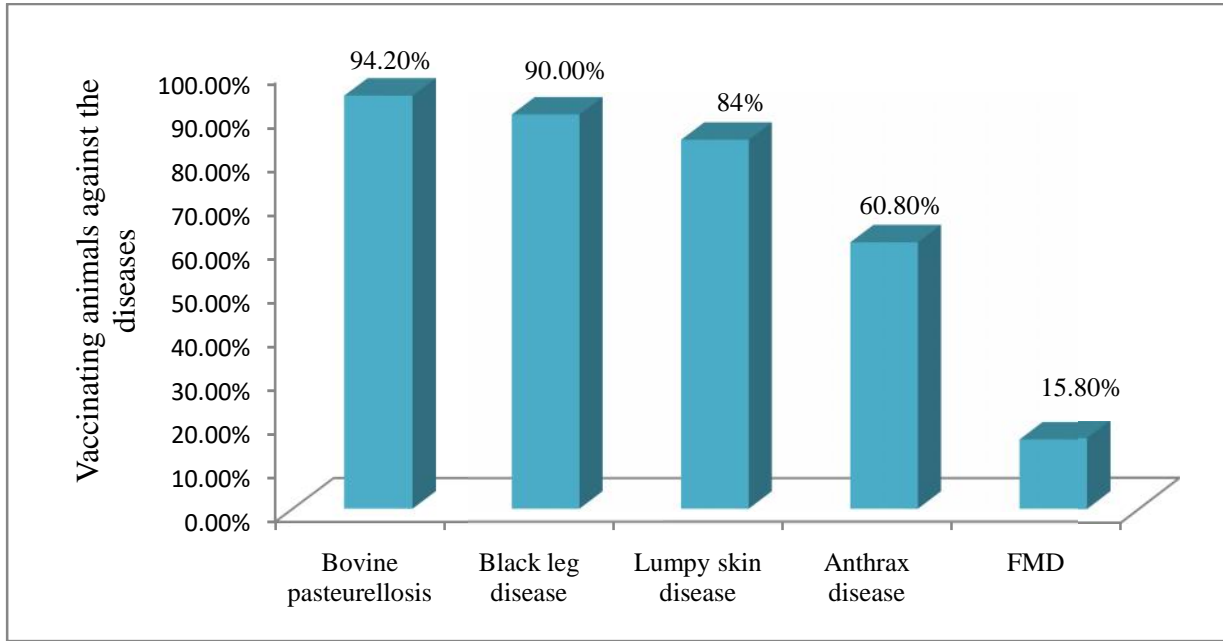


Figure 2: List of diseases and farmers practice to vaccinate their cattle against different animal disease.

Among the major cause for low vaccination practices against FMD in the study area, inaccessibility and unaffordable cost of the vaccine were mentioned by 83.7% (36/43) and

72.1% of the respondents, respectively. Moreover, 68.3% (82/120) of the farmers interviewed don’t perceive vaccination as a preventive measure for the disease (Table 4).

Table 4: Farmer’s perception on vaccinating their cattle

Variables	Response	Frequency (%)
Dairy cattle production type	Yes	64(53.3)
Mixed production type	Yes	56(46.7)
Vaccinated their cattle against disease	Yes	120(100)
Perceive as vaccination is better than treatment	Yes	104(86.7)
Perceive vaccination as preventive measure against FMD	Yes	38 (31.7)
Vaccinated their cattle against FMD	Yes	19(15.8)
FMD is a common disease	Yes	77(64.2)
Pervious occurrence of FMD in the farm	Yes	66(55%)
Information about FMD	Yes	108(90)
Information about FMD vaccination	Yes	43(35.8)

Sero-prevalence study of FMD

Overall sero-prevalence of FMD recorded in this study (15.5%) was in agreement with the previous findings of 15.4% (Mohamoud *et al.*, 2011) and 14.05% (Zerabruk *et al.*, 2014) from Jijiga zone and Tigray respectively. In contrast, it is higher than previous reports made from different parts of Ethiopia which range from 4.8% - 12.08% (Negussie *et al.*, 2011; Abunna *et al.*, 2013; Beyene *et al.*, 2015; Gelana *et al.*, 2016; Belina *et al.*, 2016).

Compared to the present finding relatively higher sero-prevalence in bovine was reported as, 24.22%, 38.9% and 21.4% from central Ethiopia (Sulayeman *et al.*, 2018), Borena (Melkamsew, 2018) and West Ethiopia (Desissa *et al.*, 2014) respectively. Similarly, higher sero-prevalence of the disease was also reported from the neighboring countries of Africa, 52.5% in Kenya (Kibore *et al.*, 2013), 61% in Uganda (Miaron *et al.*, 2004) and 72.62% in Nigeria (Lazarus *et al.*, 2012). These differences in the prevalence of the disease among the studies could be related to variation in agro-ecology; distribution of the disease and variations in the production or herding systems, vaccination coverage against FMD vaccine, immune status, interaction with cattle with other animals like small ruminants and management type of different study areas.

Cattle managed semi-intensively were shown higher sero-prevalence than those kept under intensive management. Similarly, higher sero-prevalence was previously recorded in cattle kept under semi-intensive managements (Bedru, 2006). Free movement of animals for watering point and grazing areas, and relatively larger

herd holding capacity were the possible causes for the disease prevalence difference in different management system. This is supported by the work of previous studies report that the movement of animals in search of feeds from one area to another and interaction of small ruminants is a significant risk factor for the occurrence of FMD (Gelaye *et al.*, 2005; Fevre *et al.*, 2006; Habiela *et al.*, 2010).

Significantly higher sero-prevalence of FMD was recorded in old animals than in young groups. Similar findings were also previously reported from central Ethiopia (Sulayeman *et al.*, 2018) and Awbere and Babilie districts of Jijiga zone (Mohamoud *et al.*, 2011). Older animals are more likely to have been exposed to FMDV during their lifetime and have developed immunity to the virus. Additionally, old animals are driven freely in grazing and watering points where infection could increase by contact (Jenbere *et al.*, 2011).

Higher sero-prevalence was recorded during the dry seasons, which might be associated with herd movement to grazing area after crops were collected. This finding is supported by previous study as dry season increase the risk of FMD occurrence (Sarker *et al.*, 2011) and also described as FMD is a seasonal disease mostly seen during the dry season (Jibat *et al.*, 2013). Because during the dry season, cattle may experience physiological stress due to the factors such as high temperatures, low humidity, and limited availability of fresh forage and water. This can weaken their immune system, making them more susceptible to FMD infection and increasing the sero-prevalence.

Nearly 87% of the respondents' perceived vaccination is better than treatment, but only

15.8% of them had vaccinated animals against the disease. Similarly Megersa *et al* (2009) reported that vaccine as prophylactic measures against FMD was accepted by most farmers, but very few of them regularly vaccinate their animals. On other hand, some farmers did not consider vaccination of FMD as significant prevention methods due to self-limiting disease and low mortality among affected animals. In a district, Wondo genet, where farmers perceive and practice vaccine as a preventive measure, lower FMD sero-prevalence was recorded than the other districts.

The study further revealed that 90% of respondents had information about FMD in the selected districts. Similarly 92.5% awareness level was also previously reported from Bale zone (Misgana *et al.*, 2013). From the respondents only 15.8% vaccinate their cattle against FMD. Lower vaccination practice against FMD was also reported from Nigeria (Olabode *et al.*, 2014). However, comparable higher vaccination practices against the disease were reported from Tanzania (Miaron *et al.*, 2004, Moenga *et al.*, 2013). Inaccessibility and unaffordable cost of the vaccine were mentioned as a leading cause for the low vaccination practice in the current study areas. Moenga *et al.* (2013) and Soko *et al.* (2018) were also stated that aforementioned causes were the major reason for lower vaccination practices of the farmers.

Most of the respondents from the selected districts had experienced FMD outbreak in their farm at least once before the interview. In line with this investigation previous work reported that FMD is endemic, widely distributed and frequently noted in different farming systems and agro-ecological zones of the country (Asfaw

and Sintaro, 2000; Sahle, 2004; Leforban, 2005). Despite this fact 82(68.3%) of the farmers interviewed don't perceive vaccination as preventive measure for the disease. In line with this finding most livestock owners don't perceive vaccinating animals against FMD as one of the important preventive measures (Moenga *et al.*, 2013; Soko *et al.*, 2018).

CONCLUSIONS & RECOMMENDATIONS

The present serological study indicates that the presence of FMD sero-positive animals in the current study areas. Semi-structured questionnaire based surveys indicated that farmers' awareness about FMD vaccine is very low. Even some farmers' having awareness on FMD vaccine, their perception on vaccinating cattle against FMD is significantly low due to inaccessibility and unaffordability of the vaccine. The current finding has provided information on the complex epidemiological situation of FMD and farmer's perception on vaccine against the disease; thus needs more detailed investigation for vaccine-based control methods and improved veterinary extension services.

Authors' contribution

All authors have directly participated in the planning, execution & analysis of this study. MS and TD participated in data collection, analysis and writing up of the final manuscript. GH and SA participated in editing of the manuscript. AM assisted the laboratory test. All authors read and approved the final manuscript.

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Ethics approval and consent to participate

The study was approved by college of natural and computational science research proposal review committee, Hawassa University. Oral informed consent was obtained for both questionnaires interview and blood sample collection to keep the confidentiality of specific farmers at the time of sample collection. All methods were carried out in accordance with relevant guidelines and regulations.

Competing interests

Authors declare no conflict of interest.

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