

*Full length paper*

## **FOOT AND MOUTH DISEASE (FMD): OUTBREAK CONTAINMENT AT CATTLE HERD LEVEL IN SAMDRUP JONGKHAR DISTRICT**

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**ABSTRACT:** A study was conducted with the objective to determine the risk factors of Foot and Mouth Disease (FMD) outbreak occurrence in Samdrup Jongkhar district in Bhutan. Twenty-six household that had experienced FMD outbreak and diagnosed as FMD in cattle between January 2012 and December 2015 were defined as a case. Two households that owned cattle and had not experienced any outbreaks of FMD within the same village were selected as control. Data related to management and environmental factors were collected with the questionnaire survey during November and December 2016. The univariate and multivariate logistic regression models were built to identify risk factors of FMD. The adjusted odds of FMD outbreak occurrence was 3.91 times greater in the households that had large herd size (>5 cattle) when compared to small herd size (<5 cattle). Similarly, the occurrence of FMD was significantly higher in herds that had not vaccinated against FMD than those vaccinated. Therefore, the FMD control strategy such as bi-annual vaccination is still an effective tool to prevent FMD outbreak. The findings recommend further study to explore why large herd size has higher chance of FMD infection.

**Keywords:** Case control study; cattle; Foot and Mouth Disease; herd; risk factors.

### **1. INTRODUCTION**

Foot and Mouth Disease (FMD) is a highly contagious viral disease that affects all cloven-footed animals. It is characterized by pyrexia, salivations, vesicles formation on mouth and buccal cavity, interdigital space, and teats, causing occasional death in young animals. The disease is endemic in many parts of the world, particularly in developing countries of Asia, Africa, Middle East, and some parts of Europe, leading to huge economic

losses. FMD is endemic in Bhutan but most commonly prevalent in southern districts bordering India (Dukpa et al. 2011a). An average of 18 outbreaks occur annually in the country. Serotype O is involved in FMD outbreaks in Bhutan (Dukpa et al. 2011a). Bhutan practices annual and also bi-annual mass vaccination against FMD with a target to achieve at least Stage 3 of the FAO/OIE Progressive Control Pathway by 2020 (NCAH 2016). Previous study conducted in the central and western part of the country had identified several

risk factors (e.g. management and animal level factors) for the occurrence of FMD outbreaks (Dukpa et al. 2011b), but there is only scarce information about disease epidemiology in south-eastern region of the country. In order to develop prevention and control strategy, information about the disease epidemiology is essential. Therefore, a study was conducted with the objective to determine the risk factors of FMD outbreak occurrence, using the retrospective case-control study design.

## 2. MATERIALS AND METHOD

### 2.1 Study area

The study was conducted in Samdrup Jongkhar district, which is located in south-eastern Bhutan and shares border with India (Figure 1). The district has 11 sub-districts and each sub-district livestock centre has livestock development workers who provide veterinary and production related services to the community. Nine villages of seven sub-districts were selected for the study.

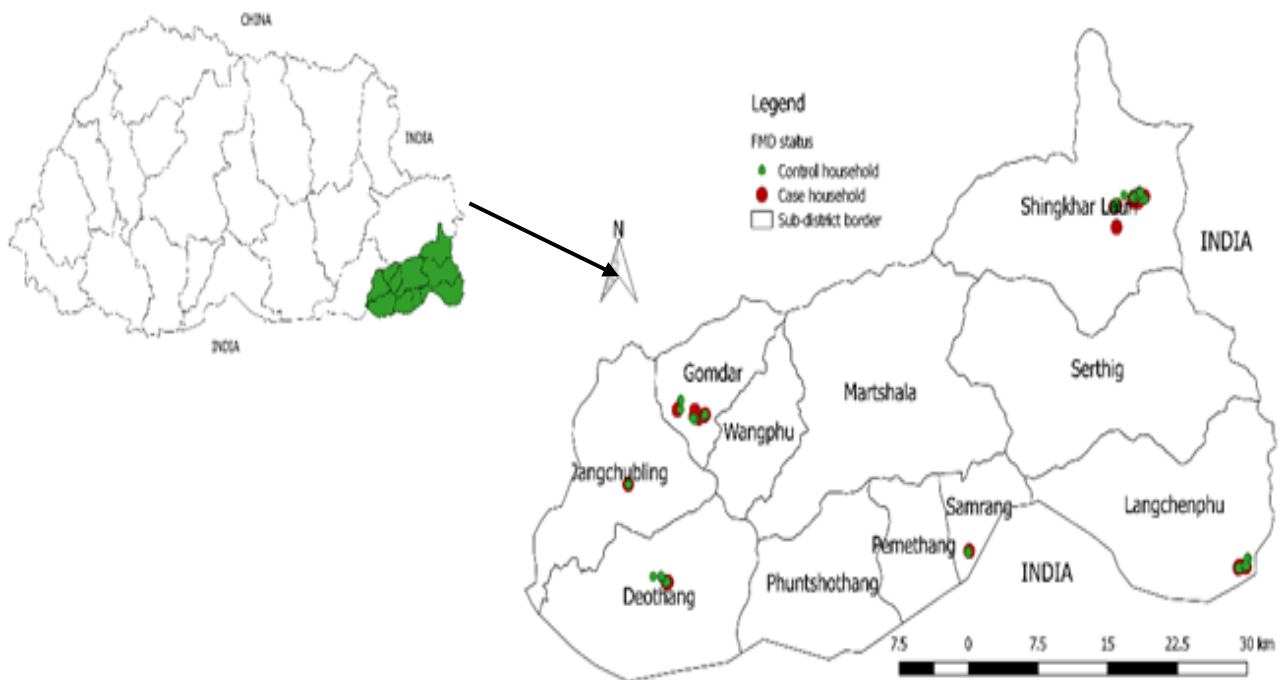
### 2.2 Study design

A retrospective case-control study design was used to collect data at the herd level. Within a village, households or herds that had experienced FMD outbreak in cattle during January 2011 to December 2015 were selected as case. Two cattle owning households within the same village that have not experienced any outbreaks of FMD were randomly selected as controls. FMD outbreaks were initially investigated and reported by livestock development

workers and the case was further investigated by Veterinary Officials of District Veterinary Hospital and Satellite Veterinary Laboratory. The FMD cases in animals were clinically diagnosed in the field and also confirmed at the laboratory. Further, the epithelial tissue samples were collected and referred to the international laboratory for molecular analysis. The location of each case household was retrieved from the database maintained at the District Veterinary hospital, Satellite Veterinary Laboratory and online transboundary animal disease information system (TADInfo). The database was further verified during field visits with the help of the sub-district control household in the same village. A household from another village nearer to the case village was selected. The information about the control households that have not experienced any cases of FMD in their cattle during the study period were verified with the help of sub-district livestock development workers. Seventy-eight households (26 case and 52 control households) from nine villages and seven sub-districts were selected and interviewed (Table 1).

### 2.3 Data collection and analysis

A structured questionnaire with closed questions was used for the study. The questionnaire was pretested with five farmers prior to actual survey. Owners of each case were interviewed. The geographic coordinates of each case and control household were collected. The data were entered into a database developed in EpiInfo™ version 7.1.2.0 (Centers for Disease Control and Prevention



**Figure 1:** Study areas in Samdrup Jongkhar district.

**Table 1:** Locations and number of households selected and interviewed.

Villages	Number of households		
	Case	Control	Total
Domphu	5	10	15
Khenorong	1	2	3
Richanglu	4	8	12
Jangsa	4	8	12
Durtsi	1	2	3
Samrang	1	2	3
Tshothang	8	16	24
Zangthi	2	4	6
Total	26	52	78

(CDC), Atlanta, GA, USA) and analyzed using STATA version 14.0 (StataCorp USA).

In order to understand the risk factors of FMD occurrence at the household level, an unconditional univariate logistic regression analysis was performed. The model used FMD status (case vs control households) as the outcome and each risk indicator variable as predictor variable. Predictor variables associated with FMD outbreak status with p value less than 0.25 were selected for multivariate logistic regression analysis. A forward stepwise method of mixed-effect multiple logistic regression analysis was performed to identify risk factors for FMD occurrence. To determine the best fitting model, a variable with the smallest p-value based on log likelihood ratio statistics in the univariate analysis was entered into the model first. Thereafter, each of the remaining variable was added to the model containing the first variable to test whether its addition significantly improved the fit of the model. The variable with the highest likelihood ratio statistic (chi-square test with one degree of freedom) was selected for addition to the model and the process was then repeated. The final model was selected based on the significant p value ( $p \leq 0.05$ ). Following the fitting of the main effects model, the goodness of fit of the model was assessed by examining the residuals and outliers.

### 3. RESULTS

The respondents comprised of 48 (61.54%) males and 30 (38.46%) females with a mean age of 47 years. Each respondent's household owned about seven cattle at the time of outbreak. In the study areas, the outbreak occurred mostly in summer and winter seasons.

Ten variables were identified as risk factors of FMD outbreak occurrence at the household level (Table 2). When adjusted for other variables in the

final multivariable model, two variables were found to be associated with FMD outbreak occurrence. The odds of FMD outbreak occurrence was about four times greater in the households that had large herd size ( $>5$  cattle) when compared with small herd size ( $<5$  cattle). Significantly higher odds of FMD occurrence was observed in herds that were not vaccinated against FMD than those vaccinated (Table 3). The model diagnostic test revealed best fit of the model without any outliers (Dahoo et al. 2009).

### 4. DISCUSSION

We determined the risk factors associated with outbreaks of FMD in cattle at the household level in Samdrup Jongkhar district, using a case-control study design. Except for one outbreak that occurred during winter (December), all other outbreaks ( $n=25$ ) in the study area occurred during summer season (June-August), which is a normal trend in Bhutan (Dukpa et al. 2011a; Tenzin and Thapa 2016). Summer season in Samdrup Jongkar is hot and humid, which causes stress to the animals and may predispose them to infections (Dohms and Metz 1991).

Herd size was an important risk factor for the occurrence of FMD in the study area, indicating that the probability of experiencing FMD outbreak increases with increase in herd size (i.e. the more animals that are at risk, the greater the likelihood that at least one of them will acquire infection). Similar findings have been reported in a previous study in Bhutan (Dukpa et al. 2011a) and elsewhere in the world (Khounsy et al. 2008; Verma et al. 2008) where a higher animal density was found to be associated with an increased FMD incidences. In the village context in Bhutan, farmers that own smaller number of animals mostly keep their animals within the cattle shed or by tethering in the nearby field or household compound and are managed by stall feeding. Thus, there may be limited interaction with other animals in the village. In contrast, those households that have large number of cattle are often let out in the forests for grazing due to fodder shortage and other management difficulties.

These animals come into contact with other households' animals, including wildlife at the common grazing ground and water source, thus posing risk of contracting infectious diseases, including FMDV. Therefore, it is important to create awareness among farmers on the risk of contracting infectious diseases during open grazing and options for limiting disease outbreaks through improved pasture development.

This study also demonstrates that an annual FMD vaccination in animals decreased the odds of

FMD occurrence in cattle, compared with those herds that have not been vaccinated regularly.

Large scale outbreaks of FMD in cattle have been reported previously in non-vaccinated herds in central Bhutan (Tenzin 2007) and also during recent outbreak in Paro in western Bhutan. Although, FMD

vaccines are distributed free of charge by the government, several logistical challenges in the remote villages result in low coverage of vaccination. For instance, there is only one livestock extension staff in each sub-district that looks after animal health (preventive and curative). Production

**Table 2:** Univariate logistic regression analysis of the risk factors for the occurrence of FMD outbreak at the household level, Samdrup Jongkhar district.

Variables and categories	<i>b</i>	<i>SE</i>	OR (95% CI)	p-value
i. Cattle herd size (No of cattle)				
<5 cattle	0		1	
>5 cattle	1.469	0.51	4.34(1.60-11.80)	0.004
ii. Presence of bulls/bullocks in the herd during the time of outbreak				
No	0		1	
Yes	0.713	0.497	2.04(0.77-5.40)	0.151
iii. Keeping animals in open space (outside shed)				
No	0		1	
Yes	1.006	0.522	2.73(0.98-7.61)	0.054
iv. Grazing of cattle in the forests				
No	0		1	
Yes	0.749	0.498	2.11(0.80-5.62)	0.133
v. Mixing of cattle with animals of other owners or village				
No	0		1	
Yes	1.567	0.677	4.80(1.27-18.05)	0.021
vi. Drinking water source for cattle				
Tap water	0		1	
Open source/stream	1.485	0.678	4.41(1.17-16.67)	0.029
vii. Mixing of cattle with other cattle at the water source				
No	0		1	
Yes	1.485	0.678	4.41(1.17-16.67)	0.029
viii. Hiring out of the bulls/bullocks by the household for ploughing				
No	0		1	
Yes	0.706	0.488	2.03(0.78-5.27)	0.147
ix. Letting out of the bulls/bullocks in the forest for free grazing				
No	0		1	
Yes	0.999	0.502	2.71(1.02-7.25)	0.047
x. Whether the HH practice seasonal migration of cattle				
No	0		1	
Yes	1.258	0.54	3.50(1.21-10.10)	0.02
xi. FMD vaccination status of cattle in the herd				
Vaccinated	0		1	
Not vaccinated	2.094	0.613	8.12 (2.44-26.97)	0.001

**Table 3:** Final multivariable logistic regression model for FMD outbreak occurrence at the household level in Samdrup Jongkhar district.

Variables and categories	<i>b</i>	<i>SE</i>	OR(95%CI)	P-Value
Constant	-2.594	0.617	-	-
Cattle herd size				
<5 cattle	0		1	
>5 cattle	1.364	0.557	3.91 (1.31-11.67)	0.012
FMD vaccination status of cattle in the herd				
Vaccinated	0		1	
Not vaccinated	2.015	0.634	7.50 (2.16-26.03)	0.0004

and extension work are carried out in a scattered and remote community, which makes the task of vaccinating thousands of animals difficult and leads to low vaccination coverage. In addition, the cattle are usually let out for grazing in the forests when extension officials visit the household for vaccination, leading to non-vaccination of animals, thus, becoming susceptible to infection. Further, some owners may not allow their animals to be vaccinated against FMD believing that vaccination would result in abortion of pregnant animals and reduction in milk yield. Therefore, it is important to create awareness among farmers on cost-benefit of vaccination versus economic loss due to infection. Since Samdrup Jongkhar district is classified as high-risk zone for FMD, a bi-annual vaccination program with more than 80% coverage is required to prevent outbreaks, as per the National FMD Prevention and Control Plan 2016 (NCAH 2016).

The relatively small sample size may have affected the ability of risk factors to be retained in the final model. Most of these characteristics were found to be significant risk factors for FMD occurrence in Bhutan in the previous study (Dukpa et al. 2011b) and elsewhere in the world (Cleland et al. 1996; Bronsvort et al. 2004).

The main limitation of this study is small sample size where only 26 cases and 52 control households were interviewed, which is demonstrated by wide confidence interval of the odd ratio. The retrospective nature of case-control study design in this study could have also affected the findings due to recall bias. Nevertheless, it has provided important information to guide the policy decision on FMD prevention and control options in Samdrup Jongkhar and elsewhere in the country.

## 5. CONCLUSION

This study has identified herd size and management risk factors to be targeted for prevention and control of FMD and future research. Promoting a bi-annual vaccination protocol as per the National FMD Prevention and Control Plan for cattle against FMD should build up herd immunity and prevent outbreaks. Similarly, cattle management system including biosecurity should be improved to prevent animals from acquiring infectious diseases.

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