Outbreak, Surveillance, Investigation & Response (OSIR) Journal
Field Epidemiology Training Program, Division of Epidemiology
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Investigation of Foot-and-Mouth Disease Outbreaks in Dairy Cattle from Kageshwari and Shankharapur Municipalities, of Kathmandu, Nepal and Associated Risk Factors from March to April 2020

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Abstract

Foot and mouth disease (FMD) is endemic in Nepal and significantly impacts the livelihood of farmers, national economy, and trade of Nepal. However, outbreak investigations are not frequently conducted, and there have been limited studies to understand the associated risk factors. A case-control study was performed in dairy cattle farms of Shankharapur and Kageshwari Municipalities, Kathmandu from March to April 2020 to describe the outbreak and identify the risk factors associated with FMD. There were 31 case farms, while 62 farms were selected as control farms (1:2). The information from case and control farms was collected by semi-structured questionnaire survey through field visits and observations. The univariable and multivariable logistic regressions were performed. The farm-level prevalence of FMD was 25.2% (n=31/123). Among the FMD affected farms, the proportion of positive farms in Shankharapur (61.3% (19/31)) was significantly higher than Kageshwori (38.7% (12/31)). The final multivariable logistic regression analysis identified four variables: cattle purchased within 14 days (OR=12.9; CI=2.4-69.5), milk market distance less than two kilometers from the farm (OR=32.7; CI=5.8-186.3), sharing of the bull from other farms for natural insemination (OR=5.7; CI=1.2-26.8), and no vaccination against FMD in the past six months (OR=19.1; CI=2.0-186.2) as significant risk factors for the occurrence of FMD. This study suggests farmers vaccinate their dairy cattle with FMD vaccine as per the vaccination schedule suggested by the veterinarians, practice quarantine measures when new animals are introduced to their farms, practice biosecurity measures in their farms, and do not use bulls from areas where there are ongoing FMD outbreaks.

Keywords: epidemiology, FMD, Kathmandu, outbreak investigation, risk factors

Introduction

Foot and mouth disease (FMD) is a highly contagious and infectious disease that causes substantial economic losses to farmers due to decreased milk production, growth rate and restricted trade.[1,2] The FMD affects cloven-hoofed animals, including cattle, sheep, goats, pigs, and wildlife, and is caused by a RNA virus of the family *Picornaviridae*. FMD disease is characterised by the vesicular eruptions inside the oral cavity, foot and udder.[3] Other symptoms include fever, lameness, salivation, and anorexia.[4] The transmission of the FMD virus occurs from direct contact, fomites, animal products, contaminated surfaces, and sometimes through the air.[4] FMD is endemic in Nepal and has been occurring for many years. Three of the seven FMD virus serotypes (O, A, and Asia1) are circulating in Nepal. The serotype C was historically present in Nepal[5] but has not been detected since 1996.[6] Outbreaks of FMD are reported from all three ecozones of the country: Mountain, Hill, and Terai. Though FMD outbreaks occur throughout the year in Nepal, the higher incidence has been observed during the monsoon and post-monsoon periods.[5]

The strategy for FMD control in Nepal is focused on risk-based ring vaccination surrounding the outbreak area and limited mass vaccination of cattle, buffaloes and pigs in selected areas with a trivalent vaccine, identification and testing of animals, enforcement of quarantine and biosecurity measures.[7] The high prevalence of FMD is a colossal challenge for the livestock sector of Nepal amidst the lack of proper nutrition and veterinary care, and poor herd management leading to low production rates.[8] Nepal has started the National FMD Control Strategies since 2012, which initially targeted the Eastern and Far Western Development Regions and eventually has expanded to cover the entire country.[2] Every year, several outbreaks of FMD occur in different parts of the country. However, very few of these outbreaks have been investigated thoroughly by researchers and government agency. Moreover, there have been limited studies to understand the risk factors associated with these outbreaks. The main objectives of this study were to describe the descriptive epidemiology and identify the risk factors associated with FMD outbreaks reported from March to April 2020 in Kageshwari and Shankharapur Municipalities, Kathmandu, Nepal.

Methods

Study Design

This case-control study was performed from March to April 2020 to describe the situation of FMD outbreak and aimed to evaluate the risk factors associated with the FMD outbreak in the dairy cattle farms of Shankharapur and Kageshwari Municipalities, Kathmandu (Figure 1).

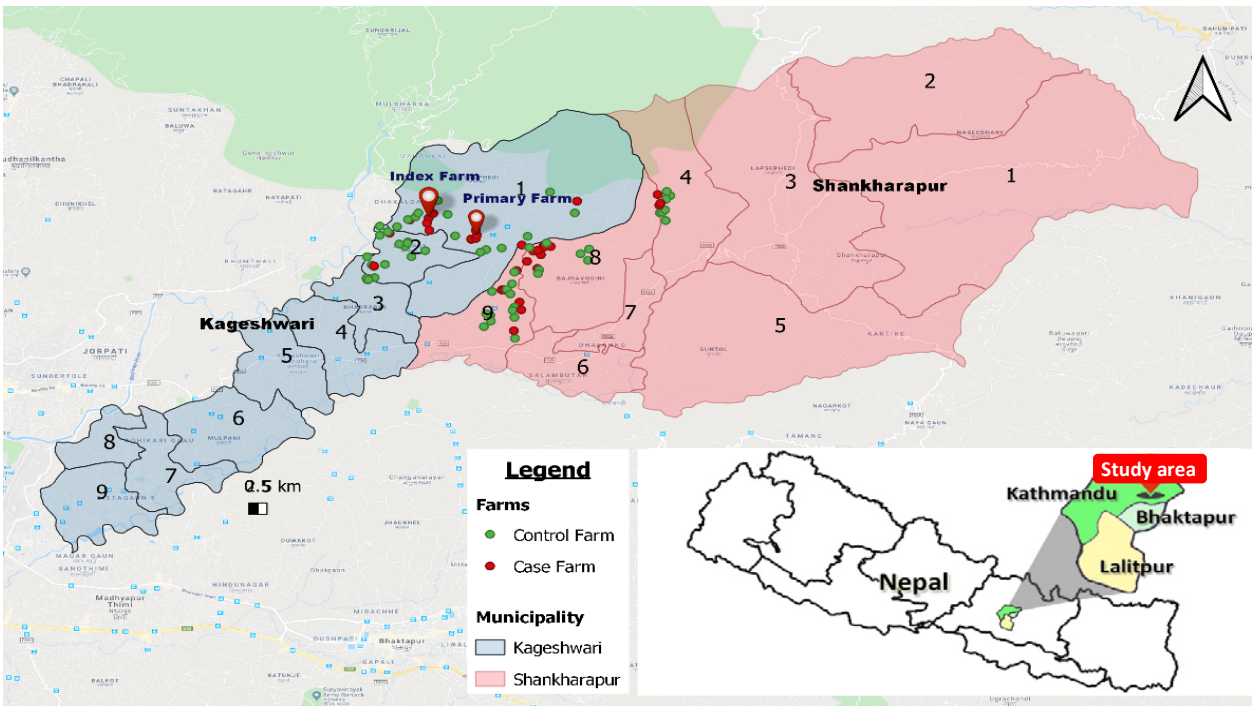

Figure 1. Map of Kageshwari and Shankharapur Municipalities, Kathmandu, Nepal, indicating the case and control farms of FMD outbreak from March to April 2020

Sampling Method

The dairy cattle farms having at least one animal confirmed by polymerase chain reaction (PCR) for FMD or cattle having fever and showing at least one of the signs: drooling of saliva or buccal vesicles or vesicle formation in claws or coronary band observed by the owner and the attending trained veterinary technician of Kageshwari and Shankharapur Municipalities from March to April 2020 were considered as case farms. The cattle farms in which the owner and the attending veterinary technician did not observe clinical signs suggestive of FMD or negative laboratory results by PCR of Kageshwari and Shankharapur Municipalities from March and April 2020 were defined as control farms. Out of the 123 (723 cattle) dairy cattle farms of the study area, the FMD outbreak was reported in 31 cattle farms. All 31 FMD infected farms (228 cattle) were considered as case farms. A total of 62 dairy cattle farms were selected as control farms (case versus control=1:2) from the study area.

Data Collection

The data of case and control farms for the descriptive and analytical study were collected by field visits and observation. In case of incomplete information, follow ups were carried out by subsequent telephone

interviews with the farm owners. The information regarding twelve variables, namely "small farm size", "use of natural-source water", "grazing system", "mixed farming with sheep and goat", "vehicles allowed to enter the farm", "farm to farm distance", "milk market distance", "sharing of the bull for breeding", "sharing of equipment", "cattle purchased within 14 days", "wild deer contact" and "cattle not vaccinated within six months" were collected from fifty-seven semi-structured questions. They were considered as potential risk factors and obtained from the literature review and expert opinion.

Statistical Analysis

Data were entered and processed in Microsoft Excel 2016. The descriptive analysis was done by time, place and animal. The median, mean, range, case fatality rate, morbidity rate and mortality rate were used to describe the situation and demography of FMD farms in the study areas. First, a univariable analysis was performed to measure the association between the individual potential risk factor and the presence of FMD in the farm. The variables that met a cut-off of $p \leq 0.15$ in the univariable analysis were considered for the final multivariable logistic regression model. We checked for multicollinearity using a criterion of the variance of inflation factor (VIF) <4 and a correlation of more than 80% between the variables. The normality of the continuous variable such as "small farm size", "farm to farm distance", and "milk market distance" were tested using Shapiro Wilk test in Stata/S.E. 14. The variables found not to be normally distributed, they were classified as a binary variable using a median cut-off. Odds ratios (OR), their 95% confidence intervals (CI), and corresponding *p*-values were estimated by backward multivariable logistic regression. The Stata 14 software was used to analyse the data. Spatial distribution of the cases was mapped using QGIS 3.4.9.

Results

Descriptive Epidemiology of FMD Outbreak

Out of 123 cattle farms, in the study area, 31 case farms (228 cattle) had FMD outbreaks. This indicated that the farm-level prevalence of FMD was 25.2% (n=31/123). Among the FMD affected farms, in Kageshwari and Shankharapur Municipalities there were 38.7% (12/31) and 61.3 (19/31) farms, respectively. The FMD virus serotype O was confirmed by PCR in two of the case farms. The median farm size with the range of the case and control farms were 6 (3-9) and 5 (2-6), respectively.

The median morbidity and mortality rates (range) of case farms (n=31) were found to be 100.0% (66.7-100.0) and 14.3% (0.0-25.0), respectively. The median case fatality rate (range) in case farms was low in adults (20.0% (0.0-33.3)) in comparison to those in calves (50.0% (0.0-100.0)) of case farms. The index case was reported on 20 Mar 2020, but the first case was traced back to have occurred on 13 Mar 2020. The number of farms affected was increasing until the end of March 2020 and then decreased sharply. The progression of the disease can be seen in the epidemic curve (Figure 2).

The case farms that had not been vaccinated against FMD in the last six months were found to be 96.8%. Up to 67.7% of case farms practiced grazing around the farms or in grazing land, and 51.6% of case farms had chances of contact with wild deer in the common grazing area or through the grass brought from the same area. Similarly, 80.6% of the case farms were located within a distance of 200 meters from another nearest farm.

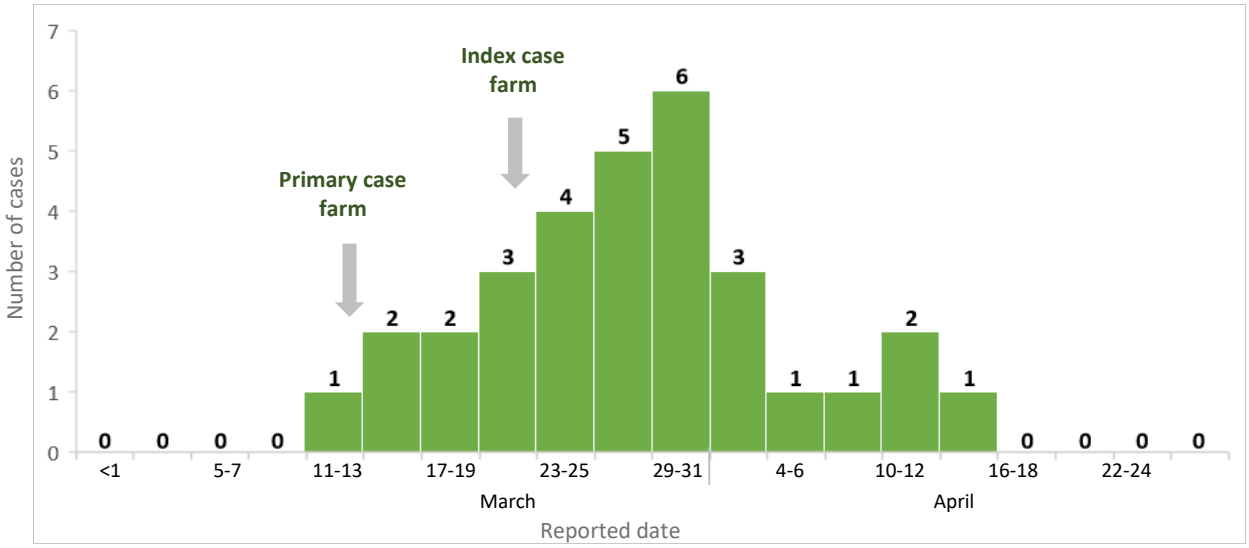

Figure 2. Epidemic curve of case farms (n=31) of Kageshwari and Shankharapur from March to April 2020

Univariable and Multivariable Logistic Regression Analysis

The univariable analyses of risk factors associated with the FMD outbreak in dairy cattle farms in the study area have been presented in Table 1. Among the twelve variables, eight explanatory variables ($p \leq 0.15$) were selected for the multivariable analysis. They included "small farm size", "use natural source water", "grazing system", and "mixed farming". Similarly, they included "milk market distance", "sharing of the bull for breeding", "cattle purchased within 14 days", and "cattle not vaccinated within six months" (Table 1).

Table 1. Result of univariable analysis for risk factors associated with FMD outbreaks (n=93 farms)

Variables	Category	Case (n=31)	Control (n=62)	OR (95% CI)	*p*-value
Farm type					
Small farm size	≤4 cattle	13	43	0.31 (0.11-0.85)	0.011
	>4 cattle	18	19		
Husbandry type	Grazing	21	23	3.56 (1.31-9.94)	0.005
	Stall feeding	10	39		
Farm location					
Farm to farm distance	≤200	25	43	1.84 (0.59-6.35)	0.25
	>200	6	19		
Milk market distance	<2 kilometres	16	9	6.28 (2.08-19.35)	<0.001
	≥2 kilometres	15	53		
Possibility of wild deer contact	Yes	16	29	1.21 (0.46-3.14)	0.65
	No	15	33		
Farm management					
Use natural source water	Natural water	18	46	0.48 (0.17-1.33)	0.11
	Municipality water	13	16		
Mixed farming with sheep and goat	Yes	29	45	5.48 (1.14-51.64)	0.018
	No	2	17		
Sharing bull for breeding	Yes	24	30	3.66 (1.27-11.42)	0.008
	No	7	32		
Sharing of equipment	Yes	19	33	1.39 (0.53-3.71)	0.46
	No	12	29		
Vehicles allowed to enter the farm	Yes	12	23	1.07 (0.39-2.83)	0.87
	No	19	39		
History of vaccination and movement					
Cattle vaccinated within six months	No	30	34	24.70 (3.53-1043.00)	<0.001
	Yes	1	28		
Cattle purchased within 14 days	≤14 days	10	4	6.90 (1.71-32.69)	0.001
	>14 days	21	58		

The multivariable logistic regression yielded four risk factors associated with FMD outbreaks. These included milk market distance less than 2 kilometres (OR=32.74; CI=5.75-186.25), sharing of the bull for breeding (OR=5.71; CI=1.21-26.79), cattle purchased within 14 days (OR=12.85; CI=2.37-69.48) and cattle not vaccinated within six months (OR=19.07; CI=1.95-186.21) which were identified as important risk factors for the occurrence of FMD (Table 2).

Table 2. Result of multivariable logistic analysis for risk factors associated with FMD outbreak (n=93 farms)

Variable	Adjusted OR (95% CI)	*p*-value
Milk market distance less than 2 kilometres	32.74 (5.75-186.25)	<0.001
Sharing bull for breeding	5.71 (1.21-26.79)	0.027
Cattle purchased within 14 days	12.85 (2.37-69.48)	0.003
Cattle not vaccinated within 6 months	19.07 (1.95-186.21)	0.011

Discussion

FMD is an economically significant disease which was observed in 2018 in Kathmandu. The serotype O was confirmed in that outbreak. The serotype O is the most common serotype in Nepal, which was observed in 97% of the samples in the last decade of 2006-2015.[2] This outbreak was confirmed in April 2020, although an earlier study also showed most of the farms reported FMD in December and January and even in the pre-monsoon period (April-May) more than the other times of the year. However, FMD outbreak has been reported throughout the year in Nepal.[2]

The median morbidity of case farms (n=31) was 100.0% which ranged from 66.7-100.0% and the median mortality rates of case farms (n=31) was 14.3% which ranged from 0.0-25.0%. A study in Ethiopia found the morbidity, and mortality rates to be 24.4% and 4.0%, respectively.[9,10] It might be due to the differences in the age composition of herds as the mortality due to the disease is known to be higher in young calves[3] and could also be due to the difference in the pathogenicity of the serotypes found in a different place and type of cattle breed.[9] Up to 97 percent of the case farms were not vaccinated against FMD, which might be the reason for high morbidity. Vaccination against a specific FMD virus serotype does not usually protect animals against other serotypes, and vaccination of FMD carried out every four months (OR=0.06; CI=0.01-0.68) has been found more effective.[11,12] Previous studies have indicated that the timing and number of vaccine rounds are an essential factor against FMD outbreaks and period more than six months between adult vaccination and FMD virus infection resulted in low protection.[13,14] Thus, the time taken to respond to outbreaks through vaccination is critical for the effectiveness of FMD control.[15]

Close distance to the milk markets increased the chances (OR=32.74; CI=5.75-186.25) of disease incursion. The presence of FMD in the milk markets may create problems for all livestock owners who are connected to them. This connection may be geographical or via market chains.[16] The chances of FMD outbreak due to cattle purchased within 14 days (OR=12.85; CI=2.37-69.48) was found higher than the farms that purchased cattle more than 14 days ago which might be due to moving cattle between farms and having contact with potentially infected animals.[17] The farm with no vaccination of the cattle within six months (OR=19.07; CI=1.95-186.21) had a higher risk of an outbreak of FMD than the farms vaccinated against FMD.

Limitations

All cases of FMD considered in this study were not laboratory confirmed. Only 29 cattle in two farms were confirmed by PCR among the 31 case farms with a total of 228 cattle. The role of wild deer, sheep, and goats in FMD spread could not be assessed and verified due to the time limitation.

Conclusions

Our study has provided an insight into risk factors for the recurrence of FMD outbreaks in Kathmandu and found out some recommendations for farmers and policymakers. The descriptive study of this investigation provides valuable insights about the source of transmission, which could even be the wild animal (deer) or silent FMD virus hosts like sheep and goats. This study highlights the importance of continued FMD surveillance in domestic and wild animal populations. Additionally, precautions adopted during the milk marketing, vaccination every six months, and sharing of vaccinated breeding bull need to be improved in farm management practices.

Recommendations

All susceptible animals should be vaccinated for FMD at least every six months, including sheep and goats along with cattle and pigs. There has been limited FMD surveillance carried out in wildlife, so further investigation is needed in wildlife. Farmer awareness about the economic and trade impact, biosecurity measures like movement control, and visitor control would help to reduce the number of outbreaks.

Acknowledgements

The authors would like to extend special thanks to the staff of FETPV-Thailand, Department of Livestock Services, Nepal, FMD and TADs Laboratory, Kathmandu; FAO-RAP Thailand and FAO-ECTAD Nepal; Kageshwari and Shankharapur Municipalities, Kathmandu for their continuous support during the outbreak investigation.

Investigation Approval

This FMD outbreak investigation was done during the second module training of Regional Field Epidemiology Training Programme for Veterinarian (R-FETPV), Thailand. The main author was nominated for the training programme from the Ministry of Agriculture and Livestock Development, Nepal (Ref. no.1795/2019). The verbal consent of farmers were taken before being interviewed.

Suggested Citation

Shahi MK, Boonyo K, Wongphruksasoong V, Upadhyaya M, Rana S, Karki S, et al. Investigation of foot-and-mouth disease outbreaks in dairy cattle from Kageshwari and Shankharapur Municipalities, of Kathmandu, Nepal and associated risk factors from March to April 2020. OSIR. 2021 June;14(2):52-57.

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