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Using participatory epidemiology tools to determine perceived risk factors for foot-and-mouth disease occurrence in selected sub-counties of Isingiro district in Uganda

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Preliminary steps of the progressive control pathway for foot-and-mouth disease (PCP-FMD), underscores information on risk areas and risk factors for FMD circulation, as essential in development and implementation of appropriate control and elimination strategies. Isingiro district in Uganda, suffers annual FMD outbreaks despite controls implemented by the Government. Using participatory epidemiology (PE) approaches, we determined risk factors perceived important for FMD occurrence in selected sub-counties of Isingiro district. The PE tools involved use of focus group discussions (FGDs), transect walks, interviews with key informants (KIs) and structured questionnaires. Data from the FGDs and KI interviews were subjected to thematic framework analysis and highlighted that communal grazing, porous border, uncontrolled livestock movement, and livestock markets as major risk factors for FMD occurrence. Linear regression analysis of questionnaire data showed that households closer to the international border and Lake MburoNational Park reported more FMD outbreaks (OR 7.9 and 5.5, respectively). Communally grazed cattle and those that grazed in other villages were 8 times more likely to get FMD (OR 8.3 and 8.4, respectively) in contrast to paddocked or zero grazed cattle. This study highlights factors and physical features substantial for strategic FMD control in the two sub-counties of Isingiro district.

Key words: Farmers' epidemiology perception, foot-and-mouth disease, interviews, Isingiro, Uganda, risk factors.

INTRODUCTION

Foot-and-mouth disease (FMD) is a major notifiable livestock disease caused by the foot-and-mouth disease virus. The disease is highly contagious and is easily spread through direct contact of infected animals with susceptible ones (Jamal and Belsham, 2013). Additionally, experiments have shown that wind currents,

fomites and vehicles are important in FMD spread (Donaldson and Alexandersen, 2002). Foot-and-mouth disease affects all cloven hooved animals, which include both domestic and wild life species. The disease has no treatment but can be prevented through vaccination using virus vaccine strains similar to circulating viruses in the area of proposed vaccination (Kitching et al., 2007). Although FMD has a low mortality in adults, its morbidity is high with severe social and economic consequences, both at local and international level Rushton and Kinght-Jones., 2015). Between 2001 and 2010, the government of Uganda spent between 58,000 and 1,088,820 USD on purchase of vaccines (Muleme et al., 2012), while Baluka et al. (2014) observed that in Isingiro and Nakasongola districts a farmer forfeited averagely 123 USD per cattle head during an FMD outbreak.

Currently, Uganda is in preliminary stages of the Progressive Control Pathway for foot-and-mouth disease (PCP-FMD) (FAO, 2011b) - a step by step guide for the reduction of FMD circulation in endemic countries. One of the important steps in the pathway is identification of the risk areas and understanding the risk factors that predispose an area to FMD outbreaks. The United Nation's Food and Agricultural Organization encourages disease control strategies to consider risk factor analysis, as this ensures execution of appropriate control strategies and reduces unnecessary expenses (FAO, 2011a). It is apparent that identification of these risk factors could consequently aid in designing strategic FMD control approaches for its eradication in a particular area.

Reports by the Ministry of Agriculture Animal Industries and Fisheries (MAAIF) in Uganda showed that FMD outbreaks had been on the increase annually between 2010 and 2014. Isingiro situated southwest of the country, had constant outbreaks and was one of the focus districts for FMD outbreaks in the country (Agriprofocus, 2015; MAAIF, 2017, 2018). In 2017, investigations by the Ministry of Agriculture Animal Industry and Fisheries showed that Isingiro district was singled out as a source of FMD outbreaks that spread to Gomba, Ntungamo, Kirihura, Mbarara and Lyantonde districts in Uganda that year. Despite the vaccination campaigns and the ten-year quarantine imposed on the district since 2007 to 2017, FMD outbreaks still continued to occur (MAAIF, 2017; Rowney, 2014). According to Ayebazibwe et al. (2010), most FMD outbreaks in Uganda occurred in district sub-counties that were found near the Uganda-Tanzania border, while Picado et al. (2010) also showed FMD clustering was prominent in the Kagera region (a region in Tanzania that borders Isingiro and Rakai districts). The district of Isingiro lies along the border area between Uganda and Tanzania and this border area has been identified among other eastern African border areas as one of the risk areas for FMD circulation in Eastern Africa (Di Nardo et al., 2011). The reason for the occurrence of FMD in Isingiro district remains unclear, although inferences have been made towards the presence of wild life at Lake Mburo National Park and the border that the district shares with Tanzania (Ayebazibwe et al., 2010). It may be due to spill-over and spill-back of infection as also seen in many other pathogens (Moudgil and Singla, 2013). This study therefore sought to identify perceived risk factors for FMD occurrence in selected sub-counties in Isingiro district. The study also sought to map specific features and shared resources perceived responsible for FMD occurrence in the selected sub-counties.

MATERIALS AND METHODS

Study area

The study was conducted in October 2018, in Isingiro district that lies north of the Uganda-Tanzanian border (Figure 1). Two sub-counties were purposively selected for inclusion in this study. Endinzi sub-county was selected because it lies directly adjacent to the border, and Isingiro Town Council (TC) sub-county was selected because it harbors the Lake Mburo National Park.

Data collection and management

Focus group discussions and proportional piling

Four focus group discussions (FGDs) were held to get farmers' perspective on FMD risk factors. Farmers from Endinzi held a meeting in Endinzi sub-county hall, whereas the ones from Isingiro TC had a meeting in the compound of the Isingiro TC sub-county offices. The interviews were with each FGD that had 10 farmers, with at least ten years' experience in rearing cattle. The participants listed the risks they perceived were associated with FMD outbreaks. Boxes were drawn on paper to represent the mentioned risk factors with 100 counters (beans) allocated to the participants based on the assumption that the risk factors mentioned made up 100%. Farmers then ranked the mentioned risk factors using proportional piling where they used bean seeds to quantify each risk factor.

Key informant interviews

Ten key informants were interviewed using a semi-structured questionnaire. The key informants (KI) included 4 District veterinary personnel three politicians, two prominent cattle farmers and one cattle trader. The checklist included questions on whether the sub-county had suffered an FMD outbreak in the last 12 months, when

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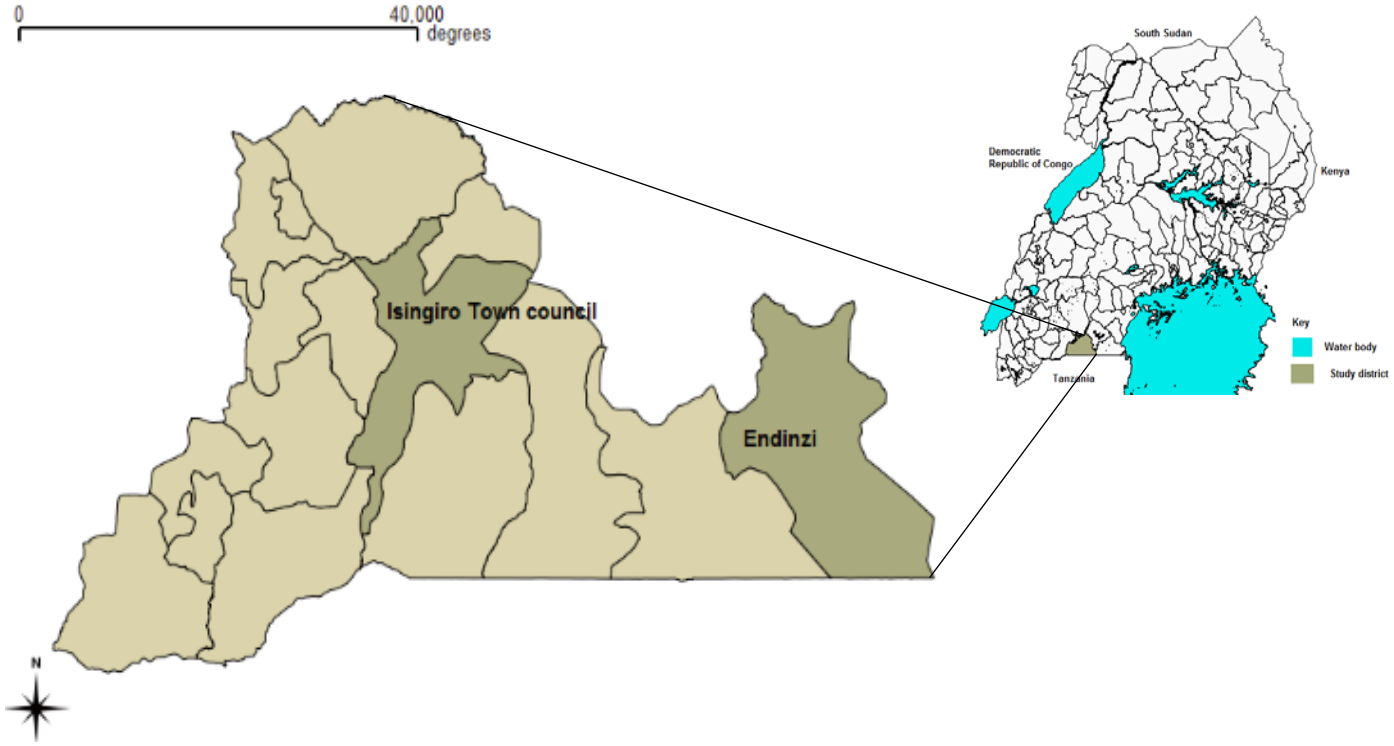

Figure 1. Map of Uganda showing location of Isingiro district.

and where the outbreak(s) had occurred, control measures that were put in place. The risk factors that the KI thought were important for FMD occurrence in the sub-county were ranked.

Mapping and transect walk

All the farmers who participated in the FGDs contributed to sketching the map of their communities using the actual information obtained from the participants with respect to livestock markets, grazing areas animal watering points, proximity to the border, and proximity to the national park. The mapping process additionally considered information on other natural resources like the national parks, the international border, water dams, rivers, streams to be positioned in the sketched map. Farmers and respondents identified the features in these two sub – counties. These were perceived as risk factors to FMD outbreaks. The research team led by the respondents went for a transect walk after every community interview. Dams, markets and milk collection points in the two sub-counties were visited by the team and geographic positioning system (GPS) location of these features were taken using a smart phone, which had Event Mobile Application – i (EMA-i) software installed. The transect walk provided an opportunity to the team to observe the listed features that were particularly important risk factors for FMD outbreaks. The location points were after transferred in an excel sheet.

Structured questionnaire

Eighty cattle farmers were interviewed using structured questionnaires. Forty cattle farmers were randomly selected from Endinzi and 40 from Isingiro TC sub-counties. The questionnaire tool included questions on whether farmers had experienced an outbreak or not, distances from the border, markets, watering points, national park and main roads. Questions also included locations where farmers sold their animals, where they bought their animals from, whether they practiced communal watering and grazing and the number of animals they had. Farmers also interviewed on whether they grazed in other villages and if they practiced communal grazing and watering. Three villages in each sub-county were purposively selected based on history of FMD outbreaks in the previous 12 months. Households randomly selected based on a list provided by the sub-county veterinary officers. Ten farmers selected per village per sub-county based on previous reported cases of FMD. Outbreaks that had occurred on the selected farms were confirmed by the District Veterinary Officers that had either carried out clinical or laboratory diagnosis.

Data analysis

Qualitative data from the FGDs and KI interviews were analyzed using thematic frame work analysis. Thematic frameworks identified, coded and interpreted accordingly as described by Gale et al. (2013).

Quantitative analysis of the structured questionnaire data performed in R software version 3.3.2 (R core Team, 2013). To ascertain the relationship between the FMD outbreak on farm as an outcome variable and each explanatory variable a simple linear regression model used. The outcome variable was an FMD infection on a farm (this was confirmed by either clinical or laboratory diagnosis by the District Veterinary Officer). Explanatory variables included distance from border (how far the farm was from

Table 1. Ranking of risk factors pointed out by the focus group discussions.

Variable	Sub-county
Perceived risk factor (%)	**Endinzi**
Livestock Markets (Kamwema-border market)	34
Ugandan livestock farmers grazing their animals in Tanzania	20
Communal grazing	27
Uncontrolled livestock movement	13
Animals from Tanzania watering in Ugandan dams	06
Perceived risk factor (%)	**Isingiro TC**
Uncontrolled livestock movement and poor enforcement of laws	32
Animals from Tanzania watering in Ugandan dams	19
Communal grazing	18
Uncontrolled livestock movement	13
Grazing and watering animals in Lake Mburo	11
Livestock markets	07

Table 2. Ranking of risk factors for foot-and-mouth disease outbreaks bythe key informants.

Factor	Sub-county bean count	
	Endinzi	**Isingiro TC**
Livestock markets	100	100
Uncontrolled livestock movement (during outbreaks)	100	100
Dry seasons (poor pastures and lack of water)	100	100
Porous international borders	100	100
The national park influence (grazing)	00	40
Ugandans grazing in Tanzania during the dry season	40	40
No vaccination/vaccination inadequacy	20	20
Tanzanians accessing water in Uganda	40	20

the Uganda Tanzanian border), distance of household from the national park (how far in kilometers the farm was from Lake Mburo National Park) and distance from the nearest cattle market (kilometers). Others were: grazing system practiced by farmer (communal grazing =1, paddocking or zero grazing = 0), distance from the nearest shared water source (how far in kilometers the farm was from a watering source shared by the community), cattle herd size, goat herd size, sheep herd size and FMD vaccination status (vaccinated= 1, non-vaccinated= 0). Farm related variables included shared water source (Farm that shared water source with community =1, Farm that did not share water source with community= 0) and households buying livestock from neighbors (Farm bought livestock from neighbors =1, did not buy livestock from neighbors= 0). For explanatory variables that turned out significant in the univariate analysis, multivariate analysis performed using generalized linear mixed models (Poisson distribution in package lme4) and likelihood ratio tests undertaken to determine the significance of mixed effects.

RESULTS

From the FGDs held with the farmers, in Endinzi sub-county, livestock markets (34%), communal grazing (27%) and uncontrolled livestock movement (13%) were the top three risk factors ranked by the farmers. In Isingiro TC, uncontrolled livestock movement (32%), animals from Tanzania watering in Ugandan dams (19%) and communal grazing (18%) were the top three risk factors ranked (Table 1). Grazing and watering livestock in Lake Mburo National Park were two of the factors mentioned by farmers from Isingiro TC where the national park was averagely 12.25 km away from most of the Isingiro TC households included in this study. From the KI interviews, livestock markets, uncontrolled movement of livestock, dry seasons and the porous Uganda-Tanzanian border stood out as major perceived risk factors from both sub-counties (Table 2). The risk factor of farmers grazing in the national park was highlighted by the 4/5 KI from Isingiro TC, whereas Ugandans grazing in Tanzania during the dry season was a major factor raised by the KI in both sub-counties.

Univariate analysis of the quantitative data showed that distance from the border was a key variable for outbreaks to occur ($P<0.01$) with an odds ratio (OR) of 7.9 and a

Table 3. Probability values (P value), Odds ratios (OR) and 95% confidence intervals (CI) of variables associated with foot-and-mouth disease outbreaks in selected sub-counties of Isingiro district.

Explanatory variable	P value	Odds ratio	CI
Distance from the border	0.00358**	7.9	1.96-31.67
Distance from the National Park	0.01100*	5.5	1.46-19.03
Grazing in other villages	0.002838**	8.4	2.08-33.00
Grazing system (communal)	0.001381**	8.3	2.26-30.67

**P<0.01, *P<0.05.

95% confidence interval (CI) of 1.96-31.67. Distance from the national park was significant (P<0.05) as well, with an OR of 5.5 and a CI of 1.46-19.03. Univariate analysis also showed that grazing system was significant with an OR of 8.3 and a CI of 2.26-30.67; grazing in other villages was highly significant (P<0.01) with an OR of 8.39 and a CI of 2.08-33.00) (Table 3). Multivariate analysis of significant factors showed that grazing system did not correlate with FMD occurrence in the two sub-counties (P= 0.090).

DISCUSSION

The continued occurrence of FMD in Isingiro district amidst previously instituted control strategies may mean that one considers new strategies for FMD control. In this study, both qualitative and quantitative data was analysed to determine the perceived risk factors for FMD occurrence in Isingiro. The risk analysis performed using univariate and multivariate analysis on the two sub-counties that had at least two different risk variables. The results from this study showed that the households closer to the border were 7.9 times more likely to get FMD than those that were far away from the border, implying that the greater the distance from the border the less likely an outbreak would occur (P<0.005) (Table 3). These findings are in tandem with results from other studies in Uganda by Ayebazibwe et al. (2010) and in Tanzania by Allepuz et al. (2015), who showed that increased distances from border and from the national park were associated with decreased number of outbreaks in both Uganda and Tanzania. Moreover, Kerfua et al. (2018) also showed that sub-counties/wards adjacent to the Uganda-Tanzania border had more outbreaks reported compared to those that were afar off from the border. The results from interviews held with the farmers during the focus group discussions and with the key informants further portrayed the border as important risk factor for FMD occurrence of FMD in Isingiro district. Allegedly, Tanzanians usually crossed the border to access water and markets for their cattle, whereas Ugandans crossed into Tanzania to access pastures during the dry season. The lack of control of animal movement was raised as a major factor for the complexity in controlling FMD in Tanzania (Kivaria, 2003). The Isingiro District Planning Report (IDLG, 2011) highlights the border as playing a major role in the spread of FMD from Tanzania into Uganda. One of the plausible reasons could be that Tanzania does not consider FMD as a public good (Ndhlovu, 2016) thus FMD vaccination rates are low (Railey, 2018) creating pockets for disease circulation. Additionally, because of the opportunities border areas present in terms of trade between two countries especially when prices are higher on one side of the border (Otte et al., 2004), these have been implicated as critical in FMD circulation, with disease easily moving from one area to another (Di Nardo et al., 2011).

The distance from the national park was key in FMD occurrence in this study (P= 0.011). The Lake Mburo National Park is closer to Isingiro TC than it is to Endinzi sub-county and during the FGD in Isingiro, the Park emerged as one of the risk factors for FMD occurrence in Isingiro TC. During the FGDs, farmers reported that during the dry season, some farmers move to the park for months to graze their animals since the park has a lake and constant pastures available. This factor emerged in Isingiro TC, which is about 12.5 km away from the park. The park harbours wild life species such as buffalos and zebras (Lake Mburo National Park, 2020) that are susceptible to FMD infection. The role of wild life in spread and maintenance of FMD has been elucidated by studies carried out in southern Africa (Vosloo et al., 2005), which showed that proximity to wild life was an important risk for the spread of FMD given the FMD carrier status of the wild life, especially buffalos. Additionally, a study in Uganda, Ayebazibwe et al. (2010) showed that sub-counties that harboured wild life were likely to suffer from an FMD outbreak compared to those that did not.

In this study, communal grazing system had a high association with the incidence of FMD on a farm; a farm that practiced communal grazing was 8.3 times more likely to report an FMD outbreak. Communal grazing is a common practice in pastoral communities associated with spread and maintenance of FMD in many communities.

Under the communal grazing system, the cattle farmer is limited in whatever they can do to prevent exposure of his livestock from infection in case the animals that graze with his animals are infected (Knight-Jones and Rushton, 2013), therefore susceptible animals will easily succumb to infection. Also, a study in Bhutan (Dukpa et al., 2011) showed that cattle sharing grazing grounds was one of the most important risk factors for FMD spread with an OR of 5.3 ($P<0.0001$). In the FGDs, farmers ranked communal grazing as one of the top three important risk factors for FMD occurrence in both sub-counties. Although there was high collinearity between communal grazing and grazing in other villages, in the univariate analysis, grazing in other villages was key, showing that mixing of different cattle herds still held high chances of animals being infected. Farmers who grazed in other villages were 8.4 times more likely to experience an FMD outbreak on their farm. During the dry seasons, when pastures are depleted, many cattle farmers reported that they travelled to villages either within Uganda or in Tanzania seeking for pasture and water. About 33% of the farmers in Endinzi and 10% of the farmers in Isingiro TC said they grazed in the Tanzanian villages when there was pasture and water shortages; thus, the odds that an animal would pick the disease from another village was high.

Conclusion

The control and management of a disease mainly based on applied appropriate strategies based on risk factors. Our study has revealed some of the important perceived risk factors for FMD occurrence in the selected sub-counties in Isingiro district. Thus, design FMD control strategies based on the results from this study.

Recommendation

This study recommends the design of appropriate control strategies based on the risk factors as found in this study. The study additionally recommends cross border collaboration between Uganda and Tanzania in efforts to control FMD and other Transboundary Animal Diseases.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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