RISK ANALYSIS FOR FOOT-AND-MOUTH DISEASE IN THE STATE OF BAHIA, 2022 AND 2023

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ABSTRACT

The concept of epidemiological risk is essential for managing infectious diseases such as foot-and-mouth disease, requiring constant reassessment of conceptual foundations and adherence to the guidelines of the World Organisation for Animal Health (WOAH) (Leal, Mascarenhas, Alves, 2022). This study aimed to identify priority municipalities and Territories in Bahia for preventive actions, based on the Strategic Plan of Brazil's National Foot-and-Mouth Disease Surveillance Program (PNEFA). The results indicated that most municipalities exhibit up to three risk factors, except for Teodoro Sampaio, which has six factors. A 14.6% reduction was observed in the number of municipalities with more than three risk factors compared to the previous year, showing a positive trend. Although the average risk decreased in several Identity Territories, regions such as Vale do Jiquiriçá, Extremo Sul, and Semiárido Nordeste II still perform below the average. Issues such as the absence of disease notifications, insufficient agricultural transit inspection, and the entry of animals from other states remain, highlighting the challenges for animal health and safety in Bahia.

Keywords: Epidemiology; Animal Health; Animal Health Defense; Livestock.

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INTRODUCTION

The notion of risk, from an epidemiological perspective, implies the idea of probability or chance, based on epidemiological studies, thereby allowing the identification of actual (present) and potential (future) risks in a given health scenario (ROUQUAYROL, 2018). Therefore, risk represents the probability of a disease or condition occurring, either in the present or the future (FRANCO; PASSOS, 2005).

Public health risk assessments can be divided into qualitative and quantitative approaches. Unlike quantitative assessment, qualitative evaluation does not involve mathematical modeling and is commonly used in routine decision-making processes (Leal, Mascarenhas, Alves, 2022). This methodology enables the identification of risk scenarios without the need for complex calculations, facilitating rapid decision-making based on observational data (SANTOS et al., 2014).

The formalization of the concept of risk as a conditional probability of events related to health and disease has brought advances in theoretical rigor and predictive capacity in health management and planning. This approach has been essential for understanding the links between epidemiological processes and public health outcomes (Leal, Mascarenhas, Alves, 2022).

Although currently surpassed by recent demands arising from advances in knowledge about pathological processes, this particular way of representing the connections between health-disease processes and events in modern society requires a critical reexamination of its logical and historical foundations (ALMEIDA-FILHO; COUTINHO, 2007).

According to recent reflections, the concept of risk can be described as follows: a) "Risk" as a latent or hidden danger in common social discourse; b) "Individual Risk" as a concept in Clinical Practice; c) "Population Risk" as a strictly epidemiological concept; d) "Structural Risk," in the fields of Environmental/Occupational Health; and e) "Contingent Risk," as an operator in the emerging field of Health Promotion practices (ALMEIDA-FILHO; COUTINHO, 2007).

Depending on the surveillance objective, combining various data sources can provide an indication of the overall system sensitivity and increase confidence in the results. Risk assessment is useful for optimizing resource allocation (WOAH, 2022a).

For the recognition of foot-and-mouth disease control by the World Organisation for Animal Health (WOAH, formerly known as OIE), a Member Country must submit a dossier to the OIE in support of its request. This dossier should not only explain the epidemiology of foot-and-mouth disease in the specific region but also demonstrate how all risk factors, including the role of wildlife, where applicable, are identified and managed. It must include scientifically-based supporting data, especially if a higher likelihood of infection can be identified in specific locations or species (WOAH, 2022b).

The major livestock epidemics of the last two decades have had substantial economic impacts, and the COVID-19 pandemic underscores the devastating socioeconomic consequences that such events can have when not identified and controlled early in the emergence process. This highlights the importance of Veterinary Services, through integrated efforts across society, in controlling infectious animal diseases. Veterinary Services should prioritize prevention. Four key areas are emphasized for continuous improvement in Veterinary Services to address this challenge: ongoing staff capacity development for risk assessment and value chain analysis linked to enhanced policies and communication; appropriate adaptation of prevention and control approaches in resource-limited settings; improved multisectoral and cross-border cooperation, enabling shared resources and knowledge; and systematic approaches that allow Veterinary Services to influence decision-making on trade, markets, business, public health, and livelihood development at national and regional levels (JOST et al., 2021)

The Brazilian Ministry of Agriculture established the National Foot-and-Mouth Disease Surveillance Program (PNEFA), which developed a Strategic Plan for the period 2017-2026. This plan aims to gradually eliminate foot-and-mouth disease vaccination in areas previously free of the disease with vaccination, until all of Brazil is recognized as free from foot-and-mouth disease without vaccination by the World Organisation for Animal Health (WOAH) (MAPA, 2023).

The Strategic Plan of the National Foot-and-Mouth Disease Surveillance Program (PNEFA) 2017-2026 establishes risk analysis and cost-benefit assessment as essential foundations for decision-making. Aligned with this directive, a specific analysis was conducted using municipalities in Bahia as the primary unit for monitoring surveillance actions (Leal, Mascarenhas, Alves, 2022).

The main purpose of the present study is to identify municipalities and Territories in the state of Bahia that require prioritization in preventive actions within the context of

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foot-and-mouth disease surveillance, aiming to support the formulation of goals for risk mitigation.

MATERIALS AND METHODS

To conduct the proposed analysis, data from the official registry of the State Agency for Agricultural Defense of Bahia (ADAB) were used, including information recorded in the Agricultural Integration System (SIAPEC) and management spreadsheets from the Directorate of Animal Health Defense (DDSA). These data served as the primary source for evaluating risk factors in the monitored municipalities (Leal, Mascarenhas, Alves, 2022).

Additionally, the data compilation considered the municipalities in the state of Bahia as the basic units of analysis, using information from the first semester of 2023. This time frame allowed for observation of the main risk factors in the regional context, enabling comparisons with previous years (Leal, Mascarenhas, Alves, 2022).

For the descriptive data analyses, Microsoft Excel for Office 365 and the R System were used, ensuring a rigorous and automated approach to organizing and visualizing the results. These programs enabled statistical calculations and graphical representations that supported the interpretation of findings (Leal, Mascarenhas, Alves, 2022).

The analysis identified the main risk factors requiring continuous monitoring within the PNEFA framework. These factors include: (1) entry of animals from bordering states; (2) vaccination coverage below 90%; (3) gathering of species susceptible to foot-and-mouth disease; (4) lack of inspection in rural properties; (5) absence of control over agricultural transit; (6) lack of inspection in slaughterhouses; and (7) absence of notifications for vesicular diseases (Leal, Mascarenhas, Alves, 2022).

RESULTS

Based on the analyzed risk factors, it was found that most municipalities (72.9%) exhibit up to three risk factors. The municipality of Simões Filho, located in the Metropolitan Territory of Salvador, and Santa Cruz de Cabrália, in the Costa do Descobrimento (Discovery Coast) Territory, each presented only one risk factor. Meanwhile, the municipality of Madre de Deus, also in the Metropolitan Territory of Salvador, did not have its risk calculated due to the absence of registered properties in ADAB, and for the purposes of this analysis, a risk level of zero was assigned. Teodoro Sampaio, located in the Portal do Sertão

Territory, presented the highest risk factor (6), with a cattle population of 18,317 (Table 1).

Compared to the previous year's risk analysis (2022), there was a 14.6% reduction in the number of municipalities with more than three risk factors. Considering each municipality, 20.6% showed an increased risk factor, 37.9% remained with the same risk factor, and 41.5% achieved improvements in their figures.

Table 1: Number of municipalities and percentage by risk level in Bahia, in 2023.

Risk Level	Municipalities	%
0	1*	0,2
1	2	0,5
2	124	29,7
3	177	42,4
4	92	22,1
5	20	4,8
6	1	0,2
6	1	0,2
Total	**417**	**100**

* The municipality of Madre de Deus, due to the absence of registered properties, had its risk factors disregarded in the analysis.

When calculating the average risk factors for municipalities within the Identity Territories, a variation between 2.2 and 3.8 was observed, with the state average at 3.0. Among the Territories, 55.6% are below this average. Most Territories showed a reduction in the average risk factors for municipalities compared to the previous analysis. The most significant progress was identified in the Territories of the Rio Corrente Basin, Metropolitan Salvador, Paramirim Basin, Discovery Coast, and Médio Rio de Contas.

The Metropolitan Territory of Salvador, comprising 13 municipalities, presented an average risk level of 2.2, representing the best index achieved. The ten lowest-performing Territories were: Vale do Jiquiriçá Territory, Extremo Sul Territory, Semiárido Nordeste II Territory, Sisal Territory, Chapada Diamantina Territory, Sertão do São Francisco Territory, Piemonte Norte do Itapicuru Territory, Litoral Sul Territory, and Velho Chico Territory.
The Vale do Jiquiriçá Territory is composed of 20 municipalities, with 20% of them having a risk level above 3 in this analysis. No notifications or transit inspections were recorded in any municipality. Animals from neighboring states entered three

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municipalities. All municipalities achieved vaccination rates above 90%.

The Extremo Sul Territory, comprising 13 municipalities, presented 30.8% of municipalities with a risk level higher than 3. No vesicular disease notifications were recorded, and animals from neighboring states entered two municipalities. Only one municipality failed to reach the minimum vaccination coverage of 90%. The municipality of Alcobaça, with a risk level of 5, has a cattle population of 44,226 head (Leal, Mascarenhas, Alves, 2022).

In the Semiárido Nordeste II Territory, comprising 18 municipalities, 44.4% of municipalities recorded a risk level higher than 3. All municipalities achieved a minimum vaccination coverage of 90%. Additionally, five municipalities received animals from other states, and transit inspection was conducted only in the municipality of Ribeira do Pombal (Leal, Mascarenhas, Alves, 2022).

The Sisal Territory, which encompasses 20 municipalities, had 45% of its municipalities with a risk level higher than 3. Six of these municipalities received animals from other states, and there were no records of notifications or transit inspections in any municipality. The municipalities of São Domingos and Santa Luz, both with a risk level of 5, presented cattle populations of 8,542 and 12,198 head, respectively (Leal, Mascarenhas, Alves, 2022).

The Chapada Diamantina Territory, comprising 24 municipalities, had 50% of its municipalities with a risk level higher than 3. None of the municipalities recorded notifications of vesicular diseases or transit inspections. Only 14 municipalities achieved the minimum vaccination coverage of 90%, and there was no record of entry of susceptible animals from neighboring states (Leal, Mascarenhas, Alves, 2022).

The Sertão do São Francisco Territory consists of ten municipalities, with 40% of them showing a risk level above three in this analysis, with only the municipality of Sobradinho presenting a risk level of 2. All municipalities lacked notifications of vesicular diseases. In this Territory, only two municipalities achieved the minimum vaccination coverage of 90%, and the entry of susceptible animals from neighboring states was recorded in two municipalities. Notably, the municipality of Campo Alegre de Lurdes, with a risk level of 5, has a cattle population of 17,269 head.

The Piemonte Norte do Itapicuru Territory, comprising nine municipalities, had 44.4% with a risk level greater than 3. None of them conducted transit inspection actions or submitted notifications. Animals from bordering states entered, and gatherings were reported. Only the municipality of Antônio Gonçalves did not register inspections on properties. Notably, the municipality of Senhor do Bonfim, with a risk level of 5, has a cattle population of 21,695 head.

The Litoral Sul Territory has the largest number of municipalities (26), with 57.7% presenting a risk level above 3. Only one municipality received animals from another state. No notifications were recorded in any municipality. There was an increase in the number of property inspection records, from one to 10 municipalities, and transit inspection was only recorded in the municipality of Itabuna due to the presence of a Fixed Inspection Post.

The Velho Chico Territory includes 16 municipalities, with 56.3% of municipalities showing a risk level above three in this analysis. All municipalities lacked vesicular disease notifications. In this Territory, only two municipalities recorded property inspections, and the entry of susceptible animals from neighboring states was recorded in three municipalities. Notably, five municipalities had a risk level of 5: Bom Jesus da Lapa, Muquém do São Francisco, Oliveira dos Brejinhos, Riacho do Santana, and Serra do Ramalho, with cattle populations of 77,077, 117,784, 31,912, 100,625, and 99,454 head, respectively.

Among the analyzed risk factors, the poorest performance was related to the absence of vesicular disease notifications, present in 97.6% of municipalities, despite a slight improvement from the previous year (98.3%), followed by the lack of transit inspections (93.5%). Although there was an increase in the number of inspections, these were conducted in nearly the same municipalities. The absence of inspections on properties with susceptible species was notably reduced, from 74.6% to 67.1%. During the analyzed period, 74 municipalities (17.7%) received animals from other states, a considerable increase compared to the 10 municipalities (2.4%) in 2022. In 2023, 21 out of 27 territories received animals from other states.

DISCUSSÃO

The entry of animals into Brazil through border areas is a significant concern due to the extensive length of these borders, totaling more than 15,000 km. Additionally, sanitary issues in neighboring regions increase the country's vulnerability to the introduction of the foot-and-mouth disease virus. The irregular transit of susceptible animals in these areas, combined with differing sanitary conditions in bordering countries, presents a considerable challenge for the official veterinary service, which is responsible for minimizing this risk (Thrusfield, 2004). This study identified 74 municipalities in Bahia that are vulnerable to receiving animals from higher-risk areas, which have been mapped for priority monitoring (Leal, Mascarenhas, Alves, 2022; Leal, Mascarenhas, Alves, 2024).

Brazil is recognized by the World Organisation for Animal Health (WOAH) as a country with foot-and-mouth disease-free zones, both with and without vaccination. Vaccination against foot-and-mouth disease is mandatory for cattle and buffaloes of

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all ages in zones where it is still implemented, and vaccination strategies may vary according to the state or region. For states where mandatory vaccination is maintained, a minimum vaccination coverage of 90% is expected. As part of the 2017-2026 Strategic Plan, Brazil aims to gradually transition to foot-and-mouth disease-free zones without vaccination, strengthening surveillance systems and rapid response methods for early disease detection (Brazil, 2020). In Bahia, the latest vaccination campaign revealed that 123 municipalities did not reach the minimum coverage of 90% (Leal, Mascarenhas, Alves, 2022; Leal, Mascarenhas, Alves, 2024).

In the current study, gatherings of species susceptible to foot-and-mouth disease were identified in 106 municipalities. Agricultural events represent a potential pathway for the spread of foot-and-mouth disease within the country, increasing the risk of virus reintroduction. For this reason, gatherings of susceptible animals should be inspected by the official veterinary service, allowing qualified professionals to detect possible clinical suspicions. Additionally, this inspection contributes to ensuring animal traceability, promoting surveillance in the rural properties of origin (Silva Júnior et al., 2017; Leal, Mascarenhas, Alves, 2022; Leal, Mascarenhas, Alves, 2024).

Inspection of rural properties is an essential active surveillance measure aimed at inspecting herds at higher risk for foot-and-mouth disease. These inspections, conducted by trained professionals, seek to identify clinical signs or lesions consistent with the disease. Active surveillance is one of the goals of the Strategic Plan for eliminating foot-and-mouth disease vaccination and includes, among other activities, annual vaccination campaigns on animal production properties (MAPA, 2020). In the study in question, it was found that inspections were conducted in 280 municipalities in Bahia, representing 67.1% of the total (Leal, Mascarenhas, Alves, 2022; Leal, Mascarenhas, Alves, 2024).

In Bahia, the survey indicated that mobile inspection occurred in 27 municipalities (6.5%), showing an area that still requires strengthening. Animal transit control is a fundamental method for ensuring traceability, carried out through the Animal Transit Guide (GTA). This control allows for safer movement from a health perspective, preventing irregular transit and reducing the risks of introducing or reintroducing diseases into other regions. Agricultural inspection posts play a crucial role in this prevention, contributing to the protection of public health and the economy (MAPA, 2020; Leal, Mascarenhas, Alves, 2022; Leal, Mascarenhas, Alves, 2024).

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Inspection of slaughterhouse processes is extremely functional in data collection for disease prevention and control, also allowing the detection of possible pathological lesions related to diseases and extending the inspection to the rural properties of origin. This surveillance also ensures that the processing of animal-origin products is carried out safely, preventing the potential transmission of diseases through food, with a focus on public health (PRAZERES et al., 2022). In this study, the municipalities with records of official inspections accounted for 94.7% (395 municipalities) of the state.

Notifications of suspected vesicular diseases in Brazil are mandatory and essential for the rapid detection of positive cases, enabling the implementation of control measures for disease spread and eradication, thereby reducing impacts on animal production and related sanitary restrictions. Any citizen who suspects possible cases of the disease must inform the Official Veterinary Service, which will act to protect the herds (BRAZIL, 2013; CORREIA DO MONTE, 2021).

Disease notification systems rely on the communication of animal health-related events to the Veterinary Authority. Data from these systems can be combined with other information sources to substantiate claims of animal health status, generate data for risk analysis, or provide early warnings and rapid responses. Effective laboratory support is an important component of any reporting system (WOAH, 2022a). This study demonstrates the need to intensify this action, as notifications were recorded in only 10 municipalities (2.4%).

Overall, the analysis showed a positive trend when comparing the results of 2022 with those of 2023. There was a 14.6% decrease in the number of municipalities with a risk level higher than 3. Among the municipalities analyzed, 20.6% showed an increase in risk level, 37.9% maintained the same level, and 41.5% showed improvements in their risk indicators (Leal, Mascarenhas, Alves, 2022).

The risk analysis for the introduction and spread of foot-and-mouth disease in Bahia, considering the years 2022 and 2023, aimed to provide complementary information to PNEFA for decision-making. It identified the municipalities and Territories that should be prioritized for preventive actions through foot-and-mouth disease surveillance, with the establishment of targets for risk reduction, thus meeting one of the fundamental principles of the 2017-2026 Strategic Plan.

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