



Epidemiological Analysis of Lumpy Skin Disease Outbreaks in Tien Giang Province, Vietnam (2023): Risk Factors and Clinical Manifestations

VO TUAN KHAI HUYEN¹, THAI QUOC HIEU², TRAN NGOC BICH^{3*}

¹Interdisciplinary Graduate Program in Veterinary Therapeutics and Pathology, Faculty of Veterinary Medicine, College of Agriculture, Can Tho University, Can Tho, Vietnam; ²Tien Giang Sub-Department of Animal Health, Ministry of Agriculture and Rural Development, My Tho, Tien Giang, Vietnam; ³Faculty of Veterinary Medicine, College of Agriculture, Can Tho University, Ninh Kieu, Can Tho, Vietnam.

Abstract | Lumpy skin disease (LSD) is a significant viral disease affecting cattle. Transmitted primarily by arthropod vectors, LSD has substantial economic impacts. LSD has become a major issue in Vietnam, with the first occurrence recorded in October 2020 in Lang Son province. In 2021, there were outbreaks of LSD in many regions, with Tien Giang province being the most severely affected. This research aims to analyze the epidemiological features of LSD, determine possible sources and related risk factors for an epidemic of LSD in Tien Giang. In 2023, the morbidity rate was 42.55% (20/47), and the death rate was 6.38% (3/47), leading to a case fatality rate of 15.0% (3/20). The primary clinical manifestations were cutaneous lesions, dyspnea, and lameness. The most impacted group was cattle under six months old. The investigation found indicators associated with disease outbreaks, including clinical symptoms in nearby farms, unvaccinated animals, and the absence of vector control measures. Given the significant economic repercussions caused by LSD, it is crucial to establish and enforce efficient control and prevention measures. These measures include animal movement regulation and isolation, adherence to biosecurity procedures during neighboring disease outbreaks, and focused immunization of vulnerable populations to halt disease transmission.

Keywords | Lumpy skin disease, Clinical signs, Epidemiological, Tien giang province, Vietnam, 2023

Received | February 24, 2025; **Accepted** | May 11, 2025; **Published** | June 18, 2025

***Correspondence** | Tran Ngoc Bich, Faculty of Veterinary Medicine, College of Agriculture, Can Tho University, Ninh Kieu, Can Tho, Vietnam; **Email:** tnbich@ctu.edu.vn

Citation | Huyen VTK, Hieu TQ, Bich TN (2025). Epidemiological analysis of lumpy skin disease outbreaks in tien giang province, Vietnam (2023): Risk factors and clinical manifestations. Adv. Anim. Vet. Sci. 13(7): 1525-1531.

DOI | <https://dx.doi.org/10.17582/journal.aavs/2025/13.7.1525.1531>

ISSN (Online) | 2307-8316; **ISSN (Print)** | 2309-3331



Copyright: 2025 by the authors. Licensee ResearchersLinks Ltd, England, UK.

This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

INTRODUCTION

Lumpy skin disease (LSD), caused by the lumpy skin disease virus (LSDV), a member of the *Poxviridae* family and *Capripoxvirus* genus, is a significant viral disease affecting cattle. Although phylogenetically distinct,

LSDV cross-reacts serologically with sheep and goat pox strains within the same genus (Tuppurainen *et al.*, 2017). LSDV is non-zoonotic and primarily transmitted by arthropod vectors such as mosquitoes, flies, and ticks; direct contact transmission is ineffective (Magori-Cohen *et al.*, 2012). Clinical manifestations include fever, nodular skin

lesions, lesions on the mucous membranes of the respiratory and digestive tracts, enlarged subscapular and precrucial lymph nodes, lameness, a sharp decrease in milk production in lactating animals, lacrimation, nasal discharge, and salivation (Datten *et al.*, 2023; Tuppurainen *et al.*, 2017). The incubation period typically ranges from 4 to 14 days, but can extend to 28 days (Li *et al.*, 2022). Morbidity rates vary from 2% to 45%, with mortality generally around 10% (Tuppurainen *et al.*, 2017).

LSD causes substantial economic losses due to decreased production, reduced hide quality, delayed growth, infertility, and mortality. Consequently, the World Organization for Animal Health has classified LSD as a notifiable transboundary disease. The impact on the international trade of cattle and animal products and the costly control and eradication measures pose significant economic consequences for affected countries (Tuppurainen *et al.*, 2017). First identified in Zambia in 1929, caused by the Neethling strain of *Capripoxvirus*, LSD has historically been prevalent in Africa and the Middle East. Recombinant LSDV lineages from these regions have since spread to China, Mongolia, Vietnam, Cambodia, Laos, Thailand, Malaysia, and Indonesia (Li *et al.*, 2023). In Vietnam, the first LSD case was reported in Lang Son province in October 2020. Since then, the disease has been reported in 55 of 63 provinces and cities, 457 districts, and 4,280 communes. From January to May 2024, 68 outbreaks occurred in 10 provinces, resulting in 404 diseased cattle and 93 buffaloes being culled, marking a 9.67% increase compared to 2023 (DAH, 2024). The initial LSD outbreak in Tien Giang province emerged in August 2021 in Cho Gao district and rapidly spread, affecting 10 out of 11 districts by December of that year. In 2022, the province recorded 16 outbreaks across 6 of its 11 districts. LSD, a newly introduced disease in Vietnam, has persisted for three years with recurrent outbreaks. The abundance of disease vectors and the subtropical climate in the Mekong Delta region may contribute to the ongoing transmission of LSD. Epidemiological understanding of LSD in Tien Giang province is limited due to the lack of comprehensive investigations into numerous outbreaks. This study aims to address this gap by investigating the ongoing LSD outbreak in Tien Giang province, elucidating its epidemiological characteristics, identifying potential sources of LSD introduction, and assessing associated risk factors.

MATERIALS AND METHODS

SAMPLE COLLECTION AND PRESERVATION METHODS

To assess the prevalence and distribution of LSDV in cattle in Tien Giang province, sampling was conducted from January 2023 to December 2023, using a retrospective cross-sectional design. Data on LSD outbreaks, clinical cases, and mortality will be obtained from official veteri-

nary reports and interviews with farm owners. Cattle farm selection for sampling will be entirely randomized. Nasal swabs will be collected following QCVN 01-83:2011 and TCCS 04:2020/TY-DT (MARD, 2020) guidelines, with three swabs taken from each cattle farm and combined to form a representative sample for the farm. These swab samples will be collected along with epidemiological information on risk factors, including herd size, animal introduction, vector control, signs of disease in neighboring farms, grazing practices, and vaccination status, which will be gathered via a questionnaire.

The collected swab samples will be preserved in a 10% glycerol solution, labeled, and stored in a cold box at temperatures between 2°C and 8°C. They will then be transported to the laboratory of the Faculty of Veterinary Medicine at Can Tho University for diagnostic monitoring and detection of LSDV using PCR methodology.

PCR METHODOLOGY

Nasal swab samples were transported to the laboratory under chilled conditions and prepared as a 20% suspension in PBS. The suspensions were centrifuged at 3,500 rpm for 10 minutes, and the supernatant was collected for DNA extraction. Viral DNA was extracted using the TopPURE® RNA/DNA Viral Extraction Kit (ABT, Vietnam) according to the manufacturer's protocol. Detection of LSDV was performed using a conventional PCR assay targeting the P32 gene, following the OIE guidelines (OIE, 2017). The primers used were: forward 5'-TTTCCTGAT-TTTTCTTACTAT-3' and reverse 5'-AAATTATAT-ACGTAAATAAC-3', which amplified a 192 bp fragment specific to LSDV. PCR amplification was carried out in a 25 µL reaction mixture containing 12 µL of GoTaq® DNA Polymerase Master Mix (Promega, USA), 1 µL of each primer (10 µM), 8 µL of nuclease-free water, and 3 µL of extracted DNA template. The thermal cycling conditions were as follows: initial denaturation at 94°C for 5 minutes, followed by 35 cycles of denaturation at 94°C for 60 seconds, annealing at 50°C for 30 seconds, and extension at 72°C for 60 seconds, with a final extension step at 72°C for 5 minutes. PCR products were separated by 1.5% agarose gel electrophoresis, stained with ethidium bromide, and visualised under UV light using a BIO-Rad transilluminator. To ensure assay validity, positive and negative controls were included in each PCR run. The positive control contained LSDV DNA from a confirmed case, and the negative control contained nuclease-free water to detect any contamination. Only results validated by appropriate control reactions were considered for interpretation.

DATA ANALYSIS

Epidemiological data were collected through structured questionnaires administered to cattle farm owners. The collected data were entered into Microsoft Excel 2016 for

coding and initial management. Morbidity, mortality, and case fatality rates were calculated based on reported clinical cases. Temporal trends of the outbreak were visualized using epidemic curves, while the spatial distribution of LSD cases was mapped using QGIS version 3.22.5.

Risk factor variables were selected based on previous literature and expert consultation, including the introduction of new animals, grazing practices, vaccination status, clinical signs observed in neighboring farms, and the implementation of vector control measures. Univariable logistic regression was initially performed using Minitab version 2021 and WinEpi (<http://www.winepi.net>) to estimate crude odds ratios (OR) and 95% confidence intervals (CI). A cutoff value of p-value ≤ 0.2 was employed to select variables for inclusion in multivariable analysis. Multivariable logistic regression was performed in R (version 4.3.0) using the `glm()` function (binomial family) to assess independent risk factors for LSD. Adjusted odds ratios (AOR), 95% confidence intervals, and p-values were calculated. Model refinement was done via backward stepwise elimination based on the Wald test. Model fit and multicollinearity were evaluated using the Hosmer–Lemeshow test (ResourceSelection package) and Variance Inflation Factor (car package), respectively. A p-value < 0.05 was considered statistically significant.

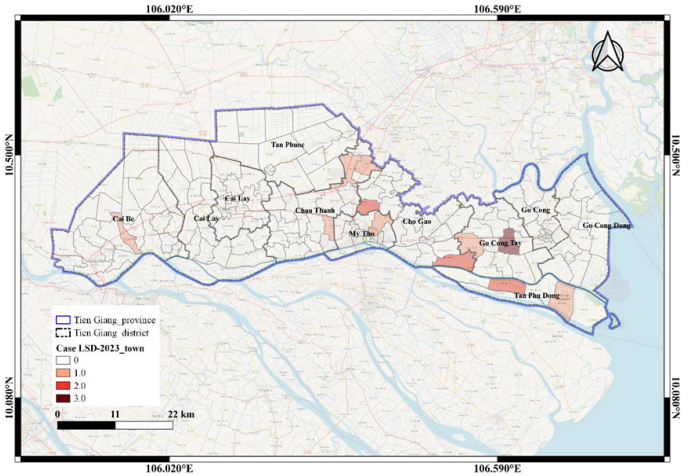


Figure 1: Geographic distribution of LSD outbreaks in cattle, Tien Giang province, Vietnam.

RESULTS AND DISCUSSION

CURRENT SITUATION OF LSD IN CATTLE

A total of 110 farms were examined to investigate LSD outbreaks in Tien Giang province. Among them, 20 farms experienced incidents of LSD between January 1, 2023, and December 31, 2023. Figure 1 depicts the geographic spread of the index farm and the farms impacted by LSD. The first instance of LSD in the region was detected in the Go Cong Tay district on January 12, 2023. Furthermore, Table 1 presents comprehensive data on the total number

of cases, morbidity rates, and death rates of LSD in the districts of Tien Giang province.

Table 1: Summary of LSD outbreak distribution across districts in Tien Giang province.

Admin- istrative unit	Farms	Num- ber of sick farms	Num- ber of ani- mals	Num- ber of sick animals	Num- ber of dead animals	Mor- bidity (%)	Mor- tality (%)
Cai Be district	10	1	5	1	0	20.00	0
Cai Lay district	10	0	0	0	0	0.00	0
Chau Thanh district	10	3	8	4	0	50.00	0
Cho Gao district	10	5	10	7	0	70.00	0
Go Cong Dong district	10	0	0	0	0	0.00	0
Go Cong Tay district	10	3	6	4	1	66.67	16.67
Tan Phu Dong district	10	2	11	3	1	27.27	9.09
Tan Phuoc district	10	0	0	0	0	0.00	0.00
My Tho city	10	1	7	1	1	14.29	14.29
Cai Lay commune	10	0	0	0	0	0.00	0.00
Go Cong commune	10	0	0	0	0	0.00	0.00
Total	110	15	47	20	3	42.55	6.38

In this study, the overall morbidity of the disease was 42.5%, the mortality was 6.38%, and the case fatality was 15.0% (3/20 cases). The highest morbidity rates were observed in the districts of Cho Gao, Go Cong Tay, and Tan Phu Dong, which were higher than the findings of Huyen et al. (2023) in Tien Giang province in 2022, where the morbidity and mortality of LSD were observed to be 32.34% and 4.25%, respectively. In a study conducted by Cuong et al. (2022) in Tra Vinh and Dong Thap provinces, the morbidity and mortality rates of LSD were found to be 40.16% and 9.11%, respectively. Arjkumpa et al. (2024) conducted a study in Thailand and found that the morbidity rate of LSD was 34.57% and the mortality rate was 3.47%. Orynbayev et al. (2021) conducted a study in Kazakhstan and documented a morbidity rate of 12.9%. This variance is due to different geographical regions and periods of the studies. Countries with lower illness rates have had the disease for

longer, allowing cattle to develop more robust defenses. In contrast, Tien Giang province has seen the morbidity rates emerge only in the last two years, resulting in higher infection rates due to the lack of immunity. Additionally, epidemics cause panic among cattle producers, limiting their ability to identify and contain the disease effectively.

As of December 2023, [Figure 1](#) shows that 11 out of 156 communes (7.05%) in 6 out of 11 districts/cities in Tien Giang province reported families with livestock infected by LSD. This marks an increase from 2022, when 10 communes (6.41%) were affected across 9 districts/cities. The districts of Cho Gao, Go Cong Tay, Tan Phu Dong, and Chau Thanh are particularly impacted, with the highest number of communes reporting LSD cases. Specifically, 15.79% of communes in Cho Gao, 23.07% in Go Cong Tay, 33.33% in Tan Phu Dong, and 15.00% in Chau Thanh reported cases. There has been an increase in outbreaks in Cho Gao (2 out of 19 communes), Go Cong Tay (2 out of 13 communes), Tan Phu Dong (2 out of 6 communes), and Chau Thanh (0 out of 20 communes) compared to 2022. The number of cases in Cho Gao is 7, Go Cong Tay has 4, Tan Phu Dong has 3, and Chau Thanh has 4. In other districts, just one commune per district reported an LSD epidemic. The rise in cases compared to 2022 may be due to neglecting the revaccination of herds. Infected cattle are mainly under six months old and lack defensive antibodies. Vaccination, as recommended by the Vietnam Department of Animal Health [MARD \(2020\)](#) and [OIE \(2017\)](#), is crucial. Enhancing the knowledge and awareness of livestock producers about vaccination and implementing biosecurity protocols in animal agriculture is essential.

transmit infections. These vectors are essential in transmitting the illness across vast distances from locations with cases to surrounding regions.

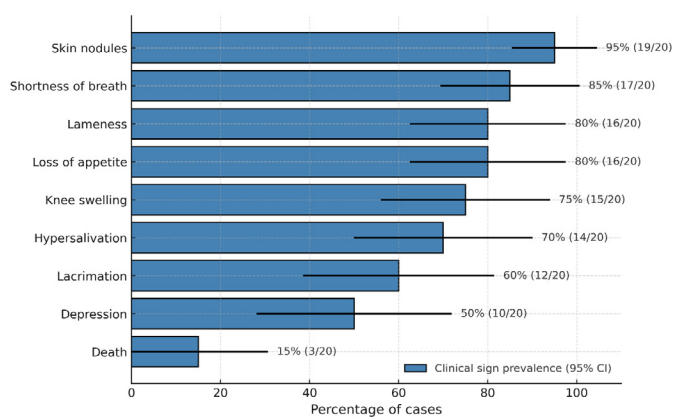


Figure 3: Percentage and frequency of clinical signs observed in cattle with LSD (n = 20), with 95% confidence intervals.



Figure 4: Clinical signs of nodular dermatitis in LSD-infected cattle. (A) and (B) Many nodules appear on the body, especially on the head and feet.

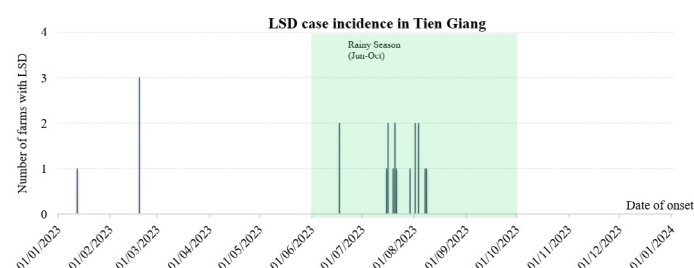


Figure 2: Epidemic curve of LSD outbreaks in cattle farms in Tien Giang Province, showing case incidence over time.

[Figure 2](#) depicts a clustering of cases from June to August 2023, corresponding to the data documented by the Sub-Department of Animal Health Tien Giang in 2021 and 2022. This phenomenon might be due to the persistent occurrence of previous epidemics and the increased prevalence of disease-carrying vectors during the rainy season in the Mekong Delta. The research done by [Gupta et al. \(2020\)](#) and [Tuppurainen et al. \(2017\)](#) has emphasised that the primary cause of the development of LSD is the movement of cattle. This transmission happens by mechanical vectors, such as flies, mosquitoes, and ticks, which carry and

CLINICAL SIGNS IN CASE FARMS

Survey results from 20 clinically confirmed LSD cases in cattle in Tien Giang Province revealed consistent patterns of symptom expression. As shown in [Figure 3](#), fever was the most frequently observed clinical sign, occurring in 95% of affected animals, followed by the presence of cutaneous nodules, which varied in number and distribution depending on disease severity. In more severe cases, cattle exhibited both high fever (ranging from 40.0°C to 41.5°C) and extensive nodular dermatitis. [Figure 4](#) provides photographic documentation of these hallmark skin lesions, with [Figures 4A](#) and [4B](#) depicting multiple raised nodules predominantly located on the head, limbs, and body, typical of advanced-stage LSD. These findings are consistent with previous descriptions of LSD symptomatology and confirm the disease's characteristic febrile and dermatological manifestations. According to [Abutarbush et al. \(2015\)](#), lesions may peel off, potentially leaving a thickened area of the entire skin, with characteristic necrotic lesions forming inverted cone-shaped ulcers known as "sit fast" [Sprygin et al. \(2019\)](#) report that in severe cases, cattle may experience

persistent high fever, severe debilitation, poor appetite, and the appearance of one or several hundred nodules, which are often of similar size on the same animal. Symptoms also include respiratory distress, shortness of breath in 85.0% of cases, and lameness, affecting 80.0% of cattle, which are common in LSD infections. Swelling and edema can be observed in the chest, face, and one or more limbs, making movement difficult for the animals (Jameel, 2016). Additionally, symptoms such as loss of appetite, knee swelling, hypersalivation, lacrimation, and depression have also been noted in LSD cases in Tien Giang. These clinical signs are characteristic of the disease and can be used to differentiate LSD from other infectious diseases.

Table 2: Univariable logistic regression analysis of potential risk factors associated with LSD occurrence in cattle farms.

Variables	Category	Cases	Non-cases	Morbidity rate (%)	OR (95% CI)	p-values
Herd size	<5	12	55	17.91	2.91	0.103*
	>5	3	40	6.98	0.80-10.56	
Introduced new animals	Yes	2	15	11.76	0.77	0.746
	No	13	75	14.77	0.16-3.78	
Use of vector control	No	5	9	35.71	4.78	0.010*
	Yes	10	85	10.53	1.45-15.79	
Symptoms in neighboring farms	Yes	6	9	40.00	6.37	0.001*
	No	9	86	9.47	2.04-19.89	
Grazing	Communal	2	8	20.00	1.67	0.539
	Zero-grazing	13	87	13.00	0.32-8.69	
Vaccine	No	9	15	37.50	8.00	0.001*
	Yes	6	80	6.98	2.76-23.15	

*Represents the values considered for further analysis; CI-confidence interval; OR-odds ratio.

PROBABLE RISK FACTORS

Results from the 2023 risk factor analysis (Table 2) identified three variables significantly associated with increased morbidity due to LSD in cattle farms in Tien Giang province: lack of vaccination (OR = 8.00; 95% CI: 2.76–23.15; $p = 0.001$), absence of vector control measures (OR = 4.78; 95% CI: 1.45–15.79; $p = 0.010$), and the presence of clinical symptoms in neighboring farms (OR = 6.37; 95% CI: 2.04–19.89; $p = 0.001$). These findings indicate that the most influential contributors to LSD outbreaks were poor vector management, regional transmission pressure from adjacent farms, and failure to implement immunization

strategies. In contrast, factors such as introduction of new animals (OR = 0.77; $p = 0.746$) and communal grazing (OR = 1.67; $p = 0.539$) did not demonstrate statistically significant associations in the univariable analysis and were excluded from the multivariable model. Their lack of significance may reflect confounding with more proximal determinants, such as vaccination coverage or farm-level biosecurity practices. Notably, these results are consistent with findings by Magori-Cohen *et al.* (2012) and Paslaru *et al.* (2021), who highlighted that while direct animal contact contributes minimally to LSDV spread, mechanical transmission via biting arthropods—including mosquitoes, tabanid flies, houseflies, and ticks—remains the primary pathway for disease dissemination.

Entomological surveys conducted during the 2023 outbreak confirmed the widespread presence of these vector species on nearly all affected farms. This aligns with Gupta *et al.* (2020), who emphasized the dual importance of low immunological protection and high arthropod vector abundance as key determinants of LSD risk. Despite the known efficacy of vector control strategies, such as insecticide application, larval habitat elimination, and physical barriers (e.g., insect netting), implementation in smallholder systems remains inconsistent. Common barriers include limited access to insecticides, inadequate farmer knowledge, and logistical challenges in applying treatments during the rainy season, when vector populations typically peak and cattle are more exposed due to muddy, flood-prone grazing areas. Additionally, Kiplagat *et al.* (2020) underscored the role of vector-borne and movement-related transmission in non-migratory herds in Kenya, while Şevik and Doğan (2017) observed increased LSD incidence following livestock movement during festive periods. Although Sprygin *et al.* (2019) proposed that *Musca domestica* (housefly) may be involved in LSDV transmission, this hypothesis remains to be clinically validated.

Table 3: Multivariable logistic regression analysis identifying significant risk factors independently associated with LSD outbreaks.

Variable	Adjusted OR (95% CI)	p-value
Lack of vaccination	6.21 (2.01–19.19)	0.002*
No vector control	3.45 (1.12–10.66)	0.030*
Symptoms in neighboring farms	5.13 (1.72–15.32)	0.004*
Herd size (>5)	1.43 (0.42–4.91)	0.565

*Represents statistically significant value; CI-confidence interval; OR-odds ratio.

Multivariable logistic regression analysis revealed three statistically significant risk factors associated with the occurrence of LSD in cattle in Tien Giang province in 2023 (Table 3): lack of vaccination (OR = 6.21; 95% CI: 2.01–

19.19; $p = 0.002$), absence of vector control measures ($OR = 3.45$; 95% CI: 1.12–10.66; $p = 0.030$), and the presence of clinical signs in neighboring farms ($OR = 5.13$; 95% CI: 1.72–15.32; $p = 0.004$). These findings reaffirm the critical role of active immunization and vector management in controlling LSD outbreaks. They are consistent with previous studies by Kiplagat *et al.* (2020), Arjkumpa *et al.* (2024) and Gupta *et al.* (2020), which also identified low vaccination coverage, high vector density, and proximity to infected herds as major contributing factors in LSD transmission. Conversely, other variables such as herd size, grazing system, and the introduction of new animals were not statistically significant in the multivariable model ($p > 0.05$), suggesting their effects may be negligible or overshadowed by stronger risk factors. This outcome reflects the small-holder and dispersed nature of cattle farming in the Mekong Delta, where herd mobility is limited and commercial animal movement is infrequent. These findings provide evidence-based recommendations for targeted interventions, including increasing vaccination coverage to exceed 80%, implementing seasonal vector control strategies, and strengthening surveillance around outbreak-prone areas to prevent viral dissemination within cattle populations.

Lumpy skin disease imposes a significant economic burden on cattle farms, highlighting the need for effective control and prevention measures. Our study has identified key risk factors for LSD outbreaks, including the presence of symptoms in neighboring farms and non-vaccination. To manage disease spread, it is crucial to prevent infected animals from entering uninfected areas and to control the vectors responsible for LSD transmission. Regulating the movement of affected animals and maintaining their purchase and sale during outbreaks is essential. Local authorities, acknowledging the disease's economic impact, should enforce strict oversight. In Tien Giang, internal quarantine checkpoints are vital for managing livestock movement from affected zones, and a mandatory 21-day quarantine for suspected animals is enforced. Early disease detection is critical for the timely implementation of control measures. Efficient laboratory surveillance in high-risk districts and stringent biosecurity measures are necessary to prevent disease spread. Educating farmers, students, and local technicians about biosecurity protocols and the risks of neglect is essential. Vector control strategies should be based on vector biology, including reducing mosquito breeding sites, using larvicides, applying insecticides, and implementing farm netting. Community education on vector biology, disease transmission, and prevention is also essential. Maintaining farm cleanliness and regular disinfection are crucial for disease prevention. Vaccination coverage of over 80% in susceptible populations is needed to curb further disease spread.

CONCLUSIONS AND RECOMMENDATIONS

The study found an overall morbidity rate of 42.5%, a mortality rate of 6.38%, and a case fatality rate of 15.0%. Morbidity was highest in Cho Gao, Go Cong Tay, and Tan Phu Dong districts. The rise in cases is attributed to inadequate vaccination and vector control. Effective management requires preventing infected cattle from entering uninfected areas, regulating animal movement, and controlling vectors. Enhanced vaccination coverage, stringent biosecurity measures, and early disease detection are crucial. Education on biosecurity, vector control, and maintaining farm cleanliness is essential to mitigate the disease's impact and prevent further spread.

ACKNOWLEDGEMENTS

The authors thank the technical staff of Tien Giang Sub-Department of Animal Health and staff from the Faculty of Veterinary Medicine, College of Agriculture, Can Tho University, who helped with the sample collection and analysis. We would also like to acknowledge the cattle farmers of the area for their valuable cooperation.

AUTHOR'S CONTRIBUTIONS

This research was conducted with the contributions of all the authors. The authors all participated in the study design, analysing the results, interpreting the results, and preparing the manuscript. All authors read and approved the final manuscript.

FUNDING

This study was funded by the Tien Giang Department of Science and Technology under Project Code No. 2096/QD-UBND, dated September 14, 2023.

ETHICS STATEMENT

All procedures involving animals in this study were conducted in accordance with national and institutional guidelines for the care and use of animals, specifically the Ministry of Agriculture and Rural Development's Facility Standards (MARD, 2020; TCCS 04:2020/TY-DT, issued October 30, 2020). The study was performed on naturally infected cattle, with no experimental interventions administered. Samples were collected solely for diagnostic and surveillance purposes. Written informed consent was obtained from all cattle owners prior to sample collection. The study protocol was approved by Can Tho University's Animal Ethics Committee, under Document No. 1368/HD-SKH&CN, dated September 19, 2023.

REFERENCES

- Abutarbush S, Ababneh M, Al Zoubi I, Al Sheyab O, Al Zoubi M, Aleksh M, Al Gharabat R (2015). Lumpy Skin Disease in Jordan: Disease Emergence, Clinical Signs, Complications and Preliminary-associated Economic Losses. *Transboundary Emerg. Dis.*, 62(5): 549-554. <https://doi.org/10.1111/tbed.12177>
- Arjkumpa O, Wachoom W, Puyati B, Jindajang S, Suwannaboon M, Premasathira S, Prarakamawongsa T, Dejyong T, Sansamur C, Salvador R (2024). Analysis of factors associated with the first lumpy skin disease outbreaks in naïve cattle herds in different regions of Thailand. *Front. Vet. Sci.*, 11: 1338713. <https://doi.org/10.3389/fvets.2024.1338713>
- Cuong QN, Tien NT, Khai LTL (2022). Lumpy skin disease in cattle in Tra Vinh and Dong Thap provinces. *Vietnamese J. Vet. Sci. Technol.*, 29(07): 25-34. <https://vjol.info.vn/index.php/kk-ty/article/download/86713/73746>
- DAH (2024). Report on the epidemic situation of papular dermatitis November 6, 2024. Ha Noi, Vietnam. Department of Animal Health.
- Datten B, Chaudhary AA, Sharma S, Singh L, Rawat KD, Ashraf MS, Alneghery LM, Aladwani MO, Rudayni HA, Dayal D (2023). An extensive examination of the warning signs, symptoms, diagnosis, available therapies, and prognosis for lumpy skin disease. *Viruses*, 15(3): 604. <https://doi.org/10.3390/v15030604>
- Gupta T, Patial V, Bali D, Angaria S, Sharma M, Chahota R (2020). A review: Lumpy skin disease and its emergence in India. *Vet. Res. Commun.*, 44: 111-118. <https://doi.org/10.1007/s11259-020-09780-1>
- Huyen TKV, Hieu HT, Trinh TTB, Bich TN, Thai QN, Trung VN, Chien TPN, Tham TD, Thanh VN, Hieu VT, Ut D (2023). Study on the epidemiology of lumpy skin disease in Tien Giang province. *Vietnamese J. Vet. Sci. Technol.*, 30(03): 44-49. https://qldiem.ctu.edu.vn/ql/docgia/tapchitrongnuoc-2023/baibao-85601.html?page_current=4
- Jameel GH (2016). Determination of complications decrease the risk factor in Cattle infected by lumpy skin disease virus in diyala province, Iraq. *Int. J. Micro Biol. Genet. Monocular Biol. Res.*, 2: 1-9. <https://www.researchgate.net/profile/Ghassan-Jameel/publication/298213968>
- Kiplagat SK, Kitale PM, Onono JO, Beard PM, Lyons NA (2020). Risk factors for outbreaks of lumpy skin disease and the economic impact in cattle farms of Nakuru County, Kenya. *Front. Vet. Sci.*, 7: 259. <https://doi.org/10.3389/fvets.2020.00259>
- Li L, Qi C, Li J, Nan W, Wang Y, Chang X, Chi T, Gong M, Ha D, De J (2022). Quantitative real-time PCR detection and analysis of a lumpy skin disease outbreak in Inner Mongolia Autonomous Region, China. *Front. Vet. Sci.*, 9: 936581. <https://doi.org/10.3389/fvets.2022.936581>
- Li Y, An Q, Sun Z, Gao X, Wang H (2023). Risk factors and spatiotemporal distribution of lumpy skin disease occurrence in the Asian continent during 2012–2022: an ecological niche model. *Transboundary Emerg. Dis.*, 2023(1): 6207149. <https://doi.org/10.1155/2023/6207149>
- Magori-Cohen R, Louzoun Y, Herziger Y, Oron E, Arazi A, Tuppurainen E, Shpigel NY, Klement, E (2012). Mathematical modelling and evaluation of the different routes of transmission of lumpy skin disease virus. *Vet. Res.*, 43: 1-13. <https://doi.org/10.1186/1297-9716-43-1>
- MARD (2020). Facility standards (TCCS 04: 2020/TY-DT): including testing procedures to detect viruses that cause Lumpy Skin Disease. Ha Noi, Vietnam. Ministry of Agriculture and Rural Development.
- OIE (2017). Chapter 2.4.13. Lumpy skin disease OIE Terrestrial Manual 2017. https://www.oie.int/fileadmin/home/eng/health_standards/tahm/2.04.14_1sd.pdf
- Orynbayev MB, Nissanova RK, Khairullin BM, Issimov A, Zakarya KD, Sultankulova KT, Kutumbetov LB, Tulendibayev AB, Myrzakhmetova BS, Burashev ED (2021). Lumpy skin disease in Kazakhstan. *Trop. Anim. Health Prod.*, 53: 1-7. <https://doi.org/10.1007/s11250-021-02613-6>
- Paslaru AI, Verhulst NO, Maurer LM, Brendle A, Pauli N, Vögtlin A, Renzullo S, Ruedin Y, Hoffmann B, Torgerson PR (2021). Potential mechanical transmission of Lumpy skin disease virus (LSDV) by the stable fly (*Stomoxys calcitrans*) through regurgitation and defecation. *Curr. Res. Insect Sci.*, 1: 100007. <https://doi.org/10.1016/j.cris.2020.100007>
- Şevik M, Doğan M (2017). Epidemiological and molecular studies on lumpy skin disease outbreaks in Turkey during 2014–2015. *Transboundary Emerg. Dis.*, 64(4): 1268-1279. <https://doi.org/10.1111/tbed.12501>
- Sprygin A, Pestova Y, Wallace D, Tuppurainen E, Kononov A (2019). Transmission of lumpy skin disease virus: A short review. *Virus Res.*, 269: 197637. <https://doi.org/10.1016/j.virusres.2019.05.015>
- Tuppurainen E, Alexandrov T, Beltrán-Alcrudo D (2017). Lumpy skin disease field manual – A manual for veterinarians. FAO Animal Production and Health Manual No. 20. Rome. Food Agric. Organ. United Nations (FAO). <https://openknowledge.fao.org/handle/20.500.14283/i7330en>