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ORIGINAL ARTICLE

Lumpy Skin Disease: A review of epidemiological study and preventive measures

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Abstract

Background: Lumpy skin disease (LSD) is a highly infectious and economically important transboundary disease that is rapidly spreading to the globe. The disease causes high morbidity and a low mortality rate of infection. The animals show acute or chronic illnesses depending on the immune responses of the hosts. The economic burden of LSD manifested the poor-quality hides, a drop in milk and meat production, abortion, and death.

Methods: This systematic literature review was accomplished according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines**.** The literature on lumpy skin disease has been explored over the last two decades and searched keywords on online databases such as Google Scholar, PubMed, and Scopus. Both automated and manual searching tools were used to screen the articles. The literature published other than English was rejected during the screening process. Conference papers were excluded during the screening.

Results: LSD is transmitted by blood-sucking arthropods and is most prevalent in summer and rainy seasons. Exotic-bred cattle and calves are highly susceptible. Although the disease has low mortality, the high mortality of the disease prevails in endemic regions in complicated cases. Calves from unvaccinated cows should be vaccinated at any age, on the other hand, the calves from vaccinated cows should be immunized at 3 months of age. Animals should be vaccinated before the risk period. Strict biosecurity, quarantine, and immunoprophylaxis can reduce the prevalence of the disease.

Conclusions: Lumpy skin disease (LSD) is an acute infectious and contagious disease affecting cattle and water buffaloes. The disease causes serious economic loss due to decreased production, skin problems, and mortality in complicated cases. Further details on genetic characterization, transmission dynamics, and host-pathogen interaction should be performed to prevent the prevalence of the disease in emerging or re-emerging countries.

Keywords: Transboundary disease, Vector-borne, Biosecurity, Quarantine, Vaccination

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Introduction

Lumpy skin disease (LSD) is caused by Lumpy skin disease virus (LSDV), a virus in the family Poxviridae, genus Capripoxvirus such as sheeppox virus (SPPV) and goatpox virus (GTPV). The viruses are antigenically similar but phylogenetically different from each other. Infection of the virus mainly affects cattle (Bos spp.) and buffaloes (Bubalus spp.). The disease is also reported in other wild ruminant species, such as giraffes, bulls, and springboks (Das *et al*., 2021; Roche *et al*., 2021). The virus (arbovirus) is transmitted by blood-sucking arthropods including mosquitoes, ticks, lice, and flies (Beard, 2016). The virus can also transmitted to susceptible animals through direct or indirect contact (contaminants of the owner, vehicle, and equipment) (Tuppurainen *et al*., 2017a). The environmental risk factors such as hot humid weather, summer, rainy conditions, and low marshy land areas are most susceptible to infection (Mulatu and Feyisa, 2018). The characteristic clinical signs are high fever (40.0°C–41.5°C), lacrimation, nasal discharge, lymphadenopathy, anorexia, and weakness, followed by the development of nodular lesions in the skin and mucous membranes of the whole body (Ratyotha *et al*., 2022). Finally, nodular lesions become necrosed with other complications such as edematous swelling of the joint and brisket region (Akther *et al*., 2023). Infection with LSD causes high morbidity and low mortality depending on the immune response, strain, and age of the individual animal. The prevalence of the disease varies from 1%-2% to 80%-90% in a different endemic region (Ratyotha *et al*., 2022). The disease was first reported in Zambia in 1929, then gradually spread to other parts of Africa and became endemic in those areas for a long time(Al-Salihi and Hassan, 2015). Lumpy skin disease has recently been seen in Asia following outbreaks in Europe and the Middle East during 1988-1990. The disease first emerged in South Asia in 2019 and then spread to Southeast Asia in 2020 (Roche *et al*., 2021). In Southeast Asia, the strain responsible for the outbreak was caused by a Kenyan sheep-and-goatpox (KSGPO)-like vaccine strain. The parenteral strain of the KSGPO-like vaccine strain spread from Bangladesh, India, Nepal, Pakistan, Sri Lanka, Myanmar, and Afghanistan (Mazloum *et al*., 2023). Azam *et al*. reported that the overall attack rate (37.6%), mortality (2.8), and case fatality rate (7.5%) of the disease were reported in the north-western region of Bangladesh. They also reported that in the calves under ≤1 month of age were highly infected where the attack rate, mortality, and case fatality rate were 44.3%, 9.3%, and 21.3%, respectively (Azam *et al*., 2024). The morbidity(71.42%), mortality (7.14%), and case fatality rate (10%) of LSD were reported in Rajshahi, Bangladesh (Khan *et al*., 2024). In Ethiopia, morbidity (15.71%%), mortality (2.86%), and case fatality (18.8%) rates of LSD were reported in cattle (Tamire.,2022).

LSD is one of the most economically important diseases in Bangladesh. A study reported that the total estimated annual loss due to LSD in the Mymensingh and Gaibandha districts of Bangladesh was 7763.25 million BDT (91.33 million US $) (Chouhan *et al*., 2022). In addition, another study in Ethiopia showed that the total economic loss of an LSD outbreak at the herd level was USD 1176 (USD 489 in subsistence farms and USD 2735 in commercial farms) (Molla *et al*., 2017).

Large-scale immunization is the most effective tool to control the spread of lumpy skin disease in cattle and buffaloes. A study of a mass LSD vaccination campaign in Thailand showed that the incidence of the disease exhibited a reduction of 119% (Punyapornwithaya *et al*., 2024). A Goatpox virus-based vaccine was evaluated in Ethiopian cattle and observed that the vaccine provided good protection against LSD infection (Gari *et al*., 2015). The goat tissue-prepared vaccine (GTPV) shows effective results against LSD infection in Bangladesh and India (Kayesh *et al*., 2020). Strict quarantine, restriction of animal movement, isolation of affected animals, immunization with live attenuated vaccines, hygienic management, insect control, proper disposal of carcasses, etc. are the important strategies for the prevention of infection of LSD (Tuppurainen *et al*., 2017a). Sometimes infected animals should be isolated and appropriate wound dressing might effectively prevent fly infestation (Mulatu and Feyisa, 2018). Recently the outbreak of LSD is gradually increasing in non-infected areas. The scenario of the clinical manifestation of the disease is changing daily.

For this reason, this review will provide a detailed epidemiological study and new preventive strategies to control LSD infection in the world.

Epidemiology

Geographical distribution

Lumpy skin disease (LSD) was first identified in Zambia in 1929. The disease was then gradually reported to other parts of Africa (Modise *et al*., 2021). However, the infection of LSD outbreak outside of Sub-Saharan was first reported in Egypt followed by Israel (Ali *et al*., 2012; Tuppurainen and Oura, 2012). It has been reported that the disease has also been identified in Saudi Arabia, Lebanon, Jordan, Iraq, and Turkey (Al-Salihi and Hassan, 2015; Namazi and Khodakaram Tafti, 2021; Sameea Yousefi *et al*., 2017). After a couple of years, the disease spread to Russia, Azerbaijan, Greece, Kosovo, and Serbia (Calistri *et al*., 2019; Beard, 2016; Zeynalova *et al*., 2016). In 2020, LSD was seen as a major threat to cattle and buffaloes in the Asian continent (Pandey *et al*., 2022). The outbreak of LSD was reported in Bangladesh in July 2019 with great importance (Hasib *et al*., 2021; Parvin *et al*., 2022). Many countries have land borders in Southeast Asia. So, the disease can easily pass from infected regions to non-infected areas. Many outbreaks have been reported in Nepal, Sri Lanka, Bhutan, Vietnam, and Malaysia in 2020 (Gupta *et al*., 2020; Tuppurainen and Oura, 2012).

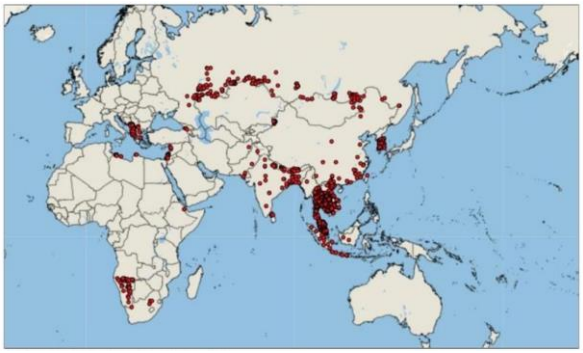

Figure 1. Map of a confirmed outbreak of LSD from 2016-2024

(https://www.tafsforum.org/news/tafs-update---lumpy-skin-disease-march-2024)

Morbidity, mortality, and case fatality

It has been reported that morbidity (63.33%), mortality (3.33%), and case fatality (5.26%) rates of LSD in Monirampur Upazila of Jashore district, Bangladesh (Biswas *et al*., 2020). Another study reported that morbidity and mortality of each outbreak were 6.6-100% and 0-16.7%, respectively (Sareyyüpoğlu *et al*., 2023; Wei *et al*., 2023). In addition, morbidity and mortality rates of LSD were reported as 8.7 % and 0.4%, respectively in Greece (Tasioudi *et al*., 2016). In Thailand, the overall morbidity and mortality rates were 40.5% and 1.2%, respectively (Vinitchaikul *et al*., 2023). The morbidity (11.68%), mortality (1.92%), and case fatality (16.44%) rates of LSD were detected in Ethiopia (Geletu *et al*., 2024). The variation in the severity of LSD might be due to the age, breed, and individual immune status of animals (Tuppurainen *et al*., 2017a). Young calves, exotic bred, and non-vaccinated cattle are most susceptible to infection (Akther *et al*., 2023; Azam *et al*., 2024; Punyapornwithaya *et al*., 2024).

Lumpy skin disease usually infects cattle, water buffaloes, and wild ruminants. The virus does not infect sheep and goats (Lamien *et al*., 2011). LSDV virus is transmitted by blood-sucking arthropods as the vector. The mouth parts of the vector help in mechanically transferring the infection without any replication (Sprygin *et al*., 2018). Some biting flies, mosquitoes, and ticks can carry the infection. In addition, houseflies, and tsetse flies may also transmit the infection (Akther *et al*., 2023). Direct contact with infected animals can also transmit infection. The affected animals can shed the virus through oral, nasal, and ocular discharges (Dubey *et al*., 2023). Sometimes shared waterer and feeder also transmit the LSDV infection to susceptible animals (Kayesh *et al*., 2020). The disease can also be transmitted iatrogenically by injecting needles during mass treatment in endemic or epidemic regions (Bianchini *et al*., 2023; Lefèvre *et al*., 2010). The LSD might be different from place to place due to climate scenarios, vector availability, season, or other geographical factors (Akther *et al*., 2023).

Host range

Cattle (*Bos indicus* and *Bos taurus*) and Asian Water buffaloes (*Bubalus bubalis*) are the most susceptible hosts. *Bos taurus* is comparatively more susceptible than indigenous cattle bred.

Wild animals are resistant to natural conditions and they act as natural reservoirs (Das *et al*., 2021). However, the role of wildlife in the epidemiology of LSD is not yet well-studied (Namazi and Khodakaram Tafti, 2021).

Table 1. Morbidity, mortality, and case fatality rate of LSD in different countries

Country	Morbidity, mortality, and case fatality of LSD	References
Bangladesh	Morbidity (63.33%), mortality (3.33%) and case fatality (5.26%)	(Biswas *et al*., 2020)
Thailand	Morbidity and mortality 0.5% and 1.2%, respectively	(Vinitchaikul *et al*., 2023)
Greece	Morbidity and mortality reported as 8.7 % and 0.4%, respectively	(Tasioudi *et al*., 2016)
Ethiopia	Morbidity (11.68%), mortality (1.92%), and case fatality (16.44%)	(Geletu *et al*., 2024)
Bangladesh	Morbidity (71.42%), mortality (7.14%), and case fatality (10%)	(Khan *et al*., 2024)
Bangladesh	Attack rate, mortality, and case fatality rate 44.3%, 9.3%, and 21.3%, respectively	(Azam *et al*., 2024)
India	Morbidity (5%-45%), mortality (1%-5%), and case fatality rate (2%-10%)	(Mathivanan *et al*., 2023)
Turkey	Morbidity (38.18%), mortality (3.64%), and case fatality rate (9.52%)	(Ince and Türk, 2019)
Bangladesh	Attack risk, mortality risk, and case fatality rate 26.5%, 0.26%, and 0.97%, respectively	(Uddin *et al*., 2022)

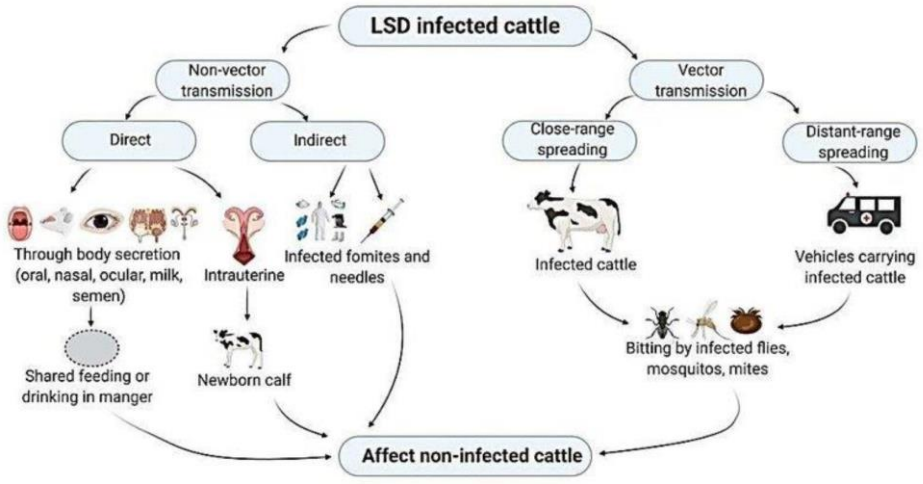

Figure 2. Transmission of Lumpy skin disease (Das *et al*., 2021)

In experimental infection, clinical lesions are produced in Giraffe (Giraffe camelopardalis) and impala (Aepyceros melampus), Arabian oryx (Oryx leucoryx), springbok (Antidorcas marsupialis), and oryx (Oryx gazelle) and Thomson's gazelle (Akther *et al*., 2023). Humans are also resistant to the virus by OIE, 2013. Animals of all ages are susceptible but calves are more infected and develop lesions within 24 to 48 h (Elhaig *et al*., 2017). Cross-bred cattle have thin skin which is more vulnerable to infection as compared with Indigenous cattle (Elhaig *et al*., 2017). Skin scratches in male zebu cattle which are used for draught purposes are more susceptible than in female cattle (Akther *et al*., 2023).

Virus stability

LSDV shows a cytoplasmic replication cycle and viral DNA synthesis starts within 1.5 to 6 hours of infection(Zewdie, 2021). The sources of infection of the virus are necrotic nodules, dried skin, and desiccated crust of the skin, and remain viable from 18 days to 35 days (Mulatu and Feyisa, 2018). The virus is so much more stable in adverse environmental conditions like dark animal sheds, freezing and thawing (Tamire, 2022).

Environment and management factor

The animals living in various agroclimatic zones are them to get infected with the LSD virus. (Gumbe, 2018). The incidence of LSD is very high in hot-humid climates as compared with the dry season (Gari *et al*., 2010). Proper management of inputs (feeder, waterer, and bedding materials), and movement of human vehicles prevent the entry of infection (Laurence *et al*., 2014). The climate change effect alters the abundance of biting flies, an important vector of LSD (Saqib *et al*., 2023). Moreover, the high temperature and humidity of tropical climate areas make a favorable environmental risk factor that increases the population of arthropod vectors (Eom *et al*., 2023). Control of LSD vectors in border areas can prevent exotic infection (Akther *et al*., 2023). Hygiene practices in farms are important for LSD distribution. A higher prevalence of LSD was reported in poorly managed farms (42.43%) compared to those with good (1.01%) and medium (25.26%) hygiene practices (Khan *et al*., 2024). The use of mosquito nets can protect against LSD infection in farms. However, most of the farmers in Bangladesh are not aware (91.17%) to use nets in their cattle barns at night (Haque *et al*., 2021). The animals sharing common grazing land and watering points may facilitate the transmission of the virus through arthropod vectors (Das *et al*., 2021). The entry of new animals needs proper quarantine to control the LSD infection in the herds (Gumbe, 2018). Regular monitoring of sick animals and proper disposal of animal waste should be necessary for the effective control of LSD infection (Choudhari *et al*., 2020).

Economic importance

The major economic importance are high morbidity rate with chronic debility of the infected animals. The control of the transboundary movement of animals is lacking in low-income countries which favor the transmission of disease (Bianchini *et al*., 2023). Proper immunoprophylaxis and eradication measures are difficult in poor countries compared with high-income countries (Tamire,2022). The disease causes a considerable reduction of milk yield (10-85%) due to high fiver and LSD-causing mastitis (Namazi and Khodakaram Tafti, 2021). The disease also damages the hides of the affected animals, decreases productivity, infertility and abortion in female cattle, vaccination, and treatment costs, and death of the affected animals (Alemayehu *et al*., 2013; Sadique *et al*., 2012). Sometimes infected or in-contact animals are slaughtered for eradication and control of the disease. For this reason, strict biosecurity measure is an economic burden on the livestock industry (Akther *et al*., 2023). Lumpy skin disease in developing countries causes devastating economic damage to small and medium-scale farmers. It has been estimated that total losses on the account of milk, meat, power of draft, treatment, and vaccination, in Ethiopia, were estimated to be 6.43 USD per head in local Zebu and 58 USD per head for Holstein Friesian (Gumbe, 2018). In addition, LSD approximately losses in the Gaibandha and Mymensingh districts of Bangladesh 31.37 and 59.7 million USD, respectively (Chouhan *et al*., 2022). A net economic loss due to the LSD outbreak in bovines in Punjab, a province of India is USD137.26

million, and USD 2217.26 million in the whole part of India (Singh *et al*., 2023). The total loss in both indigenous cattle and exotic cows ranges from 0.00 to 4,230,000 PKR (Pakistani Rupee) in Pakistan (Saqib *et al*., 2023).

Prevention and Control measures

The virus is stable in a favorable environment for a long period. So, it is difficult to clear the infection. For treatment purposes, effective therapeutic approaches have not been established. Anti-inflammatory drugs and antibiotics for secondary infection were generally used for treatment. For supportive treatment, zinc, vitamin B complex, and vitamin AD3E were effectively used (Anil and Durga, 2021; Islam *et al*., 2021). In case of early infection, quarantine of animals for at least 3-4 weeks can prevent the outbreak of infection (Calistri *et al*., 2018). Blood-sucking arthropods are the main vector that can rapidly spread infection. Destroying habitats, removing manure, and using disinfectant on the breeding ground can inhibit the growth of vectors in susceptible areas (Ratyotha *et al*., 2022). Moreover, culling the affected animals, movement restriction, and immunoprophylaxis are important control strategies for LSD outbreaks in susceptible areas (Beard, 2016; Tuppurainen *et al*., 2017b). Providing extension services to veterinarians and livestock workers would help them to early diagnosis and prevent the LSD outbreak or reduce the spread of infection (Beard, 2016). Monitoring sick animals and disposal of cattle shed waste and carcasses are effective tools for control measures of the disease (Choudhari *et al*., 2020). Coordinated efforts of local and central government, non-government, and industry efforts should be provided to the farmer (Akther *et al*., 2023). Importation of vaccines, milk, meat, and animal feed from LSD-endemic countries should be restricted (Şevik and Doğan, 2017). Introducing new animals in the herd should be vaccinated. Calves should be immunized at 3-4 months of age from mothers who were immunized or already infected. Proper legislation (monitoring, surveillance, stamping out, emergency vaccination) and risk assessment should be taken against the LSD outbreak in non-endemic countries (Eom *et al*., 2023). The Neethling vaccine strain of the Lumpy skin disease virus has been used successfully for many decades for immunization in ruminants (Matsiela *et al*., 2022). Cattle vaccinated with GTP (goat pox) vaccine (G20-LKV)showed full protection against the LSD infection (Zhugunissov *et al*., 2020). In Turkey, the simultaneous administration of Sheep pox and Goat pox (SGP) vaccine and Foot and mouth disease (FMD) vaccine provided adequate immune responses against LSD infection in cattle (Sareyyüpoğlu *et al*., 2023). The recombinant LSD-Rift Valley fever virus is highly immunogenic and shows protection against both lumpy skin disease and Rift Valley fever infection in cattle (Wallace *et al*., 2020).

Conclusions

Lumpy skin disease is an infectious disease in large ruminants (cattle and water buffaloes). The disease was first reported in Africa, then spread to the Middle East and Europe. In Asia, the disease first appeared in 2019. Calves and cross-bred cattle are highly susceptible. The tropical weather is most suitable for the growth and multiplication of the vector. Restriction of transboundary movement of the animals is the key element for the control of LSD infection. It is an economically important disease. Although LSD causes a low mortality rate, in complicated cases mortality gradually increases in endemic areas. The Neethling strain of LSD virus-derived vaccine is the most effective for immunoprophylaxis. Proper vaccination, risk assessment, hygienic management, and vector control in endemic areas can reduce the incidence of LSD infection. Further details on pathogenesis, diagnosis, and therapeutic management should be directed to check the LSD infection in endemic and non-endemic areas.

Conflict of interest

The author does not have any conflict of interest.

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