Introduction:

Lumpy skin disease (LSD) is one of the most serious poxvirus diseases of cattle caused by lumpy skin disease virus (LSDV) within the genus Capripoxvirus. The prototype strain is Neethling virus. It causes acute to sub-acute systemic disease characterized by mild to severe symptoms including fever, nodules on the skin, in the mucous membranes and in the internal organs, skin oedema, lymphadenitis and occasionally death [1, 2]. The skin nodules are painful and could involve tissues up to the musculature. Where extensive generalization occurs, animals may become lame and reluctant to move mainly because of severe oedema in the brisket and around the legs. Superficial lymph nodes draining affected areas of skin become enlarged, up to 4–10 times normal size. Abortion may occur as a result of prolonged fever [3, 4]. The diseasehas high economic costs due to production losses and chronic debilitation. Milk production ceases and permanent damage can occur to the hides [5, 6]. Laboratory diagnosis to confirm the disease can be made either through the isolation and identification of the virus, or by using serological tests such as the viru neutralization test and indirect fluorescent antibody test (IFAT) [4, 6, 7]. Under experimental infection the incubation period is 6–10 days. Clinically sick animals shed the virus through saliva, nasal and lachrymal discharges, blood and semen. Skin lesions have high viral concentration from days 7–18 post-infection. However, the virus can persist in skin plugs for about 42 days [8].

Morbidity and mortality of the disease vary considerably depending on the breed of cattle, the immunological status of the population, insect vectors involved in the transmission and isolates of the virus. In endemic areas morbidity is usually around 10% and mortality ranges between 1% and 3% [4, 9]. The most effective method of transmission is mechanically through biting flies [10–12]. The incidence of LSD occurrence is high during wet seasons when biting-fly populations are abundant and it decreases or ceases during the dry season [12]. LSD has been endemic in Africa for more than 70 years occurring in a wide range of ecotypes. The first outbreak in Egypt was reported in 1988 [5] but the disease has never reache northern African countries. Outside the African continent Israel has reported two outbreaks, the first in 1989 which was eliminated by the slaughter of all infected and contact animals [11], and the other more recently in 2006 [13].

Hathajari has the most abundant livestock population in Chattogram and the cattle population is estimated to be 10 thousand. Traditional cattle management in the rural part

of the region is extensive. Animals are free-ranging in communal grazing fields and different age groups are herded together. Natural grass, post-harvest crop residuals and straw are the main source of feed. Concentrate feeds and feed additives are seldom used. LSD was first observed in the part of Chattogram in 2019. It has now spread to almost all the regions and agroecological zones. Few epidemiological studies have been carried out since the disease has become established in Bangladesh, with limited scope in terms of the diverse agro-ecological and production systems.

METHODS

Administrative and agro-climate structure in Hathajari. The region's administrative structure encompasses 11 unions that include about 30 villages. Each village is composed of a different number of peasant associations. Hathajari's topography consists of a central high plateau bisected by the Chittagong University Valley into northern and southern highlands and surrounded by lowlands. The lowland areas are more extensive on the east and southeast of the country than on the south and west. The diverse topographic structure of the country forms the basis for several agro-climatic zones. The highlands range from 20 to 25 metres above sea level surrounded by a temperate transition zone. The daytime temperature in the lowlands varies from 20 degree Celcius to as high as 35 degree Celcius. The rainfall has two major seasons: a long rainy season that occurs between mid-June to mid-September representing around 75% of the annual rainfall and a short rainy season from mid- February to end of April. In general, relative humidity and rainfall decrease from south to north and are always merge in the eastern and south-eastern lowlands ranging from 50 to 300 mm per year. The agricultural production system is mainly a sedentary crop–livestock production system in midland and highland altitudes whereas in most lowland parts semi-pastoral and pastoral production systemsare dominant (herd-owners move their animals seasonally in search of feed and water, sometimes over long distances).

Data Collection:

A cross-sectional study based on the administration of questionnaires to 30 livestock-owners was conducted from April **2019 to July 2020 in** distributed in 30 villages which were selected from following unions [Chikondondi 1,2,3,4,5,6, Fatehpur 1,2,3,4,5,6,, Madarsha, Fatehabad, Mirjapur, Mirerkhil, Chipatoli, Mahmudabad etc. as illustrated on Table 1. The selection of the 30 livestocks-owners was performed using a multi-stage sampling strategy withfour hierarchical stages. Regions followed by village were purposively selected to include the main agroclimatic variations and different farming systems. At the third level, the selection from each village was based on geographical representation and accessibility in consultation with upazilla experts. The sample frame was obtained from respective upazilla livestock offices. Finally individual livestock owners and their respective herds were selected for interview based on willingness to participate in the study. The questionnaire was administered by me during face-to-face interviews with the farmers using the local language. In addition to the data produced from the questionnaires, data relating to LSD occurrence in the study area were obtained from upazilla livestock offices.

Questionnaire

The questionnaire was designed based on observation of the disease. 10 questions were structured under three main sections. The section on 'The history of LSD occurrence' included questions about year and month of LSD occurrence, **number, sex and age** of affected and/or animals that **had subsequently died**. The farmer's ability to identify LSD infection was cross-checked by enquiring about the **clinical signs** and **local name for LSD**. Sometimes the description of the disease was necessary in order to avoid confusion with other possible skin diseases such as dermatophilosis, demodecosis, and ringworm.

Respondents describing the occurrence of a case with a clinical sign of generalized skin nodules, fever, peripheral lymph nodes swelling and discharge from eyes, nostrils and mouth were tentatively diagnosed as LSD by me. Moreover, epidemiological records from Upazilla Livestock offices were consulted to verify the occurrence of LSD in the time and place specified by the respondents. Recorded

evidences of LSD occurrence both at upazilla and districts levels were fully based on clinical disease observation reports. The 'Herd management' section included questions herd size, vaccination, deworming, grazing/watering point. management, contact with sheep and goats and introduction of new animals. Under the section entitled 'Biting flies of cattle ', a question relating to the months during which the activity of biting flies was at its highest was recorded.

Data analysis

Data from the district disease outbreak report database and from Upazilla livestock office documentation were compared to assess whether these two sources agreed about the occurrence of LSD in the selected village. Data from both sources were the explored to investigate the disease distribution pattern in the district and LSD occurrence in the selected study village. Descriptive statistics of the studied variables were obtained. Herd-level and animal-level prevalence, as well as the frequencies associated with four binomial variables (farming system, grazing and watering point management, introduction of new animals, andcontact with sheep and goats) were estimated for each of the three agro-climate zones using back-transformed point estimates and confidence intervals from logistic regressions with agro-climate as a single explanatory variable. Statistical significance of the variation in agro-climate zones was assessed using homogeneity test for these prevalences and frequencies. Spearman rank correlation tests were used to assess

the temporal association between LSD occurrence and increase in the biting-fly population. For these correlation tests, the different months were considered as different statistical units. The number of respondents in each month for which the month was designated as a time when LSD occurred was considered as one variable. The other variable considered for the correlation test was the number of respondents for which this month was designated as a time when biting-fly density was increasing. One distinct test was performed for each type of agro-climatic zone. Analysis to identify the risk factors of LSD considered the following potential risk factors : agroecological category, type of farming system, type of grazing and watering point management, introduction of new animals, herd size, and contact with sheep and goats. The age composition of the population at risk (i.e. the herd) at the time when LSD infected the herd could not be obtained from the farmers because the farmer could not recall this quite complex piece of information. It is therefore difficult to assess whether or not age is a risk factor for LSD from these data. Each of these factors was first tested for its association with LSD occurrence at herd level by means of association test for categorical variables and Kruskal–Wallis rank test for count variable. The factors that turned out to be associated with LSD occurrence were shortlisted. All the factors shortlisted were included in a multiple logistic regression model. This model was then reduced step-wise by removing the factors. Finally, the effects of pair-wise interactions between all factors retained in the final model were tested. Confounding was considered present if the coefficients of a variable in the final model changed.

RESULTS

During having of the research I have to meet with the owners of the animals as they have come to the Upazilla Veterinary office with their animal. Not only I have meet them at

the office but also I have gone to their residence to collect the data regarding LSD. The data table as prepared is the result of two months long investigation of LSD which has occurred in the Hathazari upazilla.

Fig: The map of Upazilla under investigation

The owners were asked the questions that are enlisted in the table. The questionnaires include the number of animals of the owner, the sex of the animal, its breed type, its age, their clinical signs,

Data Table

Owner name	Address	Contact No.	Total Number of animal	Sex	Breed	Body Condition	Age	Diagnosis	Vaccination	De-worming
Md. Kamal	Sandeep Colony	01773031442	1	Female	Local	Weak	1 month	LSD	No	No
Md. Arif	Chandrapur	01818890492	1	Female	Local	Weak	4 years	LSD	Yes	Yes
Md. Rasel	Guman Mardan	01575342891	1	Female	Local	Weak	2 years	LSD	Yes	Yes
Md. Nuruddin	Charia	No	1	Male	Local	Weak	1.5 years	LSD	Yes	Yes
Abul Kalam	Mirer Hat		1	Female	Local	Weak	2 years	LSD	Yes	Yes
Md. Jasim	Mirjapur	01834533432	1	Female	Local	Weak	1.16 years	LSD	Yes	Yes
Akbar Ali	Mirjapur	No	1	Female	Local	Weak	1.16 years	LSD	Yes	Yes
Nur Ali	Charia	No	1	Male	Local	Weak	3.5 years	LSD	Yes	Yes

Jubayer	Madarsha	01834291290	1	Female	Jersey	Weak	9 months	LSD	Yes	Yes
Raju	Madarsha	01834546789	1	Male	Local	Weak	2.75years	LSD	Yes	Yes
Abdul Mannan	Alipur	01825669056	1	Female	Local	Weak	1.5 years	LSD	Yes	No
Rasel	Kamalpara	No	1	Male	Jersey	Weak	1.5 years	LSD	Yes	Yes
Sukanta Sen	Ishapur	No	1	Female	Local	Weak	8 months	LSD	Yes	Yes
Abdur Rahhman	Ishapur	No	1	Male	Local	Weak	2 years	LSD	Yes	Yes
Ali Akbar	Alipur	No	1	Male	Local	Weak	1 years	LSD	Yes	No
Akter	Gor Duara	01709345634	1	Female	Local	Weak	3.5 years	LSD	Yes	Yes
Arfat	Uttar Madarsha	01836456734	1	Male	Cross	Weak	3 months	LSD	No	No
Isha	Fateyabad	01836996454	1	Female	Cross	Weak	1 Year	LSD	Yes	Yes
Bisnu	Fateyabad	No	1	Female	Local	Weak	2 years	LSD	Yes	Yes
Abdul Salam	Ishapur	No	1	Female	Local	Weak	1.5 years	LSD	Yes	Yes

Jony Deb	Mekhol	01814547586	1	Female	Local	Weak	1.75 Years	LSD	Yes	Yes
Rafi	Mekhol	01407345890	1	Female	Cross	Weak	1Years	LSD	No	No
Sahabuddin	Nandirhat	01818542398	1	Male	Cross	Weak	1.5Years	LSD	Yes	Yes
Jiap Udddin	Nandirhat	No	1	Female	Local	Weak	2.16 years	LSD	Yes	Yes
Mozammel	Nandirhat	01709467539	1	Male	Cross	Weak	3 years	LSD	Yes	Yes
Selim	Nandirhat	No	1	Female	Local	Weak	1.5 years	LSD	Yes	Yes
Jasim	Fateyabad	No	1	Female	Cross	Weak	1 Year	LSD	Yes	Yes
Samsul Alam	Gor Duara	No	1	Male	Jersey	Weak	3 years	LSD	Yes	Yes
Mannan Sikder	Kamalpara	No	1	Female	Jersey	Weak	1.25 years	LSD	Yes	No
Rahmat Ullah	Nandirhat	01836563978	1	Male	Cross	Weak	6 months	LSD	No	No

whether the animal were given vaccination, deworming and other initial treatment. They were also asked if there were other animals of other owners with the same sign.

From the data table it is found that almost all of the animals were diagnosed for having LSD which was uncommon to the owners of the area. Based on the investigation it is found

that the disease is not subject to the age of the animal. It is also found that the owner having ownership of three or more animals have at least one animal having LSD. From the table we found that the animals having LSD are weak in physical condition while the mortality rate is very low. It is also found that the disease doesn't depend on vaccination or deworming that have been given to their animals. As the maximum owners rear female animals in their residence the total number of affected animals was female.

Discussion:

Immunity to LSD infection is predominantly driven by a cell-mediated response. The study represents the majority crop–livestock production system in the highland and midland agro-climates and has also included classical areas of semi-pastoral production system in the lowlands. Probabilistic sampling is a challenging task in a country with an infrastructure such as Bangladesh, since large areas have to be covered which are not easily accessible. Moreover, sampling frames of lower administrative units are not often available at central level. Under these circumstances, multi-stage sampling is the preferred technique to limit selection bias since the decision is then made with closer insight to the target population [31]. Nevertheless, our study might still have some degree of selection bias influencing the results.The study was based on the symptomatic disease identification experience of the herd-owners complemented by veterinary office epidemiological records at different levels. Endemically occurring skin diseases of cattle such as bovine herpes mammilitis, dermatophilosis, demodecosis, and ringworm were taken into consideration in the differential diagnosis but we cannot exclude the possibility of some degree of misclassification. In the same way confusion with pseudo-LSD cases might have occurred although its presence has not yet been confirmed in Bangladesh. The discrepancy on LSD outbreak between the selected study districts and the national level reports was presumed to be the combination of errors committed at each level of reporting from grassroots to national level. The data obtained from the selected districts were considered to be a more credible source of information than from the national level [32]. The magnitude and frequency of LSD occurrence varied across upazilla during the study period. The observed LSD prevalence at animal level found in this study was 8.1% which was close to the 10% reported by Davies [4] and Babiuk et al. [9] in endemic areas of Africa. Prevalence of LSD in Bangladesh was less than the estimate reported here. This difference might be attributable to the fact that the seroprevalence method could underestimate the prevalence of LSD [7]. However, the study conducted around the upazilla reported a similar result and it was in the 95% confidence interval range of our finding [21]. Apparent mortality in the present study was 2.12% which agreed with the previous reports by Davies and Babiuk et al. [4, 9], whose results ranged between 1% and 3% and with the previous studies done in Africa.

The potential risk of agro-climate variations in LSD occurrence showed that midland and lowland agro-climates were more likely to be at risk for LSD occurrence than the highland agro-climate. This association might be attributed to the availability and abundance of effective mechanical vector insects. The temporal association between LSD occurrence and the biting-fly population found in our study suggested that mechanical vector insects might play a major role in the epidemiology of LSD, and agro-climate variation could be the basis for the type and abundance of speculated mechanical vector insects. The warm and humid climate in midland and lowland agro-climateshas been considered a more favourable environment for the occurrence of large populations of biting flies than the cool temperature in the highlands [33–35]. The use of insecticides to control biting flies is a rare practice in Bangladesh except for few areas in tsetse infested zones where pour-on drugs are used. Regarding the extensive livestock production system, communal grazing and watering point resource utilization was dominant in all agro-climate zones. Herd contact and mixing is likely to occur in communal grazing and watering points. However, in districts like Chattogram where irrigation-fed agriculture has emerged as means of subsistence in some PAs, cattle were kept on private grazing plots which relatively lowered the percentage of communal grazing and watering resource management in lowland agroclimate zones (80.6%). Herd mixing is assumed to be less likely to occur in private grazing plots. For the midland agro-climate, introduction of new cattle was associated with an increase in the risk of disease introduction to the herd, as already reported for infectious diseases such as tuberculosis and paratuberculosis [36, 37]. Communal grazing and watering point utilization were found to be significantly associated with LSD occurrence. Sharing watering points, grazing plots and post-harvest fields would allow contact and intermingling of different herds that would probably increase the risk of exposure and enhance the virus transmission through the speculated mechanical vectors such as Stomoxys spp. and mosquitoes (Aedes aegypti) [10, 38, 39]. The host's reaction to the piercing pain from the fly's bite would interrupt the insects' feeding which would lead to the flies looking for other nearby hosts to complete their feeding, allowing the transmission of the infection from infected to susceptible animals [39, 40]. Contamination of the pasture and water could be considered as a potential risk in communal grazing and watering point utilization despite the fact that contagious transmission is considered to be inefficient route of transmission [4, 8, 30]. Cattle movement due to farming system was not significantly associated with LSD occurrence in contrast with the findings of Munyeme et al. and MacPherson [28, 41] who reported the transhumant system as a risk factor for infectious disease transmission. This could imply that cattle movement due to farming system might

not have a significant role for the spread of LSD due to the inefficient contagious transmission nature of the LSDV [38]. Our study shows that LSD has been extensively circulating across diverse agro-climatic zones with large variations between districts that could be attributed to their respective agro-ecological zones and farming practices. Moreover, factors such as virus isolates, the breed of cattle, the immunological status of the population and the vector insects involved in the transmission should also be considered for the variations observed in our findings [4, 9, 12]. Further study is required to elucidate vector insects incriminated in the transmission of LSDV and their dynamics in different agro-ecologies. Hence it is likely that improved awareness by farmers and veterinary services on the potential disease transmission associated with shared use of grazing areas and watering points as well as promotion of biosecurity consciousness in the management of the introduction of new animals may assist in the control and prevention of infectious diseases in herds in Ethiopia. Knowledgedriven risk maps could also be built based on better knowledge of risk factors associated with LSD and could help target disease surveillance and control activities. These findings are also important to direct future studies in other countries where LSD is an important livestock disease problem.

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