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Article

Sero-Epidemiology of Lumpy Skin Disease and Determine Community Awareness Level about LSD in Different Agro-Ecological Zones of Sidama Regional State, Southern Ethiopia

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Abstract: Lumpy skin disease (LSD) vaccination and epidemiological distribution remain unknown in some parts of Ethiopia including the Sidama regional state. With this, an assessment of LSD vaccine-related problems and serological study was performed in selected districts of Sidama regional state representing three agroecological zones from September 2021 to June 2022. A cross-sectional study of qualitative and quantitative studies was used. The result showed a few portion of respondents know about LSD (29.2%), and vaccinate their cattle (23.3%). 20.8% of the respondents stated LSD occurrence in their vaccinated cattle while focus group discussion with the professionals stated the possible reasons related to electric power disruption that impacted LSD vaccine cold-chain. The other study was on sero-epedimiology of LSD which showed an overall animal and herd level sero-prevalence of 40.8% and 81%, respectively. Higher and lower sero-prevalence was observed in lowland (48%) and highland (28%) areas, respectively. Furthermore, risk factor analysis showed the existence of a significant association between management systems, breed, and body condition score (BCS) of cattle. In conclusion, both qualitative and quantitative study results showed the need for intervention in terms of community-based awareness creation about LSD clinical signs, vaccination advantages, and options for electric power supply together with the frequently updated information on LSD prevalence.

Keywords: agroecology; LSD; LSD outbreak; sero epidemiology risk factor; qualitative study

1. Introduction

People in households keep cattle for multiple purpose like milk production, draft power, beef production manure for fuel fertilizer and breeding [1]. Among all the livestock that constitute Ethiopia Farm animals, ruminants comprise of Cattle, Sheep and goats among the [2].

Livestock production increasingly be affected by the competition for natural resources, particularly land and water [3]. Additionally, livestock diseases are factors that can affect the growing livestock population. From livestock diseases, lumpy skin disease (LSD) stands among the major diseases that limit the productivity of cattle with huge economic impacts in different parts of Ethiopia [4,5].

Lumpy skin disease was believed to be introduced in to Ethiopia for the first time through Northwest in 1981 [6]. After the introduction, the disease initially spread east wards, later to all direction and currently it has affected all regions and agro-climatic zones of the country. Communal grazing and watering, uncontrolled cattle movements, and pastoralism can be mentioned as a way to enhance the spread of LSD. The poor animal health situation, inefficient prevention and control efforts in combination with late detection of the disease have further contributed to spread of LSD in Ethiopia.

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This means a lot to a more than 65 million estimated cattle population of this country causing a huge socio-economic impact [7,8].

Lumpy skin disease is a severe viral disease of cattle, which often occur as regional epidemics within a larger area in which it is endemic [4,9]. It is caused by lumpy skin disease virus (LSDV) which is a member of Capripox virus (CaPVs) that are large double stranded DNA viruses belonging to the family poxiridae genus include Sheeppox virus (SPPV), Goatpox virus (GPV) and Lumpy skin disease virus (LSDV) [10]. LSDV is closely related to two other viruses in the genus Capri poxvirus sheep pox and goat pox viruses [11]. Transmission of LSDV is primarily by mechanical means by several probable arthropod vectors such as biting flies, mosquitoes (*Aedes aegypti*) [12] and three tick species of the family Ixodidae, namely *Rhipicephalus appendiculatus*, *Rhipicephalus decoloratus* and *Amblyomma hebraeum*. These vectors have been shown to transmit LSDV under experimental conditions though their capacity to transmit disease under natural field conditions is unknown [10,13].

Morbidity and mortality of the disease vary considerably depending on the breed of cattle, the immunological status of the population and insect vectors involved in the disease transmission [4]. LSD can cause 1 to 5% mortality in affected cattle [13]. Severity of LSD has been observed to be higher in *Bos taurus* than local Zebu (*Bos indicus*). Additionally, lactating cows of either breed are severely affected by LSD [14]. The morbidity can reach as high as 100% in natural outbreaks while mortality rate rarely exceeds 5%. Furthermore, in morbid cases, decreased milk production, abortion, infertility, loss of body condition and damaged hides causes enormous economic losses [15]. To reduce the diseases impact, different approaches can be used as a means of prevention and control methods. Among the approach, vector controlling and vaccination is the one commonly used. As of the later approach, four live attenuated *capripox virus* strains are currently used for vaccine production they are Kenyan sheep pox, Yugoslavian RM 65, Romanian sheep pox, and South African Neethling strains. A major neutralizing site of the Capri pox virus strains is shared by all three strains so that all have been used in vaccinations of cattle to protect against LSD infection in different parts of the world [14]. However, the control intervention for 2006 and 2007 LSD epidemic in Israel could not effectively limit the occurrence of LSD after RM65 strain vaccination [16]. Similarly, questionnaire based study in Ethiopia, showed lack of efficacy of LSD vaccine when massive epidemic occurred among the vaccinated cattle population [17].

Epidemiological study of LSD in Ethiopia based on clinical disease observation and subclinical infection which has been undertaken in different parts of the country [8,18]. However, any reported or publication was not available about epidemiological evidence of LSD in the newly formed Sidama regional state (former Sidama zone) together with its vaccine related information for its effectiveness which seems to be an issue from other places [17,19]. With this into consideration, this research was designed to estimate sero-epidemiology of LSD and LSD vaccine efficacy in different agro-ecological zones from selected districts of Sidama regional state.

2. Material and methods

2.1. Study Area

The study was conducted from September 2021 to June 2022 on sero-epidemiology of Lumpy skin disease and community problems related to LSD Vaccine in Sidama region, southern Ethiopia. For this purpose, districts like Hula (Hagere salam), Dara and Hawassa were selected representing the high land, lowland and midland agro-ecology, respectively. The agroecological classification of Ethiopia was made based on CSA [20]. Accordingly, altitude which is <500 mater above sea level is desert, from 500 to 1300 meter above sea level is classified as dry lowland, from 1300 to 2200 meter above sea level classified as midland from 2200 to 3000 considered as high lands.

The lower administrative level in Ethiopian case was used and is called 'Kebele'. Hierarchically, administrative levels in Ethiopia from lower to higher goes as Kebele, district, zone and region.

Hula (Hagere salam) districts is 336km from Addis Abeba and 91Km from Hawassa town. Geographically the district found in 6° 29N'and 38° 31'E and altitude between 2759 and 3000

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m.a.s.l. Hula district is high land districts of the region a total cattle population in the district are 95521 [21].

Dara is district that found in Sidama region that is divided into 37 Kebeles. Out of these kebeles; six kebeles are located in Lowland agro ecology. This district is 365Km from Addis Abeba and 76Km from Hawassa with 6.47 °N and 38.33°E latitude and has an altitude of that range from 1000 to 2500 m.a.s.l as well as 1200 to 1700mm mean rain fall. The temperature of the district ranges from 20°C to 27°C. In the areas mixed farming systems practiced and the grazing land is covered by different vegetation types mainly savanna grass land forest and bush land. Animal population of the districts consists of 96382 cattle 74104sheep 2197 Donkeys 8422 Horses 2728 mules and 871306 poultry [22,23].

Hawassa is capital city of the Sidama regions. Geographically lies between 4°27' and 8°30 North and 34°21' and 39°1' East with an altitude that ranges from 1700 to 2500 m.a.s.l. Hawassa city has totally of eight sub cities and 32 kebeles Total cattle population in Hawassa are 123568 (Ethiopian Bureau of finance and economic development [24].

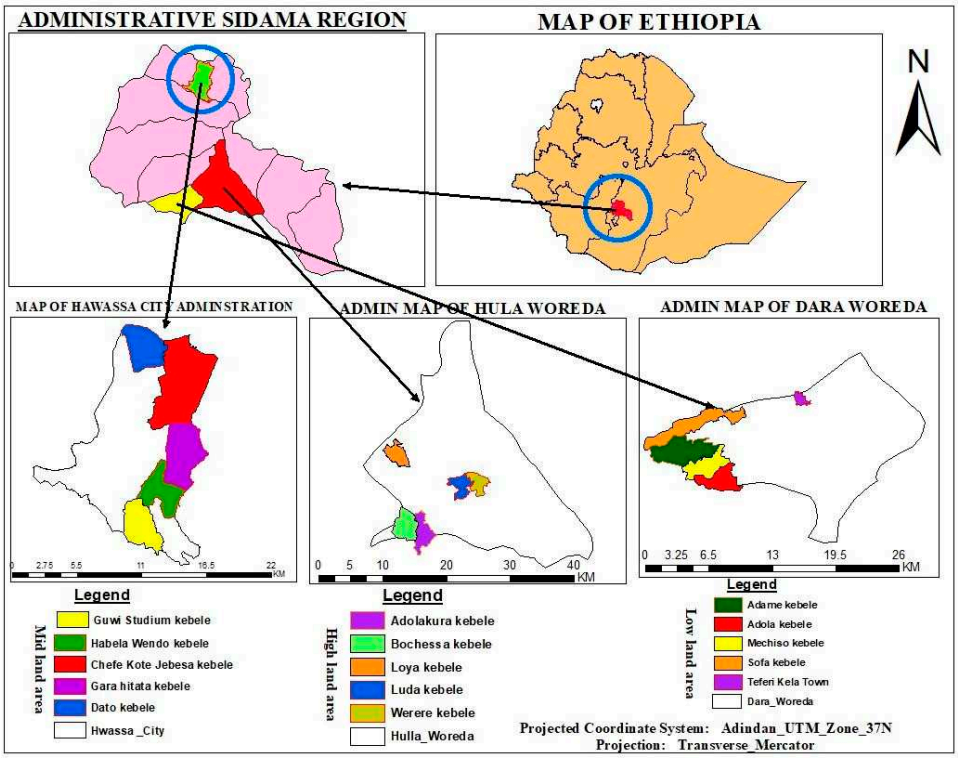

Figure 1. Graphical description of study area (done with QGIS).

2.2. Study Population

Target population was all exotic and local cattle breed population found in the study areas. Sidama region is one of the newly formed regions with a huge cattle population estimated to be 2.4 million according to the report of CSA [25]. Agro-ecological zone and/or district level cattle population done by BOFED [24] was used to know the cattle proportion in the region in correlation with that of the three agro-ecological zones of the region.

2.3. Study design and sample size determination.

Cross-sectional study design was used in the current study. The minimum sample size for this study was calculated based on predetermined parameters, 6.43% expected prevalence [18], 95% confidence level (CI) and 5% required absolute precision. The minimum calculated sample size (n) for this study was 92 as per the formula her under [26].

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$$1.96^2 \ \mathrm{Pexp}\,(1-\mathrm{Pexp})/_{d^2}$$

$n = (1.96)^2*0.0643\ (1-0.0643)/\ (0.05)^2 = 92$

where; n =required sample size, Pexp= expected prevalence, d = desired absolute precision

The minimum calculated sample size was 92, to get representative sample size; it was increased by four-fold and is 368 cattle. These 368 samples were divided in to three representative agro-ecological zones of the region based on their cattle population. The share of cattle to be sampled per district/agro-ecological zone was made proportionally based on the available cattle population from BOFED [24]. Likewise, 31%, 30% and 39% from low, high and mid land districts were selected; respectively. This share of percentage was found after dividing total number of cattle in each district for summation of all cattle population from the three districts (agro-ecological zones).

2.4. Sampling Method

Multistage sampling strategy was conducted during sampling techniques which involve the use of sample at different hierarchical levels of aggregated unit of interest. Three districts of Sidama regional state representing different agro-ecological zones as well as cattle population (Hawassa, Dara and Hula) were selected. Five kebeles were selected from each of the district/agro-ecological zone based on the accessibility and permission from the local authority. From each kebeles; 5 herds were selected based on cattle population density. Accordingly, 25 herds were selected from each agro-ecological zone which brings a total of 75 herds.

Three agro-ecological zones were represented with kebeles selected from the three different agro-ecological zones. Accordingly, the selected districts representing the different agro-ecological zones include Dara district that comprises of both midland and lowland areas. The other district representing the midland was Hawassa city administration while highland agro-ecological part was represented by Hula (Hagere selam) district.

From each selected kebele; a minimum of 10% number of individual cattle was sampled by systematic random selection followed by blood collection. The term 'herd' in intensive farming system means that aggregate of animals' having a similar resource of feeding, drinking and housing. Additionally, in case of extensive management system implies that animal from the same peasant association which share communal grazing and watering resource together with their experience of the same environment and climatic condition. Furthermore, 'herd' explanation in semi-intensive management system is when animal keep both in the intensive and extensive system that share common grazing and watering and housing [27].

2.5. Study Methods

2.5.1. Questionnaire

A pre-tested questionnaire was administered to 120 individual herds' owner, and 15-veterinary clinician. In this research a 'herd' was taken with a group of cattle that share a common watering and/or feeding sources. From each selected herds of three districts; one individual which has close relation with cattle especially elder was selected that brought our total selected herds as 75 herds. So, totally 75 herd owners was selected, purposively. These owners were asked about the general clinical signs linked to lumpy skin disease, any complain about the existence of disease outbreak after vaccination, and existence of disease (LSD) in the area (in previous years). Veterinary clinicians were asked about vaccine delivery, storage and administration at field level.

A questionnaire survey and face-to-face interview that took 5-10 minute was conducted. Farmer's abilities to identify LSD infection were cross-checked by enquiring about clinical signs and local vernacular name for LSD. The description of disease was necessary in order to avoid confusion with other possible skin disease such as dermatophilosis, and ringworm. Respondents described the occurrence of a case with clinical sign of generalized skin nodules, fever, peripheral lymph node

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swelling and discharge from eyes, nostril and mouth was tentatively diagnosed as LSD. Moreover, epidemiological records from district veterinary clinic were consulting to verify the occurrence of LSD in the time and place specified by the respondent. Question relating to vaccine efficacy was recorded in the question format prepared for this purpose.

2.5.2. Blood Collection

Blood was collected from cattle with the history of no lumpy skin disease (LSD) vaccination. Blood sampling was performed in line with the principles of good veterinary practice, animal welfare and aseptically into disposable plain tube from jugular vein [28]. The tubes then kept protected from direct sun light, kept in slant position and in ice box then transported to Hawassa University, Faculty of Veterinary medicine Microbiology laboratory for serum separation after 12 hrs. The separated sera then gently transferred to sterile cryovials, labeled tube with animal identification number, stored in -20^{o}C. Finally all collected sera were shipped to Animal Health Institute (formerly National Animal Health Diagnostic and Investigation, Sebeta) for virus neutralization test (VNT).

2.5.3. Laboratory Procedures

Virus Neutralization test (VNT): test sera were de-complemented by heating at 56 ^{o}C for 30min and 5 fold dilutions were made using MEM without serum but with 2% antibiotics and antimycotics and 1% glutamine. The virus stock, with a known titer, was also diluted to give a 10^{3} TCID50 /ml with the same media. The diluted test sera were titrated against a constant titer of capripoxvirus (100 $TCID_{50}$) 50% tissue culture infective dose in order to calculate a neutralization index. Lamb Kidney primary cells were prepared from pre-grown monolayers as a suspension of $4x10^{5}$ cells/ml in cell culture medium containing antibiotics and 2% fetal calf serum. The neutralization index is the preferred method in most laboratories although its dose requires a larger volume of test sera. The test is described using 96-well flat-bottomed tissue culture grade micro-titer plate [28].

2.6. Data Analysis

Both qualitative and quantitative data were kept into a Microsoft excel spread sheet 2010. Before the data was analyzed, clearing and coding data was done carefully. Descriptive statistics like percentage/prevalence was computed as appropriate to calculate the proportion of risk factors in relation to the occurrence of LSD. Estimation of proportion with 95% CI was also being assessed. All outcome variable factors were analyzed with STATA Corp. version 16. Univariate and multivariate logistic regression model was fit containing the appropriate independent variables with 95% confidence interval. The level of significance for statistical tests was set at 0.05 and significant difference was kept if $p< 0.05$.

3. Results

3.1. Questionnaire Survey Result

3.1.1. Farmer knowledge, vaccination habit and occurrence of LSD in vaccinated cattle

From 120 house hold farmers; only 29.2% (35/120) know the disease called "Lumpy skin disease" either saw the clinical signs and/or heard from animal health professionals. Having the knowledge of this disease; 23.3% (28/120) vaccinated their cattle in the past where 20.8% (25/120) reported the existence of LSD in vaccinated cattle in the same year of vaccination (Table 1).

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Table 1. Qualitative data summary on LSD knowledge and vaccination habit in different districts of Sidama regional state.

Study areas		Responses of farmers regarding Lumpy skin disease (LSD)					
		Do you know a disease called "LSD"		Do you vaccinate your cattle against LSD?		Have you experienced LSD disease in vaccinated cattle in the same year?	
		Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
Hula (n=40)	Werere	3	5	5	3	5	3
	Bochessa	2	6	1	7	1	7
	Adola	2	6	1	7	1	7
	Luda	1	7	0	8	0	8
	Loya	2	6	1	7	1	7
Hawassa (n=40)	Dato	4	4	3	5	1	7
	Guwe	0	8	1	7	2	6
	Gara Hitata	2	6	2	6	0	8
	Chafe	3	5	2	6	0	8
	H/wondo	3	5	0	8	3	5
Dara (n=40)	Millinium	4	4	4	4	2	6
	Safa	2	6	2	6	3	5
	Odole	3	5	2	6	2	6
	Mechisho	2	6	2	6	3	5
	Adame	2	6	2	6	1	7
Over all (N=120)		**35 (29.2)**	**85 (70.8)**	**28 (23.3)**	**92 (76.7)**	**25 (20.8)**	**91 (75.8)**

3.1.2. Respondent's demography and its association with farmers' LSD knowledge

The demographic figures of the respondents showed different ranges. Based on their education status and family status; the respondent was classified as illiterate (37.5%), Basic writing and reading (34.17%), High school (5.83%), and College (22.5%). According to their sex and age; male comprises 73.3%, Female 26.7% and ≤35 years as 21.7%, [36-55) years as 43.3%, ≥55 years as 35%; respectively. Further analysis of logistic regression analysis showed the absence of any significant difference between the knowledge of the farmers about LSD and their age, sex, and educational background ($p > 0.05$) (Table 2).

Table 2. Logistic regression analysis of farmers' knowledge of LSD and their demographic background (N=120).

Variables category		No of Participant (%)	OR (95%CI)	p-value
Sex	Female	32 (26.7)	Ref.	
	Male	88 (73.3)	1.9 (0.7, 5.2)	0.213
Age (in years)	≤ 35	26 (21.7)	Ref.	
	[36-55)	52 (43.3)	1.3 (0.4, 4.4)	0.716
	≥55	42 (35.0)	1.5 (0.4, 5.1)	0.562
Education status	Illiterate	45 (37.50)	Ref.	
	Basic writing and reading	41 (34.17)	1.6 (0.6, 4.4)	0.401
	High School	7 (5.83)	2.5 (0.2, 26.8)	0.460
	College	27 (22.50)	1.3 (0.4, 4.2)	0.640

3.1.3. LSD vaccine delivery, storage, distribution and administration

According to a focus group discussion with the three districts (Dara, Hawassa and Hula) professional in charge; LSD vaccine was usually supplied from National Veterinary Institute (NVI), Bishoftu based on the request from each offices based on their own demand. Delivery to their site as

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well as storage usually follows the cold chain system. However, they always worried about the storage of vaccine in their refrigerator due to frequent electric power disruption that range from 6 hrs to more than 48 hrs which can affect the cold chain. On further discussion professionals were the only one allowed to vaccinate cattle under their supervision in most of the cases.

3.2. Sero-epidemology of lumpy skin disease

3.2.1. Animal level sero-prevalence

A total of 368 serum samples were collected from cattle from selected districts from three agro-ecological zones of Sidama region were tested for specific antibodies against Lumpy skin disease virus. Out of the total tested samples; 150 sera were found to be positive with different level of proportion from 28 to 48% in the three agro-ecological zones. The overall prevalence in the region was 40.8% (Table 3).

Table 3. Sero-prevalence of LSD in different agro-ecological zones of Sidama regional state (N=368).

Agro-ecological zone	Sampled cattle	Positive cattle	Proportion (95%CI)
Highland	110	31	28 (20, 37)
Midland	144	64	44 (36, 47)
Lowland	114	55	48 (41, 51)
Overall prevalence	**368**	**150**	**40.8 (35.8, 45.8)**

3.2.2. Herd Level LSD Sero-prevalence

Among 75 herds investigated in the study area, 61 of the herds had at least one sero-positive cattle for LSD. The overall herd level sero-prevalence in study area was 81% (95%CI=77%-85%). The herd level sero-prevalence of LSD were highest in Hawasa (92%) followed by Dara (76%) and Hula (76%). Herd Level prevalence of LSD in selected districts (N=75) (Table 4).

Table 4. Herd Level prevalence of LSD in three agro-ecological zones (N=75).

Districts	Sampled Herd size	Positive herd size	Prevalence (%), 95%CI
Highland	25	19	76 (66, 82)
Midland	25	23	92 (84, 94)
Lowland	25	19	76 (68, 84)
Overall prevalence	75	61	81 77, 85)

3.2.3. Associated risk factors of LSD occurrence in the study area

Logistic regression analysis was done to look for the presence of an association between both animal and environmental risk factors with the occurrence of LSD sero-positivity. Accordingly, BCS and Breed from animals while management systems from environmental risk factors were found to be significantly associated with LSD sero-positivity ($p < 0.05$) (Table 5).

Table 5. Logistic regression analysis of risk factors and the occurrence of LSD sero-positive.

Risk factors		No of sampled	No of positive	Proportion (%)	COR (95CI)	AOR (95% CI)	P-values
Sex	**Female**	241	107	44.4		Ref.	
	Male	127	43	33.9	1.6 (1, 2.44)	2.1 (0.92, 4.61)	**0.078**
Age	**Young**	57	8	14		Ref.	
	Adult	86	16	18.6	1.4 (0.56, 3.53)	1.1 (0.3, 4)	**0.887**
	Old	225	126	56	7.8 (3.53, 17.22)	2.4 (0.78, 7.2)	**0.129**
BCS	**Poor**	69	36	52.2	1.8 (1.05, 3.1)	Ref.	

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Medium	246	93	37.8		1.8 (0.75, 4.5)	**0.185**
Good	53	21	39.6	1.7 (0.8, 3.4)	3.2 (0.98, 10.43)	**0.054**
Breed **Cross**	183	135	73.8		Ref.	
Local	185	13	7	39.4 (20.5, 75.76)	53 (20.53, 140)	**0.000**
Management systems						
Intensive	127	46	36		Ref.	
Extensive	241	104	43	1.3 (0.86, 2.1)	3.4 (1.4, 8.7)	**0.009**
Agro-ecological zone						
Highland	110	31	28.2		Ref.	
Lowland	144	55	38.2	2.4 (1.4, 4.1)	1.8 (0.63, 5.03)	**0.278**
Midland	**114**	**64**	**56.1**	**2 (1.2, 3.5)**	**1.3 (0.5, 3.23)**	**0.603**

AOR= Adjusted OR, COR= crude OR, OR=Odd ratio, CI=Confidence Interval, Ref=reference.

4. Discussion

Vaccination related issues such as vaccination habit and practice of farmers were assessed in the study area which showed only 23.3% of the farmers vaccinated their cattle against lumpy skin disease (LSD) in the past one year (from September 2020 to August 2021). In the contrary to this, Gnare et al. [29] reported the use of LSD vaccination by 98.3% of the respondents from Guto Gida, Wayu Tuka and Gida Ayana districts of Western Ethiopia. This difference could even be affected as there were 20.8% of respondents reported the existence of LSD in their vaccinated cattle which can also contribute to the level of low level of vaccination by the community. This finding was lower than the one reported by Molla *et* al. [5] (over 60%). Furthermore, the problem of those vaccine issues could be related to electric power disruption in the area as mentioned by the focus group discussions by veterinary clinicians who can disrupt the cold-chain of LSD vaccine. This problem worries as LSD was observed to be prevalent in the region.

Lumpy skin disease is prevalent in the country with a different range of prevalence [18,30,31] with undetermined prevalence in the newly established region, Sidama regional state. Additionally, LSD-related vaccine efficacy has been done from different perspectives mainly questioning the efficacy of the vaccine itself [8,19,32] not the vaccine delivery from production site till vaccination. As of the later assessment, the current study identifies the presence of knowledge gap about the disease, vaccination habit, and LSD disease occurrence in vaccinated cattle. From 120 interviewed household farmers only 29.2% of them know about lumpy skin disease. This finding was found to be higher than the finding of Moges and Bogale, [33] (11.38%) from North-Western Ethiopia. However, the current study was lower than the study done in East Wollega by Gnare et al. [29] (51.64%). The difference in different parts of the country could be either is related to the frequency of the case occurrence or effective awareness creation on the clinical appearance of the disease.

The current study addressed sero-prevalence of LSD in three agro-ecological zones of Sidama region. The overall animal and herd level prevalence of LSD in present study was 40.8% and 81%, respectively. This individual animal prevalence was in agreement with the previous finding by Getachew et al. [34] (41%) from Northern part of Ethiopia. However, Hailu et al. [35] (7.4%), Gari et al. [30] (6%), Abera et al. [17] (6.43%), and Molla et al. [31] (26.5%) reported lower prevalence than the current one in different parts of Ethiopia. Additionally, lower prevalence was also reported by Asfaw et al. [36] from Kordofan region, South Sudan (73.4%) and Albyrak et al. [37] from Turkey

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(54.6%). These differences could be related to agro-ecological aspects related to variation into vector flies population, level of awareness in prevention and control of LSD from one area to the other.

Herd level prevalence of the current finding was higher than the finding of Hailu et al. [35] (44%) which was done in north-eastern Ethiopia. This variation could be explained due to the difference in the study methodologies. In our research, sero-epedimiological approach was used while in the study of Hailu et al. [35] was questionnaire-based approach to assess herd level prevalence which can have a higher chance of missing unnoticed cases of LSD by owners.

From three agro-ecological zones of Sidama regional state, higher prevalence (48%) was reported from low land area followed by midland area (44%). This could be related to the warm and humid climate in mid and lowland agro-climates that favors biting flies that has their own epidemiological role in LSD transmission [38]. However, there is no significant association between agro-ecological zones with that of LSD occurrence in the study area ($p > 0.05$).

The prevalence of LSD varied significantly among different management system, where higher prevalence was recorded in extensive management system (43%) than intensive management system (36%). The finding was in agreement with the finding from other parts of Ethiopia which was expected to be related to the extensive management production system which uses communal grazing and watering which can increase the herd contact with the increased occurrence of disease if affected animal found in herds [30]. Other than environmental risk factors; animal factors that showed significance association with the occurrence of LSD were breed and BCS (good) ($p< 0.05$). In this study, higher sero-prevalence was observed in cross-bred cattle (73.8%) than local breed cattle (7%). This was in agreement with the finding of Abera et al. [17] in other parts of Ethiopia and Kiplagat et al. [39] from Kenya. This might be related to the difference of innate immune response between the cross and local breed [40]. Further risk factor analysis showed the presence of significantly lower proportion of sero-positive cattle with good BCS than the poor one.

5. Conclusions

The present questionnaire survey identified the presence of gap in the knowledge of LSD with few farmers vaccinating their cattle in the area. Respondents also stated the occurrence of LSD outbreaks in vaccinated cattle. This as per the focus group discussion can be related to poor vaccine management and interrupted electric power affecting the vaccine cold-chain in storage. In addition to the questionnaire survey; sero-epidemiological assessment showed an overall prevalence of 40.8% at animal level in three agro-ecological zones of Sidama region. From the three agro-ecological zones; higher prevalence was recorded, in lowland (48%) followed by midland (44%). Risk factor association with LSD sero-prevalence showed significant differences between extensive and intensive management systems, good and poor BCS, cross-bred and local breed cattle of the study area.

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Institutional Review Board Statement: the study was approved by both veterinary and medical institutes for its acceptable methodologies on animal and human study subjects.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. The consent was done in written form with the questionnaire and for some it was red and signed before the start of the study.

Data Availability Statement: Additional information and data can be available from the corresponding author and principal investigator of this research.

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