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Assessment of Community Knowledge, Attitude and Practice (KAP) Towards Lumpy Skin Disease (LSD) in Tanga and Pwani Region-Tanzania

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Abstract

Lumpy skin disease (LSD) is WOAH listed transboundary disease of cattle with high economic impact which threaten the global cattle industry. The disease was first diagnosed in Zambia in 1929 and the first outbreak in Tanzania was in 1981. LSD is regarded endemic in sub-Saharan countries. However, the community knowledge, attitude and practice (KAP) towards LSD in Tanzania is poorly understood. This cross-sectional study was conducted in Tanga and Pwani region between December 2022 and February 2023 to assess KAP towards LSD. A questionnaire tool was used to collect information from116 herds/households. Questionnaire was administered by face-to-face. Data analysis was done using descriptive statistic and univariate logistic regression model. In this study, it was found that majority of the respondents were aware of LSD occurrence (86.93%, CI=79.40-92.51) and over half of the respondents 54.78% (CI=45.23-64.04) had past LSD experience in their herds. However, our study revealed limited knowledge on LSD sign, associated losses, transmission control and on the role of vectors in LSD epidemiology. Majority of the respondent believed LSD has impact (86.09%, CI=78.39-91.83) and believe cattle are at risk (78.26%, CI=69.60-85.41). Moreover, respondents believed vaccine is important in LSD control (70.26%, CI=69.60-85.41). Nevertheless, majority believed they had limited access to vaccine. Respondent age, herd size, district, role in the households, main source of income, time in livestock farming, cattle type and past experience on LSD occurrence appeared to influence both the knowledge and attitude towards LSD in Tanga and Pwani regions.

Keywords: *Farmers knowledge; KAP; LSD occurrence; LSD losses; LSD control; Tanzania*

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Introduction

Lumpy skin disease (LSD) is WOAH listed transboundary disease of cattle with high economic impact threatening rural livelihood and cattle industry globally (Clemmons and Alfson, 2021). The disease has a long history in Africa as it was first diagnosed in Zambia in 1929 with the first outbreak in Tanzania in 1981 before it was declared endemic in sub-Saharan countries (Baldacchino *et al*., 2013). The disease has been reported in all African countries except in Algeria, Morocco, Tunisia and Libya (Tuppurainen *et al*., 2017). Currently the disease

is spread beyond sub-Saharan countries to Asia, Middle east and Europe, thus is an important transboundary disease with a glob threat (Tuppurainen *et al.,* 2017). LSD epidemiology has been documented in several African countries. Example, animal level prevalence of 8.1%, 6.4%, 7.6% in Ethiopia (Gari *et al*., 2010, Abera *et al*., 2015, Hasib *et al*., 2021), 8.7% in Uganda (Ochowo *et al*., 2019), 19.5% in Egypt (Selim *et al*., 2021a) and herd level prevalence of 72.3% in uganda (Ochowo *et al*., 2019), 27% and 20.8% in Ethiopia (Gari *et al*., 2012, Dubie *et al*., 2022) indicating the disease to be real in Africa. LSD is characterized by fever, lymphadenopathy, excessive salivation and nodules on the skin (OIE, 2021). Farmers are more familiar with skin lesions as pathognomonic LSD signs hence used for diagnosis and reporting the disease (Gambo *et al.,* 2018). However, it should be noted that other diseases such as pseudo-LSD caused by Allerton virus, insect bite, bovine popular stomatitis caused by parapox virus, dermatophilosis, mite infestation, and besnoitiosis are also characterized by skin lesions to varying degree and could be considered as differentials based on skin lesions (Tuppurainen *et al.*, 2017, Hunter and Wallace, 2001). Despite the low mortality associated to LSD, the disease remains of major economic importance due to its associated economic losses (Hunter and Wallace, 2001). Economic losses attributed to LSD have been estimated using different model, for example in Turkey losses due to LSD was estimated to be 886.34 USD per animal in dairy cattle and 1066.61USD per animal in beef cattle per animal (Mat *et al.,* 2021) . Estimation of economic loss has been done also in Kenya, and it was found to be USD 31 and per herd of indigenous cattle and USD 431 per herd of crossbreed cattle due to LSD associated mortalities and be USD 47 per herd and USD 266 per herd of indigenous and cross breed cattle respectively due to drop in milk production and losses related to additional veterinary costs in LSD affected herds was 37 USD per herd in indigenous breed cattle and 50USD per herd in cross breed cattle (Kiplagat *et al.,* 2020).

Drop in milk production, mastitis due secondary bacterial infection, abortion, loss of body condition affecting market value, infertility, damage of hide and increased veterinary costs from treatment and vaccination are some of the losses linked to LSD (Gambo *et al.,* 2018, Kiplagat *et al.,* 2020).

LSD is mainly transmitted mechanically by blood feeding insects such as Mosquitoes (Chihota *et al.,* 2001), stable flies (Stomoxy calcitrans) (Kitching and Mellor, 1986) and tick especially the African tick species like *Rhipicephalus* and *Amblyomma* (Tuppurainen *et al.,* 2013). Suwankitwat *et al.* (2023) reported that the risk of LSD infection is lower in herds with vector control program compared to those without. However, the role of vectors in LSD transmission is poorly understood among farmers hence vector control may not be a priority (Hatami *et al.,* 2022). LSD transmission via direct contact is possible but considered ineffective (Kayesh *et al*., 2020).

Vaccination is the most cost-effect control measure against LSDV. However, lack of reliable and cost-effective vaccine is a global challenge (Beard, 2016, Habiyaremye *et al.,* 2017) limiting LSDV control and calls for collaborative efforts to halt this transboundary disease (Beard, 2016). Practices such as introduction of new animals, communal grazing and watering points, source of replacement stock, season of the year and movement of animal are risk factors associated with LSD occurrence and transmission (Gari *et al*., 2012, Tuppurainen *et al*., 2017, Kiplagat *et al*., 2019, Ochowo *et al.,* 2019).

Community awareness on LSD has been reported previously in South Africa and Nigeria (Habiyaremye *et al.,* 2017, Atai *et al.,* 2021). However, despite Tanzania being one of the largest cattle holders in Africa, and the long history of the disease in the country (Baldacchino *et al.,* 2013), the information on community knowledge, altitude and practice towards LSD is not documented. Therefore, the present study seeks to establish KAP towards LSD which is the first study of its nature in Tanzania.

Material and Methods

Study area

The study was conducted in Tanga and Pwani administrative regions in Tanzania. Tanga is located on 5.3050ºS,38.3166ºE northeast of Tanzania bordering Kenya and Kilimanjaro in

the north, Manyara region to the west, Morogoro and Pwani region to the south and Indian ocean to the east. Tanga has a total area of 26667km^2 divided into 11 administrative districts. According to the national agricultural census 2019/2020, 23% of the household are involved in cattle keeping with a total of over 1.5million cattle (URT,2021) which makes livestock farming to be one of the key sources of income in Tanga. Pwani located on 7.3238^{o}S, 38.8205^{o}E has a total area of 32547 km^2 divided into eight (8) administrative districts and borders Tanga region to the north, Morogoro to the west, Lindi region to south and surrounds Dar es salaam to east. According to the national Agricultural census 2019/2020 (URT,2021), the region has a total of 739 101 cattle.

Study design

This cross-sectional study was conducted from December 2022 to February 2023. Multistage sampling method was employed where two district from each region and three wards from each district were purposively selected based on availability of different farming systems, geographical representativeness, accessibility, and willingness of livestock farmers to participate in the study following consultation with the district livestock officers. Ward livestock extension officers prepared sampling frame from list of households, organized logistics for data collection and systematic random sampling procedure was used to select households from the list.

Data analysis

Collected data was entered into Microsoft excel (2013) and analyzed with the help of Epinfo statistical package version 7.2.5.0. (Centers for Disease Control and Prevention, Georgia, USA). Data was further analysed using descriptive statistics, proportions were summarized in tables. Knowledge score were calculated as a proportion (%) of respondents from each category of the selected variable who had knowledge on LSD signs, transmission, losses and control and those who perceived LSD impact, risk of occurrence and preventability. These scores were used as outcomes to establish the association between selected socio-demographic factors and the observed knowledge and attitude by univariate logistic regression model at 95% confidence level and 5% p-value.

To collect information for KAP assessment, a close-ended questionnaire tool was used. Questionnaire was developed in English and administered by face-to-face interview to one household member (owner/representative) using Swahili language to which all respondents had a good proficiency. Responses were recorded in a prepared form manually. A total of 116 respondents were interviewed. All participants were residents of the study area and freely consented to participate in the study. Socio-demographic factors such as age, herd size, respondent's districts, respondent's time in livestock farming, education level, role in the household, main source of income, animal type and past experience of LSD in the herd were included in the questionnaire and its influence on the knowledge and attitude towards LSD were assessed.

Results

Majority of the respondents were male (81.9%, CI=73.67-88.43) of which adult aged 35-60years formed the largest proportion of the participants (65.52%, CI=56.12-74.10). Large number of respondents (92.42%) had attained formal education. Majority (81.03%) of the respondents had no formal employment and over half of the respondents (52.59%, CI 43.11-61.93) described livestock farming as main source of income. Large number of the respondents were owners (93.10% CI= 86.96-96.98) where over half of the respondents have been in livestock farming activities for 1-10years. Dual purpose cattle are dominant in the study area (58.76%, CI=48.70-67.39). Details of socio-demographic information are included in Table 1.

Table 1

Socio-demographic and household characteristics

Variable	Category	Proportion (%)	C I
Sex	Female	21(18.1)	11.57-26.33
	Male	95(81.9)	73.67-88.43
Age	18-34	13(11.21)	6.10-18.40
	35-60	76(65.52)	56.12-74.10
	>60	27(23.28)	15.93-32.03
Education level	None	9(7.76)	3.61-14.22
	Primary	60(51.72)	42.26-61.10
	secondary	42(36.21)	27.49-45.65
	Tertiary	5(4.31)	1.41-9.77
Marital status	Married	105(90.52)	83.67-95.17
	Divorced	0(0.0)	-
	Single	11(9.48)	4.83-16.33
Employment status	Formal employment	11(9.48)	4.83-16.33
	Unemployed	94(81.03)	71.71-87.72
	Retired	11(9.48)	4.83-16.33
Main source of income	Livestock farming	61(52.59)	43.11-61.93
	Others	55(47.41)	38.07-56.89
Time in livestock farming	1-10 years	62(53.45)	43.95-62.76
	11-20 Years	23(19.83)	13.28-28.25
	Life time activity	31(26.72)	18.95-35.74

Role in the household	Owners	108(93.10)	86.96-96.98
	Others	8(6.90)	3.02-13.14
Herd size	Large	49(42.94)	33.13-51.76
	Medium	44(37.93)	29.09-47.41
	Small	23(19.83)	13.00-28.05
Animal type	Dairy	48(41.24)	32.61-51.30
	Beef	0(0.0)	-
	Dual purpose	67(58.76)	48.70-67.39
Animal breed per herd	Cross	26(22.63)	15.33-31.35
	Indigenous	26(22.63)	15.33-31.35
	Mixed	56(54.75)	45.23-64.08

Our study findings reveal that, 88.79% (CI= 81.60-93.90) of respondents were aware of LSD. It was also found that, LSD signs and losses other than skin lesions and drop in milk production respectively, were poorly understood by respondent (Table 2). Furthermore, majority of the respondents were not aware of the role of biting vectors in LSD transmission only 4.72% understood. Respondents reported LSD occurrence in both dry and rainy season and in cattle of all ages and production stages (Table 2). Only few respondents reported occurrence of disease in young cattle (31.75%, CI=20.48-44.69), old cattle (3.17%, CI=0.39-11.00) and in lactating cattle (3.17%, CI=0.39-11.00). Our study further revealed that, over 54% of the respondents experienced LSD previously (Table 2).

Table 2

Result on Community knowledge towards LSD

Variable	**Response**	**Proportion** (%)	**95%CI**
Awareness on LSD presence	Yes	103 (88.79)	81.60-93.90
	No	13 (11.21)	6.10-18.40
Knowledge on LSD Signs	Yes	100(86.93)	79.40-92.51
	No	15(13.04)	7.49-20.60
Known LSD signs	Skin lesion	64(60.38)	50.41-69.75

	Mortality	9(8.49)	3.96-15.51
	Milk drop	18(16.98)	10.39-25.50
	Abortion	5(4.72)	1.55-10.67
	Unaware	10(9.43)	4.62-16.67
Knowledge on LSD associated Losses	Yes	102(88.70)	81.45-93.84
	No	13(11.30)	6.16-18.55
Known LSD losses	Drop in milk production	75(69.44)	59.84-77.95
	Mortalities	12(11.11)	5.87-18.60
	Abortion	4(3.7)	1.02-9.21
	Increased veterinary cost	5(4.63)	1.52-10.57
	Damaged hide	3(2.87)	0.58-7.90
	Others	9(8.33)	3.88-15.23
Knowledge on LSD Transmission	Yes	90(78.29)	69.60-85.41
	No	25(21.74)	14.59-30.40
Known means of LSD transmission	Animal contact	84 (79.25)	70.28-86.51
	Blood feeding vectors	5 (4.72)	1.55-10.67
	Others	1(0.94)	0.02-5.14
	Unaware	16(15.09)	8.88-23.35
Knowledge on control	Yes	93(80.87)	73.48-87.61
	No	22(19.13)	12.39-27.52
Known on LSD control measures	Movement restriction	60 (64.52)	53.91-60.26
	Vaccination	13 (13.98)	7.66-22.72
	Vaccination and movement restriction	20(21.51)	13.66-31.24
Known blood feeding vectors	Ticks	47(40.87)	31.79-50.43
	Ticks, tsetse fly and other biting flies	63(54.78)	45.23-64.08
	Mosquitoes	3(2.61)	0.54-7.43
	Others	1(1.74)	0.21-6.14
Knowledge on seasons of LSD occurrence	Yes	73(63.48)	53.99-72.26
	No	42(36.52)	27.74-46.10
Season which LSD is common	Rainy season	39(53.42)	41.43-65.20
	Dry season	34(46.58)	34.80-58.63
Past LSD experience	Yes	63(54.78)	45.23-64.04
	No	52(45.22)	35.92-54.77
Group of animals affected	Young	20(31.75)	20.48-44.69

	Old	2(3.17)	0.39-11.00
	No specific group	39(61.9)	48.80-73.85
	Lactating	2(3.17)	0.39-11.00
Last LSD experience	Within 6 months	9(14.29)	6.75-25.39
	One year ago	14(22.2)	12.72-34.46
	Within two years ago	20(31.75)	20.58-44.69
	More than 2 years	20(31.75)	20.58-44.69

Attitude and perception towards LSD

Majority (86.09% CI) of respondents understood the impact of LSD and believed cattle can come up with LSD in the area (78.26%, CI 69.60-85.41). Additionally, majority believed free animal movement communal grazing and watering points to be important factors for LSD transmission (Table 3). Surprisingly, the role of blood feeding vectors on LSD transmission and the value of vector control to limit LSD spread were poorly understood (Table 3). Moreover, majority of respondents believed LSD can be prevented and believed vaccination is important tool in controlling LSD. However, a significant proportion of respondents perceived vaccine as scarce and unaffordable resource (Table 3).

Table 3

Result on attitude of the respondents towards LSD

Variable/factor	Response	Percentage	95% CI
LSD impact	Yes	99(86.09)	78.39-91.83
	No	16(13.91)	8.17-21.61
Animals are at risk of being LSD infected	Yes	90(78.26)	69.60-85.41
	No	25(21.74)	14.59-30.40
Communal grazing and watering ponds facilitate LSD transmission	Yes	91(79.13)	70.56-86.15
	No	24(20.87)	13.85-29.44
Free animal movement facilitate LSD transmission	Yes	84(73.04)	63.97-80.89
	Unaware	27(23.48)	16.08-32.29
	No	4(3.48)	0.96-8.67
Blood feeding arthropods play a role in LSD transmission	Yes	13(11.30)	6.16-18.55
	No	102(88.70)	81.45-93.84
All breeds of cattle are susceptible to LSD	Yes	44(38.26)	29.35-47.79
	No	32(27.83)	19.87-36.95

	Unaware	39(33.91)	25.35-43.33
LSD is preventable	Yes	84(73.04)	63.93-80.89
	No	31(26.96)	19.11-36.03
Control blood feeding insects is important for LSD control	Yes	16(14.04)	8.24-24.79
	No	98(85.96)	78.21-91.76
Vaccination against LSD is important	Yes	90(78.26)	69.60-85.41
	No	3(2.61)	0.54-7.43
	Unaware	22(19.13)	12.39-27.52
Available vaccine can effectively protect animals against LSD	Yes	61(71.76).	60.96-81.00
	No	24(28.24)	19.00-39.04
LSD vaccine are readily available	Yes	2(1.74)	0.21-6.14
	No	83(72.17)	63.05-80.13
	Unaware	30(20.09)	18.34-35.10
LSD vaccine are affordable	Yes	1(0.87)	0.02-4.75
	No	74(64.35)	54.88-73.06
	Unaware	40(34.78)	26.14-44.23

Community practices towards LSD

Our finding reveals that majority of the respondents were using acaricide to control blood feeding vectors, which were exclusively applied using small manual sprayers (100% CI 96.82-100). Practices such as introduction of new animals, communal grazing and communal watering points were commonly observed (Table 4). Natural breeding dominated the breeding system and sharing of breeding bull was not uncommon practice. None of the participant had history of vaccinating animals against LSD in the study area. Use of antibiotics and anti-inflammatories in LSD affected cattle as supportive therapy was a common practice (Table 4).

Table 4

Results on community Practice towards LSD

Practice	**Response**	**Proportion** (%)	**95% CI**
Use of acaricide	Yes	114(99.13)	95.25-99.98
	No	0.87	0.02-4.75
Acaricide application	Home spraying	114(100)	96.82-100
	Others	0(0)	-
New animal introduction	Yes	34(29.57)	21.42-38.79
	No	81(70.43)	61.21-78.58
Grazing system	Communal grazing	69(60)	49.57-68.21

	Others	46(40)	30.98-49.55
Watering system	Piped/own source	59(51.3)	41.81-60.73
	Communal	56(44.70)	39.27-58.19
LSD vaccination	Yes	0.00	-
	No	116(100)	96.87-100
Breeding system	Artificial insemination	20(17.39)	10.96-25.57
	Natural by breeding bulls	94(81.74)	73.45-88.33
	Both	1(0.87)	0.02-4.75
Source of breeding bulls	Own	57(60.64)	50.02-70.56
	Shared	37(39.36)	29.44-49.98
Source of replacement stock	Own	104(90.43)	83.53-95.13
	Purchase	3(2.61)	0.54-7.43
	Both	8(6.96)	3.05-13.25
Treatment of LSD sick animals	Yes	63(98.44)	91.60-99.96
	No	1(1.56)	0.04-8.40

KAP score towards LSD

Table 5 shows the knowledge score on LSD signs, transmission, control and losses and the scores on attitude towards LSD on its impact, risk of occurrence in the study area and preventability are indicated in table 6.

Table 5

Knowledge scores on LSD signs, transmission, control and losses

Variable	**Category**	**Knowledge score (%) on LSD**			
		Symptoms	Transmission	Control	Losses
Age	Young	8(61.54)	7(53.85)	8(61.54)	8(61.54)
	Adult	69(92.00)	70(93.33)	62(82.67)	70(93.33)
	Old	23(85.19)	24(88.89)	20(72.07)	24(88.89)
Sex	Male	82(87.23)	74(78.72)	77(81.91)	82(87.23)
	Female	18(85.71)	16(76.19)	16(76.19)	20(95.24)
Education level	Primary	54(93.10)	47(81.03)	47(81.03)	54(93.10)
	Secondary	35(81.04)	33(76.74)	35(81.04)	37(86.05)
	Tertiary	3(60.00)	3(60.00)	3(60.00)	3(60.00)
	None	8(88.89)	7(77.78)	8(88.89)	8(88.89)
Herd size	Small	15(68.18)	8(36.36)	11(50.00)	15(68.18)
	Medium	38(86.36)	36(81.82)	37(84.07)	39(88.64)
	Large	47(97.92)	46(93.88)	45(91.84)	48(97.96)
	owner	95(88.79)	86(80.37)	90(84.11)	97(90.65)

Role in the household	others	5(62.50)	4(50.00)	3(37.50)	5(62.50)
Main source of Income	Livestock	54(88.52)	50(81.97)	51(85.00)	55(90.16)
	Others	46(85.19)	40(74.07)	42(76.36)	47(87.04)
District	Pangani	52(96.30)	44(81.48)	46(88.86)	52(96.30)
	Tanga city	16(61.54)	14(53.85)	14(53.85)	18(69.23)
	Mkuranga	17(94.44)	16(88.89)	15(83.33)	17(94.44)
	Kisarawe	15(88.24)	16(94.12)	16(94.12)	15(88.24)
Time in livestock farming	1-10 years	48(78.69)	39(63.93)	41(67.21)	49(80.33)
	10-20 years	23(95.83)	22(91.67)	24(100)	24(100)
	Lifetime	29(96.67)	29(96.67)	28(93.33)	29(96.67)

Table 6

Scores on attitude towards LSD impact, risk of occurrence

Variable	**Category**	**Attitude score (%) on LSD**		
		Impact	Risk of infection	Preventability
Age	Young	9(69.23)	7(53.85)	6(46.15)
	Adult	68(90.67)	61(81.33)	55(73.33)
	Old	22(81.48)	22(81.48)	23(85.19)
Sex	Male	81(85.26)	75(78.95)	69(72.63)
	Female	18(90.00)	15(75.00)	15(75.00)
Herd size	Small	15(65.22)	10(43.48)	7(30.47)
	Medium	37(84.09)	34(77.27)	33(75.00)
	Large	47(97.92)	46(96.83)	44(91.67)
Role in the household	Owners	94(87.85)	86(80.37)	80(74.77)
	Others	5(62.50)	4(50.00)	4(50.00)
Source of income	Livestock	55(88.52)	50(81.97)	49(80.33)
	Others	45(83.33)	40(74.07)	35(64.81)
Animal type	Dairy (cross)	34(72.34)	29(61.70)	30(63.83)
	Dual- purpose	65(95.59)	61(89.71)	54(79.41)
Past LSD Experience	Yes	60(95.24)	60(95.24)	52(82.54)
	No	39(75.00)	30(57.69)	32(61.54)
District	Pangani	51(92.73)	48(87.27)	38(69.09)
	Tanga city	15(60.00)	13(52.00)	14(56.00)
	Mkuranga	17(94.44)	16(88.89)	16(88.89)
	Kisarawe	16(94.12)	13(76.47)	16(94.12)

Factors associated with community knowledge and attitude towards LSD

The findings of our study show that, knowledge on LSD signs was significantly associated with respondent age, herd size, experience in livestock farming and respondent district. Lower odds of knowledge on LSD signs, transmission, control and LSD related losses were associated with young age and districts of residence (Tanga city council), alternative source of income and none owner role in the household (Table 7)

On the other hand, odds for LSD knowledge were higher in respondents with large number of animals (large and medium herd sizes), long time (11-20years and lifetime) engagement in livestock farming (Table 7).

Table 7

Factors associated with knowledge towards LSD

Factor	Category	OR	95% CI	P value
Factors associated with knowledge towards LSD signs				
Age	>60 years	0.50	0.13-1.93	0.314
	18-34	0.14	0.03-0.56	0.005*
	35-60 years	-	-	Reference
Sex	Female	0.88	0.22-3.44	0.852
	Male	-	-	-
Education level	Primary	1.69	0.167-17.06	0.658
	Secondary	0.55	0.05-5.06	0.594
	Tertiary	0.19	0.01-2.91	0.231
	None	-	-	Reference
Herd size	Medium	3.00	0.85-10.25	0.088
	Large	10.97	2.05-58.57	0.005*
	Small	-	-	Reference
Role in the household	Others	0.21	0.04-0.99	0.059
	Owner	-	-	Reference
Main source of income	Others	0.75	0.25-2.21	0.597
	Livestock farming	Ref	Ref	Ref
	Others	0.98	0.22-4.21	0.982
Time in livestock farming	10-20 years	6.23	0.77-50.55	0.087
	Lifetime	7.85	0.98-63.31	0.005*
	1-10 years	-	-	Reference
District	Tanga city	0.06	0.01-0.31	0.001*
	Mkuranga	0.65	0.06-7.67	0.735
	Kisarawe	0.29	0.03-2.22	0.233
	Pangani	-	-	Reference
Factors associated with knowledge score on LSD transmission				
Age	>60 Years	1.09	0.32-3.74	0.885
	18-34Years	0.22	0.06-0.77	0.019*
	35-60 Years	-	Reference	-
Sex	Female	0.71	0.23-2.20	0.548
	Male		Reference	
Education level	Primary	0.53	0.06-4.73	0.573
	Secondary	0.55	0.06-5.02	0.594
	Tertiary	0.19	0.021-2.91	0.232

	None	-	Reference	-
Herd size	medium	5.29	1.65-16.9	0.005*
	Large	11.25	3.00-42.12	0.003*
	Small	-	Reference	-
Role in the household	Others	0.11	0.02-0.52	0.005*
	Owner	-	-	Reference
Main source of income	Others	0.57	0.22-1.46	0.005*
	Livestock farming	-	-	Reference
Time in Livestock farming	11-20years	1.00	0.002-0.19	0.9657
	Lifetime	6.83	1.48-31.56	0.014*
	1-10years	-	-	Reference
District	Tanga city	0.15	0.05-0.46	0.001*
	Mkuranga	0.62	0.14-281	0.550
	Kisarawe	1.99	0.22-17.78	0.537
	Pangani	-	-	Reference
Factor associated with knowledge score on LSD control				
Age	>60years	0.60	0.21-1.71	0.338
	18-34	0.33	0.09-1.19	0.091
	35-60	-	-	Reference
Sex	Female	0.86	0.28-2.65	0.799
	Male	-	-	Reference
Education level	Primary	0.57	0.218-1.492	0.253
	Secondary	1.22	0.22-6.70	0.819
	Tertiary	0.94	0.17-5.28	0.947
	None	-	-	Reference
Herd size	Large	26.83	6.25-115.02	0.000*
	Medium	7.88	2.47-25.88	0.001*
	Small	-	-	Reference
Role in the household	Others	0.244	0.06-1.06	0.059
	Owner	-	-	Reference
Main source of income	Others	0.63	0.26-1.53	0.308
	Livestock farming	-	-	Reference
Time in livestock farming	11-20years	6.21	1.33-28.91	0.020*
	Lifetime	16.14	2.08-128.18	0.008*
	1-10years	-	-	Reference
District	Tanga city	0.27	0.09-0.74	0.012*
	Mkuranga	1.82	0.36-9.21	0.470
	Kisarawe	3.64	0.43-30.71	0.236
	Pangani	-	-	Reference
Factor associated with knowledge score on losses attributed to LSD				
Age	>60	0.57	0.13-2.57	0.466
	18-34	0.11	0.03-0.48	0.003*
	35-60	-	-	Reference
Sex	Female	2.92	0.36-2381	0.316
	Male	-	-	Reference
Education level	Primary	1.69	0.17-17.06	0.658
	Secondary	0.77	0.08-31	0.820

	Tertiary	0.18	0.01-2.91	0.231
	None	-	-	Reference
Herd size	Large	22.38	2.54-196.67	0.005*
	Medium	3.64	1.00-13.26	0.050*
	Small	-	-	Reference
Role in the household	Others	0.17	0.04-0.83	0.028*
	Owners	-	-	Reference
Main source of income	Others	0.73	0.23-2.33	0.598
	Livestock farming	-	-	Reference
Time in livestock farming	11-20years	1.00	0.01- 13.04	0.972
	Lifetime	7.10	0.88-57.48	0.0661
	1-10years	-	-	Reference
District	Tanga city	0.09	0.02- 0.44	0.003*
	Mkuranga	0.67	0.06-7.67	0.735
	Kisarawe	0.28	0.03-2.22	0.233
	Pangani	-	-	Reference

* Value significant at $p \leq 0.05$

It was further observed that, respondents owning dual-purpose cattle, large number of cattle (large and medium herd size) and with previous experience of LSD in their herds had higher odds of attitude score on LSD impact, risk of LSD occurrence and preventability. Contrary to that, respondents aged below 35 years old and respondents from Tanga city council appeared to have lower odds of perception score (Table 8).

Table 8

Factors associated with attitude and perception towards LSD

Factor	Category	OR	95%CI	P-value
Factors associated with attitude and perception towards LSD impact				
Age	>60years	0.59	0.16-2.21	0.435
	18-34	0.23	0.05-0.95	0.042*
	35-60	-	-	Reference
Sex	Female	0.21	0.30-6.87	0.659
	Male	-	-	Reference
Role in the household	Others	0.21	0.04-1.00	0.049*
	Owner	-	-	Reference
Education level	Primary	0.80	0.09-7.25	0.840
	Secondary	1.19	0.11-12.09	0.881
	Tertiary	0.19	0.01-2.91	0.232
	None	-	-	Reference
Herd size	Large	25.02	2.89-216.24	0.003*
	Medium	3.38	1.00-11.34	0.050*
	Small	-	-	Reference
Animal type	Due purpose	12.07	2.58-56.54	0.002*
	Dairy breed	-	-	Reference
Past LSD experience	Yes	9.99	1.59-22.55	0.008*
	No	-	-	Reference
District	Tanga city	0.14	0.04-0.51	0.003*

	Mkuranga	1.33	0.14-12.74	0.803
	Kisarawe	1.25	0.13-12.04	0.844
	Pangani	-	-	Reference
Factor associated with attitude and perception score on LSD infection risk				
Age	>60	1.01	0.33-3.13	0.987
	18-34	0.23	0.08-0.92	0.037*
	35-60	-	-	Reference
Sex	Female	0.80	0.26-2.47	0.698
	Male	-	-	Reference
Herd size	medium	4.4	1.49-13-07	0.007*
	Large	29.89	5.81-153.80	0.000*
	Small	-	-	Reference
Role in the household	Others	0.24	0.06-1.06	0.059
	Owner	-	-	Reference
Income source	Others	0.63	0.26-1.53	0.308
	Livestock farming	-	-	-
Animal type	Dual purpose	2.28	0.98-5.31	0.05*
	Dairy	-	-	-
Past LSD experience	Yes	14.67	4.06-52.92	0.000*
	No	-	-	Reference
District	Tanga city	0.16	0.05-0148	0.001*
	Mkuranga	1.17	0.22-6.20	0.857
	Kisarawe	0.47	0.12-1.87	0.287
	Pangani	-	-	Reference
Factor associated with attitude and perception score on LSD preventability				
Age	>60years	1.95	0.60-6.34	0.268
	35-60years	-	-	Reference
	18-34years	0.29	0.09-0.97	0.045*
Sex	Female	1.07	0.35-3.25	0.903
	Male	-	-	Reference
Role in the house hold	Others	0.32	0.08-1.38	0.1260
	Owner	-	-	Reference
Source of income	Others	0.41	0.17-0.96	0.039*
	Livestock farming	-	-	-
Herd size	Large	20.58	5.48-78.18	0.000*
	Medium	5.68	1.88-16.84	0.000*
	Small	-	-	Reference
Animal type	Dual purpose	2.28	1.00-5.31	0.057
	Dairy	-	-	Reference
Past LSD experience	Yes	2.72	1.15-6.44	0.022*
	No	-	-	Reference
District	Tanga city	0.52	0.20-1.39	0.194
	Mkuranga	3.28	0.68-15.95	0.141
	Kisarawe	6.56	0.80-53-72	0.079
	Pangani	-	-	Reference

* Value significant at $p \leq 0.05$

Discussion

The present study which is the first in Tanzania has established factors associated with knowledge and attitude towards LSD in Tanga and Pwani regions. Majority of the respondents were male, suggesting that livestock farming in Tanzania is male dominated and is in agreement with previous studies by (Habiyaremye *et al*., 2011). This can be explain by the tradition and culture of most of African societies where male have a responsibility of taking care of animals and making decision of various familly matters. Literate respondents affirms their ability to adapt to new technologies in livestock farming and disease control.

Majority of the respondents were adult aged above 34 years, which is in agreement with previous studies (Mlozi *et al*., 2015, Habiyaremye *et al*., 2011; Ngoshe *et al*., 2023). Lack of capital and motivation among young individuals to get engaged in livestock farming could be the reason for their low number. It can also be speculated that young individuals are still looking for jobs with monthly wages before they can invest in livestock farming activities.

Over half of the respondents described livestock farming as a main source of their income which is similar to the findings reported previously (Ngoshe *et al*., 2023). This finding justifies the importance of livestock farming in household economy and towards poverty alleviation, food security and sustainable livelihood in Tanzania.

Furthermore, large number of respondents appeared to have engaged in livestock farming activities within past 10 years. This can be explained by high unemployment rate and population growth which increases demand for animal source proteins as allude to by Mlozi *et al.* (2015). Therefore, the livestock sector in Tanzania has potential for employment creation subject to supportive environment such as improved veterinary service, pasture resource and ensuring reliable market for livestock products.

In the present study, majority of the respondents in the surveyed area were aware of lumpy skin disease which agrees with the findings reported early by Atai *et al.* (2021). This suggests that LSD possibly continue to be a production challenge in cattle since its first outbreak in 1981 and 1986 (Baldacchino *et al.,* 2013). However, majority of the respondents described LSD based on skin lesions (nodule) only from which different tribes assigned LSD local dialect names such as *mapele ngozi* (Swahili language), *malutu* (in Tanga), *Ovevedoi* (Maasai) and *nyawishita/tamgulu* (Barabaig), all of them meaning big rashes. This is in agreement with the findings reported in by Gambo *et al*. (2018), Atai *et al.* (2021) and Ngoshe *et al.* (2023). On the other hand, the current finding is suggesting limited knowledge on signs other than skin lesions which in turn can lead to misreporting due to confusion with differential diseases characterized by skin lesion as documented by Tuppurainen *et al*. (2017). Retooling on differential diagnosis through extension services is recommended.

Drop in milk production was the most frequent reported economic loss attributed to LSD, and confirmed in previous studies (Gambo *et al*., 2018, Kiplagat *et al*., 2019). Increased milk demand and market availability possibly due to presence of milk processing plants like Tanga fresh, Dar fresh and ASAS with well-established milk collection centers in different parts of the country is speculated to increase farmers sensitivity and awareness on milk loss. Other losses such as from permanent damage of hide and increased veterinary cost were poorly understood by majority of the respondents which could be due to low value of hide and poor record keeping in traditional farming system.

Furthermore, respondents attributed animal movement and contact between animals as main means for LSD transmission but were not privy to the role of vector in LSD epidemiology (Tuppurainen *et al.,* 2017, Kayesh e*t al.,* 2020). This agrees with the previous study in Iran (Hatami *et al.,* 2022). Lack of knowledge on vector management in LSD control requires attention to build competence among stakeholders.

More than a half (54.78%) of the respondents appeared to have past experience of LSD in their

herds. This proportion is slightly lower than the over 64% reported in Nigeria by Gambol *et al.* (2018). In our study, the number of respondents who mentioned LSD occurrence in dry and rain season was very close suggesting the possibility of LSD occurrence throughout the year in the study area.

Majority of the respondents mentioned occurrence of LSD in cattle of all ages and production stages. However, few respondents reported to observed LSD in specific animal groups such as young animals, old animals and lactating animals only, which agree with the previous studies (Abera *et al.,* 2015, OIE, 2021). Occurrence of LSD in young animals is associated with incompetency of the immune system due to low exposure while occurrence in old animals and lactating animals can be linked to production stresses and possibly increased exposure.

Majority of the respondents (86.09%) believe LSD had great economic impact. Findings of similar nature have been documented previously in Nigeria (Gambo *et al.,* 2018). This indicate the possibility of LSD to be among the setback to cattle productivity in many areas in Africa.
Moreover, respondents highlighted the role of vaccination in LSD control but there are concerns on limited access and high cost of the vaccines that hinder their use (Habiyaremye *et al*., 2017, Suwankitwat *et al*., 2023). This observation mirrors findings in South Africa where LSD vaccine is regarded as expensive (Habiyaremye *et al*., 2017). This suggest the need for government agencies and scientist to ensure cost effective vaccine is developed and available to farmers.

Our study further observed the use of acaricide by majority of the respondents. This indicate the willingness of farmers to control vectors which is also suggested for LSD control especially during outbreaks (Issimov *et al*., 2020, Suwankitwat *et al*., 2023). High prevalence of vectors is conceivably the major driver for the extensive use of acaricides rather than targeting LSD control. Despite the commitment of farmers to use acaricide, the process was very challenging due to lack of dipping facilities therefore, acaricide were applied manually leading to doubtful efficiency of the process especially in households with large cattle herds.

Some practices such as introduction of new animals, sharing of grazing areas, watering points and breeding bulls were common are risk factors for LSD occurrence (Hasib *et al.,* 2021). These practices are driven by pasture scarcity and poor knowledge on LSD transmission. There were no reports of LSD vaccination among study respondents implying that the cattle population are at risk of LSD infection.

Majority of the respondents used antibiotics and anti-inflammatory drugs as a supportive therapies to animals showing LSD sign, which is parallel to the findings reported by Bett *et al.* (2008). The use of antibiotics observed does not only add to veterinary costs, but also threaten the national and global public health by contributing to increased risk of antimicrobial resistance. Its therefore important to stress on preventive measures such as vaccination and vector control.

Furthermore, our study reports on factors that influenced knowledge and attitude towards LSD in the study area where respondent age, role in the household, main source of income, herd size, residence district, time in livestock farming, animal type and previous LSD experience in the herd to be important factors for both community knowledge and attitude towards LSD.

Lower odds of knowledge and attitude on LSD were associated with young age which is in agreement with the findings reported by Ngoshe *et al.* (2023). This is likely due to lack of interest in livestock farming activities and limited time of exposure in this age group with a possibility that they have never come across LSD.

Respondents from Tanga city council also appeared to have significantly lower odds of knowledge and perception compared to Pangani, Mkuranga and Kisarawe districts. This can be linked to environmental factors and management practice in the city settings that narrow down the possibility of LSD occurrence. Large number of people in the city leading to increased human activities that interferes with the breeding and resting places for vectors, the key players in LSD epidemiology, hence low exposure in the city (Malele *et al*., 2011).

Moreover, respondents other than owner also appeared to have lower odds of knowledge and perception on LSD than owners. Resource commitment and return expectation from the livestock project by the owner, possibly differentiate from other family members (Mlozi *et al.,* 2015). The owner can directly feel the cost and losses attributed to disease which is likely to influence awareness of various animal diseases.

Interestingly, respondents with activities other than livestock farming as their main source of income had lower odds of knowledge on LSD. This can be explained by differences in levels of dependence on livestock for household need. These findings give the impression that, respondents with no alternative source of income other than livestock are likely more attached to their animals and aware of different condition that can affect animals.

Our study further reveals that, respondents with large number of cattle, long history in livestock farming and those with dual-purpose cattle type had significantly higher odds of knowledge and attitude. This can be explained by the possibility of previous exposure to LSD. Being engaged in livestock farming for long time likely make farmers more familiar with different livestock diseases as documented previous by Anne *et al.* (2020). With herd size and animal type, variation in management practice is thought to influence the exposure rate to diseases and hence awareness. Due to large feed requirement, farmers with large number of cattle, in most cases graze their cattle in communal areas where there is increased exposure (Gari *et al.,* 2010). Similarly dual-purpose cattle, in most cases are indigenous cattle that are believed to be resistant to most diseases (Vordermeier *et al.,* 2012). They are therefore, less protected from diseases. Increased exposure and possibly increased frequency of LSD occurrence is linked to the observed high odds of knowledge and attitude

Additionally, respondents with previous LSD experience in the herd had specifically higher perception score on LSD impact, infection risk and preventability. This is in agreement with the previous studies (Hatami *et al.*, 2022) where experience on diseases and associated losses appeared to influence attitude and willingness to control diseases.

Conclusion

Farmers are familiar with LSD occurrence suggesting its importance in livestock production. However, LSD signs, transmission, control and losses were poorly understood by farmers.

Recommendations

Therefore, extension programmes for education and awareness creation are required for farmers to understand the disease and authorities should consider planning and implementation of effective control program including making cost effective vaccine available and construction of dipping facilities for vector control. Further studies should also be conducted to confirm the presence of the responsible virus and to understand the epidemiology of this disease in Tanzania.

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Ethical Clearance

Granted by Research Ethics Committee at Sokoine University of Agriculture with approval number SUA/DPRTC/R/186/031. All participants freely consented to participate in this study.

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