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A Retrospective Report of Viral and Bacterial Diseases in Livestock, Eastern Cape Province, South Africa

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ABSTRACT

Livestock disease, particularly viral and bacterial disease, impedes livestock farming productivity and reduces available food in the current system, leading to food insecurity and economic losses. The current study aimed to determine the prevalence of viral and bacterial disease in the Eastern Cape, South Africa. A retrospective data of livestock diseases in the Eastern Cape Province from 2013 to 2018 was obtained from veterinary records in the Department of Rural and Agrarian Reform (DrDAR), Bisho South Africa database, decoded, analyzed, and interpreted. The result revealed a significant association between local municipality, season, year, and livestock species. The highest prevalence of disease was found in the Lukhanji (29.4%) and Mbhashe (17.5%), while bacterial diseases were more prevalent in Nelson Mandela Bay (27.7%) and Raymond Mhlaba (34.9%) municipalities. More diseases were in autumn (53.8%) and spring (58.5%). The highest proportions of bacterial and viral diseases were in caprine (97.2%) and bovine (41.4%). Odds of disease occurrence were the highest in Intsika yethu local municipality (OR = 3.279, 95% CI = 0.043-263.6) in autumn (OR = 2.131, 95% CI = 0.815-5.569), and in bovine (OR = 58.825, 95% CI = 16.283-205.591). The results necessitate veterinary authorities to strengthen preventative program activities to mitigate livestock diseases in study area.

Keywords: Animal diseases, Bacterial diseases, Bovine malignant catarrhal fever, Livestock disease, Rabies, Viral diseases

INTRODUCTION

The livestock sector has well-established market chains and employs at least 1.3 billion people worldwide and contributes significantly to the lives of over 600 million poor smaller holder farmers in developing countries (Thornton, 2010). In developing countries, communal livestock farmers keep livestock to create an investment and sell them to solve different needs, including paying school fees for the children (Goni et al., 2018).

Diseases are the most limiting factor in livestock production. Livestock production losses, market declines, and unemployment in the livestock sector are some of the negative consequences of animal disease (Pritchett et al., 2005). Such impediment to production will consequently lead to a decline in food security and economic indices.

World Organization for Animal Health (OIE) estimates on the global damage caused by livestock disease reveals that at least 60 million tons of meat and 150 tons of milk are lost due to diseases with an estimated value of approximately USD 300 billion per year (Pradère, 2019). Infectious diseases are responsible for economic breakdowns and public health issues. The OIE designated the list A diseases as those with high impacts on the economy, trade, and food security. These include anthrax, brucellosis, bluetongue virus, and foot and mouth disease (FMD). Some of these diseases pose significant public health challenges (Penrith, 2019).

Foot and mouth disease has been persistent in cattle in Southern Africa since its first outbreaks in the 1930s (Sinkala et al., 2014). In recent years, the outbreak of FMD in South Africa has been successfully controlled by applying traditional mitigation strategies, including separating infected wildlife from susceptible livestock, culling, and vaccination (Modisane, 2009). However, some infectious diseases, such as malignant catarrhal fever, bovine brucellosis, campylobacteriosis, and rabies, are still reported in some South Africa, including Eastern Cape Province (ECP). There are only a few reports on diseases, such as cowdriosis. Provincial information on the status of other animal illnesses that have been published is scanty. Hence, this study documented livestock viral and bacterial disease prevalence and seasonal distribution in Eastern Cape Province, South Africa.

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MATERIALS AND METHODS

Ethical approval

The study was conducted under the permit granted by the University of Fort Hare research and ethics committee (UREC) with ethical clearance certificate number JAJ011SPHI01.

Study area

The study data covers all veterinary areas in ECP, which is among the nine provinces of South Africa located in the southern region of South Africa. The northern part of the province opens to Free State and Lesotho, the north-eastern part to KwaZulu Natal, the south and south-eastern part to the Indian Ocean, and the western and northern sides (Figure 1). It occupies 13.9 % of South African land with an estimated population density of 41 persons per square kilometer. The ECP's geographic location is 32.2968° S, 26.4194°E, and 3019 m above sea level. Major vegetation types in the Eastern Cape are valley thicket and Karoo vegetation, alpine grassland, and sub-tropical coastal flora (Jaja et al., 2017). The weather condition is divided into winter (cool-dry, May-July), summer (hot-wet, November-January), spring (hot-dry, August-October), and autumn (post-rainy, February-April) seasons (Nantapo and Muchenje, 2013). An average of 1152 mm of annual rainfall is mostly received in the summer season.

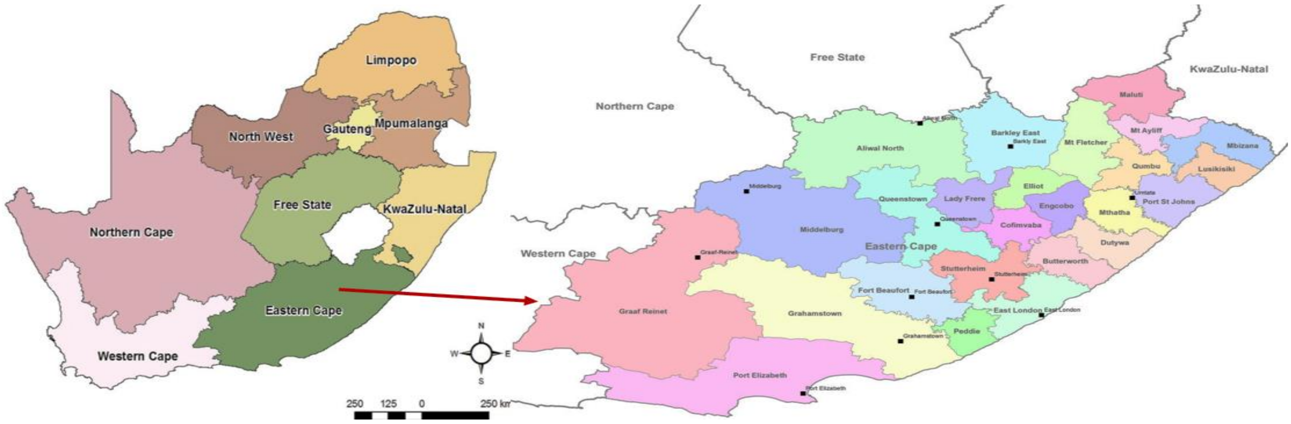

Figure 1. Map of South Africa provinces with a pointer from the Eastern Cape province showing various veterinary districts

Data collection

Clinical data of diagnosed disease cases from 2013 to 2018 was obtained from the Department of Rural and Agrarian Reform (DrDAR), Veterinary Service Unit, in Bhisho in the Eastern Cape Province, South Africa. The data was initially compiled by state veterinary clinics in the province and sent to the provincial veterinary office in Bisho. State veterinarians diagnosed all diseases using approved laboratories, and disease records were stored in the repository system. The variables include the type of livestock species (1220 Bovine species, 470 Caprine species, and 526 Ovine species), diagnosed diseases, time of diagnoses, location of diagnoses, and GPS coordinates. The data was decoded from the DrDAR system and then entered into Microsoft Excel and sorted in a variable form, such as local municipality, season, year of diagnosis, causative agent, livestock species, and disease diagnosis. Each disease diagnosed were sorted and classified into Microsoft column as either viral or bacterial infections. The month in which the disease occurred was used to categorize the disease in different seasons. Summer was considered as (November-January), and autumn (February-April). The May-July and August-October were considered as winter and spring (Nantapo and Muchenje, 2013). Farms, veterinary clinics, and veterinary laboratories where the diseases identified and diagnosed were classified according to a local municipality in that jurisdiction.

Statistical analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 27. Descriptive statistics such as measures of central tendency and dispersion (mean, median, mode, range, standard deviation, and variance), and qualitative variables were reported as frequencies and percentages to report disease prevalence. The Chi-square and t-test were used to examine the association and their significance between the local municipality, causative agent, season, and disease and their interaction with the viral and bacterial disease prevalence. A multinomial logistic regression model was used to determine odds ratios and confidence intervals of viral and bacterial disease for local municipality, season, and livestock species. Livestock species, local municipality, and season were independent variables, while the causative agent was the dependent variable. Statistical significance was set at $p < 0.05$. Senqu local municipality, spring, and caprine were taken as the reference of comparison.

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RESULTS

There were significant associations among local municipality, season, year of diagnosis, diseases diagnosed, and livestock species (Tables 1 and 2). Viral disease infections increased from 6.9% to 15.6% from 2013 to 2016 but declined to 15.6-8.8% in 2017 (Figure 2). Following a similar pattern, bacterial disease prevalence increased from 4.7% to 37% in 2013-2017. Conversely, there was a significant decline from 37% to 9.4% in 2017-2018. During this period of time, there was a steady increase in viral diseases from 8.8% to 45%, whereas bacterial disease declined sharply from 37% to 9.4% (Figure 3). The prevalence of viral infections in summer, autumn, winter and spring were 9.4%, 53.8%, 21.9%, 15%, respectively while bacterial infections were 14.1%, 15.4%, 12%, 58.5% for same seasons. Viral diseases were more prevalent in Lukhanji (29.4%), Intsika yethu (16.3%), and Mbhashe (17.5%) local municipalities (Figure 4). Bacterial diseases were more prevalent in Raymond Mhlaba (34.9%) and Nelson Mandela Bay (27.7%) local municipalities. Cowdriosis (63.4 %), Bovine malignant catarrhal fever (33.3%), rabies (32.6%), and bovine brucellosis (73.2%) were the most frequently diagnosed disease case in all municipalities during the study period (Table 1). Bovine had the highest percentage of viral (41.4%) and bacterial (58.6%) infections (Table 2). Odds of disease occurrence were highest in Intsika yethu local municipality (OR = 3.279, 95% CI = 0.043-263.6, $p < 0.05$) in autumn (OR = 2.131, 95% CI = 0.815-5.569, $p < 0.05$) and in bovine species (OR =58.825, 95% CI = 16.283-205.591, $p < 0.05$, Tables 3-5).

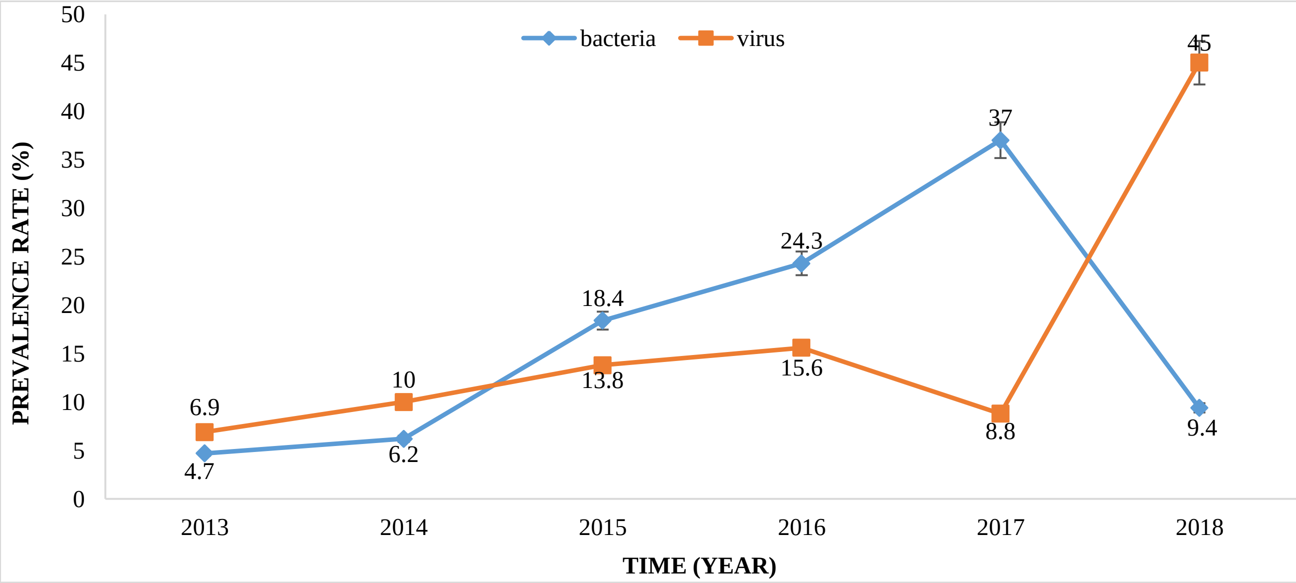

Figure 2. Prevalence rate of viral and bacterial diseases in livestock during 2013-2018 in the Eastern Cape Province, South Africa

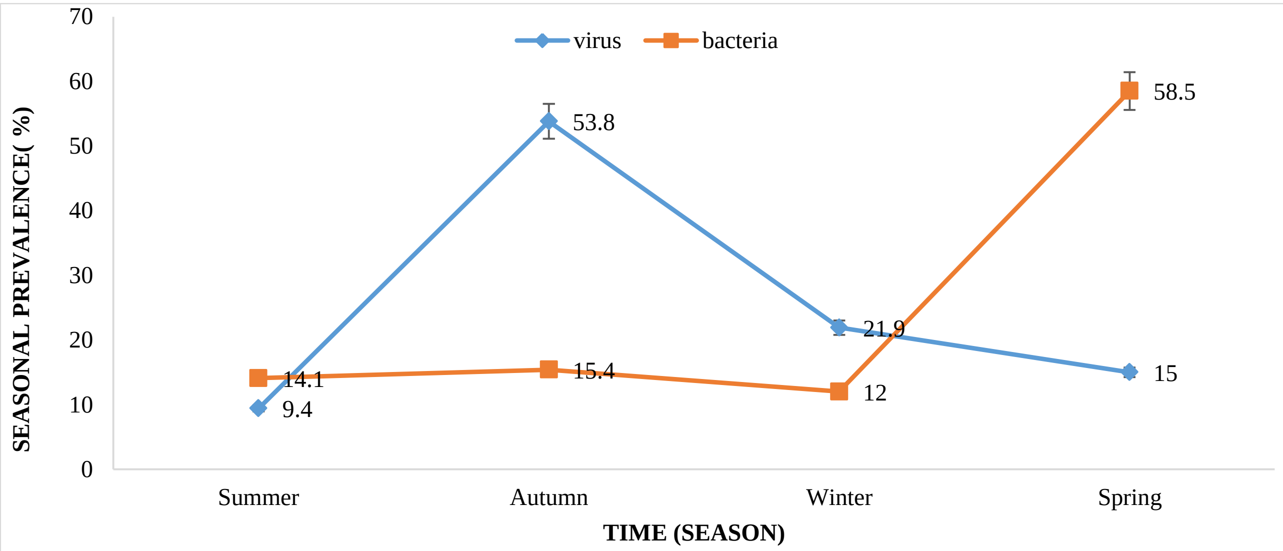

Figure 3. Average seasonal prevalence of viral and bacterial diseases in livestock in the Eastern Cape province, South Africa during 2013-2018

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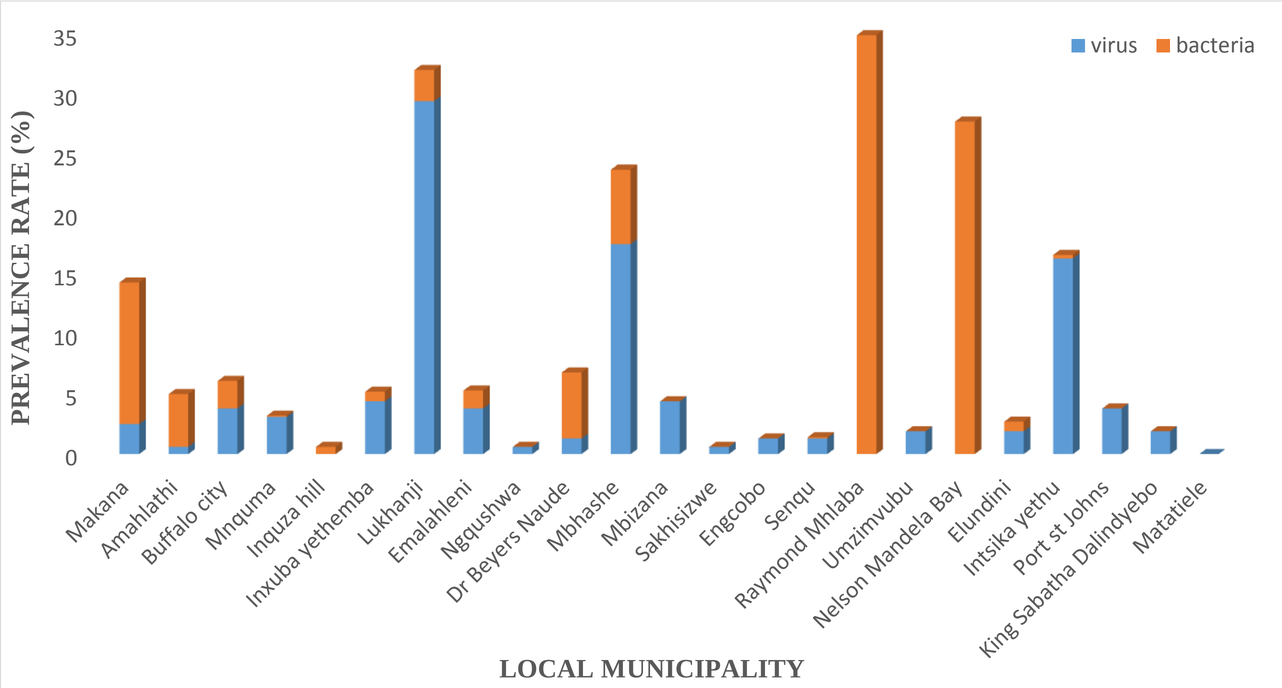

Figure 4. Prevalence rate of viral and bacterial disease in livestock in local municipalities of the Eastern Cape province, South Africa during 2013-2018

Table 1. Seasonal prevalence and distribution of diagnosed viral and bacterial diseases in the Eastern Cape Province, South Africa during 2013-2018

Agent	Disease	Seasons				DO (%)
		Summer	Autumn	Winter	Spring	
Virus	Bluetongue	4 (33.3)	2 (16.7)	4 (33.3)	2 (16.7)	12 (16.4)
	Bovine malignant catarrhal fever	2 (10.5)	8 (42.1)	5 (26.3)	4 (20.1)	19 (26.0)
	Bovine virus diarrhoea	1 (50)	1 (50)	0	0	2 (2.7)
	Pulmonary adenomatosis	0	1 (33.3)	0	2 (66.7)	3 (4.1)
	Rabies	8 (21.6)	11 (29.7)	4 (10.8)	14 (37.8)	37 (50,6)
Total		15 (20.5)	23 (31.5)	13 (17.8)	22 (30.1)	73
Bacteria	Actinomycosis	0	1 (100)	0	0	1 (0.5)
	Anthrax	0	1 (100)	0	0	1 (0.5)
	Bovine genital campylobacteriosis	1(50)	0	0	1 (50)	2 (1.0)
	Blackleg	2 (40)	1 (20)	0	2 (40)	5 (2.6)
	Bovine brucellosis	6 (20)	9 (30)	8 (26.7)	7 (23.3)	30 (15.6)
	Chlamydia infection	0	0	2 (66.7)	1 (33.3)	3 (1.5)
	Contagious ophthalmia	1 (100)	0	0	0	1 (0.5)
	Dermatophilosis	0	0	0	1 (100)	1 (0.5)
	Foot-rot	6 (46.2)	3 (23.1)	1 (7.7)	3 (23.1)	13 (8.0)
	Cowdriosis	23 (21.1)	41 (37.6)	19 (17.4)	26 (23.9)	109 (56.7)
	Mastitis	4 (21.1)	9 (47.4)	5 (26.3)	1 (5.3)	19 (9.8)
	Pasteurellosis	0	0	0	1 (100)	1 (0.5)
	Ovine epididymitis	0	1 (50)	1 (50)	0	1 (0.5)
	Paratuberculosis	1 (25)	1 (25)	0	2 (50)	4 (2.0)
	Q fever	1 (100)	0	0	0	1 (0.5)
Total		45 (23.4)	67 (34.8)	36 (18.7)	38 (19.7)	192

DO: Disease occurrence, Disease variable were compared within seasons. $X^2 = 56.561$, $p > 0.05$

Table 2. Proportion of viral and bacterial diseases of livestock species in the Eastern Cape, South Africa during 2013-2018

Species	Virus (%)	Bacteria (%)	P-value
Ovine	57 (10.8)	469 (89.2)	0.01
Caprine	13 (2.8)	457 (97.2)	0.01
Bovine	505 (41.4)	715 (58.6)	0.01
Total	575	1614	

P value less than 0.05 is significant.

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Table 3. Logistic regression of viral and bacterial diseases of livestock species in the local municipalities of the Eastern Cape, South Africa during 2013-2018 (Senqu is the reference of comparison)

Local municipality	Exp B	Sig	Odd ratio	CI (95%)	
				Lower	Upper
Amahlathi	-5.521	0.018	0.004	-	0.390
Buffalo city	-1.106	0.617	0.331	0.004	25.148
Elundini	-3.411	0.124	0.033	0.01	2.554
Emalahleni	-2.241	0.297	0.106	0.002	7.146
Intsika yethu	1.218	0.584	3.279	0.043	263.6
Inxubayethemba	-1.406	0.517	0.425	0.003	17.164
Lukhanji	-1.712	0.418	0.181	0.003	11.383
Makana	-4.887	0.024	0.008	0.01	0.519
Mbhashe	0.866	0.680	0.420	0.007	25.769
Mnquma	0.926	0.717	2.252	0.017	378.9
Senqu	0 (b)	-	-	-	-

Sig: Significance, Exp (B): Exponentiation of the B coefficient, which is an odds ratio, CI: Confidence interval

Table 4. Logistic regression of viral and bacterial diseases of livestock species from 2013 to 2017 in various seasons in Eastern Cape, South Africa during 2013-2018 (Spring is the reference of comparison)

Season	Exp B	Sig	Odd ratio	CI (95%)	
				Lower bound	Upper bound
Summer	-1.401	0.012	0.246	0.083	0.734
Autumn	0.757	0.123	2.131	0.815	5.569
Winter	-0.303	0.594	0.739	0.243	2.249
Spring	0 (b)	-	-	-	-

Sig: Significance, CI: Confidence interval, Exp (B): Exponentiation of the B coefficient, which is an odds ratio

Table 5. Logistic regression of viral and bacterial diseases from 2013 to 2018 in livestock species in Eastern Cape, South Africa (Caprine is the reference of comparison)

Species	Exp B	Sig	Odd ratio	CI (95%)	
				Lower bound	Upper bound
Ovine	0.547	0.469	1.728	0.393	7.608
Bovine	4.075	0.01	58.825	16.283	205.591
Caprine	0 (b)	-	-	-	-

Sig: Significance, CI: Confidence interval, Exp (B): Exponentiation of the B coefficient, which is an odds ratio

DISCUSSION

Disease, particularly infectious diseases, is an important limitation of biologically proficient livestock production. Endemic and foreign infections lead to morbidity and mortality and subsequently a decline in food production (Fitzpatrick, 2013). In South Africa, documented reports on the prevalence of bacterial infections, such as *Coxiella burnetii* and other viral species were last published in the 1970s and 80s (Adesiyun et al., 2020). In the present study, livestock viral and bacterial infections are prevalent in many local municipalities of ECP. In particular, a large proportion of viral diseases were reported in Lukhanji (29.4%), Intsika yethu (16.3%), and Mbhashe (17.5%) local municipalities.

In comparison, bacterial infection was frequently detected in Raymond Mhlaba (34.9%) and Nelson Mandela Bay (27.7%) local municipalities. Similar findings were reported in a serological survey of bovine diseases in Himachal Pradesh, India (Katoch et al., 2017). The prevalence of viral and bacterial infections in the present study was higher than in the Indian study. The likely reason for the difference may be geographical locations, endemicity of diseases, and the control and eradication programs for animal diseases in both countries.

In the present study, the highest prevalence was reported in 2018 for viral disease (45%) but the lowest in 2013 (4.7%), while bacterial infections (37%) were reported high in 2017, very low in 2013 (6.9%). Viral and bacterial diseases were more diagnosed in autumn (viral 53.8%) and spring (bacterial 58.5%). This contradicts the higher proportion of viral and bacterial diseases reported in summer in Pakistan (Khan et al., 2009). The reason for such difference remains unclear. However, there is evidence of climate change alteration of disease patterns. Favorable climatic conditions enhance pathogens to survive and replicate in the environment. Other factors that may shape the patterns of diseases in the present study include but are not limited to agro-climatic zones, temperature, disease surveillance tools, and seasonal variations (Lacetera, 2019). Changes in season are known to be associated with outbreaks of infectious diseases directly. Such disease incidences are positively related to climatic factors, such as rainfall, temperature, and relative humidity (Sivakumar et al., 2012).

This study reports the prevalence of bovine malignant catarrhal fever (BMCF, Table 1) to be 33.3%. Bovine malignant catarrhal fever is a severe and frequently fatal syndrome of susceptible hoofed animal species. Wildebeest are

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natural carriers or a host of BMCF. Often a significant number of infections in livestock is common with the wildebeest-livestock interface. Substantial economic losses associated with the disease have been recorded in areas with an elevated risk of infection (Lankester et al., 2015). The present study's finding aligns with another study investigating the molecular epidemiology of ovine herpesvirus type 2 infection in Kashmir, India (Wani et al., 2006). The study reported herpes virus-2 prevalence of 84.8% in sheep and 61.5% in goats. A similar study investigating the prevalence of bovine malignant catarrhal fever (herpesvirus-2) in four sheep breeds reports a higher prevalence of 85.7% and 63.6% in Dorper and Karakul. The study further reported a 75.7% prevalence in Dohne Merino sheep in Somerset East, South Africa (Bremer, 2012). The prevalence of BMCF in the current study might be due to the proximity of Adelaide and Somerset East to the surrounding forest, where wildebeests graze with livestock. The lack of wildebeest control measures such as fencing wildebeest away from livestock and actively grazing livestock away from wildebeest herds might explain the high transmission of the diseases to livestock in the ECP.

The prevalence of cowdriosis (63.4%) in the present study was high and similar to the result obtained in Ethiopia (Hailemariam et al., 2017). However, a lower prevalence (7%) was reported in a Nigerian study (Egbe-Nwiyi et al., 2018). Tick-borne diseases (TBD), such as anaplasmosis, babesiosis, cowdriosis, and theileriosis, constrain cattle production leading to considerable economic losses. One study notes that tick-borne diseases affect 80% of the cattle population worldwide and cost countries over 18.7 billion annually through vaccine procurement and deaths (Shekede et al., 2021).

Heartwater is often ignored in the endemic areas of South Africa, and proper diagnoses are usually only conducted for precious animals (Yawa et al., 2020). This leads to the prevalence rates of the disease being under-reported. Ticks such as *Rhipicephalus (Boophilus) decoloratus, R. evertsi, R. appendiculatus, Amblyomma hebraeum, R. simus, Ixodes pilosus, Hyalomma rufipes, R. follis, Haemaphysalis elliptica,* and *H. silacea* have been widely reported in the study area (Yawa et al., 2018). Farmers perceive ticks and ticks-associated diseases as the most critical disease problem their animals face in the ECP (Yawa et al., 2020). Moreover, more tick-borne disease outbreaks have been associated with the resistance of ticks to acaricides (Okuthe and Buyu, 2006).

Brucellosis poses a significant public health problem worldwide. However, the economic importance of animal brucellosis is felt most strongly by countries engaged in intensive livestock farming. The disease causes losses in production and constitutes a barrier to trade. In this study, the prevalence of bovine brucellosis was 73.2%. A survey in Sudan reported a similar prevalence of 63% (Madut et al., 2018). However, the lower prevalence was reported in seroprevalence studies conducted in Ethiopia (25.8%) and South Africa (1.45%). Bovine brucellosis is a controlled disease in South Africa. The high prevalence in the Eastern Cape Province could be due to the poor knowledge of the diseases. There is a lack of awareness about the disease among farmers in the Eastern Cape Province (Cloete et al., 2014). The bacteria can also contaminate a vast portion of grazing land and pasture during parturition. Livestock in the rural areas in Eastern Cape Province is generally grazed on communal pastures and can move over several kilometers. An infected animal could further spread the contamination of large areas as calving is not restricted to a specific place, such as a pen (Hesterberg et al., 2008). Hence, this could function as a source of infection for other animals within that community utilizing the same pasture.

Rabies is a preventable viral disease of humans and animals often transmitted through infected and carrier animals (Regea, 2017). Rabies is an overlooked and underreported zoonosis that is 100% deadly in untreated human beings and livestock, resulting in a substantial social and economic burden for humans (Jibat et al., 2016). Livestock rabies epidemiological information is very scanty. The current prevalence (32.6%) could indicate a growing rabies problem in the province. Surveillance and timely reporting of rabies cases are still insufficient. Hence, the burden of rabies in the region may be underestimated (Sittert et al., 2010). Wildlife species, such as yellow mongoose and dogs, have been reported as responsible for the spatial spread of rabies in the ECP (Sittert et al., 2010). As livestock grazes near forest pasture and shares the grazing field with infected wild animals, they are often attacked by yellow mongoose, leading to rabies virus transmission. Canine rabies is often the primary driver of rabies transmission in South Africa (Weyer et al., 2020).

The prevalence of bluetongue in the current study was 4.49%. This was in contrast with the 19.4% prevalence rate recorded in Western Sudan (Adam et al., 2014). Bluetongue is a vector-borne disease of immense economic importance for small and large ruminants (Sohail et al., 2019). It is a notifiable disease in South Africa, in terms of the Animal Diseases Act of 1984. However, the Act is not enforced, and generally, suspected outbreaks may not be confirmed or reported (Bergh et al., 2018). Bluetongue mainly infects sheep in South Africa, while goats and cattle are mostly sub-clinically infected (Bergh et al., 2018).

In this study, mastitis was 10%; however, a study in south Ethiopia reported a prevalence of 74.7% (Abebe et al., 2016). It has a complicated etiology and complex treatment and management methods. Many bacteria pathogens cause mastitis. Hence, differences in prevalence obtained in the current study with those obtained elsewhere would be likely due to causative agent, teat management measures, milking system, and animal health programs at the farm level (Iraguha et al., 2017). Mastitis is an inflammatory disorder of the mammary gland that negatively impacts the dairy

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industry. The economic consequences of mastitis consist of veterinary costs, the cost of discarded milk, increased workload, reduced milk production, and culling and replacement costs (de Jong et al., 2018).

CONCLUSION

The current study indicated that the prevalence of viral and bacterial diseases was significantly higher in spring and autumn than in winter and summer. Campylobacterosis and brucellosis are zoonoses which compromise food systems worldwide. Pathogens responsible for these infections have been listed among the top five foodborne disease causative agents. Lukhanji, Mbhashe, and Intsika yethu, South Africa recorded the highest viral disease rate, but few bacterial infections were recorded. Similarly, Raymond Mhlaba Nelson Mandela Bay and Makana recorded the highest proportion of bacterial diseases. The prevalence of bovine malignant catarrhal fever, cowdriosis, rabies, and bovine brucellosis was at the highest levels in Lukhanji, Raymond Mhlaba, Mbhashe, and Nelson Mandela Bay, respectively. The highest prevalence was reported in 2018 for viral diseases. However, viral infection was the lowest in 2013, while bacterial disease was reported higher in 2017 in the course of the study.

Disease prevalence obtained in this study poses a problem for sustainable animal production, food security, and public health in South Africa and other parts of the world. South Africa is a net exporter of livestock as well as meat and meat products, thus, the ramification of the study finding to export should be considered. Hence, all relevant stakeholders, including the Department of Rural Development and Agrarian Reform (DrDAR), the National Department of Agriculture, and related sector education training and authority (SETA), train farmers about coordinated dipping of animals. Such training will enhance farmers' ability to seek proper animal health measures for their farms. The government should also upgrade existing infrastructure such as fencing nearby forests to create a barrier between livestock and wild animals. Such barriers will mitigate livestock diseases like rabies and bovine malignant catarrhal fever in the study area.

DECLARATIONS

Competing interests
No potential conflicts of interest were reported by the authors.

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Authors' contribution
Ishmael Festus Jaja and Phingilili Wanga-Ungeviwa conceived, carried out the research, analyzed the data, and drafted the manuscript. Emmanuel Okechukwu Njoga edited the manuscript.

Ethical considerations
Ethical issues (including plagiarism, consent to publish, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy) have been checked by the authors.

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