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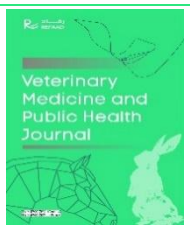

Retrospective Study of Anthrax Occurrence and Vaccination Coverage in South Ethiopia Region from 2019 - 2023

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Abstract:

Objectives: This study was aimed to assess the five- year (2019 - 2023) anthrax occurrence and vaccination coverage trend in the South Ethiopia Region to get valuable input for future intervention.

Methods: A retrospective study was conducted based on a five-year (2019 - 2023) anthrax occurrence and vaccination coverage report data retrieved from two regional laboratories in South Ethiopia and South Ethiopia Bureau of Agriculture Department of Animal Health.

Results: In this study, a total of 13 animal anthrax reported events were recorded in this five- year interval. The highest outbreak was recorded in South Omo zone 30.8% (4/13) and the lowest anthrax occurrence was reported from Ale, Basketo and Ari zone 7.7% (1/13). The highest vaccination coverage was in 2019 recorded at 2,899,001 doses followed by 2020 which was 2,788,136 and the lowest was recorded in 2021 was 1,106,997 doses. A total of 189 cases of anthrax in animals and 174 animal deaths due to anthrax were reported. The highest numbers of animal anthrax cases were reported in 2020 (n = 116) sharing 31.96% of the 5- year animal anthrax reported. The highest number of animal deaths due to anthrax (n = 72) in 2022. The overall cases fatality rate of anthrax was 47.93%. The highest cases of anthrax were registered in May (n = 64), and no anthrax cases were reported during November, December, and March. The highest and the lowest number of animal deaths due to anthrax were reported during October (n = 57) and April (n = 8), respectively.

Conclusion: Anthrax cases have occurred in all the seasons of the year; however, the relatively highest cases of anthrax were reported in the hot dry season (n = 78; 41.3%) whereas the lowest was reported during the post- rainy season (n=10; 5.3%). In conclusion, the current study showed a considerable number of animal anthrax cases and deaths in the South Ethiopia Region in five- year. Therefore, it is necessary to practice prevention strategies including immunization programs before the peak season of anthrax occurrence.

Keywords: *Animal anthrax; Ethiopia; Retrospective study; South Ethiopia Region.*

1 Introduction

Animal anthrax is an endemic disease in Ethiopia which occurs in May and June every year (anthrax season) in several farming localities of the country, although suspected cases of livestock anthrax are reported from several districts, few of those are officially confirmed (Shiferaw, 2004). The previous studies indicate that the disease is well recognized by rural communities but little is known about its prevalence, epidemiology and public health significance (Esser *et al*., 2003).

Anthrax is an acute disease of warm- blooded animals including human beings caused by spore-forming gram-positive, non-motile (Rahim *et al*., 2023). The name of the bacterium is derived from "anthrakis", the Greek word for coal; because Anthrax in humans causes black coal-like lesions on the skin at the site of incubation (Parthiban *et al*., 2015). Herbivorous and wild mammals are most infected by anthrax through ingestion or inhalation of spores while grazing. Ingestion is thought to be the most common route by which herbivores contract anthrax. Carnivores living in the same environment may become infected by consuming infected animals. Human usually become infected when they come into contact with infected animals or their products. Anthrax is primarily an occupational hazard for handlers of processed hides, goat hairs, bone products, wool, and infected wildlife. It can be also contracted by contact with meat (Boron *et al*., 2002).

Anthrax is a globally distributed disease, reported from all continents that are populated heavily with animals and humans. Animal anthrax outbreaks have been recorded in nearly 200 countries by The World Health Organization Collaborating Center for Remote Sensing and Geographical Information Systems for Public Health in 1996-1997 (Hugh-Jones, 2001). The data types recorded by The World Anthrax Data Site are: - country-of-origin, anthrax status, Vaccination program, species affected, year of outbreak, number of outbreaks during the year, number of cases, number of vaccinated, and total livestock population. The anthrax status of a given country may be classified in to one of the six categories: hyper endemic/epidemic, endemic, sporadic, probably free, free, and unknown (Inglesby *et al*., 2002; Mohamed *et al*., 2020). Animal anthrax is an endemic diseases and seasonal in Ethiopia which occurs in May and June every year in several farming localities of the country, although suspected cases of livestock anthrax cases are reported from several districts, few of those are officially confirmed (Hugh-Jones, 2001), posing a health risk to people who come into contact with infected animals. The disease is recognized by Ethiopian farmers as one of the most important livestock diseases (Gizaw *et al*., 2020) and it is ranked second only to rabies according to the recent joint-ministerial zoonotic disease prioritization exercise (Pieracci *et al*., 2016). The most efficient ways of preventing and controlling anthrax infection in domestic herds are suitable surveillance, annual vaccination of livestock, and proper carcass disposal management (Assefa *et al*., 2020). So the purpose of the study was to assess the five- year (2019-2023) anthrax occurrence and vaccination coverage trend in the South Ethiopia Region to get valuable input for future intervention.

2 Materials and Methods

2.1 Description of the Study Area

The study was conducted in the South Ethiopia Region, Ethiopia. The region is one of 12 regional states in Ethiopia (Figure 1). South Ethiopia (6°51'10"N and 37°45'16"E) is located in the southern part of Ethiopia, bordered by South Sudan and north Kenya. Geographically, it is located at an elevation of 395-4200 meters above sea level. The region's agro-ecology is characterized as semi-desert, kola (lowland), woynadega (midland), and dega (high-land). Pastoral and mixed farming system practice in a region which accounts for cattle 14,346,600, sheep 6,877,704, goats 11,625,831 donkeys 1,050,085, mule 189,193, horse 318,833 and Poultry 15,058,843 livestock in Regional state (2016 budget year data of the region) (SERSAB, 2024).

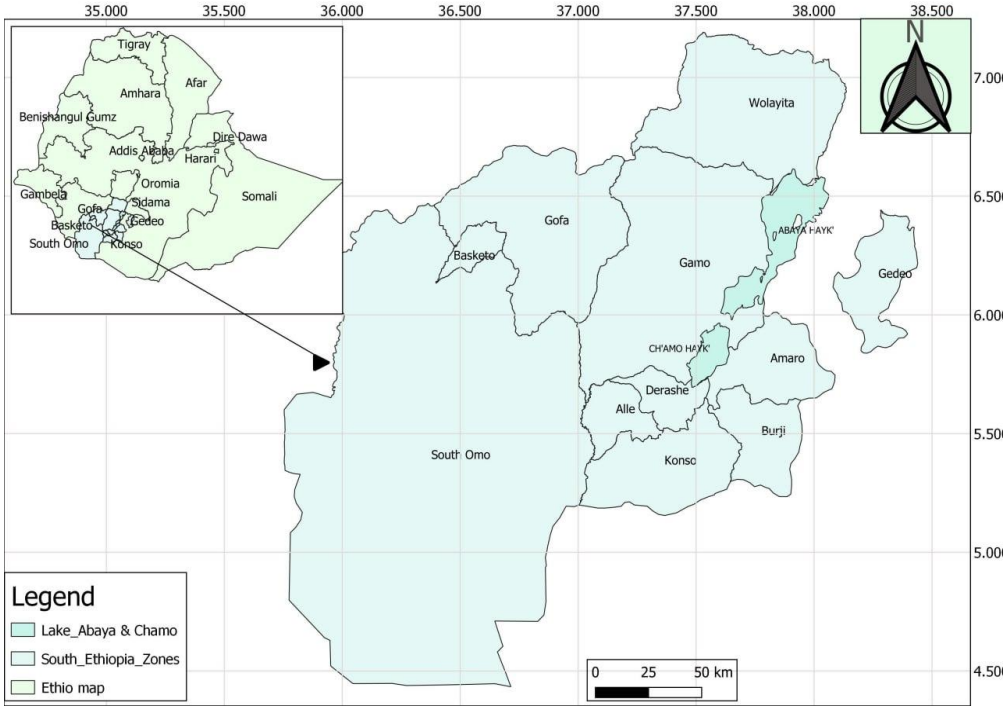

Figure 1: Map of Study Area.

2.2 Study Design, Population and Data Collection

A retrospective study design was conducted from data recorded for five years, from 2019 - 2023. The study population include: bovine and equine species, which were identified in the report. A structured data sheet was developed in Microsoft Excel to extract information on anthrax vaccination coverage, reported events, clinical cases, and animal deaths.

2.3 Source of anthrax data

Animal vaccination coverage, disease outbreaks, cases, and deaths associated with anthrax were collected retrospectively for five years (2019 - 2023) of recorded data from each zone in South Ethiopia. The data were extracted from Secondary data from annual vaccination coverage data from the Bureau of Agriculture five-year report, and Soddo and Jinka Regional Veterinary Laboratory monthly disease outbreak report DOVAR data sent from the district to the Regional Veterinary Laboratory from 2019 - 2023 were used to review the occurrence of anthrax disease in the region.

2.4 Case Definition

Bacillus anthraces are an obligate pathogen, having an incubation period of 3-7 days or ranging from 1-14 days. In herbivores, the clinical course ranges from acute to chronic (Pal *et al*., 2024). The per-acute form is characterized by sudden and rapid onset, staggering, dyspnea, trembling, collapse, and a few convulsive movements that may occur in cattle, sheep, or goats without any previous evidence of illness (Carter *et al*., 2004). Rigor mortis is absent or incomplete. Dark, tarry-like blood which does clot is evident at the mouth, anus, nostrils, and vulva (Pal *et al*., 2024). In the case of an acute form, there is an abrupt rise in body temperature and a period of excitement followed by depression, respiratory or cardiac distress, staggering, convulsion, and death. The body temperature may rise to 41.5°C, animals may abort and rumination ceases. Blood discharges from the natural body orifice; usually last about 48 hours (Oyda *et al*., 2019). In pigs and horses, there is fever, anorexia, and listlessness with edema of the throat, face, neck, and abdomen with petechial hemorrhage on the skin. Dysentery may be present with bloody froth at the nostrils (Tagesu, 2018). The chronic form is characterized by localized subcutaneous edematous swelling, most frequently at the area of the ventral neck, shoulders, and thorax (Fulako, 2004).

2.5 Data Analysis

Descriptive statistics was used to summarize the number of outbreaks, cases, and deaths that occurred in all zones during the five-year 2019 - 2023. The main variables that were considered in this study were the number of animals at risk, morbidity and mortality due to anthrax, the month and year, and seasonal distribution of anthrax outbreak, the prophylaxis and control vaccination coverage. The year was categorized into four seasons: rainy (June to August), post-rainy

(September to November), cold-dry (December to February), and hot-dry (March to May) seasons. The trend and distribution of anthrax cases by animals, place, and time were presented using graphs, and tables.

3 Results

A total of 363 animal anthrax case reports were found from 2019 to 2023, of which 174 were animal deaths due to anthrax. The highest proportion of animal anthrax cases was reported in 2020 (n=116), which shares 31.96% of the 5 years of animal anthrax reports. Similarly, animal anthrax the highest proportion of animal anthrax deaths due to anthrax (n= 72; 41.4%) was reported in 2022. In contrast, no animal anthrax case was reported in 2021. In this study, the overall case fatality rate of anthrax was 47.93 % (n=174) with the highest case fatality rate (62.61%) recorded in 2022 followed by 2019 (50%) (Table 1).

Table 1: The number of cases, Deaths, and Case Fatality Rate of Anthrax in South Ethiopia Region during 2019 – 2023.

Year	No. cases (%)	No. deaths (%)	PAR	Mortality rate %	Morbidity rate %	Case Fatality rate (%)
2019	40 (11.05)	20 (11.49)	2,200	0.91	1.82	50
2020	116 (31.96)	42 (24.14)	11,200	0.38	1.04	36.21
2021	0 (0.00)	0 (0.00)	0	0	0	0
2022	115 (31.68)	72 (41.4)	18,406	0.39	0.62	62.61
2023	92 (25.34)	40 (23)	79,329	0.05	0.12	43.48
Total	**363**	**174**	**111,135**	**0.16**	**0.33**	**47.93**

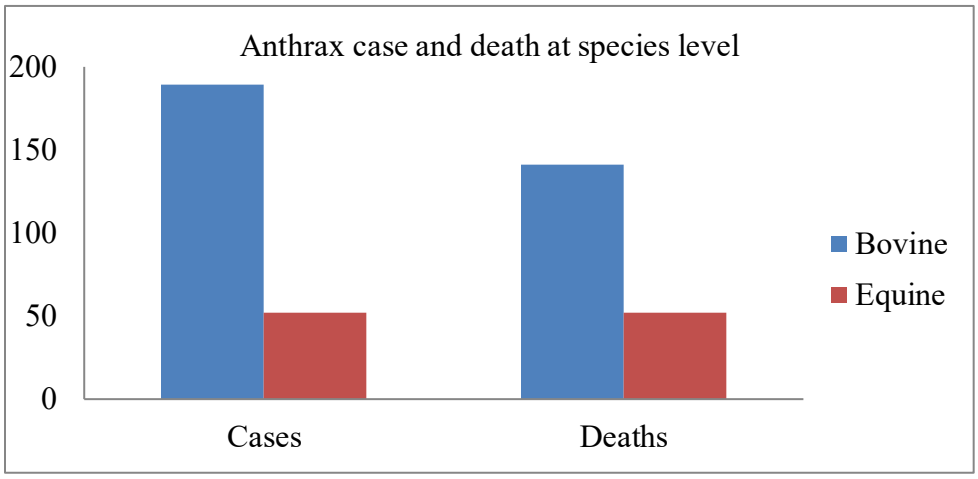

Figure 2: Distribution of animal anthrax among animal species affected in South Ethiopia Region, 2019 – 2023.

Among animals, the highest animal anthrax cases were recorded in bovine (n=363; 100%), and there were no cases of anthrax in other species. Similarly, the highest number of animal anthrax deaths were reported in bovine (n = 122; 70.11%) followed by Equine (n = 52; 29.89%) (figure 2). and there was no case and death of animal anthrax was reported in other species. In this study, the distribution of animal anthrax cases and deaths varies among districts in the South Ethiopia Region. The highest number of anthrax cases was reported in the Hamer district (n=69) followed by the Garda Marta district (n = 45). The highest number of animal deaths due to anthrax was reported in Hamer district (n = 68) followed by Kolango Zuria district (n = 52), While the lowest number of animal deaths was recorded in Salamago district (n = 1) (Figure 3).

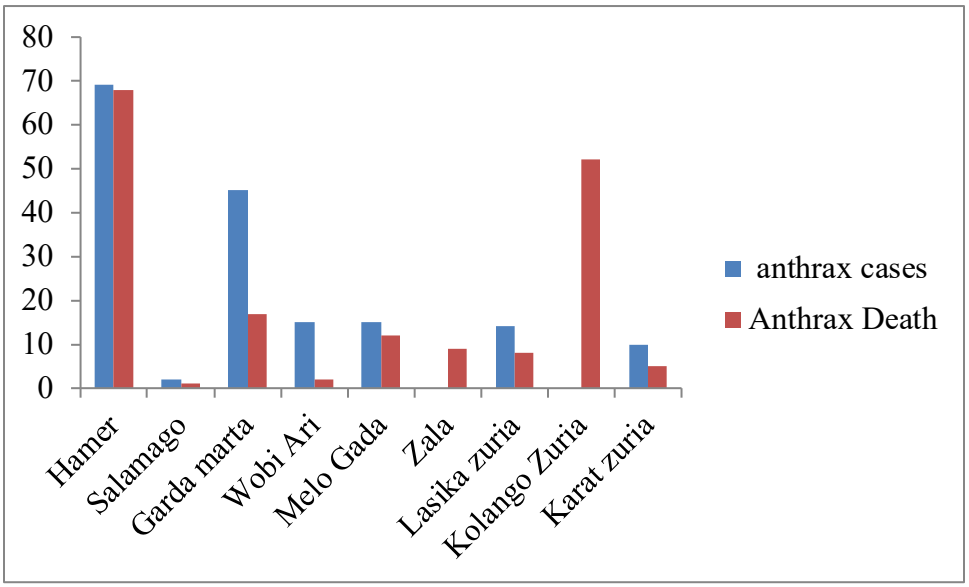

Figure 3: Distribution of animal anthrax across districts in South Ethiopia, 2019 – 2023.

According to the five years of recorded animal anthrax cases and deaths, the highest cases of anthrax were recorded in May (n = 64) followed by February (n = 39). The lowest number of animal anthrax cases was reported during October (n = 10) and no anthrax cases were in March, July, November and December during the five years. The highest number of animal deaths due to anthrax was reported during October (n = 57) followed by February (n = 37). In contrast, the lowest number of animal deaths due to anthrax was reported in April (n = 8) (Figure 4).

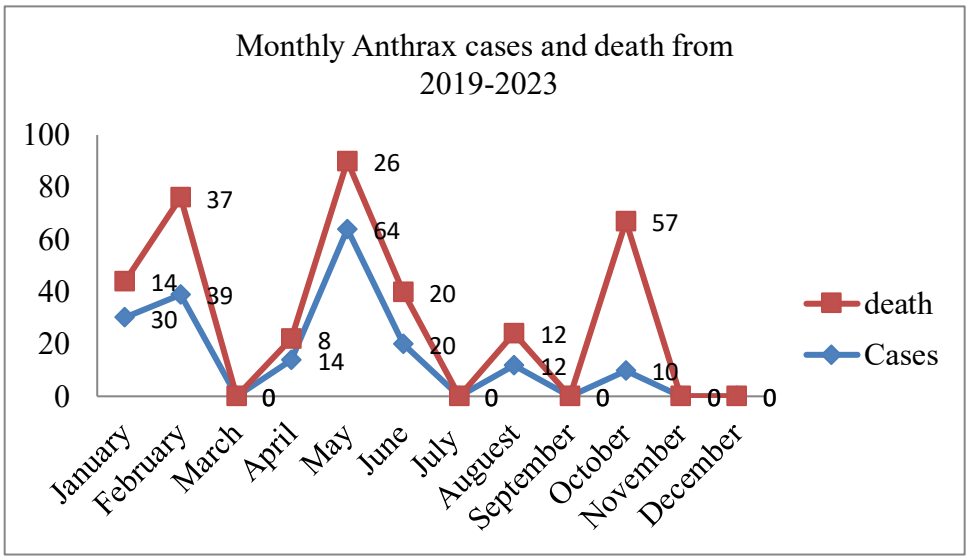

Figure 4: Monthly distribution of animal anthrax in South Ethiopia.

Seasonal distribution of anthrax cases and deaths were reported during the study period in all seasons. The Highest cases were reported in hot dry (n = 78) followed by cold dry (n = 69), and the lowest cases were reported in post rainy (n = 10). Death due to anthrax was higher in post rainy season (n = 57) followed by cold dry (n = 51) and the lowest death was reported in the rainy season (n = 32) (Figure 5).

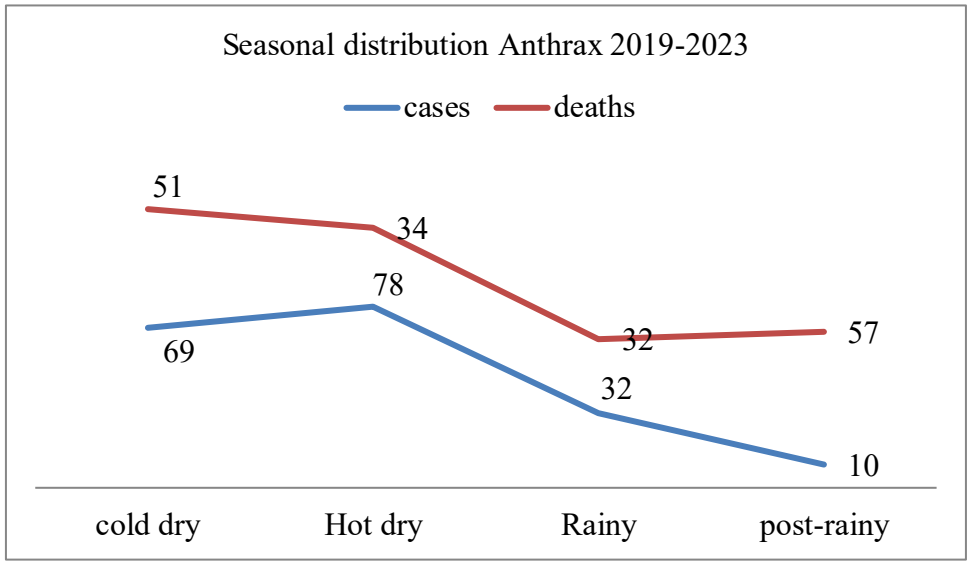

Figure 5: Seasonal distribution of animal anthrax in South Ethiopia 2019-2023.

The highest number of animal anthrax outbreaks registered in the South Omo zone (n = 4) followed by Konso and Gofa zone (n = 2) each and no animal anthrax report from Wolaita, Gedio, Garidula, Kore, and Burji zones, as shown in the table below.

Table 2: Animal anthrax outbreak in South Ethiopia, from 2019 - 2023

Zone	Anthrax outbreak
South Omo	4
Konso	2
Gofa	2
Gamo	2
Basiketo	1
Ari	1
Ale	1
Total	**13**

The number of animals vaccinated in a year is reported in Figure 5. It was noted that the highest number of animal anthrax vaccinated in 2019 (n = 2,899,001) dose and followed by (n = 2,788,136) dose and the lowest number of animals vaccinated in 2021 (n = 1,106,997) dose (Figure 6).

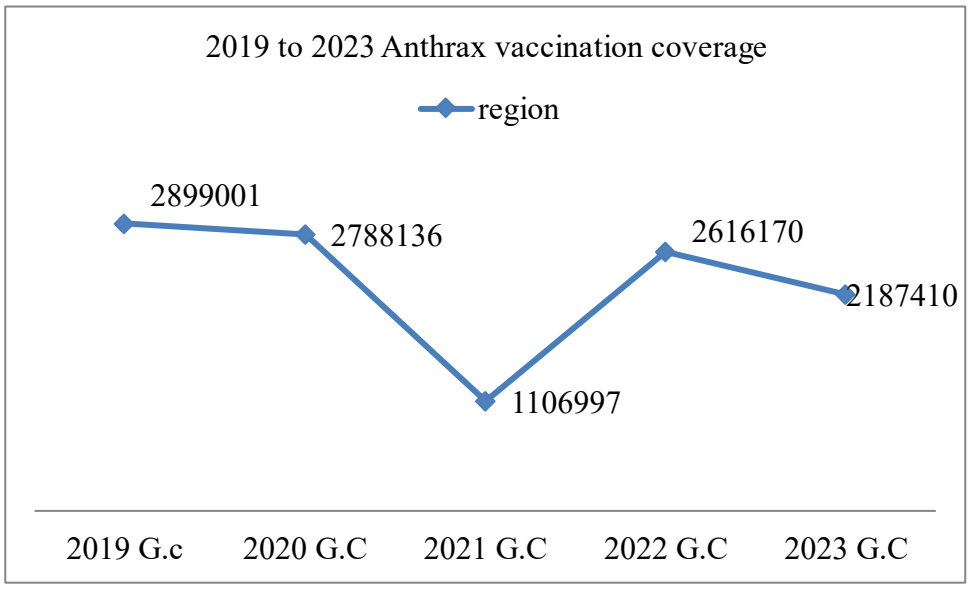

Figure 6: Anthrax Vaccination coverage in five years from 2019 -2023, in South Ethiopia.

4 Discussion

The Total number of animal anthrax outbreaks reported in the South Ethiopia region during the five years (2019 - 2023) was 13 from this Jinka and Wolaita Soddo Regional Laboratory 9 and Regional Bureau of Agriculture animal health department outbreak rumor log book 4 reported. Analysis of the temporal pattern of disease occurrence over the five year showed the highest outbreak reported in 2022 (n = 5; 38.46%) followed by 2020 (n = 4; 30.8%) and the lowest outbreak reported in 2019 (n = 1; 7.7%) and there was no anthrax disease outbreak reported in 2021. The absence of an animal anthrax outbreak report is because there is no law of compensation in Ethiopia, particularly true when livestock is a valuable household asset and the value of the meat could be lost if reported. Toward this, the Vietnamese Law of Infectious Disease and Control in 2007 mentioned compensation for financial losses of livestock owners to encourage them to notify local authorities about livestock dying of certain diseases (Luong *et al*., 2022).

The highest anthrax vaccination coverage was reported in 2019 (2,899,001) doses of domestic animals vaccinated were sheep, goats, cattle, and equines followed by 2020 (2,788,136) and 2022 (2, 616,170 doses), respectively. The lowest anthrax vaccination coverage report was recorded in 2021 which was 1,106997 doses. In 2020 even though there was high vaccination coverage there was a drought in south the Ethiopia region which triggered the occurrence of anthrax. During the dry season when pastures are scarce and the grass has become shorter, there is a high probability for animals to consume the grass together with soil particles often leading to abrasions in the mouth thus increasing chances of disease transmission in contaminated areas (John *et al*., 2024). The lowest disease outbreak was recorded in 2019 because the vaccination coverage of this year was highest compared to other years. In 2021 low vaccination coverage and no disease outbreak this contradicts, Poor coverage of livestock anthrax vaccination and ineffective vaccination in some livestock animals contributed to outbreaks of the disease. The improvement of anthrax vaccination coverage among livestock is also one of the most critical control strategies to control anthrax in Bangladesh (Mohamed *et al*., 2020).

The current study found that from year 2019 - 2023, a total of 363 animal anthrax cases and 174 animal deaths associated with anthrax were reported in South Ethiopia. In this study, the highest proportion of animal anthrax during the year 2019 - 2023 about 31.96% reported in 2020. This high proportion of anthrax cases in this period might be attributed to the occurrence of the longest-dry season, and low awareness and practices to manage the disease (Seyoum *et al*., 2022). The lowest number of animal anthrax was recorded in 2019. This might be due to good vaccination coverage, then outbreaks cannot occur until a sufficient number of young, non-resistant animals have been bred or non-immune animals from outside are introduced in the herd (Oyda *et al*., 2019). However, Anthrax is a potentially fatal naturally occurring infectious disease of warm-blooded animals (WHO, 2020). The highest animal anthrax 311 (85.7%) reports were recorded in bovines and 52 anthrax cases were recorded in equines for the past 5 years. These differences might be due to the grazing or browsing behavior of animals and animal owners' health-seeking behavior and attitude toward their animals (Seyoum *et al*., 2022).

In this study, variations in the proportion of cases and deaths associated with anthrax among zones in South Ethiopia were reported. The highest number of anthrax cases were recorded in the south Omo zone at 37.6% (71/189), followed by the Gamo zone at 33.9(64/189). The lowest number of anthrax cases was reported in the Basiketo zone 7.4% (14/189) followed by the konso zone 5.3% (10/89). The highest number of animal death due to anthrax were recorded in the South Omo zone at 39.7% (69/174) followed by the Ale zone at 30% (52/174), while the lowest number of animal death was recorded in Ari zone 1.15% (2/174). As the surveillance data from 2019-2023 indicates, more cases of animal anthrax were reported from the region's pastoralist and semi-pastoralist zones and districts. Those districts stated above were prolonged drought-affected areas of the region which led to a shortage of water and a shortage of feeds and grazing land-affected areas of the South region. This result similar study in Zimbabwe in 2024, the occurrence of anthrax in endemic areas is usually associated with pasture degeneration caused by over-utilization or drought. The condition of the pastures leads to nutritional stress and herbivores are forced to feed on heavily utilized short grass or herbs and thereby contract anthrax through ingesting soil containing the spores. Hence, the height of the grass in the grasslands and wooded areas has an influence on

the occurrence of anthrax outbreaks (John *et al*., 2024).

Variations in the proportions of animal anthrax cases among different months and seasons of the year were observed. The highest proportion of animal anthrax cases was reported in May (33.9%) followed by February (20.63%).

This result was similar to Shiferaw (2004), anthrax is an endemic disease and seasonal in Ethiopia which occurs in May (Shiferaw, 2004).

The seasonal distribution in this study indicated that anthrax cases occur in all seasons; however, the highest proportion of animal anthrax cases was reported during the dry season 33.05% (120/363) and followed by the short rainy season 30.9% (112/363).

This result was similar to studies conducted in the Amhara region, in the Awi administrative zone from 2011 to 2020, during the dry season in the study areas, it was noted that the vegetation for grazing was depleted and became short, which led the animals to close grazing to the ground. This significantly increases the chance of contracting *B. anthracis*. During long-dry seasons of the year, vegetation was scarce or short. The lowest proportion of animal anthrax cases was recorded in the rainy season 17.63% (64/363) during heavy rainy seasons, there may be soil disturbance, which results in ease of exposure of animals to the spores of *B. anthracis* leading to high numbers of cases or probably to outbreaks (Seyoum *et al*., 2022). The current study revealed that during the 5 years, there was no report of animal anthrax in November, December and March.

5 Conclusion and Recommendations

The current study showed that a considerable number of animal anthrax cases and deaths occurred in South Ethiopia, with varying degrees among different species of susceptible animals, months/seasons, and districts. In this study, the highest number of cases of anthrax was registered in May and during the hot-dry season; that calls for the need for practicing prevention strategies including immunization programs before the peak season of anthrax outbreaks. Based on the above conclusion, the following recommendations are forwarded:

- In outbreak investigation, data collection format must be necessary to collect data during disease outbreaks from kebele for district-level confirmatory diagnosis disease.
- The prevention programs through vaccination must be conducted before the peak season of an outbreak.
- Continuous data analysis and feedback to all stakeholders should to be conducted on regular bases to improve quality of both human and animal surveillance data, since anthrax was zoonotic and life-threatening, a single case of anthrax must be reported.

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