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INVESTIGATING A SHEEP ANTHRAX OUTBREAK IN MUDDABALLI VILLAGE, KARNATAKA, INDIA: AN INTEGRATED STUDY OF DEMOGRAPHIC, ECOLOGICAL, SOCIO-ECONOMIC, AND RISK FACTORS

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ABSTRACT
Anthrax, caused by *Bacillus anthracis*, is a persistent global threat to both public health and livestock industries. This study investigates a outbreak of sheep anthrax in Muddaballi Village, Karnataka, India. The demographic and ecological characteristics of this region are pivotal factors influencing disease emergence, with varying outbreak years observed among sheep farmers. Socio-economic factors and Risk and Emergency Management Behaviour (REMB) were found to be critical determinants of anthrax incidence, emphasizing the multifaceted nature of the disease's spread. Sheep migration and proximity to water bodies, notably the Tungabhadra reservoir, facilitated spore transfer and contributed to the outbreak in this village. The study highlights the urgency of proactive measures, including comprehensive disease surveillance, vaccine accessibility, training initiatives for local veterinarians and farmers, and the integration of AI tools for early detection and rapid response.

KEYWORDS: Anthrax outbreak, Sheep anthrax, Disease surveillance, Livestock trading, Disease prevention.

INTRODUCTION
Anthrax is an acute, infectious, non-contagious, zoonotic disease that remains a threat to public health throughout the world. The causative agent of anthrax is *Bacillus anthracis*, which is a rod-shaped, spore-forming, soil-borne bacterium that survives in the soil under suitable conditions for long periods of time. *B. anthracis* is an extracellular pathogen that replicates rapidly in the blood, conquering high density to make the host diseased. The soil pH, organic calcium, potassium, and zinc concentrations of soil are believed to be correlated with the survival of spores. Animals come into contact with the spores by grazing grass closer to the surface when the grass is low or scarce, or by moving herds to restricted areas when water is scarce (Suresh et al., 2022). The spores are very resistant to unfavourable environmental extremes of heat, cold, desiccation, chemicals and irradiation. The incidence of anthrax varies with the type of the soil and climate. It is many times restricted to a particular area where it is endemic and such areas are known as “Anthrax belts”. Cattle and sheep are very susceptible to anthrax and dogs and cats are quite resistant. There are only few reports of anthrax outbreak in domestic animals in India. Venkatesha, et al., (2006) reported 2 anthrax outbreaks in Hassan and Kolar districts of Karnataka State.

CASE PRESENTATION: DEMOGRAPHY, ECOLOGY AND POPULATION DYNAMICS OF MUDDABALLI VILLAGE, KOPPAL TALUK, KOPPAL DISTRICT
Muddabalii in Karnataka, India, falls under village location code 601779 and is situated in Koppal taluk of Koppal District. It is positioned 10.2 km away from the District and Sub district headquarters at Koppal. The total geographical area of village is 1048.88 hectares with coordinate’s 5°12'33.4"N Latitude 75°56'12.3"E Longitude (Fig 1.0) Muddaballi has a total population of 2,450 peoples, out of which male population is 1,223 while female population is 1,227. Literacy rate of Muddaballi village is 64.90% out of which 74.65% males and 55.18% females are literate. In the village of Muddaballi, the livestock population comprises 756 cows, 82 buffaloes, 1129 sheep, and 312 goats, totalling 2279 animals (Table 2).

Table 1: Demography of Muddaballi Village, Koppal	
Area	1048.88 ha
Latitude	5°12'33.4"N
Longitude	75°56'12.3"E
Altitude	526 mt
Population	2,450
Literacy rate	64.90%

Table 2. Livestock Populationn			
Cow	Buffalo	Sheep	Goat
756	82	1129	312
Total=2279			

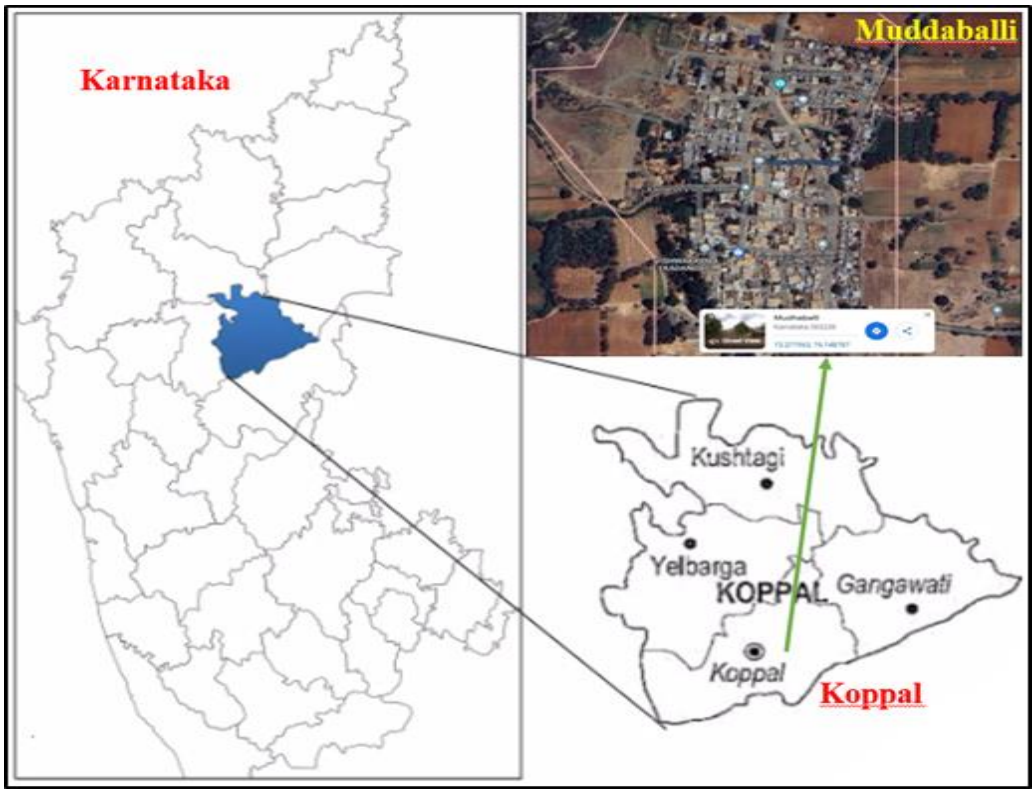

Fig. 1: Google map of Muddaballi Village, Koppal.

The ecology of Muddaballi village of Koppal district is characterized by its semi-arid climate, diverse vegetation, wildlife adapted to dry conditions, agricultural practices and the influence of human activities. The Tungabhadra reservoir, situated at Munirabad and bordering Muddaballi village, serves as a primary water resource for nearby villages and also tube wells are major source of water needs for both agriculture and livestock. The region experiences an average annual temperature of 27.0°C, receives around 587 mm of rainfall annually over 30-40 days, maintains an average annual wind speed of 5.18 meters per second, and sustains an average annual pressure ranging between 1008-1010 millibars (Table 3).

The soil type prevalent in the area is primarily composed of Red Loamy soils, which are known for their fertility and suitability for agriculture. Agriculture in this region relies on both rainfed and irrigated methods, with tube wells being a common irrigation source. Major crops cultivated in this region include maize, sugarcane, sorghum, pigeon pea, black gram, green gram, cowpea, and groundnut, reflecting a diverse agricultural landscape that caters to various food and economic needs.

Table 3: Ecological, Soil type and Cropping pattern of Muddaballi village.

1.Ave. annual Temperature	27.0 °C
2.Ave. annual Rainfall	587 mm
3.Ave. annual Rainfall days	30-40 days
4.Ave. annual wind speed	5.18mt/sec
5.Ave. annual pressure	1008-1010 mb
6. Soil type	Red Loamy soils
8. Major crops	Maize, sugarcane, sorghum, pigeon pea, black gram, green gram, cowpea, groundnut

Analyzing Patterns, Risk Factors, and Community Responses to Sheep Anthrax in Muddaballi Village

In a survey conducted in Muddaballi village, sheep anthrax cases were recorded among various farmers (Table 4 & Fig. 2). The analysis of anthrax incidence among sheep farmers revealed varying outbreak years. In 2016, MH had 200 sheep, and 4 of them were infected or died due to anthrax. In 2023, three farmers experienced anthrax issues: BP had 100 sheep with 20 deaths, RP had 100 sheep with no anthrax cases, and GH had 80 sheep with 8 deaths. Additionally, BP and KH each had 70 and 100 sheep in 2023, with 4 and 10 deaths, respectively. In 2021, MP had 150 sheep, and 25 of them were affected by anthrax.

The questionnaire responses showed that most farmers strongly agreed on the influence of socio-economic factors in anthrax incidence (Likert Scale: 5). Additionally, farmers generally acknowledged the significance of Risk and Emergency Management Behaviour (REMB) in anthrax prevention (Likert Scale: 4-5). However, there was variability in responses regarding the relevance of migration patterns (Likert Scale: 1-5). Despite experiencing anthrax outbreaks in different years, their agreement levels vary significantly. While some farmers consistently express strong agreement across all domains, others exhibit mixed responses, suggesting that their perception of risk, preparedness, and migration behaviour may be influenced by individual circumstances or experiences with anthrax. Overall, the data underscores the complexity of farmer attitudes and preparedness in the face of anthrax incidents.

DISCUSSION

Anthrax, an enduring conundrum in numerous regions, presents a significant public health peril owing to its propensity for infecting livestock.

Table 4: Data of Anthrax of Sheep at Muddaballi village.

Sl No.	Farmers Name	Total No of Sheep's	No of Sheeps died (Anthrax)	Year in which anthrax occurred/ not occurred	Questionnaire # (Likert Scale: 5 = strongly agree, 4= agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree)							
					Socio-economic		REMB		Migration		Preparedness	
					I	II	I	II	I	II	I	II
1.	MH	200	4	2016	5	5	5	5	5	5	5	5
2.	BP	100	20	2023	1	5	5	4	5	4	5	5
3.	MP	150	25	2021	5	4	5	4	5	5	5	5
4.	RP	100	0	2023	5	4	5	5	5	4	5	5
5.	GH	80	8	2023	5	5	5	5	5	5	5	5
6.	BP	70	4	2023	2	4	5	5	5	4	5	5
7.	KH	100	10	2023	2	5	5	5	5	4	5	5

Questionnaire #
Socio-economical: I. Do you think you're hesitant to dispose anthrax affected carcass in a way that goes against your religious teachings? **II.** Do you think you avoid social gatherings and public spaces due to fears related to the anthrax outbreak?
Risk Exposure and Mitigation behaviour (REMB): **I.** Do you think anthrax spores can survive in the soil for extended periods, posing a risk to grazing livestock? **II.** Do you think inadequate disease surveillance measures have hindered early detection of anthrax outbreaks?
Migration: I. Do you think unregulated movement of people and livestock can contribute to the spread of anthrax to unaffected areas? **II.**: Do you think shifting of animals or change of grazing area from infected to uninfected area is effective in avoiding occurrence of anthrax?
Preparedness: I. Do you think collecting and analysing data helps identify patterns and trends in anthrax cases? **II.** Do you think prior anthrax outbreak information is important for preparedness?

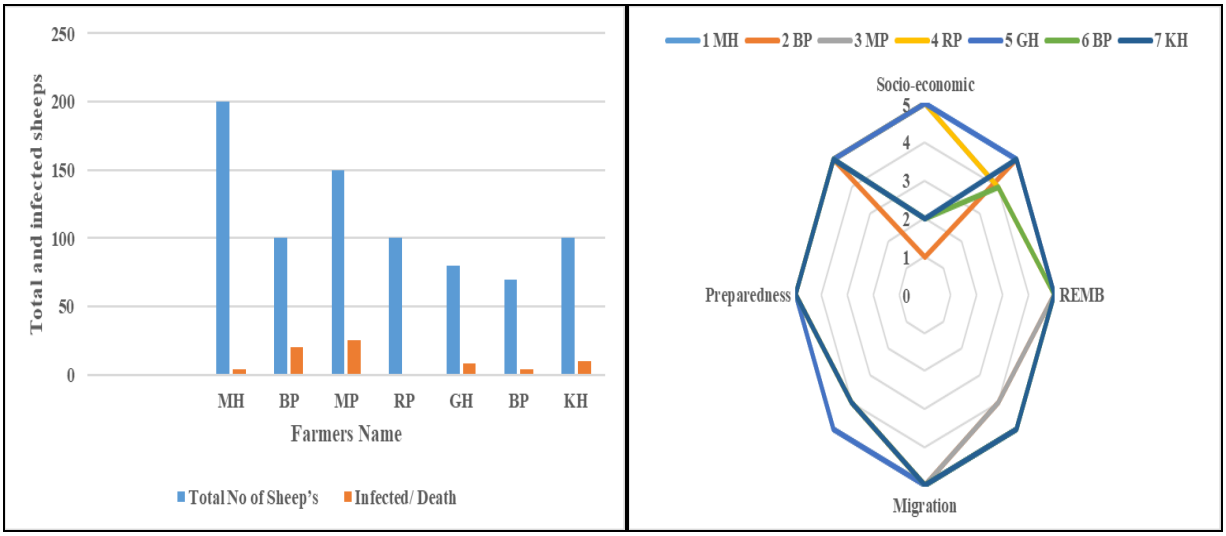

Fig. 2: Data of Anthrax of Sheep and Questionnaire details of farmers at Muddaballi village.

The field diagnosis hinges upon clinical manifestations, particularly the occurrence of abrupt mortality accompanied by exudation of non-coagulated blood from natural orifices. Mongoh et al. (2005) discerned pivotal clinical indicators, encompassing the sudden demise of afflicted animals and the manifestation of hemorrhagic symptoms. Anthrax outbreaks typically arise from the ingestion of spores residing within the soil, frequently intertwined with antecedent incidents and the disposal of deceased animals. The contemporary outbreak has unveiled two distinct infection categories: the per-acute variant, characterized by unforeseen fatalities devoid of overt clinical manifestations, and the acute form, distinguished by discernible symptomatic presentations and the potential for case recovery. Bodies of water and the seasonal migration of sheep to the Tungabhadra reservoir have played a pivotal role in facilitating the transfer of anthrax spores, thereby exacerbating the outbreak dynamics within this locality. In the environs of Muddaballi Village, livestock husbandry and commerce constitute integral components of the local economic fabric, albeit they concurrently pose formidable disease transmission risks within the precincts of local markets. These risks are further compounded by the inadequacies in veterinary oversight and the persistent adherence to traditional practices. To mitigate the proliferation of disease through the marketing of animals, an imperative call for the dissemination of knowledge, implementation of quarantine measures, and collaborative engagement with authorities to uphold the well-being of both animals and humans alike.

CONCLUSION

The case report of the sheep anthrax outbreak in Muddaballi Village, Koppal, Karnataka, highlights the complex interplay of factors contributing to the disease's emergence. The demographic and ecological characteristics of the region, coupled with traditional livestock trading practices, pose significant challenges in disease prevention and control. To mitigate future outbreaks, it is imperative for the government to take proactive measures. This includes allocating resources for comprehensive disease surveillance, ensuring a consistent supply of anthrax vaccines, conducting regular training sessions for local veterinarians and farmers, and establishing robust early detection and rapid response mechanisms using Artificial intelligence (AI). Engaging with the community, dispelling myths, and fostering trust is crucial, as is collaborating with international organizations to strengthen disease management efforts. Addressing these aspects holistically is essential for safeguarding the health and livelihoods of both the community and their livestock in Muddaballi Village and similar regions.

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Authors Contribution

The study on the anthrax epidemic in Muddaballi Village, Karnataka, was a collaborative effort led by Suresh K P, who served as the corresponding author and played a pivotal role in designing and executing the

research. Sagar N, Jayashree A, Naveesh Y B, and Sushma R contributed significantly to data collection and analysis, particularly in gathering vital demographic and ecological information about the village. They also assisted in the analysis of collected data while providing support in manuscript editing. Suresh K P and Ramesh Doddamani brought an international perspective, lending expertise in analyzing ecological factors and their influence on the anthrax outbreak. Hemadri D, Ramesh Doddamani and S S Patil, experts in veterinary epidemiology contributed to identifying the anthrax-prone area in Koppal and provided brief information regarding the preparation of the questionnaire, in addition to editing the manuscript.

REFERENCES

1. Suresh, K.P.; Bylaiah, S.; Patil, S.; Kumar, M.; Indrabalan, U.B.; Panduranga, B.A.; Srinivas, P.T.; Shivamallu, C.; Kollur, S.P.; Cull, C.A.; et al. A New Methodology to Comprehend the Effect of El Niño and La Niña Oscillation in Early Warning of Anthrax Epidemic Among Livestock. *Zoonotic Dis*, 2022; 2: 267-290.
2. Venkatesha, M. D, et. al. (2006): Anthrax- a study in Karnataka state. *Intas-Polivet*, 7(2): 307-312.
3. Mongoh, M. N., et.al.(2005): Characterization of an outbreak of anthrax in animals in North Dakota: 243 cases. *Bovine-Practitioner*, 41(2): 101-109.