

# A Retrospective Study on Snake Bite Fatalities at a Tertiary Care Hospital in Visakhapatnam (2021 -2023)

Gummadi Venugopal Rao<sup>1</sup>, Mopuri Venkateswarlu<sup>2</sup>, Srinivasa Rao Vavilapalli<sup>3</sup>,  
Devaraj Boddepalli<sup>4</sup>, Hari Krishna Chowdary Lingampalli<sup>5</sup>,  
Mamatha K<sup>6</sup>, Kattamreddy Ananth Rupesh<sup>7</sup>

<sup>1</sup>Associate Professor of Forensic Medicine and Toxicology, Government Medical College, Sangareddy, Telangana State, <sup>2</sup>Associate Professor of Forensic Medicine and Toxicology, ACSR Government Medical College, Nellore, Andhra Pradesh, <sup>3</sup>Assistant Professor of Pathology, Andhra Medical College, Visakhapatnam, Andhra Pradesh, <sup>4</sup>Resident, Department of Forensic Medicine and Toxicology, Visakhapatnam, Andhra Pradesh, <sup>5</sup>Resident, Department of Forensic Medicine and Toxicology, Visakhapatnam, Andhra Pradesh, <sup>6</sup>Professor and Head, Department of Forensic Medicine and Toxicology, Visakhapatnam, Andhra Pradesh, <sup>7</sup>Assistant Professor of Forensic Medicine, Andhra Medical College, Visakhapatnam, Andhra Pradesh.

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## Abstract

Snake bite remains a significant clinical toxicology concern in India, particularly in rural areas where access to medical care is limited, delays in treatment are common, and faith healing is often sought. This study analyses the epidemiology of snakebite fatalities at King George Hospital, Visakhapatnam (2021-2023), focusing on sociodemographic patterns, geographical distribution, seasonal trends, and venom toxicity types. All cases with a confirmed history of snakebite were included. Results indicate a higher prevalence among middle-aged male farmers, with the monsoon season posing the highest risk. The lower limb was the most common bite site in farmers, with a marginal occupational association ( $p = 0.080179$ ). However, the time of bite showed no significant correlation with venom toxicity type ( $p = 0.214918$ ). Public education on venomous snake identification, first-aid measures, and prompt antivenom administration are essential to reducing fatalities. Vulnerable populations, particularly agricultural workers, must exercise keen caution during the monsoon season and adopt protective measures such as wearing appropriate clothing and footwear.

**Keywords:** Snake bite, Envenomation, Autopsy, Anti Snake Venom, Chrono-fatality.

## Introduction

Snake-bite fatalities remain a significant public health concern across various regions globally. The

wide range of geographical landscapes and diverse habitat in India are responsible for the high incidence of snake-bite cases apart from agrarian snake-human

**Corresponding Author:** Gummadi Venugopal Rao, Associate Professor of Forensic Medicine and Toxicology, Government Medical College, Sangareddy, Telangana State.

**E-mail:** venugopalgummadi99325@gmail.com

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encounters. Of the approximately 3,000 snake species recognized globally, only about 15% are venomous and have the potential to cause fatalities in humans through their bites<sup>1</sup>. The Elapidae and Viperidae families comprise two major groups of venomous snakes responsible for most of the snakebite fatalities<sup>2</sup>. India harbours more than 60 species of venomous snakes. Among these, four highly venomous species, the common cobra (*Naja naja*), Russell's viper (*Daboia russelii*), common krait (*Bungarus caeruleus*), and saw-scaled viper (*Echis carinatus*), are extensively distributed across the region. These species are collectively and conventionally designated as the "Big Four"<sup>3</sup>.

Snakebite fatalities in India constitute nearly half of all snakebite-related deaths worldwide annually. Between 2000 and 2019, India recorded an estimated 1.2 million snakebite deaths, equating to an average of approximately 58,000 deaths per year<sup>4</sup>. Individuals residing in rural households, particularly those near farms, as well as those engaged in agricultural and related activities, are more susceptible to snake encounters. This heightened exposure increases the likelihood of snakebites, resulting in significant mortality and morbidity within these populations<sup>2</sup>.

This present study aims to analyse the epidemiology of snakebite fatalities at King George Hospital, Visakhapatnam (2021–2023), focusing on sociodemographic patterns, geographical distribution, seasonal trends, and venom toxicity types.

### Materials and Methods

All cases with a history of snakebite, either clinically confirmed or eye witnessed, were included, while other cases were excluded. The study analysed autopsy findings of snakebite fatalities conducted between 2021 and 2023 at the Department of Forensic Medicine, Andhra Medical College, King George Hospital, Visakhapatnam. Data were collected from medical records, death summaries, inquest reports and autopsy records, tabulated in Microsoft Excel, and analysed. The Institutional Ethics Committee approved the study.

### Results

This study included a total of 30 snakebite fatality cases, comprising 21 males (70%) and 9 females

(30%). The age distribution of cases is detailed in Table 1. Regarding locality, 86.67% of the victims were from rural areas, while 13.33% were from urban areas (Table 2). In terms of occupation, 60% were farmers, 26.67% were students, and 13.33% belonged to other professions. Based on snake venom toxicity, 50% of cases were attributed to neurotoxic bites, 40% to hemotoxic bites, and 10% to unknown toxicity (Table 3).

Concerning the time of envenomation, 33.33% of victims were bitten during the daytime (6 AM to 6 PM), while 66.67% were bitten at night (6 PM to 6 AM). Seasonal distribution showed that 10% of cases occurred in winter, 23.33% in summer, and 66.67% during the rainy season (Table 4). The lower limb was the most commonly affected body part (63.33%), followed by the upper limb (23.33%) and other regions (13.34%) (Table 5).

Survival analysis revealed that 26.66% of victims succumbed within 6 hours, 13.33% between 6 to 12 hours, 10% within 24 hours, 13.33% within 48 hours, and 36.67% survived for more than 2 days after envenomation (Table 6).

**Table 1: Age Distribution of Snake Bite Death Cases**

Age	No. of victims		Percentage
	Males	Females	
0-10	3	0	10%
11-20	3	2	16.67%
21-30	1	0	3.33%
31-40	6	3	30%
41-50	2	1	10%
51-60	1	2	10%
>60	5	1	20%
	<b>21 (70%)</b>	<b>9 (30%)</b>	<b>100%</b>

**Table 2: Distribution of Locality of Victims**

Locality	No. of victims	Percentage
Rural	26	86.67%
Urban	4	13.33%

**Table 3: Type of Toxicity of Snake**

Toxicity	No. Of victims	Percentage
Neurotoxic	15	50%
Hemotoxic	12	40%
Unknown	3	10%

**Table 4: Seasonal Distribution of Snake Bites**

Seasons	No. of victims		Percentage
	Day	Night	
Winter (Nov to Feb)	1	2	10%
Summer (March to June)	2	5	23.33%
Rainy (July to Oct)	7	13	66.67%
	<b>10</b> (33.3%)	<b>20</b> (66.7%)	100%

**Table 5: Part of the Body Involved**

Body part	No. of victims	Percentage
Upper limb (arm/forearm/wrist/hand)	7	23.33%
Lower limb (ankle/foot)	19	63.33%
Other	4	13.34%

**Table 6: Period of Survival Between Snake Bite and Death**

Period of survival	No. of victims	Percentage
0-6 hours	8	26.67%
6-12 hours	4	13.33%
12-24 hours	3	10%
24-48 hours	4	13.33%
> 2 days	11	36.67%

In farmers, the lower limb was the most common bite site, showing a marginal association with occupation (p-value = **0.080179**). In contrast, the association between the time of the bite and the type of snake venom toxicity was not statistically significant (p-value = **0.214918**).

### Discussion

In the present study, out of 30 cases, 21 (70%) were males, and 9 (30%) were females, indicating that males are more commonly the victims of snakebites. This can be attributed to the fact that in India, males predominantly engage in outdoor work, increasing their risk of accidental exposure to snakebites compared to females. The findings of this study are consistent with those reported by Kumar et al.<sup>5</sup>, V. Rajashekar et al.<sup>6</sup>, Katta Sri Ram et al.<sup>7</sup>, and Mohapatra et al.<sup>8</sup>

The most commonly affected age group was 31–40 years (30%), followed by >60 years (20%). These values are consistent with the findings of Katta Sri Ram et al. and Vinay J et al.<sup>9</sup> but are discordant with those of Kumar et al. and V. Rajashekar et al.

In the current study, 86.67% of the victims were from rural areas, while 13.33% were from urban areas. This highlights the increased incidence of snakebites in rural areas along with the limited availability of facilities for early treatment. Similar findings were reported by V. Rajashekar et al. and Rakhi Dandona et al.<sup>10</sup>, where the majority of patients also belonged to rural areas.

In the current study, 60% of the victims were farmers, aligning with findings from comparative literature. This emphasises the higher risk of snakebites among individuals working in agricultural fields, as these areas serve as natural snake habitats. The highest number of snakebite-related deaths occurred during the monsoon season (66.67%), followed by summer (23.33%) and winter (10%). The increased incidence in the monsoon season is likely due to heightened agricultural activity. These findings are consistent with those of V. Rajashekar et al., and Vinay J et al.

In the study population, 36.67% of victims survived for more than 2 days, while 26.66% succumbed within 6 hours, and 13.33% survived between 6 to 12 hours after the bite. These findings contrast with the studies by V. Rajashekar et al. and Katta Sri Ram et al., where most victims succumbed within 6 to 24 hours.

In the current study, snakebites occurred most frequently on the lower extremities (63.33%), followed by the upper extremities (23.33%) and other body parts (13.34%). These findings align with comparative literature, as snakes are ground-dwelling, and the legs are the most accessible. Activities like walking barefoot, farming, and moving through vegetation increase exposure, with bites often occurring defensively when snakes are stepped on or disturbed, particularly in rural areas during nights.

In the current study of 30 victims, 50% were bitten by neurotoxic snakes (cobras and kraits), 40% by hemotoxic snakes (vipers), and 10% by unidentified species. The same has been deduced from the clinical

phenotype before death. These findings align with V. Rajashekar et al. and Katta Sri Ram et al. but differ from Peranantham et al.<sup>11</sup> and Vinay J et al. Additionally, 66.67% of bites occurred between 6:00 PM and 6:00 AM (night), consistent with Peranantham et al. but contrasting with Katta Sri Ram et al., who reported more cases between 6:00 AM and 6:00 PM (day).

India's "Big Four" venomous snakes exhibit distinct activity patterns influencing bite risks. The Indian Cobra (*Naja naja*) and Russell's Viper (*Daboia russelii*) are primarily diurnal and crepuscular but may also show nocturnal activity in warm conditions. In contrast, the Common Krait (*Bungarus caeruleus*) is strictly nocturnal, often biting people in their sleep, while the Saw-scaled Viper (*Echis carinatus*) is also mainly nocturnal but may bask during early mornings or late evenings. Studying the associations between venom toxicity type and bite timing has limitations since envenomation syndromes overlap. A more accurate approach is utilising species-specific bite timing to understand chronofatality. However, species identification is a challenging task in most of the cases<sup>12</sup>.

Cobras and kraits bite defensively, with cobras displaying their hood as a warning, while vipers, particularly saw-scaled vipers, are highly aggressive and strike quickly when provoked. Kraits, being less aggressive, tend to avoid confrontation; however, their nocturnal activity increases accidental encounters, often occurring during sleep when individuals unknowingly roll over them. In contrast, cobras are more active during the day and transition hours like the dawn and dusk<sup>12</sup>.

The distribution of these snakes is influenced by prey availability, with rodents, lizards, and amphibians forming a major part of their diet. As a result, they are commonly found in agricultural fields, wetlands, grasslands, backyards, gardens near human settlements, and abandoned areas<sup>12</sup>.

Snake activity is also seasonally influenced. During winter hibernation, they remain largely inactive, sheltering in burrows, leading to fewer human encounters and snakebite incidents. However, as temperatures rise, snakes emerge to regain energy, seek food, and prepare for breeding, resulting in increased activity and a rise in snakebite

cases. The breeding season further heightens human encounters, particularly for kraits and Russell's vipers, whose breeding coincides with the monsoon season. Additionally, increased agricultural activity, prey abundance, lack of shelter, and the search for warm places during the rainy season contribute to a peak in snakebite incidents. These trends align with the findings of the present study<sup>12</sup>.

Confirming snakebite as the cause of death can be difficult without clear physical evidence like fang marks or local toxicity manifestations, but Radioimmunoassay (RIA) offers a highly sensitive method for detecting venom antigens. By using radioactively labelled antibodies that bind to venom components, RIA can accurately quantify venom even in low concentrations, making it useful in postmortem investigations and clinical diagnoses. However, its use is limited by the need for specialized equipment, radioactive materials, and trained personnel, as well as challenges like cross-reactivity and venom metabolism. Despite these limitations, RIA remains an important tool in confirming envenomation and guiding treatment.

Snakebite fatalities are a persistent public health challenge in India, disproportionately affecting rural populations, particularly male agricultural workers. Previous studies have established an increased incidence of snakebites during the monsoon season. Moreover, frequent lower limb involvement in bites has been well documented in the literature, with prior studies indicating mortality within 24 hours of envenomation. Most fatal cases are attributed to bites from the "Big Four" venomous snakes—cobra, krait, Russell's viper, and saw-scaled viper—with night-time bites, particularly from kraits, posing a significant risk due to their nocturnal behaviour and tendency to bite victims while asleep.

This study provides new insights into the epidemiology of snakebite fatalities in the Visakhapatnam region, identifying a marginal occupational association (p-value = 0.080179) between farming and lower limb bites, and observing a greater proportion of victims surviving beyond 48 hours compared to previous studies. This finding highlights the need to investigate factors influencing fatality during this period, such as the time taken to seek medical care, and the availability of antivenom (ASV)

in peripheral centers. Furthermore, the present study adds to the growing body of evidence on snakebite fatalities occurring predominantly between 6 AM and 6 PM(66.67%), suggesting that dawn and dusk are particularly high-risk periods for snake-human encounters, also aligns with the nocturnal behavior of certain venomous species. Visibility conditions and the use of protective measures by farmers are important variables to consider when interpreting these findings. To the best of our knowledge, this is the first study of its kind in the Visakhapatnam region.

Although the present study focused on the mortality aspect of snakebites, examining associations between occupation, timing of bites, and venom toxicity, it is important to acknowledge the significant progress made in reducing mortality through increased access to antivenom in India<sup>13</sup>. The major limitations of the present study include the limited sample size, and the unknown species of the snakes involved in the bites (we categorised them in to type of toxicity based on clinical picture from medical records).

Future studies should explore the morbidity associated with snakebites, as well as conduct spatiotemporal analyses<sup>14</sup> to identify clusters of incidents. Additionally, further research is needed to understand snake behaviour and human-snake encounters in a holistic manner, aiming to prevent snakebites while preserving the reptiles' right to live and contribute to biodiversity, thus enhancing the planet's overall health. A collaborative approach involving herpetologists, agricultural scientists, local municipalities, and panchayat bodies –utilizing AI and technology-based tracking systems –could offer innovative solutions to reduce harmful snake-human encounters, benefiting both human populations and wildlife conservation. It is essential to foster a safety culture among vulnerable agricultural populations through behavioural changes to reduce snakebite risk.

### Conclusion

This study highlights the higher prevalence of snakebites among middle-aged male farmers working in agricultural fields during the monsoon season. Implementing protective and preventive

measures can significantly reduce snakebite fatalities. These measures include exercising caution in snake-prone areas, wearing proper foot wear and protective clothing, avoiding bushy backyards, staying vigilant by carefully checking surroundings, and maintaining a clean household environment to deter snakes from seeking food and shelter. Public education on identifying venomous snakes, providing first aid for bites, and the importance of seeking antivenom rather than relying on faith healing is crucial. Additionally, offering psychological support to snakebite victims post-encounter plays a vital role in their recovery. Studies on the economic impact of human-snake encounters are essential to persuade policymakers to invest in snakebite prevention and fatality reduction.

**Conflict of interest:** None to declare.

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