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**Original Research Article**

# Epidemiological and Clinical Profile of Venomous Snake Bite: A Prospective Observational Study from a Teaching Hospital in North Karnataka

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**Abstract**

**Background:** Snakebite envenoming is an acute, life-threatening and time-limited medical emergency that predominantly affects rural agricultural communities in tropical countries. The World Health Organization designated it a Category A neglected tropical disease in 2017. Its epidemiology varies markedly between regions according to the species present, occupational patterns and climate, so that data from one district cannot reliably be extrapolated to another. No clinical data on snakebite were available from the Koppal region of North Karnataka.

**Objectives:** To describe the demographic, epidemiological and clinical profile of patients admitted with venomous snake bite, including age and sex distribution, occupation, socioeconomic status, anatomical site of bite, seasonal and diurnal pattern, interval between bite and hospital arrival, and the spectrum of envenomation syndromes.

**Materials and Methods:** A hospital-based prospective observational study was conducted in the Department of General Medicine, Koppal Institute of Medical Sciences, Koppal, from 1 August 2022 to 30 May 2024. One hundred consecutive patients with a history of snake bite and one or more clinical manifestations of envenomation — fang marks, local swelling, haemorrhage, blister formation, vomiting, abdominal pain, regional lymphadenopathy or neurotoxicity — were enrolled after institutional ethics committee clearance and written informed consent. Patients with bites other than snake bite and non-poisonous snake bites were excluded. Demographic details, circumstances of the bite, primary measures taken and time of hospital arrival were recorded, followed by clinical examination and laboratory investigation including complete blood count, renal and liver function tests, coagulation profile, serum electrolytes, urine microscopy and the 20-minute whole blood clotting test. Data were analysed using SPSS version 21.

**Results:** Mean age was 35.98 ± 13.55 years (median 34, range 16–65), with 55 patients (55%) aged between 21 and 40 years. Seventy patients (70%) were male. Farmers constituted the largest occupational group (41%), followed by students (32%) and housewives (26%); 70 patients (70%) belonged to the middle socioeconomic class. Bites involved the lower limb in 68 patients (68%) and the upper limb in 28 (28%), the right leg alone accounting for 32 (32%). Forty-six bites (46%) occurred during the monsoon and 40 (40%) in winter, with a fairly even diurnal spread. Mean interval between bite and hospital arrival was 4.17 ± 2.05 hours, and 91 patients (91%) presented within six hours. Fang marks were visible in 93 (93%) and local swelling in 76 (76%). Local envenomation alone was the commonest syndrome (52%), followed by haemotoxic (30%), neurotoxic (16%) and combined neurotoxic-haemotoxic envenomation (2%).

**Conclusion:** Snake bite in this district affected predominantly young adult male agricultural workers, involved the lower limb in two-thirds of cases and clustered in the monsoon season. Encouragingly, nine in ten patients reached hospital within six hours. Local envenomation predominated over systemic syndromes. These findings support targeted prevention through protective footwear, lighting and community education during the monsoon months.

**Keywords:** Snake Bite; Envenomation; Clinical Profile; Epidemiology; Neglected Tropical Disease; Anti-Snake Venom.

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## Introduction

Snakebite is an acute, life-threatening and time-limited medical emergency, and a largely preventable public health risk borne chiefly by rural populations of the subtropical and tropical regions [1]. The consequences of envenomation span a wide spectrum, from trivial local tissue injury at one extreme to multi-organ dysfunction and death at the other, and the burden falls disproportionately on people in their most economically productive years [1,2].

Despite this, snakebite was long overlooked by global health policy. It was placed on the World Health Organization's list of neglected conditions in 2009 and subsequently elevated to a Category A neglected tropical disease in 2017 [3]. Contemporary estimates suggest between 1.8 and 2.7 million envenomings occur worldwide each year, causing approximately 81,000 to 138,000 deaths [4]. India carries a disproportionate share: the nationally representative Million Death Study estimated 45,900 snakebite deaths annually, with the highest rates in rural districts [5]. Karnataka, with a large population engaged in agriculture, records a correspondingly high incidence.

Of roughly 216 identifiable snake species in India, some 52 are venomous [6]. Medically important envenoming is dominated by the so-called "big four" — the spectacled cobra (Naja naja), the common krait (Bungarus caeruleus), Russell's viper (Daboia russelii) and the saw-scaled viper (Echis carinatus) [7]. Viperine bites characteristically produce haemotoxic envenoming with local necrosis, coagulopathy and spontaneous systemic bleeding, whereas elapid bites produce a progressive descending neuroparalysis that culminates in respiratory failure [8]. Acute renal failure, seen mainly after Russell's viper and saw-scaled viper bites, is an important cause of morbidity and adds substantially to the cost of treatment [9].

Snakebite is fundamentally an occupational, environmental and domestic hazard [2]. Most bites are inflicted on the feet and ankles of barefoot agricultural workers who inadvertently tread on snakes while working in fields or walking after dark, and on people who sleep on the floor in open-style dwellings [2,10]. Because the habit of moving barefoot is so strongly associated with incidence, prevention is in principle straightforward, yet uptake of protective measures remains poor.

Critically for clinical practice, there is wide inconsistency in the pattern of snakebite from one region to another, determined by the range of species present locally together with environmental and population factors [11]. It is therefore essential to interpret reported experience in relation to the specific area concerned, the characteristics of the snake species inhabiting that region, and the characteristics of the population at risk [11]. Published Indian series bear this out, differing substantially in the predominant envenomation syndrome, the anatomical site of bite and the reported mortality [12,13].

Timely administration of appropriate anti-snake venom is the cornerstone of specific treatment, and one would hope for complete neutralisation of venom effects with zero morbidity and mortality — although in practice this is not achieved [14]. Delay in reaching hospital, prior recourse to traditional healers and geographical variation in venom composition all contribute to variable outcome.

Against this background, no systematic clinical data on snakebite were available from the Koppal district of North Karnataka, an arid agrarian region whose species mix and occupational profile may differ from those described elsewhere. The present study was therefore undertaken to define the epidemiological and clinical profile of venomous snake bite among patients admitted to a teaching hospital serving this population.

## Materials and Methods

This was a hospital-based prospective observational study conducted in the Department of General Medicine, Koppal Institute of Medical Sciences, Koppal, Karnataka — a tertiary care teaching institution serving a predominantly rural and agrarian district population.

**Study period and sample:** One hundred consecutive patients admitted with snake bite between 1 August 2022 and 30 May 2024 who satisfied the eligibility criteria were enrolled.

**Ethical considerations:** Institutional Ethics Committee clearance was obtained before commencement of the study. Written informed consent was obtained from every participant, or from an accompanying relative where the level of consciousness precluded personal consent. Participants were informed that they were free to withdraw at any stage, that the investigations performed were those routinely indicated in snakebite, and that treatment would be identical irrespective of participation. Confidentiality of identity was maintained throughout.

**Inclusion criteria:** Patients with a history of snake bite together with one or more clinical manifestations of envenomation — visible fang marks, local swelling, haemorrhage, blister formation, vomiting, abdominal pain, regional lymphadenopathy, or neurotoxicity following the bite.

**Exclusion criteria:** Patients with bites attributable to creatures other than snakes, and patients with non-poisonous snake bites in whom no manifestation of envenomation developed.

**Data collection:** Demographic data including age, sex, place of residence, occupation and address were recorded on a structured proforma. Details specific to the bite were documented, comprising the date and time of bite, whether the bite occurred indoors or outdoors, the anatomical site, the season, the diurnal timing, primary first-aid measures already undertaken, and the time of arrival at hospital, from which the bite-to-hospital interval was derived. Socioeconomic status was classified into upper, middle and lower categories.

**Clinical assessment:** Vital signs — blood pressure, pulse rate, respiratory rate and oxygen saturation — were recorded on admission. A detailed history and complete clinical examination followed, with particular attention to neurotoxic features (ptosis, drowsiness, diminution of vision, dysphagia, slurring of speech, dyspnoea, loss of consciousness), haemorrhagic features (gingival bleeding, epistaxis, purpura, petechiae, haematuria, oliguria, abdominal pain) and local features (pain and swelling at the bite site, blistering, tender regional lymph nodes). Local examination documented fang marks, extent of swelling, blistering and bleeding from the bite site. The single breath count and neck-holding test were performed to assess neuromuscular compromise. On the basis of these findings each patient was assigned an envenomation syndrome: local, haemotoxic, neurotoxic, or combined neurotoxic and haemotoxic.

**Investigations:** All patients underwent complete blood count, renal function tests, liver function tests, coagulation profile (prothrombin time with international normalised ratio, and activated partial thromboplastin time), bleeding and clotting time, serum electrolytes, urine routine and microscopy, and the 20-minute whole blood clotting test. Electrocardiography and chest radiography were performed as indicated.

**Treatment protocol:** Polyvalent anti-snake venom was administered as 10 vials in 500 mL of normal saline infused over one hour. Prothrombin time with international normalised ratio, the whole blood clotting test and clinical assessment were repeated thereafter to determine the requirement for further doses, up to a maximum of 30 vials. The need for ventilatory support, dialysis and transfusion of blood or blood products was assessed and acted upon as clinically indicated.

**Statistical analysis:** Data were analysed using SPSS version 21 together with Microsoft Excel. Categorical variables are presented as frequency tables, and continuous variables as mean ± standard deviation and as median with minimum and maximum values.

## Results

One hundred patients admitted with venomous snake bite were studied.

**Table 1: Age and sex distribution of study subjects (n = 100)**

| Variable | Category | Number of subjects | Percentage (%) |
|---|---|---|---|
| **Age (years)** | ≤20 | 12 | 12.0 |
| | 21–30 | 27 | 27.0 |
| | 31–40 | 28 | 28.0 |
| | 41–50 | 18 | 18.0 |
| | 51–60 | 9 | 9.0 |
| | >60 | 6 | 6.0 |
| | **Mean ± SD** | **35.98 ± 13.55** | — |
| | **Median (min, max)** | **34 (16, 65)** | — |
| **Sex** | Male | 70 | 70.0 |
| | Female | 30 | 30.0 |
| | **Total** | **100** | **100.0** |

Snake bite in this cohort was overwhelmingly a disease of young working-age adults.

The 31–40 and 21–30 year bands together accounted for 55 patients (55%), and 85 patients (85%) were aged 50 years or below. Only 15 patients (15%) were over 50. The mean age of 35.98 ± 13.55 years, with a median of 34 years and a range spanning 16 to 65 years, confirms that the burden falls squarely on the economically productive segment of the population.

Males outnumbered females more than twofold (70% versus 30%), a ratio consistent with greater outdoor occupational exposure among men in this agrarian setting.

**Table 2: Distribution by socioeconomic status and occupation (n = 100)**

| Variable | Category | Number of subjects | Percentage (%) |
|---|---|---|---|
| **Socioeconomic status** | Middle | 70 | 70.0 |
| | Lower | 23 | 23.0 |
| | Upper | 7 | 7.0 |
| **Occupation** | Farmer | 41 | 41.0 |
| | Student | 32 | 32.0 |
| | Housewife | 26 | 26.0 |
| | Driver | 1 | 1.0 |
| | **Total** | **100** | **100.0** |

Ninety-three patients (93%) belonged to the middle or lower socioeconomic strata, with only 7 (7%) from the upper class — a distribution that reflects both the occupational nature of the hazard and the limited access of poorer households to protective footwear and secure housing. Farmers formed the single largest occupational group at 41%, consistent with direct field exposure. The finding that students (32%) and housewives (26%) together accounted for 58 patients is notable, since it indicates that more than half the bites occurred outside the context of formal agricultural work — most plausibly during domestic activity, movement around dwellings and the peridomestic environment, rather than in the fields themselves.

**Table 3: Anatomical site of bite (n = 100)**

| Site of bite | Number of subjects | Percentage (%) |
|---|---|---|
| Right leg | 32 | 32.0 |
| Left foot | 11 | 11.0 |
| Right foot | 11 | 11.0 |
| Left hand | 9 | 9.0 |
| Left leg | 9 | 9.0 |
| Left finger | 5 | 5.0 |
| Right wrist | 5 | 5.0 |
| Right finger | 4 | 4.0 |
| Left toe | 3 | 3.0 |
| Left forearm | 2 | 2.0 |
| Left wrist | 2 | 2.0 |
| Right toe | 2 | 2.0 |
| Right arm | 1 | 1.0 |
| Site not identified | 4 | 4.0 |
| **Total** | **100** | **100.0** |
| **Grouped — lower limb** | **68** | **68.0** |
| **Grouped — upper limb** | **28** | **28.0** |
| **Grouped — not identified** | **4** | **4.0** |

The right leg was the commonest single site, involved in 32 patients (32%), followed by the right and left foot at 11 (11%) each. When aggregated, the lower limb accounted for 68 bites (68%) and the upper limb for 28 (28%), with the site unidentifiable in 4 (4%). This two-to-one preponderance of lower-limb bites is the anatomical signature of the barefoot agricultural worker who treads on a concealed snake, and it identifies protective footwear as the single most direct preventive intervention available.

The 28% of upper-limb bites — hands, fingers and wrists — most likely reflect bites sustained while reaching into vegetation, grain stores or debris where snakes shelter.

**Table 4: Seasonal and diurnal distribution of bites (n = 100)**

| Variable | Category | Number of subjects | Percentage (%) |
|---|---|---|---|
| **Season** | Monsoon | 46 | 46.0 |
| | Winter | 40 | 40.0 |
| | Summer | 14 | 14.0 |
| **Time of day** | Morning | 28 | 28.0 |
| | Night | 27 | 27.0 |
| | Afternoon | 24 | 24.0 |
| | Evening | 21 | 21.0 |
| | **Total** | **100** | **100.0** |

Bites clustered strongly in the monsoon, which accounted for 46 cases (46%), with winter contributing a further 40 (40%) and summer only 14 (14%). The monsoon predominance is readily explained: heavy rainfall floods burrows and drives snakes onto higher ground and into human habitation, while simultaneously intensifying agricultural activity in the fields. In marked contrast, the diurnal distribution was strikingly even, ranging only from 21% in the evening to 28% in the morning, with night-time bites accounting for 27%.

This absence of a clear circadian peak suggests that risk in this district is continuous throughout the day rather than concentrated in the nocturnal hours, and implies that preventive messaging cannot be confined to any single part of the day.

**Table 5: Interval between bite and hospital arrival (n = 100)**

| Time lapse (hours) | Number of subjects | Percentage (%) |
|---|---|---|
| 1 | 9 | 9.0 |
| 2 | 9 | 9.0 |
| 3 | 22 | 22.0 |
| 4 | 23 | 23.0 |
| 5 | 13 | 13.0 |
| 6 | 15 | 15.0 |
| 7 | 1 | 1.0 |
| 8 | 6 | 6.0 |
| 10 | 1 | 1.0 |
| 12 | 1 | 1.0 |
| **Total** | **100** | **100.0** |
| **Mean ± SD** | **4.17 ± 2.05** | — |
| **Median (min, max)** | **4 (1, 12)** | — |
| **Presented within 6 hours** | **91** | **91.0** |
| **Presented after 6 hours** | **9** | **9.0** |

The mean interval between bite and hospital arrival was 4.17 ± 2.05 hours, with a median of 4 hours and no patient presenting beyond 12 hours. The modal intervals were 4 hours (23%) and 3 hours (22%). Critically, 91 patients (91%) reached hospital within six hours of the bite — the window within which anti-snake venom is most effective — while only 9 (9%) presented later. This represents a considerably better care-seeking pattern than that described in several other Indian series, and is likely attributable to reasonable road access and to a functioning referral network within the district. Since delay to antivenom is among the strongest determinants of mortality in snakebite, this early presentation profile is of direct prognostic importance for the cohort.

**Table 6: Clinical features and envenomation syndrome (n = 100)**

| Category | Feature | Number of subjects | Percentage (%) |
|---|---|---|---|
| **Local features** | Fang marks | 93 | 93.0 |
| | Swelling at bite site | 76 | 76.0 |
| | Local bleeding | 4 | 4.0 |
| **Systemic features** | Abdominal pain | 18 | 18.0 |
| | Ptosis | 18 | 18.0 |
| | Haematuria | 7 | 7.0 |
| | Unconsciousness | 3 | 3.0 |
| | Vomiting | 0 | 0.0 |
| **Coagulation** | 20WBCT — clot formed | 67 | 67.0 |
| | 20WBCT — non-clotting | 33 | 33.0 |
| **Envenomation syndrome** | Local only | 52 | 52.0 |
| | Haemotoxic | 30 | 30.0 |
| | Neurotoxic | 16 | 16.0 |
| | Neurotoxic + haemotoxic | 2 | 2.0 |
| | **Total** | **100** | **100.0** |

Fang marks were the commonest single finding, visible in 93 patients (93%), followed by local swelling in 76 (76%). Systemic manifestations were considerably less frequent: ptosis, the earliest and most reliable sign of neuroparalysis, and abdominal pain each occurred in 18 patients (18%), haematuria in 7 (7%) and unconsciousness in 3 (3%). No patient reported vomiting. The 20-minute whole blood clotting test formed a clot in 67 patients (67%), leaving 33 (33%) with incoagulable blood indicating venom-induced consumption coagulopathy. Classified by syndrome, local envenomation alone predominated at 52%, followed by haemotoxic envenoming at 30% and neurotoxic at 16%, with 2 patients (2%) showing combined features. Systemic envenomation of any type therefore affected 48 patients (48%), almost exactly half the cohort.

**Discussion**

The mean age of 35.98 ± 13.55 years in the present cohort corresponds closely to the average of 37 years reported by Kumar et al. from Jharkhand [12], confirming that snakebite consistently affects adults in their most productive years. Ashwini Patil and Patil, working in Gulbarga in neighbouring North Karnataka, similarly found the majority of their 237 cases to fall between 21 and 50 years [15], as did Satyanarayan et al. in Jharkhand, where 44.5% were aged 18 to 30 [16].

The male preponderance of 70% sits at the upper end of the published range: Kumar et al. recorded 65%, Mondal and Khuntdar 61.7%, Raju et al. 61.4% and Mathur et al. 59% [12,17,18,19]. This points to outdoor occupational exposure, though it may partly reflect the higher male proportion in these district populations [19]. Farmers formed the largest occupational group at 41%, but that students and housewives together contributed 58% is more instructive, indicating most bites occurred around the home rather than in the fields.

Lower-limb bites accounted for 68% of cases, almost identical to the 68.5% reported by Raju et al. and the 69% described by Etim et al. from Nigeria [18,20]. Kumar et al. likewise found the right and left leg to dominate at 40.3% and 26.9% respectively [12]. In contrast, Mathur et al. reported the hand as the commonest site at 44% [19], a divergence that plausibly reflects differing local agricultural practice. The consistency of the lower-limb pattern across most series underlines the preventive value of stout footwear [2].

The monsoon predominance of 46% accords with the established seasonality of snakebite, driven by displacement of snakes from flooded burrows coinciding with peak field activity [10]. The near-uniform diurnal distribution observed here, however, differs from series in which nocturnal krait bites predominate, and suggests continuous rather than time-concentrated risk locally.

The mean bite-to-hospital interval of 4.17 ± 2.05 hours, with 91% presenting within six hours, compares very favourably with much of the published literature. Harshvardhan et al. reported a mean interval of 21.8 hours among patients who developed renal failure, against 4.1 hours in those who did not [21]. Kaushik et al. found delay beyond six hours in 66.7% of their Himachal Pradesh cohort [22], and Kunal et al. in Odisha reported fatal outcomes in 76% of those treated after six hours, against successful outcomes in 92% treated within one to six hours [23]. Early presentation is therefore likely to be a major determinant of the favourable outcome profile in this series.

Local envenomation predominated at 52%, with systemic syndromes in 48%. This contrasts with Pradhan et al., who found neurotoxic bites in 43.2% and vasculotoxic in 29.5% [24], and with Vamshee Krishna et al., who reported 87.5% venomous bites of which 52.9% were neurotoxic [25]. Such variation reinforces the principle that the spectrum of envenoming is determined by local species composition [11].

**Limitations:** The offending snake could not be identified in any case, since neither patients nor attendants were able to recognise the species, and no dead specimens were brought. The study was confined to a single centre with a modest sample of 100, and formal tests of association between epidemiological variables and outcome were not performed.

**Conclusion**

In this prospective study of 100 patients admitted with venomous snake bite to a teaching hospital in North Karnataka, the typical patient was a young adult male — mean age 35.98 ± 13.55 years, 70% male — of middle or lower socioeconomic status, most often a farmer, though students and housewives together accounted for the majority of cases. Bites involved the lower limb in 68% and the upper limb in 28%, the right leg alone accounting for 32%. Almost half of all bites (46%) occurred during the monsoon, with a further 40% in winter, while the diurnal distribution was remarkably even across morning, afternoon, evening and night.

The mean interval between bite and hospital arrival was 4.17 ± 2.05 hours, and 91% of patients reached hospital within six hours — a care-seeking pattern substantially better than that reported from several comparable Indian districts and one that carries clear prognostic benefit. Fang marks were visible in 93% and local swelling in 76%, while systemic features were far less common, ptosis and abdominal pain each occurring in 18%. Local envenomation alone was the commonest syndrome at 52%, with haemotoxic envenoming in 30%, neurotoxic in 16% and combined features in 2%.

These findings identify three practical priorities for this district. First, the dominance of lower-limb bites argues for sustained promotion of protective footwear among agricultural workers. Second, the monsoon clustering allows preventive messaging and antivenom stock planning to be concentrated in specific months. Third, the substantial proportion of bites among students and housewives indicates that prevention must extend to the peridomestic environment — clearing debris, storing grain securely, using a light and stick after dark, and sleeping under a well-tucked mosquito net on a raised bed. Because the offending species could not be identified in any case, prospective studies incorporating species identification, ideally with venom antigen detection, are needed to define the local snake fauna responsible.

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