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Original Research Article

Socio-Demographic Profile of Snake bite deaths and its Medico-legal aspect- An Autopsy based Retrospective study at Tertiary Care Hospital

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Abstract:

Snakebite is a major public health problem in tropical and subtropical countries, with an estimated 4.5–5.4 million people bitten worldwide each year, of whom 1.8–2.7 million develop signs of envenomation, and 81,000–138,000 succumb to the effects. India, which harbors 52 venomous snake species, accounts for almost half of the global mortality burden. The occurrence of snakebite varies across regions depending on climate, snake distribution, biodiversity, ecology, and human population density. The present study was undertaken on fatal cases of snakebite subjected to medico-legal autopsy at the Department of Forensic Medicine and Toxicology, Patna Medical College, Patna, with observations recorded regarding age, sex, occupation, socioeconomic background, location, seasonal trends, site of bite, local tissue changes, and manner of injury. Findings revealed that most victims were males between 21 and 30 years of age, predominantly farmers or agricultural laborers, who sustained accidental bites on the hands and feet, particularly during the rainy season. In a majority of cases (69.2%), two fang marks were identified, accompanied by local features such as subcutaneous hemorrhage (23.9%), necrosis (30.4%), and swelling with cellulitis. The study highlights the urgent need for preventive strategies including community awareness, use of protective gear during agricultural work, and the execution of a nationwide initiative to prevent and control snakebite to reduce morbidity and mortality associated with this neglected tropical health issue.

Keywords: Snake Bite, Farmer, Fang Marks, Adolescents, Anti-Snake Venom.

Introduction

Indian physicians have been recognized for their knowledge of treating poisonous snakebites since as early as 326 BC, and for more than 2500 years venomous snakes have remained familiar to the Indian subcontinent; yet the country continues to struggle with high mortality from snakebite envenomation. [1] Recognizing its significance, the WHO classified snakebite envenoming as a neglected tropical disease (NTD) in June 2017. [2] Although more than 3000 snake species exist globally, approximately 250 are considered of medical importance by WHO due to the toxicity of their venoms. [2] Snakebite continues to be a pressing health problem and medico-legal issue in tropical and subtropical regions. Annually, an estimated 4.5–5.4 million people suffer snakebites worldwide, of whom 1.8–2.7 million develop envenoming, with fatalities ranging from 81,000 to 138,000. [3] Mortality and envenoming rates vary by geography, with the greatest burden in Sub-Saharan Africa, South-East Asia and South Asia. [3] India is home to 52 venomous snake species, [4] of which 24 are regarded as particularly significant. [5] The country accounts for nearly 50% of global snakebite deaths. [6] According to the Registrar General's Million Death Study (MDS), one of the most comprehensive investigations of premature mortality, India reports around 50,000 deaths annually due to snakebite, compared with approximately 125,000 globally and over 75,000 in Asia. [7]

The incidence and frequency of snakebite are influenced by regional differences in climate, biodiversity, snake distribution, ecology, and human population density. [8] Despite being a frequent medical emergency, snakebite primarily affects rural communities, where victims often first seek care from traditional healers instead of nearby hospitals, thereby increasing the risk of death. Mortality is

further linked to delayed recognition of envenoming, poverty, misidentification of snakes, reliance on untrained local practitioners, lack of transport facilities, delayed arrival at health centers, and improper administration of antivenom. In order to depict the current situation in this area, the current sociodemographic study was conducted on fatal snakebite cases that were submitted to medico-legal autopsy at Patna Medical College, Patna, Bihar. [9]

Materials and Methods

A hospital-based retrospective study was undertaken in the Department of Forensic Medicine and Toxicology, Patna Medical College, Patna, covering a period from July 2020 to November 2023. A total of 46 fatal snakebite cases undergoing medico-legal autopsy were analyzed. Inclusion criteria were restricted to patients admitted to the hospital with a verified history of snakebite or with clinical and local findings suggestive of envenomation; individuals who were brought dead without hospitalization were excluded. Basic demographic information such as age, sex, and place of residence was collected from inquest reports, while occupation, circumstances surrounding the bite, location of the incident, socioeconomic profile, identification of the snake, time of bite, seasonal trend, and details of local tissue reactions were extracted from treatment records available in the Medical Record Department (MRD). During autopsy examinations, special note was made of the exact site of the bite and the characteristic features of the fang marks. All observations were compiled in a structured proforma, subjected to statistical analysis, and findings were displayed through appropriate charts and graphical representations.

Observations and Results

During the study period from July 2020 to November 2023, a total of 46 hospitalized snakebite cases that resulted in death and were referred for medico-legal autopsy were recorded, representing 1.8% of all autopsies performed.

Gender and Age: Out of the 46 victims, 33 were male (72%) and 13 were female (28%), with a male-to-female ratio of 2.53:1. The year 2022 witnessed the maximum number of fatal snakebite cases (Table-1, Figure-1). The highest frequency was noted in the 21–30 year age group with 21 cases (45%), followed by 11–20 years with 10 cases (22%). Only one case (2%) was observed among individuals older than 50 years (Table-2).

Locality and Season: A majority of victims, 40 cases (87%), were residents of rural areas, while only 6 cases (13%) were from urban regions (Table-3). Seasonal distribution showed that 35 cases (76%) occurred during the rainy season between July and October, followed by 9 cases (19.5%) during the summer months of March to June, and just 2 cases (4.5%) during the winter season from November to February (Table-4).

Occupation: Agricultural workers were the most affected group, with 28 victims (61%). This was followed by laborers 8 (17%), housewives 6 (13%), and students 3 (7%) (Table-5).

Socioeconomic Class: Most victims came from the lower socioeconomic category (26 cases, 56.5%), followed by the lower middle class (11 cases, 23.9%), middle class (7 cases, 15.2%), and upper class (2 cases, 4.3%) (Table-5).

Bite/Fang Mark Pattern: The classical two pin-point fang marks were observed in 36 cases (69.2%). Other patterns included arc-shaped marks in 7 cases (13.5%), scratch marks in 5 cases (9.6%), while in 4 cases (7.7%) fang marks were absent (Table-6).

Site of Bite: The hands were the most frequent site with 13 cases (28.2%), followed by the feet in 10 cases (21.7%), legs in 7 cases (15.2%), forearms in 5 cases (10.8%), back of the body in 4 cases (8.6%), and thorax/abdomen in 3 cases (6.5%). Four cases (8.6%) had no visible fang or bite marks (Table-6).

Local Tissue Changes: Necrosis was the most frequent local reaction, documented in 14 cases (30.4%), followed by subcutaneous hemorrhage in 11 cases (23.9%), swelling and cellulitis in 10 cases (21.7%), and bleeding in 6 cases (13%). In 5 cases (10.8%), no local pathological change was detected (Table-6).

Manner of Death: All 46 cases were accidental in nature. Among these, 36 were males and 10 were females. No instances of suicidal or homicidal snakebite were observed (Table-3).

Table 1: Sex wise distribution of snake bites cases

Year	Male	Female	Total (Year wise)
2020	11	06	17
2021	07	02	09
2022	09	04	13
2023	06	01	07
Total	33 (72%)	13 (28%)	46

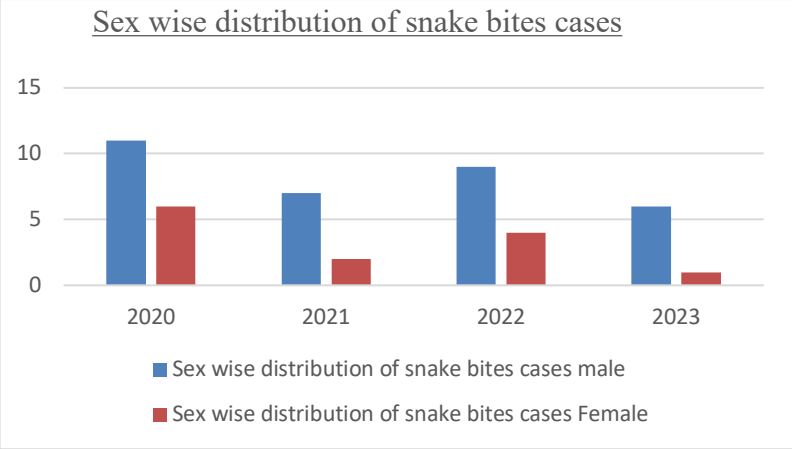

Figure 3: Sex wise distribution of snake bites cases

Table 2: Age group distribution

Age Group	Case	Percentage
0-10 years	02	(04%)
11-20 years	10	(22%)
21-30 years	21	(45%)
31-40 years	08	(17%)
41-50 years	05	(10%)
>50 years	01	(02%)
Total	46	

Table 3: Distribution of snake bite cases according to Area of occurrence & manner of death

Area of occurrence		
Area	**Case**	**Percentage**
Rural	40	87%
Urban	06	13%
Manner of death		
Manner	**Male**	**Female**
Accidental	36	10
Homicidal	0	0
Suicidal	0	0

Table 4: Season Wise Distribution of Snake Bite victims

Season	Month	Cases	Percentage
Summer	March to June	09	(19.5%)
Rainy	July to October	35	(76%)
Winter	November to February	02	(04.5%)
Total	46		

Table 5: Occupation & Socioeconomic status of the diseased of snake bite cases

Occupation		
Occupation	**Cases**	**Percentage**
Farmer	28	(61%)
Laborer	08	(17%)
Housewife	06	(13%)
Student	03	(07%)
Others	01	(02%)
Socioeconomic status		
Lower Class	26	56.5
Lower Middle Class	11	23.9
Middle Class	7	15.2
Upper Class	2	4.3
Total	46	100

Table 6: Site of bite on body, pattern of bite/ fang marks & pattern of local changes at the site of bite mark of snake bite

Site of bite on body		
Site of bite	**cases**	**Percentage**
Hand	13	(28.2%)
Feet	10	(21.7%)
Forearm	05	(10.8%)
Leg	07	(15.2%)
Back of body	04	(08.6%)
Thorax and abdomen	03	(06.5%)
Absent bite mark	04	(8.6%)
Pattern of bite/ fang marks		
Pattern of bite/ fang marks	**cases**	**Percentage**
2 puncture wounds	36	(69.2%)
Arc pattern	07	(13.5%)
Scratch mark	05	(09.6%)
Absent/ no fang marks	04	(07.7%)
Pattern of Local Changes		
Pattern of Local Changes	**case**	**Percentage**
Subcutaneous haemorrhage	11	(23.9%)
Bleeding	06	(13%)
Necrosis	14	(30.4%)
Swelling and cellulitis	10	(21.7%)
No change	05	(10.8%)

Discussion

Snakebite remains a significant cause of injury and mortality. Envenomation from venomous species can lead to death either through neurotoxic or hematotoxic mechanisms. In India, such deaths are categorized as unnatural and require medico-legal autopsy under statutory provisions. [10] Historically, most fatalities in the Indian subcontinent have been attributed to the "Big Four" species—Russell's viper, Indian cobra, saw-scaled viper, and the common krait. [11] Venomous snakes are largely members of the families Viperidae, Elapidae, Atractaspidae, and Colubridae, with Colubridae forming the largest family, representing nearly 60% of all snakes. The Atractaspidae, recently included within Viperidae, are burrowing snakes capable of protruding their fangs without fully opening the mouth. [12] The species most strongly linked with human deaths in India include the cobra (Najanajanaja), krait (Bungarus caeruleus), Russell's viper (Vipera russelli), and the saw-scaled viper (Echis carinatus). [13] For clinical purposes, venomous snakes are generally divided into haemotoxic (mainly vipers) and neurotoxic (cobras and kraits). [14] Their venoms are predominantly made up of proteins and peptides, both enzymatic and non-enzymatic, accounting for over 90% of the dry weight. [15]

The manifestations of snakebite differ with species. Common local effects include pain, swelling, blistering, and necrosis, while systemic features of neurotoxic envenomation include ptosis, blurred vision, and respiratory failure. Haemotoxic venoms cause bleeding from sites such as gums, nasal mucosa, skin, and the gastrointestinal tract, with deaths resulting from cerebral hemorrhage or retroperitoneal bleeding. Renal involvement, including glomerular and tubular damage, has also been documented in cases of neurotoxic and haemotoxic bites. [16] Outcomes depend on several factors including the species involved, site of the bite, venom load, and host health status. Most bites, even from non-venomous species, lead to some degree of local reaction. [17] The chemical composition of venom is highly complex, comprising proteins, peptides, lipids, amines, carbohydrates, and non-protein toxins, with variations observed not only across families and species but also among individuals within the same species. Diet, habitat, age, and seasonal influences can further alter venom composition. [18,19] Such variability contributes significantly to the diverse clinical presentations seen in snakebite cases.

Snakebite has been recognized by WHO as a neglected tropical disease, disproportionately affecting rural, impoverished populations. [20] In the present study, a male predominance was observed (male-to-female ratio 2.53:1), likely due to increased outdoor activity and agricultural work, consistent with findings from Madhya Pradesh, [21] Maharashtra, [22] and Karnataka. [23] Fatalities occurred across all age groups, but the 21–30 year category was most affected, paralleling other reports where individuals aged 21–50 were at highest risk. [24] The decline in fatalities after 50 years of age may be linked to reduced participation in

agricultural labor and limited outdoor activity among the elderly. [25]

Globally, snakebite mortality is concentrated in rural settings. [26,27,28] In this series, deaths were 6.6 times higher in rural populations compared to urban, aligning with prior research attributing this disparity to factors such as inadequate housing, greater agricultural exposure, reliance on traditional healers, and limited access to antivenom. [29] Seasonality was also evident: most incidents occurred during the monsoon months when snakes and their prey are displaced by flooding, frogs breed in large numbers, and rodents move closer to human habitation. [30] Consistently, July to October had the highest fatality rates in Bihar, while winter months recorded minimal cases due to snake hibernation.

The anatomical distribution of bites revealed that the hands (28.2%) and feet (21.7%) were the most frequent sites, a finding consistent with other Indian studies.[31,32,33] This is likely explained by barefoot farming practices, manual fieldwork, and accidental trampling of snakes during monsoon farming activities. Socioeconomic analysis demonstrated that victims from the lower socioeconomic strata were most frequently affected (56.5%), supporting earlier findings by Harrison RA [34,35] who reported a direct link between snakebite risk and poverty.

In the present study, all cases (100%) were accidental. Homicidal and suicidal bites are exceedingly rare. Historical accounts describe their use in ancient Egypt as a method of execution, where victims were thrown into snake pits or forced to insert their hand into baskets containing venomous snakes. [36] Rare cases of suicide by snakebite have also been documented, including the well-known death of Queen Cleopatra [37] and several isolated reports thereafter. [38-42]

Bleeding disorders following viper bites are well established. [34] Local edema and hemorrhage are caused by venom enzymes such as proteases and phospholipases, which increase vascular permeability. [44] Systemic hemorrhage results from platelet depletion and disseminated intravascular coagulation. [45] Though uncommon, cerebrovascular complications have been described; Mosquera [46] reported such events in 2.6% of his 309-case series, predominantly hemorrhagic rather than ischemic strokes.

Conclusion

Snakebite predominantly affects males from economically weaker sections, particularly those engaged in agricultural activities in rural areas. The age group of 21–30 years emerges as the most vulnerable, while individuals above 50 years are comparatively less affected. Although cases occur throughout the year, the highest incidence is observed during the rainy season. To reduce mortality, public awareness initiatives are essential, emphasizing the importance of seeking timely medical attention at hospitals rather than relying on traditional healers, so that the critical early hours can be effectively utilized for proper management. Farmers should be motivated to adopt protective measures during fieldwork, and government support is needed to safeguard this workforce. Establishing a National Programme on Snakebite Prevention is imperative, focusing on improving healthcare delivery, promoting health education, providing financial assistance to reduce dependence on manual farming, and ensuring implementation of WHO guidelines on snakebite management in the South-East Asia Region.

Ethical Consideration: Not required (based on hospital and autopsy records)

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