

"A COMPREHENSIVE STUDY OF EPIDEMIOLOGICAL PROFILE OF FATAL SNAKEBITE POISONING CASES IN JHALAWAR REGION".

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ABSTRACT:

Background: Snakebite envenomation is a neglected, preventable medical emergency that continues to cause significant morbidity and mortality, particularly in rural populations. India reports approximately 2.8 million snakebite cases/year, resulting in approximately 45,000–50,000 deaths. Our study aimed to assess epidemiological profile of fatal snakebite cases and emphasize preventive & awareness measures. A prospective autopsy-based study was conducted on 30 fatal snakebite cases brought to the Mortuary of S.R.G. Hospital, Jhalawar Medical College, Rajasthan, over a one-year period. Cases involving other animal bites, decomposed bodies, and individuals with pre-existing chronic illnesses were excluded.

Results: Most victims belonged to 21–40 years age group. Females (63.33%) were affected more frequently than males (36.67%). Farmers constituted Largest occupational group (46.67%), and most victims were from rural areas (70.0%). The maximum victims were married (83.33%) overall while married females were predominant (89.47%) compared to males. Incidence peaked during the daytime at outdoors (86.36%) & during night at indoors (75.0%) while the rainy season (July–October; 76.67%) has maximum cases. A substantial proportion (40.0%) were brought dead. Respiratory failure was the leading cause of death in 60.0% victims.

Conclusion: Fatal snakebite remains a preventable cause of unnatural death. Early administration of antivenom, prompt medical intervention, public awareness, and adoption of protective measures are essential to reduce mortality.

KEYWORDS: Snakebite; Autopsy; Epidemiological profile; Antigen Detection kit.

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Introduction:

Snakebite envenomation is a well-recognized medical emergency, affecting humans since ancient times, with references found in some of the earliest medical writings. Globally, >3,000 snake species exist, of which about 350 are venomous and India is home to approximately 330 species including 50–70 venomous species. The major venomous snake families in India are *Elapidae* (cobras and kraits), *Viperidae* (Russell's viper and saw-scaled viper), traditionally referred as "Big Four" and Sea snakes. Envenomation by these produces distinct clinical manifestations, including neuromuscular paralysis, haemorrhagic syndromes & myotoxicity (Fig. 1). Additionally, fear and anxiety following snakebite may cause symptoms even in non-venomous bite.^{1,2,3,4}

Anti-snake venom, a purified immunoglobulin, is the only specific treatment for snakebite envenomation and is available as either monovalent (species specific to single snake) or polyvalent (effective against multiple species). In India, commonly used polyvalent ASV is effective against venoms of Cobra, Common Krait, Russell's Viper and Saw-scaled Viper. The recommended ASV dose is same for both children and adults, as the amount of venom injected is independent of the victim's age or body size.^{2,3,4,5}

Snake-venom **Antigen Detection Kits** has been recent advancement. The latest study in 2019-20 at Rajiv

Gandhi Center for Biotechnology, Thiruvananthapuram, completed field trials of a "strip device" to identify and to speed up the treatment of snakebite, which has 5 lines, 1 control line, which is indicator for test to being functional & 1 line each for Cobra, Krait, Russell's viper, Saw-scaled viper respectively.⁶

Globally, estimated 2.5 million venomous snakebites occur annually, causing over 125,000 deaths, predominantly in tropical and rural regions, while India bears a substantial burden, accounting for approximately 10,000 deaths annually, with most of snakebites occurring among agricultural workers and individuals walking barefoot in fields or rural areas. Despite being a common & potentially life-threatening condition, diagnostic and treatment delays due to inadequate healthcare facilities and lack of awareness contribute significantly to snakebite-related morbidity and mortality in developing countries such as India. Agricultural workers, farm laborers, hunters, shepherds, and children are particularly vulnerable due to frequent occupational exposure and limited access to preventive measures and timely healthcare.^{7,8,9}

Despite generations of coexistence with snakes among certain occupational groups & snake-charmers, awareness regarding prevention, first-aid and appropriate treatment remains inadequate; highlighting the need for

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community education and strengthened public health interventions. In India, it is a major cause of morbidity and mortality & is responsible for 2.85-5.30% of mortality of total hospital admissions, although many cases go unreported.¹⁰

World Health Organization states snakebite envenoming as potentially life-threatening disease & can also be caused by having venom sprayed into eyes by certain species of snakes. High quality ASV are only effective treatments and are in the **WHO list of Essential medicines**.

Prevalence stats shows inadequate past-efforts to control has produced fragmented, inaccurate epidemiological data. Many victims do not attend healthcare centre and rely on traditional treatments. High-risk groups include rural agricultural workers, herders, fishermen, hunters, working children, people living in poorly constructed houses and those with limited access to education and healthcare.

In India alone, an estimated 2.8 million people experience snakebites, with almost 47,000 fatal cases. An enormous community-level study of snakebite deaths in India gave the direct estimate of 45,900 deaths in 2005, over 30 times higher than the Government of India's official figure.

WHO classifies common "Indian Snakes of Medical Importance" into 3 categories:

Category I – Commonly cause death or serious disability: Cobra, Russell & Saw-scaled viper.

Category II– Uncommonly cause bites but are recorded to cause serious effects (death or local necrosis): Common krait, king cobra.

Category III- Commonly causes bites but serious effects are very uncommon.

In response, **WHO** formally listed snakebite poisoning as a "Highest priority neglected tropical disease" in June 2017. The development of a strategic **WHO road-map** on snakebites was noted. This strategy focuses on a 50% reduction in mortality and disability by 2030. This aim will be achieved through 4 key objectives: 1. Empower & engage communities; 2. Ensure safe, effective treatment; 3. Strengthen health systems; and 4. Increase partnerships, coordination and resources.^{11,12,13}

In context of the above facts, our study was undertaken in Jhalawar region of Rajasthan, India, to study epidemiological factors, profile of victims, various distributions in snakebite poisoning deaths and also to draw public attention and awareness towards safety measurements and treatment of snakebites to reduce fatalities & incidence rates.

MATERIALS & METHODS:

The study was carried out with the aim and objectives of Epidemiological Profile analysis of snakebite poisoning in comprehensive type, with in duration of 1 year and to identify & suggest all types of effective protective & safety measures & spread awareness about safety features. Data was collected from the medico-legal autopsies of all 30 snakebite cases conducted at Mortuary.

General particulars of each case were taken from police personnel accompanying victim, relatives & other

information was obtained from attendants of deceased, Inquest *Panchnama*, Bed-Head Ticket, in case of Hospitalization.

Thorough Postmortem examination of snakebite victims was carried out by Standard Routine Methods of dissection and viscera were preserved in 10% formalin & sent for examination of HPE & FSL. The detailing & autopsy findings of each case were recorded in proforma.

All statistical data analysis was done by Proportion formula & Tabulation of data for purpose of observation and results were compared in Epidemiological profile of snakebite envenoming with observation of various authors.

Inclusion Criteria: All cases with alleged history of Snakebite poisoning, brought for autopsy at Mortuary of our hospital during the period of August 2020 to July 2021.

Exclusion Criteria: It enlisted "Bite from other reptiles, insects or animals; Decomposed bodies; and Patients with pre-existing chronic illness.

Clinical Trial Number: NOT APPLICABLE

Observation & Results:

Table 1 showed that among 30 cases, maximum victims 13 (43.34%) of Fatal Snakebites belonged to age group 21-40 years, followed by 41-60 years of age with 40.0% cases, while the least associated age group was < 20 years of age (adolescents) comprising only 02 (6.66%) cases. In our study population, male victims were 11 (36.67%) and female victims were 19 (63.33%). The most affected male age group was 21-40 years, while most affected female age group was 41-60 years.

Table 2 showed, among study population, farmers/ agriculture workers were most commonly affected 14 (46.67%), followed by laborer and housewives (20.0% each), While least common group was students, accounted for only 4 (13.33%) cases.

Table 3 showed the majority (93.34%) of cases belonged to Hindus population including many local residential castes such as *Mali, Bheel, Gurjar, Brahmins, Bairwa*, etc., as compared to Muslims which comprised of only 7% of fatal snakebite cases.

Table 4 showed the majority (70.0%) of cases belonged to Rural population, compared to 30% of Urban population of fatal snakebite cases brought for autopsy, may be due to the fact that majority of rural population depend on farming and labor work as their bread & butter, making them more susceptible for these mishaps at work and residential places.

Table 5 showed Gender-wise, fatal snakebite cases were most common in married females comprising of 17 cases (89.47%), while the least, only 2 cases (10.53%) were among unmarried females. Although, overall fatal snakebites were highest in married victims with 25 (83.33%) cases compared to unmarried victims with 5 (16.67%) cases, may be due to married person tends to do more work at outside as compare to unmarried ones and become more susceptible.

Table 6 showed the analysis on association between place and time of snakebite incidence. While, Highest incidence during day time (6 am. to 6 pm.) in 19 (86.36%) cases occurred at outdoor location or at fields,

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followed by 3 cases indoor, Highest incidence in night (6pm. to 6am) in 6 (75.0%) cases were at indoor location.

Table 7 shows the maximum fatal snakebites occurred between July to October months during Rainy season, comprising 23 (76.67%) cases, while winter season from November to February comprised minimum 03 (10%) incidence of fatal snakebites. This variation shows clear and huge deviation of incidences in Rainy or monsoon season as compared to other seasons.

Table 8 shows maximum no. of victims 12 (40.0%) could not survive and arrived as Brought dead at the casualty or mortuary, followed by 7 (23.33%) victims, who survived for period of 4-7 days after being admitted and managed with ASV and other treatments. While, only 01 (3.34%) victim survived for 8 days.

Table 9 illustrate highest mortality among study population was due to Respiratory Failure in 18 (60.0%) cases, while Renal Failure accounted for (40.0%) 12 cases only.

The Gross Macroscopic Examination showed that Brain tissue were bright shiny, smooth surface, unremarkable grey and white matter, but some pin-point hemorrhagic lesions seen in some victims with congested membranes. The Lungs showed Edematous changes in most 26 (86.66%) cases & on dissection, lungs showed edematous fluid-filled spaces with hemorrhagic spots around capillaries.

While Liver showed smooth, consistent and congested surfaces but on dissection, heavily congested areas seen in most 27 (90.0%) cases; Spleen showed congestion in 25 (83.34%) cases and hemorrhagic spots in 4 cases (13.33%) and otherwise unremarkable.

The Gross examination of Kidneys (Fig. 2) showed swelling, slight oedema, dark reddish appearance and variable degrees of congestion on the outer surface in most kidneys (27 cases; 90.0%), also on capsule in some cases. Sub-capsular pinpoint hemorrhage was noted in 1 female victim. On the longitudinal dissection of kidneys, cortices were paler and medulla were congested, showing a sharp, distinct Cortico-Medullary junction demarcation in most cases (24 cases; 80.0%), Cortico-Medullary petechial hemorrhage in 4 (13.34%) cases, and congestion in 26 (86.66%) of cases & renal petechial hemorrhage in 2 (6.66%) cases.

Table 1: Age and Sex Distribution of Fatal Snakebites.

Age (years)	Male		Female		Total	
	No.	Percent	No.	Percent	No.	Percent
< 20 years	1	9.09%	1	5.26%	2	6.66%
21-40	5	45.45%	8	42.10%	13	43.34%
41-60	3	27.28%	9	47.38%	12	40.00%
> 60 years	2	18.18%	1	5.26%	3	10.00%
Total	11	100%	19	100%	30	100%

Table 2: Occupational Distribution of Fatal Snakebites.

Occupation	No. of Cases	Percent
Farmer	14	46.67%
Labourer	6	20.00%
Student	4	13.33%
Housewife	6	20.00%
Total	30	100%

Table 3: Religion wise Distribution of Fatal Snakebites.

Religion	No. of Cases	Percent
Hindu	28	93.34%
Muslims	2	6.66%
Total	30	100%

Table 4: Domicile Distribution of Fatal Snakebites.

Domicile	No. of Cases	Percent
Rural	21	70.00%
Urban	9	30.00%
Total	30	100%

Table 5: Marital status wise distribution of Fatal Snakebites.

Marital status	Male		Female		Total	
	No.	Percent	No.	Percent	No.	Percent
Married	8	72.72%	17	89.47%	25	83.33%
Unmarried	3	27.28%	2	10.53%	5	16.67%
Total	11	100%	19	100%	30	100%

Table 6: Time and Place of incidence wise Distribution of Fatal Snakebites.

Time Place	Day 6am - 6pm		Night 6pm - 6am		Total	
	No.	Percent	No.	Percent	No.	Percent
Outdoor/Fields	19	86.36%	2	25.00%	21	70.00%
Indoor	3	13.64%	6	75.00%	9	30.00%
Total	22	100%	8	100%	30	100%

Table 7: Distribution of Seasonal Variation in Fatal snakebites.

Season	No. of Cases	Percent
Nov. - Feb. / Winter	3	10.00%
March - June / Summer	4	13.33%
July - Oct. / Rainy	23	76.67%
Total	30	100%

Table 8: Distribution of duration of Survival of Fatal snakebite

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Duration of Survival	No. of Cases	Percent
Brought Dead	12	40.00%
< 24 hours	4	13.33%
1 - 3 days	6	20.00%
4 - 7 days	7	23.33%
> 7 days	1	3.34%
Total	30	100%

Table 9: Mortality wise Distribution of Fatal snakebites.

Cause of Death	No. of Cases	Percent
Renal Failure	11	36.67%
Respiratory Failure	19	63.33%
Total	30	100%

Figure Legends:



Fig. 1 (A) (B) (C)



Fig. 2 (A) (B) (C)

Discussion:

1. Age and Sex Distribution: Our study showed the most commonly affected victims were from age group of 21-40 years (43.34%), followed by 41-60 years with 40.0% cases. This observation is in concordance with study done by other authors.^{7,9,21,30-34,37} This is in the fact that young males and females work out of their homes in fields, farms, forests etc. for bread and butter and get victimize of this occupational hazard.

With 36.67% male and 63.33% female victims, the most affected male age group was 21-40 years and female age group was 41-60 years. This observation was corroborated with Yogesh C & Satish K V³¹ and contradictory to other authors.^{7,30,32,33,34,37}

This gender-based differentiation of outcome may be due to that in this region of Rajasthan, middle aged females also go out to work in fields or to cut woods from forests as much as men, making them equally vulnerable.

2. Occupational Distribution: In our study, farmers/agriculture workers were most commonly

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affected (46.67% cases), followed by laborer and housewives (20.0% case each). It was corroborated with studies done by other Authors.^{9,20,30,31,32,34,37} It is observed that almost every study found similarity about farmers or field workers being most vulnerable. Adult farmers are chief victims of snakebite because of their active involvement in field works. Most of farm workers do not have proper footwear for protection against this problem.

3. Religion Distribution: In our study, the majority (93.34%) of fatal snakebite victim belonged to Hindus population (local residential castes), as compared to Muslims which comprised of only 7% cases of fatal snakebite cases. This observation should be similar with most of studies done by other authors.

This major gap difference is may be due to majority of local population in Jhalawar region, as well as many regions of India are Hindus and also the fact that Muslim population doesn't depend on farming or laboring & have income sources like shops or businesses, making them less susceptible.

4. Domicile Distribution: In our study, the majority (70.0%) of cases belonged to Rural population, compared to 30% of fatal snakebite cases of Urban population. This has similarity with the studies done by other Authors^{31-34,37} and it is so that almost every study found similarity about rural population being most vulnerable like our observation.

Rural people live in huts, mud houses. Waste material, dry cow dung, dry firewood and firm tools are often Kept close to their houses. This encourages rats, mice and lizards which are the prey of snakes. It is routine practice in rural areas to walk bare foot blindly in grass and Crops. All of these somehow contributes to the high numbers of rural victims.

5. Marital status Distribution: In our study, gender-wise, the incidences were most common in Married Females (89.47% case), while least number (10.53% cases) were among Unmarried Females. Overall, highest fatal snakebites were in Married victims (83.33% cases). This observation was corroborated with Navinkumar M. Varma and P. R. Kulkarni³⁴. It may be due to the fact that married persons go out more often to work on daily basis either on fields or elsewhere, making them more susceptible.

6. Time and Place of incidence Distribution: In our study, Highest incidence (86.36% cases) of snakebite during day time (6 am. to 6 pm.) occurred at outdoor location or at fields; while, Highest incidence (75.0% cases) in night (6pm. to 6am) were at indoor location. This result corroborated with studies done by A. Halder et. Al³³ (maximum cases at outdoors), Navinkumar M. Varma and P. R. Kulkarni³⁴ (maximum cases between 6 AM to 6 PM) and is contrary to study done by Bawaskar HS et al²⁴ and Bhoj Kumar Sahu et al³² (maximum cases at night time). It can be reasoned with that at day time most of victim population work outside or in fields & stays indoor at night.

7. Seasonal Distribution: In our study, the maximum (76.67%) fatal snakebites cases occurred between July-October months during Rainy season, while 10%

incidence of fatal snakebites occurred from November-February in winter season. This observation is in concordance with other Authors.^{32,33,34}

This variation shows clear, huge deviation of incidences in Rainy or Monsoon season, either due to being the optimum time of year for farming or due to the fact that snakes come out more often, roam and take shelter near humans due to water-filled holes/burrows in Earth and increases chances of causing these fatal incidences more, either as prey or in self-protection.

8. Survival Duration Distribution: The Maximum victims (40.0%) arrived as "Brought dead" at casualty or mortuary, followed by 7 (23.33%) victims, with survival period of 4-7 days after being admitted and managed with ASV or other treatments. Our observation is in concordance with Navinkumar M. Varma and P. R. Kulkarni³⁴, while it's contrary from study done by Alakesh Halder et. Al³³ & Alessandro Feola et al³⁷, (maximum died < 24 hours).

The survival duration may depend on factors like victim's health status, mental status after being bitten, type of snake, amount of venom injected, timely provided or delayed medical aids, transport facilities and so on.

9. Mortality (cause of death) Distribution: We observed that maximum victims died due to Respiratory Failure in 60.0% cases. Our observation was in concordance with studies done by many other authors mentioning Respiratory Failure as the cause of mortality.^{26,28,31}

This may be reasoned with that, in snakebite, the coagulation disorders caused by hemotoxic effects and DIC like picture may develop & Components like Haemorrhagins-1,2 and Metallo-endopeptidase causes acute hemorrhage in lungs. Fatal Envenoming by different species may cause death primary mechanism related to paralysis of respiratory muscles causing asphyxia, hyponatremia, hyperkalemia, hypertension & cardiogenic pulmonary edema with congestion, followed by possible respiratory failure.

While Renal Failure was caused of death in 40.0% cases. This was similar with studies done by many authors mentioning Renal Failure as the cause of mortality.^{14,15,16,17,18,19,21,22,23,25,27,29,30,33,35,36}

This may be due to combination of mechanisms like bleeding, hypotension, coagulopathy, circulatory collapse, intra-vascular hemolysis, rhabdomyolysis, complement activation, capillary-leak syndrome, DIC and sepsis be responsible for development of Acute Renal Failure. Krait-bite can cause hyponatremia, hyperkalemia, myo-lysis, myocardial damage & arrhythmia causing cardiogenic pulmonary edema leading to possible respiratory & renal failure.

Conclusion: Snakebite envenoming is an under-reported, ignored, morbid and fatal, though preventable & one of the common Medical Emergencies. Yet, this remained overlooked for long time. Even though in almost every country in the world, in every part of India and in this Jhalawar region of Rajasthan State, many poor and innocent people get victimize of this accidental, unnatural, untimely Death.

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In our study, 30 fatal snakebite cases brought to the Mortuary of our hospital & we observed -

1. Overall, the most commonly affected victims were of 21-40 years age, male victims were 36.67% and female victims were 63.33% and most affected male age group was 21-40 years, while female age group was 41-60 years.
2. Farmers or employed in agriculture activity and Labour is most commonly affected (46.67%) Occupation.
2. Most of cases were Hindus (93.34%), from rural background (70.0%) and highest in married victims (83.33% cases) overall, while married females being 89.47% cases.
3. The maximum cases were recorded between 06:00 am. to 06:00 pm. (day) at outdoors (86.36%) and highest in night (6pm. to 6am) were at indoor (75.0%) and rainy season of July to October (76.67%) being Highest.
4. Maximum victims (40.0%) arrived Brought dead at casualty/mortuary, followed by 23.33% victims, who survived for period of 4-7 days, after admitted in hospital.
5. Highest Mortality was due to Respiratory Failure as Cause of Death in 60.0% cases.

Limitations: The largest limitation of our study was small sample size of study population, which was 30 fatal snakebite cases brought to the Mortuary of our hospital & chosen in accordance with the projected sample size from the reference article and another limitation is that in many cases attendant could not bring the snake or identify the species of snake. Yet, those snakebites included in study has strong association with their characteristics as documented.

Recommendations: Incidence & mortality of snakebite envenoming can be reduced with following recommended measures:

1. Promote preventive practices wearing protective clothing (full-length pants, shoes, and gloves), working in groups and exercising caution during rainy season.
2. Maintain snake-safe environments by clearing bushes, trimming grass and eliminating holes, gaps, and other potential snake shelters around homes and fields.
3. Ensure immediate first aid and rapid transportation of victims to nearest healthcare facility.
4. Encourage safe identification of the snake, where feasible, to assist in standardize evidence-based snakebite appropriate clinical management.
5. Perform coagulation studies and promptly administer Anti-Snake Venom without delaying treatment for investigations & Strengthen healthcare services by ensuring the availability, accessibility, affordability along with supportive treatments such as ventilation, fluid therapy, haemodialysis, and antibiotics.
6. Promote research into novel therapies, including recombinant antibody technologies and toxin inhibitors.
7. Snake-venom "Antigen Detection Kits" should be made available Pan-India.
8. Improve transportation and community awareness, while discouraging ineffective traditional treatments.

9. Implement integrated public health strategies with community engagement, strengthened health systems, intersectoral collaboration, and resource mobilization.

10. Develop and adopt a single, evidence-based national protocol for snakebite management, relevant to the Indian context.

11. Radioimmunoassay (RIA), most sensitive & specific test; and Enzyme Immunoassay (EIA), cheap and simple; to be promoted for the detection of snake specific venom.

Abbreviations:

ASV: ANTI-SNAKE VENOM

WHO: WORLD HEALTH ORGANISATION

HPE: HISTOPATHOLOGICAL EXAMINATION

FSL: FORENSIC SCIENCE LABORATORY

DIC: DISSEMINATED INTRAVASCULAR COAGULATION

RIA: RADIOIMMUNOASSAY

EIA: ENZYME IMMUNOASSAY

A.M.: ANTE MERIDIEM

P.M.: POST MERIDIEM

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