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When the bite is not the threat: non-venomous snakebites and their impact on rural child health

Kavinda Dayasiri ,[1] Achila Ranasinghe,[1] Nayani Suraweera,[2] Priyanga Burhan[3]

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[1]Paediatrics, University of Kelaniya, Kelaniya, Sri Lanka
[2]Paediatrics, Rajarata University of Sri Lanka Faculty of Medicine and Allied Sciences, saliyapura, Sri Lanka
[3]Paediatrics, Wayamba University of Sri Lanka, Kuliyapitiya, Kurunegala, Sri Lanka

Correspondence to
Prof. Kavinda Dayasiri;
kavindadayasiri@gmail.com

ABSTRACT

Background While the clinical management of venomous snakebites has been widely studied, little attention has been paid to paediatric bites from non-venomous or mildly venomous snakes in Sri Lanka. Although medically less severe, these bites frequently lead to healthcare visits and even hospital admissions, primarily due to caregiver anxiety and concern, and may result in minor complications.

Methods A multicentre descriptive cross-sectional study was conducted across four referral hospitals in Sri Lanka. Children aged 0–17 years with confirmed bites from snakes of low or no medical significance were included. Data were collected through medical records and caregiver interviews. A matched control group was used to explore environmental and behavioural risk factors. Multivariate logistic regression identified independent predictors of snakebites.

Results Among 183 children, the mean age was 10.5 years (SD=4.1), with 68.3% being male. Most lived in rural areas (86.9%), and rat snakes and water snakes were the most frequently implicated species. Bites primarily affected the feet (71%) and occurred during outdoor activities at home. Most children presented to healthcare facilities within 1 hour of the bite. Multivariate analysis showed that regular use of a torchlight (OR: 0.38, p<0.001) and home garden cleaning (OR: 0.35, p<0.001) were protective, while the presence of rats (OR: 2.01, p<0.001) and proximity to water bodies (OR: 1.92, p=0.04) were associated with increased risk.

Conclusion Non-venomous and mildly venomous snakebites in children are common in rural Sri Lanka and are influenced by modifiable behavioural and environmental factors. Targeted community education and preventive measures could reduce unnecessary health system burdens

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Snakebites are a recognised public health issue in tropical countries, including Sri Lanka.
⇒ Most research has focused on venomous bites and their clinical outcomes.
⇒ Non-venomous or mildly venomous snakebites, though medically less severe, can cause anxiety in both children and parents and often lead to hospital admissions, particularly in children.

WHAT THIS STUDY ADDS

⇒ This is one of the few studies in Sri Lanka to describe the epidemiology of paediatric snakebites from species of lesser medical concern.
⇒ It identifies specific behavioural and environmental risk factors—such as poor lighting, inadequate garden maintenance and rodent presence—associated with these bites.
⇒ The study shows that most children presented promptly to healthcare facilities, but some still sought traditional care and received unnecessary antibiotics.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Supports the development of targeted community education to reduce anxiety and healthcare-seeking for low-risk snakebites.
⇒ Provides evidence for integrating environmental hygiene and preventive behaviours into public health messaging.
⇒ Encourages policy consideration for differentiated snakebite management protocols based on snake identification and risk level.

INTRODUCTION

Snakebite envenoming remains a significant yet under-recognised public health concern in many tropical and subtropical countries, including Sri Lanka.[1] While the burden of venomous snakebites and their clinical management has been extensively studied, non-venomous and mildly venomous snakebites—particularly those involving snakes of low or no medical significance—have received limited attention.[2] In children, even bites from non-venomous snakes can generate substantial anxiety among caregivers, contribute to unnecessary healthcare utilisation and occasionally result in complications such as secondary bacterial infections.[3]

Sri Lanka's diverse snake fauna includes several non-venomous or mildly venomous species that frequently come into contact with humans due to overlapping habitats, especially in rural and peri-urban settings.[4] These include rat snakes (*Ptyas mucosa*), water snakes (*Xenochrophis* spp.), vine snakes (*Ahaetulla*

spp.), cat snakes (*Boiga* spp.), trinket snakes (*Coelognathus helena*) and wolf snakes (*Lycodon* spp.).[5] Although bites from these species do not result in life-threatening envenomation, they may still cause local symptoms and provoke strong health-seeking responses, particularly among paediatric populations and their caregivers.[6]

Children in rural communities are particularly vulnerable to snakebites due to their natural curiosity, involvement in outdoor activities and lack of awareness about preventive behaviours.[7] Furthermore, rural environments with close proximity to agricultural land, water bodies and poor waste management practices often increase the likelihood of human-snake encounters.[8] Despite these known risks, there is a paucity of data on the epidemiological patterns and contextual risk factors associated with paediatric snakebites from species of lesser medical concern. This study was conducted to describe the demographic and clinical characteristics of paediatric snakebite cases involving non-venomous or mildly venomous snakes in Sri Lanka and to identify the environmental and behavioural risk factors associated with these incidents.

METHODS

Study design and settings

A multicentre descriptive cross-sectional study was conducted involving four major referral hospitals in Sri Lanka: Colombo North Teaching Hospital, Kurunegala Teaching Hospital, Polonnaruwa Teaching Hospital and Anuradhapura Teaching Hospital (figure 1). The study settings were purposefully selected due to their high caseloads of paediatric snakebite cases and their geographic representation of both urban and rural settings in Sri Lanka. These hospitals serve as key tertiary care referral centres in regions where snakebite incidence is notably high, particularly in rural communities where human-snake encounters are more frequent due to agricultural activities and environmental conditions.

Figure 1 Distribution of study settings. DGH, District General Hospital; NCTH, North Colombo Teaching Hospital; TH, Teaching Hospital.

Study population

The study population included children aged 0 to 17 years who presented to any of the selected hospitals following a snakebite incident. Inclusion was limited to cases in which the offending snake was identified as a species of low or no medical significance in Sri Lanka. Snake identification was verified either by direct visual inspection of the snake brought to the hospital—dead or alive—or through a clear photograph presented by the caregiver. Exclusion criteria included snakebites caused by medically significant or highly venomous species,[5] cases where the identity of the snake could not be reliably confirmed through visual or photographic evidence, and instances where medical records were incomplete or informed consent was not obtained.

Sample size and sampling procedure

A total population sampling approach was employed for this study. All eligible paediatric snakebite cases meeting the inclusion criteria were consecutively recruited during the study period. No sampling frame or randomisation process was used. In total, 183 children were enrolled over 3 years in all four study settings. To explore environmental and behavioural risk factors, a control group of 183 children was recruited from the same hospitals. Controls were matched for age, sex, and geographic location and had presented to the hospital for non-snakebite-related conditions during the same period.

Data collection

Data collection involved both retrospective extraction from hospital medical records and prospective caregiver interviews. A structured, pretested data collection tool was used to gather demographic information (such as age, sex, household income, parental education level and type of residence), details related to the bite incident (including time and location of the bite, activity during the bite and anatomical site affected) and healthcare-seeking behaviour following the incident (such as time taken to reach a healthcare facility, type of first healthcare contact and whether traditional healers were consulted). Environmental and behavioural exposures, such as proximity of the house to water bodies or paddy fields, presence of domestic animals, sightings of rodents and hygiene practices such as regular cleaning of home gardens and use of torchlights at night, were also documented. Interviews were conducted by trained research assistants fluent in native languages (Sinhala or Tamil). These interviews were held within 24 hours of hospital admission to minimise recall bias. In cases where the snake was not brought to the hospital, identification was recorded based on caregiver recognition or photographic evidence and cross-checked by the treating medical team when possible.

Study variables

For the purpose of this study, a snakebite was defined as any incident in which a child sustained a bite from a

snake, with or without physical injury or envenomation, and where the snake species was identified as being of low or no medical significance, based on regional herpetological classifications and national snakebite management guidelines.[5] Environmental and behavioural risk variables were operationally defined as follows: 'regular use of footwear' referred to the habitual wearing of closed-toe shoes or sandals while outdoors; 'regular use of a torchlight' indicated consistent use of a flashlight when walking in the dark; 'regular home garden cleaning' referred to weekly or more frequent removal of overgrown vegetation and clutter around the household; 'unsafe garbage disposal' included practices such as dumping food waste in open areas without secure containment; 'presence of rats or chickens' was determined based on self-report; and 'proximity to water bodies or paddy fields' was defined as a distance of less than 100 metres from the home to these features, as estimated by caregivers. Clinical variables included anatomical site of bite, time of bite (categorised into morning, midday, evening and night), time interval to hospital presentation and use of antibiotics or other interventions during hospitalisation. The data related to these variables were verified based on medical records to ensure accuracy of data.

Data analysis

All data were entered into a password-protected electronic database and analysed using IBM SPSS Statistics V.26.0. Descriptive statistics were computed for all variables, with categorical data presented as frequencies and percentages. Differences between children with snakebites and the control group were assessed using the χ^2 test. Multiple logistic regression analysis was performed to identify independent environmental and behavioural risk factors for snakebites. Statistical significance was set at a two-tailed p value of less than 0.05.

Ethical considerations

Ethical approval for the study was obtained from the Ethics Review Committee of the Postgraduate Institute of Medicine, University of Colombo. Written informed consent was obtained from the parents or guardians of all participating children, and assent was sought from children aged 12 years and older. All data were anonymised, and confidentiality was strictly maintained throughout the study.

Patient and public involvement

Patients and/or the public were not involved in the design, conduct, reporting or dissemination plans of this research.

RESULTS

A total of 608 children presented with snakebites during the study period. Of these, 181 cases (29.8%) were due to venomous snakes, while in 244 cases (40.1%), the snake species could not be identified. Among the confirmed venomous bites, the hump-nosed viper was the most frequently reported species, accounting for 110 cases. This was followed by Russell's viper with 27 cases and the Indian krait with 24 cases. Cobra bites were reported in 12 cases, while bites from the saw-scaled viper (five cases), Ceylon krait (two cases), and green pit viper (one case) were relatively rare.

Among the 183 children with non-venomous snakebites included in the study, the majority were between 8 and 15 years of age (105, 57.4%), with a mean age of 10.5 years (SD=4.1). Males comprised 68.3% of the sample, indicating a higher incidence of snakebites among boys. Nearly half of the households reported a monthly income between LKR 30 000 and 50 000, with the overall mean household income being LKR 56,010 (SD=27 530). Most parents had either incomplete or complete secondary education, and only 7.1% had tertiary education. The majority of participants (86.9%) resided in rural areas, underscoring the rural predominance of paediatric snakebites (table 1).

Table 1 Demographic characteristics of children with snakebites (n=183)

Demographic characteristics	Variable	N (%)
Age	< 4 years	15 (8.2%)
	4–8 years	29 (15.8%)
	8–11 years	54 (29.5%)
	11–15 years	51 (27.9%)
	15–17 years	34 (18.6%)
Sex	Male	125 (68.3%)
	Female	58 (31.7%)
Household income (LKR)	< 30 000	20 (10.9%)
	30 000–50 000	91 (49.7%)
	50 000–100 000	66 (36.1%)
	>1 00 000	16 (8.7%)
Highest education level in a parent	No formal education	2 (1.1%)
	Primary education	7 (3.8%)
	Secondary education (incomplete)	67 (36.6%)
	Secondary education (complete)	55 (30.1%)
	Advanced level education	49 (26.8%)
	Tertiary education	13 (7.1%)
Type of residential location	Rural	159 (86.9%)
	Urban	24 (13.1%)

Patterns of snakes implicated in bites

Rat snakes were the most commonly reported, accounting for 59 cases (32.2%), followed closely by water snakes

with 56 cases (30.6%). Vine snakes were responsible for 19 bites (10.4%), while both cat snakes and trinket snakes were each involved in 16 cases (8.7%). Wolf snakes were less frequently reported, accounting for 10 cases (5.5%). Identification of the snake was made by caregivers in 109 cases (59.6%) and by the treatment team in 74 cases (40.4%).

In 32 cases (17.5%), snakes were killed and brought in despite caregivers identifying them as non-venomous. An additional of 34 snakes (18.6%) were brought in dead because caregivers were uncertain about whether the snakes were venomous. In the majority of cases (n=113, 61.7%), the snake was not brought to the hospital; instead, identification was based on either the caregiver's visual recognition or through a photograph shown at the hospital. Only 4 (2.2%) snakes were brought to the hospital alive.

Circumstances of the snakebites

Play-related activities at home or home garden accounted for 42 snakebites (22.9%). Stepping on a snake indoors was reported in 33 cases (18.0%). Non-play activities in the home garden, including picking fruits or leaves, standing or placing objects, contributed to 23 cases (12.6%). Exposure in or around paddy fields accounted for 20 cases (10.9%), while incidents related to water bodies such as lakes, wells and tube wells (eg, bathing, washing) comprised 19 cases (10.4%). Other home-related activities, including walking to an outside bathroom or kitchen, standing near taps or waiting at the door, made up nine cases (4.9%). Movement to or from external locations, such as going to a neighbour's house or school, was reported in five cases (2.7%). Bicycle-related incidents, including placing or riding the bicycle and finding snakes hidden in it, were recorded in three cases (1.6%). Resting or sleeping incidents were reported in two cases (1.1%).

The majority of snakebites occurred on the foot (130 cases, 71.0%), followed by the leg (28 cases, 15.3%), hand (12 cases, 6.6%) and other parts of the body (13 cases, 7.1%). Regarding the timing of the bites, 38 cases (20.8%) occurred in the morning, 47 cases (25.7%) at midday, 54 cases (29.5%) in the evening and 44 cases (24.0%) at night.

Location of snakebites

A total of 55 bites (30.1%) occurred inside the home, while 60 bites (32.8%) took place in the home garden. Water bodies, including lakes, wells and canals, accounted for 27 bites (14.8%). Agricultural land, such as paddy fields and other farming areas, was the site of 14 bites (7.7%).

Home remedies

The most common potentially harmful first-aid measures were the application of a tourniquet above the bite site, observed in 36 cases (19.7%). Home remedies such as applying onions, lime, coconut milk or herbal mixtures to the wound were reported in 10 cases (5.5%). Suction of the bite site to remove venom was attempted in three cases (1.6%), while making an incision to drain blood was reported in one case (0.5%). Religious rituals or devotions before hospital presentation were conducted in two cases (1.1%). Notably, none of these cases resulted in complications such as limb gangrene or tissue necrosis.

Healthcare seeking behaviour in caregivers

Most children were brought to a healthcare facility within 1 hour from the time of bite (154 cases, 84.2%). Twenty-two children (12%) were brought within 1–2 hours, while the other seven children (3.8%) were brought to the hospital more than 2 hours after the time of the bite. A total of 95 children (51.9%) were initially taken to the nearest local hospital following the snakebite, while 85 children (46.4%) were brought directly to the nearest referral hospital. In contrast, three children (1.6%) were first taken to a traditional healer before seeking care at a medical facility.

Complications and outcome of the hospitalisation

All children were discharged home without any complications directly related to the snakebite. Twelve children (6.6%) received antibiotics as for a secondary bacterial infection of the bite site.

Environmental and behavioural risk factors for snake bites

Table 2 illustrates the comparison of the environmental and behavioural risk factors between children with snakebites and controls.

In the analysis of proposed risk factors, children with snakebites were significantly less likely to use a torchlight when walking in the dark (p=0.0006) and had lower rates of regular home garden cleaning (p<0.0001). The presence of rats at home (p=0.0031) and proximity to a waterbody (p=0.0376) were also significantly associated with snakebites. No significant differences were observed in regular footwear use, garbage disposal practices or proximity to paddy fields.

Multivariate logistic regression identified several key risk factors for paediatric snakebites (table 3). The regular use of a torchlight when walking in the dark (OR 0.38, 95% CI 0.23 to 0.64, p=0.00) and regular cleaning of home gardens (OR 0.35, 95% CI 0.22 to 0.56, p=0.00) were significantly associated with reduced risk. Conversely, the presence of rats at home (OR 2.01, 95% CI 1.26 to 3.20, p=0.00) and close proximity to a waterbody (OR 1.92, 95% CI 1.02 to 3.61, p=0.04) increased the likelihood of snakebites.

DISCUSSION

This study provides new insights into the epidemiology and contextual risk factors of paediatric snakebites caused by non-venomous or mildly venomous snakes in rural Sri Lanka. While the clinical burden of venomous snakebites has been extensively documented in South Asia, including Sri Lanka, the patterns, behaviours and

Table 2 Comparison of environmental and behavioural risk factors between children with snakebites and controls (n=366)

Proposed risk factor	Children with snakebites (n=183)	Control group (n=183)	χ^2	P
Regular use of footwear	140 (76.5%)	139 (76.0%)	0.01	0.99
Regular use of a torchlight when walking in the dark	134 (73.2%)	161 (88.0%)	11.81	0.00
Presence of chickens at home	10 (5.5%)	5 (2.7%)	1.11	0.29
Presence of rats at home	141 (77.0%)	114 (62.3%)	8.74	0.00
Store paddy at home	65 (35.5%)	54 (29.5%)	1.25	0.26
Unsafe disposal of garbage	34 (18.6%)	41 (22.4%)	0.60	0.43
Regular cleaning of home garden	71 (38.8%)	114 (62.3%)	19.28	0.00
Close proximity of house to a waterbody	34 (18.6%)	19 (10.4%)	4.32	0.03
Close proximity of house to a paddy field	18 (9.8%)	16 (8.7%)	0.03	0.85

healthcare responses associated with less medically significant bites—particularly among children—remain underexplored.[2] Our findings suggest that although these bites do not result in severe envenomation, they are associated with distinct behavioural and environmental risks and can still lead to healthcare visits, hospital admissions and psychosocial distress.

In this study, rat snakes (*Ptyas mucosa*) and water snakes (*Xenochrophis* spp.) were the most commonly implicated species. Similar distributions have been reported in ecological and hospital-based studies in India and Southeast Asia, where non-venomous colubrids frequently inhabit human settlements, particularly in rural and agricultural landscapes.[9–11] Although these snakes are generally harmless, the fear they generate often leads to overreaction, including unnecessary medical consultations and killing of the snake, as observed in 34 cases in our study.

Children aged 8–15 years were the most affected group, which aligns with previous studies that identify school-aged boys as having higher exposure to snakebite risk due to increased outdoor activity, reduced supervision and greater mobility.[3 6] Recent studies in Sri Lanka emphasised that older children often participate in household or agricultural tasks, increasing their risk of snake encounters.[12 13] Most bites occurred on the feet or legs, consistent with previous reports from rural India and Thailand, where bites are typically sustained while walking barefoot or playing outdoors.[14]

The risk factors reported in this study are consistent with prior literature and remain highly relevant to both venomous and non-venomous snakebite occurrences. Regular use of a torch at night and frequent home garden cleaning were significantly associated with reduced bite risk. These behaviours are well-established in the literature as protective factors against snakebites.[15] The presence of rats in the home—observed in over 75% of affected households—was also significantly associated with increased bite risk. This may reflect the ecological attraction of snakes to rodent-rich environments, a relationship reported in prior studies of domestic snake intrusions.[16]

Healthcare-seeking behaviour in this study was largely appropriate, with the majority of children being brought to a medical facility within 1 hour of the bite. This contrasts with some previous studies from Sub-Saharan Africa and rural India where delays in presentation were common due to reliance on traditional healers or logistical barriers.[17 18] Nonetheless, a small proportion (1.6%) in our study still sought care initially from traditional

Table 3 Multivariate logistic regression of risk factors associated with paediatric snakebites (n=366)

Proposed risk factor	Adjusted Odd's ratio	95% CI	P
Regular use of footwear	1.02	0.55 to 1.89	0.96
Regular use of a torchlight when walking in the dark	0.38	0.23 to 0.64	0.00
Presence of chickens at home	1.57	0.60 to 4.10	0.36
Presence of rats at home	2.01	1.26 to 3.20	0.00
Store paddy at home	1.22	0.77 to 1.93	0.40
Unsafe disposal of garbage	0.82	0.48 to 1.41	0.47
Regular cleaning of home garden	0.35	0.22 to 0.56	0.00
Close proximity of house to a waterbody	1.92	1.02 to 3.61	0.04
Close proximity of house to a paddy field	1.09	0.50 to 2.36	0.82

practitioners, highlighting ongoing gaps in community awareness.

Harmful first-aid practices such as tourniquet application, use of herbal remedies and venom suction were reported in this study, echoing findings from recent qualitative research in rural Sri Lanka.[19] Despite these practices, no serious complications like limb gangrene were observed. Cultural beliefs, fear and limited awareness continue to shape emergency responses.[20] These findings highlight the need for targeted, culturally sensitive health education. Addressing these behaviours is essential to improving outcomes in paediatric snakebite care.

From a clinical perspective, it is noteworthy that none of the children in our study experienced systemic complications, and only 6.6% were treated with antibiotics, likely for localised bacterial infections. These findings underscore that while the clinical impact of such bites is minimal, the associated health-seeking behaviours and interventions (eg, antibiotic use) may still strain healthcare resources. Overuse of antibiotics in these low-risk cases, as reported in other studies, contributes to broader concerns regarding antimicrobial resistance.[21]

This study contributes to a growing body of evidence calling for differentiated management strategies for paediatric snakebites based on identification of snakes and risk stratification.[22 23] Educational initiatives aimed at improving community knowledge of local snake species, bite prevention strategies and appropriate first-response actions can mitigate unnecessary fear and reduce healthcare system burden. Similar interventions have shown promising outcomes in community-based snakebite education programmes in India and Nepal.[24 25]

Several limitations should be noted. First, snake identification relied heavily on caregiver reports or photographic evidence, without confirmation by expert herpetologists in all cases, raising the possibility of species misclassification. Second, while data collection tools were standardised and administered by trained personnel, the retrospective nature of some responses may have introduced recall bias, especially for environmental exposures and time of bite. Third, while the control group was age- and sex-matched, it was limited to children presenting to the same hospitals, which may not fully reflect the broader paediatric population in these regions. Finally, environmental risk assessments were based on self-report, and objective measures (eg, geographic mapping, household inspections) were not conducted.

CONCLUSION

Non-venomous and mildly venomous snakebites in children, though not associated with serious clinical outcomes, represent a significant public health concern in rural Sri Lanka due to their frequency and associated healthcare-seeking behaviours. Our study identified specific modifiable environmental and behavioural risk factors, including inadequate lighting during nighttime walking, poor home garden maintenance and rodent infestation, that contribute to increased exposure risk. Most children sought care promptly, suggesting a reasonable level of community awareness, but the continued use of traditional remedies and overuse of antibiotics highlights areas for improvement. Targeted health education and community-based prevention strategies—centred on improving environmental hygiene, promoting the use of footwear and torches and enhancing snake species recognition—are critical to reducing unnecessary anxiety, healthcare visits and costs associated with these low-risk bites.

Contributors Study conception and design: KD. Data collection and data cleaning: KD, NS, PB and AR. Data analysis: KD and NS. Interpretation of the results: KD. Draft manuscript preparation: KD. Planning and supervising the work: KD. KD is responsible for the overall content as the guarantor. All authors provided critical feedback, helped shape the research, analysis and approved the final version of the manuscript. AI is used only for English language corrections.

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Patient and public involvement Patients and/or the public were not involved in the design, conduct, reporting or dissemination plans of this research.

Patient consent for publication Consent obtained from parent(s)/guardian(s).

Ethics approval This study involved human participants. The regulatory approvals for this study were obtained from the Ethics Review Committee, Postgraduate Institute of Medicine, University of Colombo (ERC-PGIM-2024-029). Participants gave informed consent to participate in the study before taking part.

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ORCID iD

Kavinda Dayasiri http://orcid.org/0000-0003-0438-9837

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