

RESEARCH NOTE

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Epidemiological patterns and trends of paediatric snakebites in Sri Lanka

Kavinda Dayasiri^{1*}, Dihan Caldera¹, Nayani Suraweera², Vijayakumary Thadchanamoorthy³, Maduwanthi Hettiarachchi⁴, Thanura Denipitiya⁵ and Sudharshana Bandara⁶

Abstract

Objectives This study aimed to analyse the epidemiological patterns of paediatric snake bites in Sri Lanka over a 4-year period (2020–2024).

Methods A multi-centre, retrospective observational study was conducted from June 2020 to June 2024 across nine governmental hospitals in seven provinces of Sri Lanka. Data were collected based on 757 children presenting with snake bites. The snake bites were analysed based on age, gender, and seasonal variations. Data on the type of snake involved, geographic variations and the temporal trends in snake bite occurrences were also analysed.

Results The mean age of the 757 children recruited to the study was 10.3 years (SD—5.00, range—0.1–17 years). Males (57.7%) were significantly more affected than females (42.3%) ($p < 0.05$). Visual identification confirmed the snake species in 58.4% of cases. The hump-nosed viper (16.7%), Russell's viper (14.7%), and common krait (12.9%) were the most common medically important snakes identified in the study. Seasonal peaks in snake bites occurred in May–July and November–December. An increasing trend in snake bite incidence was noted over the first three years, with a slight decline in the final year.

Conclusion Paediatric snake bites in Sri Lanka show significant age, gender, and seasonal patterns. Targeted public health interventions are needed to mitigate the impact on children.

Keywords Snakebites, Epidemiology, Children, Sri Lanka

Background

Snakebite envenoming is an important yet neglected tropical disease that carries a significant healthcare burden and cause long term consequences such as amputations and post-traumatic stress disorder to over 400,000

humans annually [1]. Majority of the reported snakebites occur in Africa, Asia and Latin America [2]. However, the actual burden of this significant healthcare issue is unknown owing to gross underreporting and the fact that most of the snakebite envenomation occurs in low- and middle-income countries with poor access to medical care and extreme poverty [3]. The global burden of snakebites is disproportionately distributed amongst children of these countries making it an important avenue of study with many implications [4]. Children in particular experience more severe manifestations of snakebites such as rapid and more severe neurotoxicity, coagulopathy, and more severe local tissue damage, because of their smaller bodies and the higher proportion volume of injected venom [5]. However, lack of epidemiological data in the paediatric population has severely impeded

*Correspondence:

Kavinda Dayasiri
kavindadayasiri@gmail.com

¹ Department of Paediatrics, Faculty of Medicine, University of Kelaniya, Thalagolla Road, PO Box 06, Ragama, Sri Lanka

² Rajarata University of Sri Lanka, Anuradhapura, Sri Lanka

³ Faculty of Healthcare Sciences, Eastern University of Sri Lanka, Batticaloa, Sri Lanka

⁴ Teaching Hospital Peradeniya, Peradeniya, Sri Lanka

⁵ District General Hospital Hambantota, Hambantota, Sri Lanka

⁶ Base Hospital Medirigiriya, Medirigiriya, Sri Lanka



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the development of quality emergency medical care and treatment [6].

Sri Lanka is home to a diverse range of snake species, some of which are of significant medical importance due to their potential to cause severe envenomation (Fig. 1) [7].

Paediatric snake bites in Sri Lanka exhibit distinct epidemiological patterns, characterized by a high incidence rate among children, particularly in rural areas where agriculture is prevalent [8]. The vulnerability of children is exacerbated by their outdoor activities and limited awareness of snakebite risks. Seasonal variations, with higher occurrences during the monsoon period, further complicate the scenario. Despite the significant health burden, there is a paucity of comprehensive

epidemiological studies focusing on the paediatric population in these regions. This gap underscores the urgent need for targeted research to inform prevention strategies, improve clinical management, and formulate effective public health policies to mitigate the impact of snake bites on children. The current study aimed to study the epidemiological patterns of snake bites among children across multiple geographic regions in Sri Lanka.

Methods

This multi-center, retrospective observational study was conducted over four years (June 2020 to June 2024), including nine governmental hospitals across seven provinces of Sri Lanka. The hospitals were selected to provide a comprehensive representation of different geographical



Fig. 1 Medically important snakes in Sri Lanka; **A** common/Indian krait (*Bungarus caeruleus*), **B** Russell's viper (*Daboia russelii*), **C** common/Indian cobra (*Naja naja*), **D** hump-nosed pit vipers (*Hypnale* spp.), **E** saw-scaled viper (*Echis carinatus*), **F** Ceylon/Sri Lankan krait (*Bungarus ceylonicus*) and **G** green pit viper (*Peltopelorus trigonocephalus*). (By courtesy of the Expert Committee on Snake Bites, Sri Lanka Medical Association)

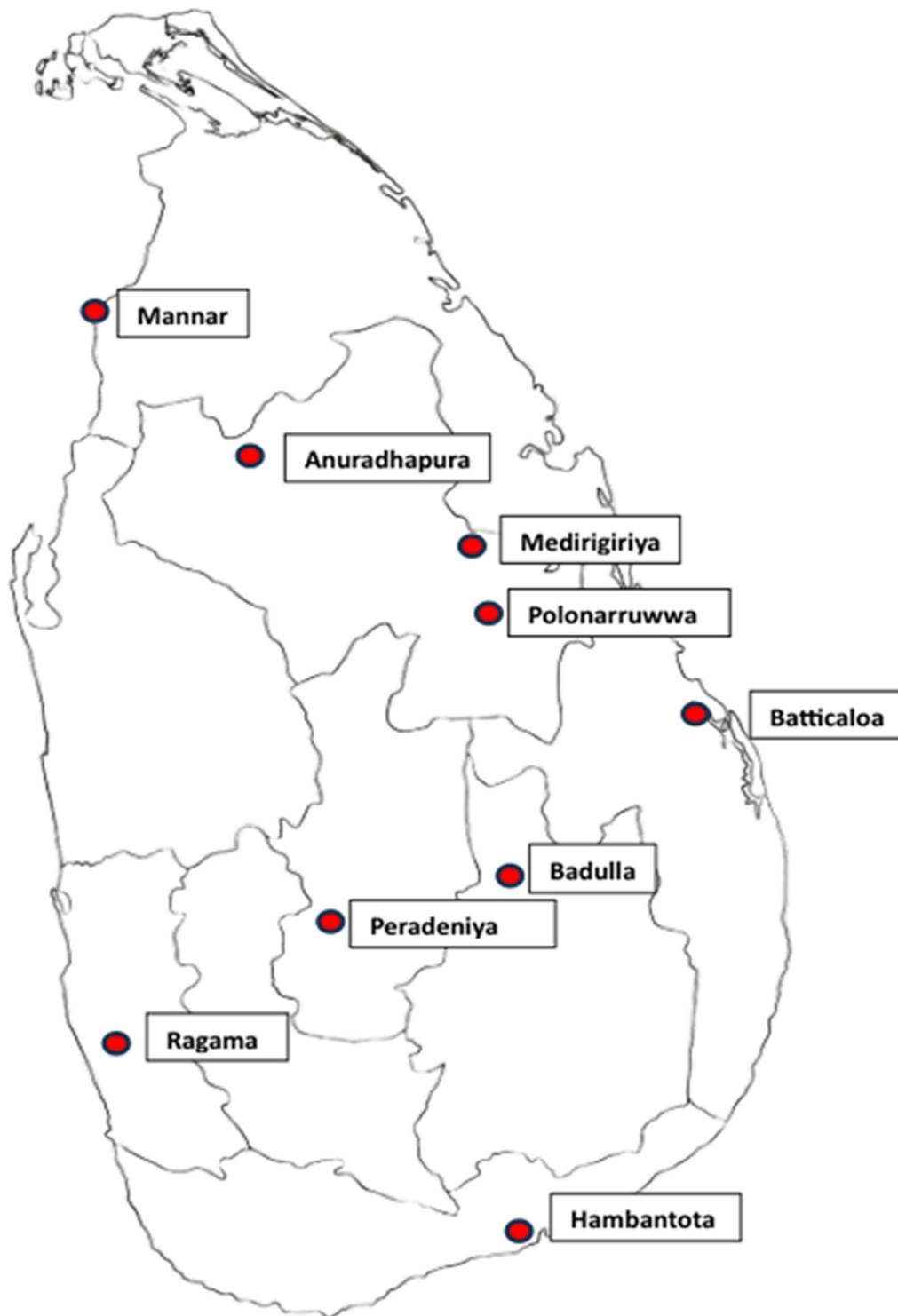


Fig. 2 Distribution of study settings within the country

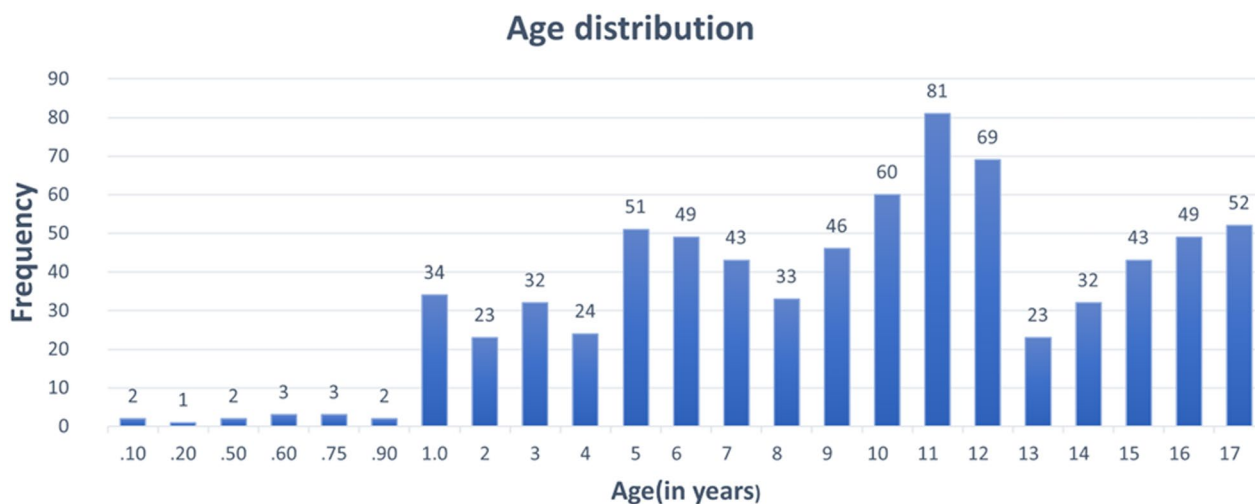


Fig. 3 Age distribution among children with snake bites

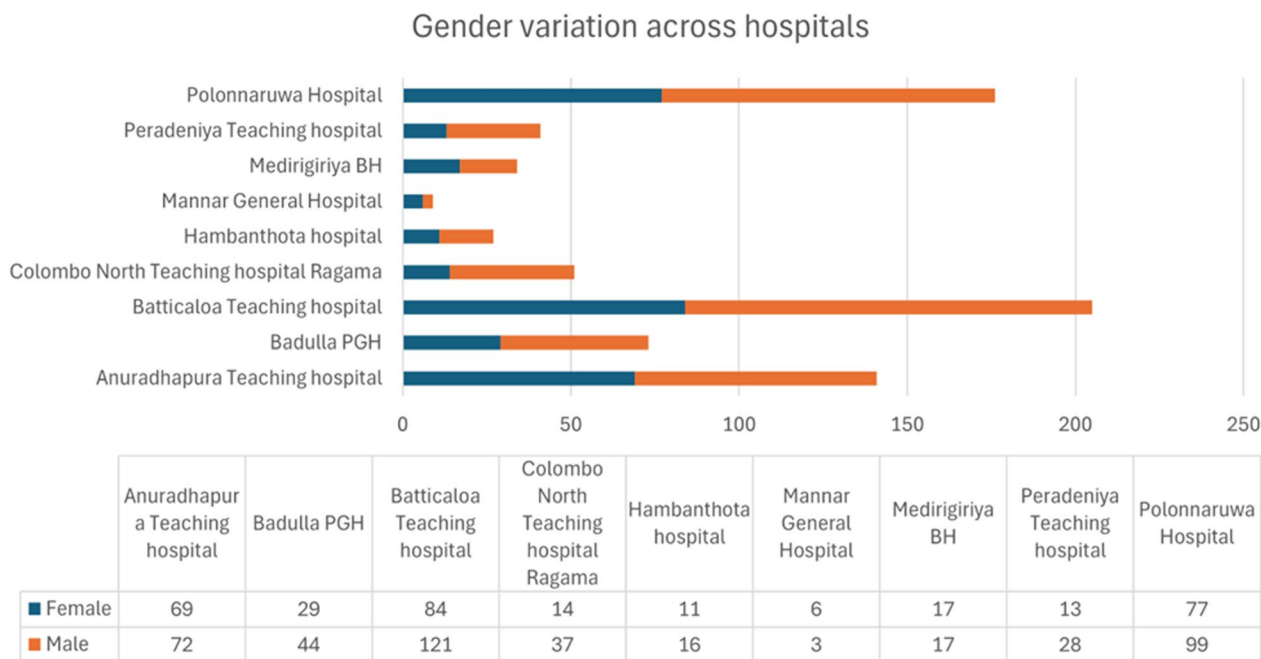


Fig. 4 Gender variations among children with snake bites across study settings

regions and healthcare settings within the country. Data on paediatric snake bite cases (age: from birth to 17 years) were collected from hospital based medical records over the 4-year study period. Minimum sample size required for the study was 384 ($Z=1.96$, $d=0.05$, $P=0.5$).

Demographic information, including age and gender, was recorded for each child. Snake identification was verified in medical records. The incidence of snake bites was analysed based on age, gender, and seasonal variations.

Statistical analyses were performed to determine the significance of differences in snake bite incidence between genders and across different age groups. Data on the type of snake involved, geographic variations and the temporal trends in snake bite occurrences were also analysed using SPSS 26.0 to provide an overview of the epidemiological patterns of paediatric snake bites in Sri Lanka. The ethical clearance was granted by the Ethics Review Committee, Post-graduate Institute of Medicine, University of Colombo.

Table 1 Patterns of snake bites with known snakes across all study settings

	Common name	Predominant geographical locations (Provinces)	Venomosity	n (%)
1	Hump-nosed pit-viper	Eastern, North Central, Western, Central	Hemotoxic, Nephrotoxic	74 (16.7%)
2	Russel's viper	Eastern, North Central, Western, Northern	Hemotoxic, Neurotoxic, Myotoxic, Nephrotoxic	65 (14.7%)
3	Common krait	Eastern, North Central	Neurotoxic	57 (12.9%)
4	Ceylon krait	Central	Neurotoxic	1 (0.2%)
5	Cobra	Eastern, North Central, Western	Neurotoxic	23 (5.2%)
6	Sea snake	Eastern	Myotoxic, Neurotoxic	2 (0.4%)
7	Saw scaled viper	Eastern, Northern	Hemotoxic	12 (2.7%)
8	Green-pit viper	Eastern, North Central	Hemotoxic	8 (1.8%)
9	Sri Lankan coral snake	North Central, Southern	Neurotoxic	5 (1.1%)
10	Water snake	North Central, Eastern, Western, Central	–	77 (17.4%)
11	Vine snake	North Central	–	25 (5.6%)
12	Cat snake	Eastern, Southern, Central, Western	–	10 (2.3%)
13	Gold and black tree snake	North Central	–	5 (1.1%)
14	Sri Lankan keelback	North Central	–	4 (0.9%)
15	Rat snake	North Central, Western, Southern, Eastern	–	45 (10.2%)
16	Wolf-snake	North Central, Southern	–	14 (3.2%)
17	Trinket snake	North Central	–	10 (2.3%)

Results

The study recruited 757 children who presented to nine governmental hospitals across seven provinces of Sri Lanka over 4 years (2020 June–2024 June). The hospitals included 4 teaching (North Colombo, Peradeniya, Batticaloa and Anuradhapura), 1 provincial general (Badulla), 1 base (Medirigiriya), and 3 district general (Polonnaruwa, Hambantota, Mannar) hospitals. Figure 2 illustrates the distributions of study settings within the country.

The mean age of the study population was 10.3 years (SD=5.00, range=0.1–17 years), with females having a mean age of 9.9 (SD=4.91) and males having a mean age of 10.6 years (SD=5.04). The peak incidence of snake bites was observed among children aged 10–12 years whilst the incidence was lowest amongst children under 1 year. The patterns of age distribution among the two genders were not significant ($p=0.11$). Figure 3 illustrates the age distribution among children with snake bites.

Male children outnumbered female children in all study settings [male: 437(57.7%), female: 320 (42.3%)]. The overall difference in incidence of snake bites observed amongst the two genders were statistically significant. ($p=0.04$). Figure 4 illustrates the gender variations among children with snake bites across study settings.

The identity of the snake was confirmed by visual identification of the snake in 442 (58.4%) children. However, the identity was made either by the syndromic approach or the snake was not identified in all other cases (315,

41.6%). All children bitten by unidentified snakes were suspected to have either dry-bites from medically important snakes or bites from non-venomous snakes.

Among the hemotoxic snake bites, hump-nosed viper was most frequently implicated in paediatric snake bites (74, 16.7%). Hump-nosed viper was the most common in all study settings in wet-zone whilst Russel's viper (65, 14.7%) and common krait (57, 12.9%) were most common in study settings in dry zone. Saw-scaled viper detection was proportionately higher in Mannar district (4, 33%). Among other snake bites, water snakes were predominantly identified in Polonnaruwa district general hospital (41, 53.2%). Table 1 shows the patterns of snake bites with known snakes across all study settings.

Data from three study settings were available for the analysis ($n=454$) of the snake bite variations within different months of the year. Two peaks (May–July and November–December) were recognisable as having an increasing trend and a higher incidence as shown in Fig. 5.

Similarly, data from three study settings were available for the analysis ($n=454$) of the variation of snake bites across the 4-year study period. During the first three years, an increasing trend was seen, the incidence was shown to be slightly declining during the last 12 months of the study. However, no statistically significant variations were seen within each hospital across different years (Fig. 6).

Snake bite variations with months

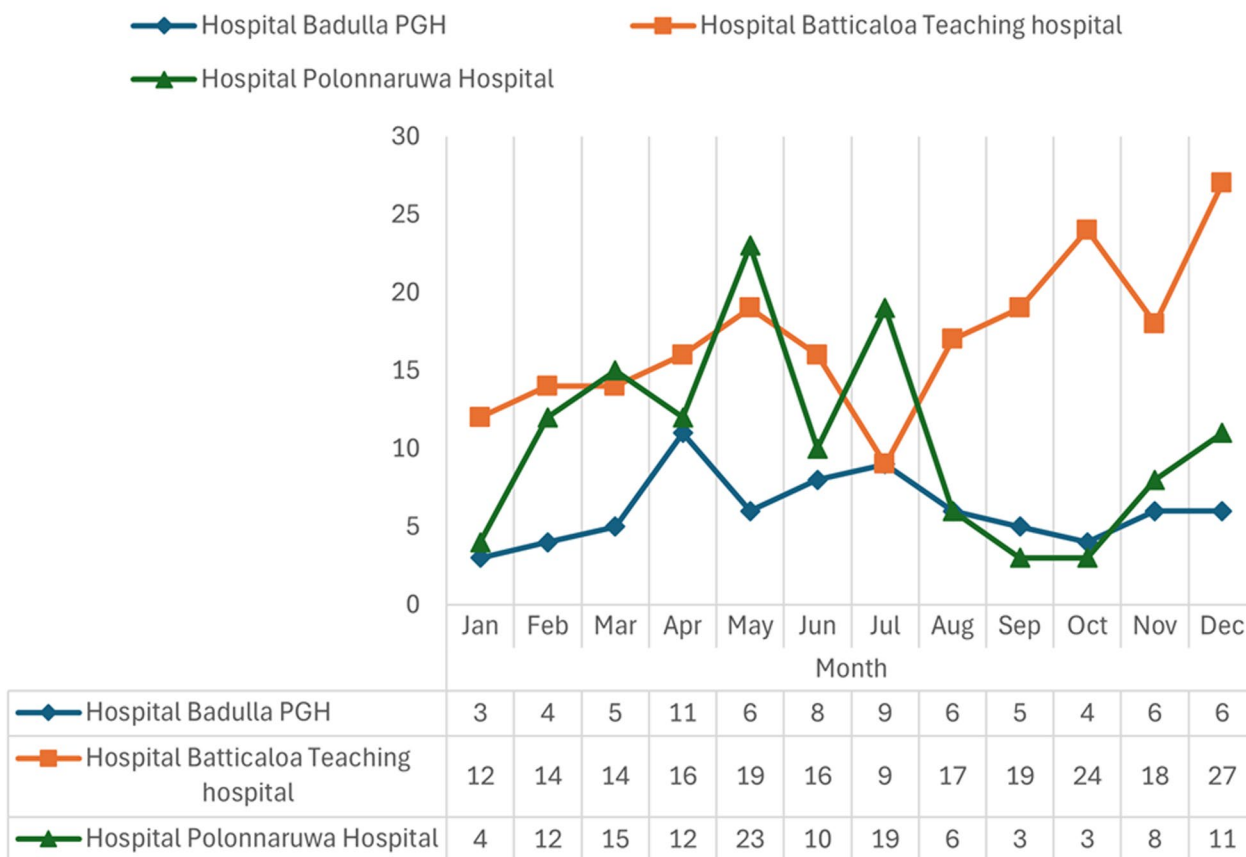


Fig. 5 Snake bite variations within different months of the year (n = 454)

Discussion

Paediatric snakebites in Sri Lanka remain a significant public health concern, with limited studies addressing their epidemiology [9, 10]. The current study offers valuable insights into selected epidemiological patterns of paediatric snake bites in Sri Lanka, a country with a high incidence of snake envenomation [11]. Over a 4-year period, we recruited 757 children from nine governmental hospitals across seven provinces, highlighting significant findings in age and gender distribution, snake species involved, and temporal trends of snake bites.

The peak incidence of snake bites was observed among children aged 10–12 years, which aligns with their increased outdoor activities and engagement in agricultural tasks [12]. Notably, the incidence was lowest in children under 1 year, likely due to their limited mobility and outdoor exposure. The age distribution patterns did not show significant differences between genders, indicating a uniform risk across both sexes in various age groups. However, male children significantly outnumbered

female children in all study settings, with the overall gender difference being statistically significant. This gender disparity might be attributed to cultural factors and behavioural differences, with boys more likely to engage in outdoor activities that increase their risk of snake encounters [13].

The identity of the snake was visually confirmed in 58.4% of cases. Among the hemotoxic snake bites, the hump-nosed pit-viper was the most frequently implicated species, accounting for 16.7% of cases. This species was predominantly found in the wet-zone regions. In contrast, the dry-zone regions reported higher incidences of bites from Russell’s viper and kraits. Other snakes, such as water snakes, were most commonly identified in the Polonnaruwa district in which reservoirs exist in abundance for agricultural work. Thus, our findings were consistent with the known geographic distribution of the snake species and their habitats in Sri Lanka. The analysis of monthly snake bite variations revealed two peak periods: May–July and November–December. These peaks

Snake bite variation with years

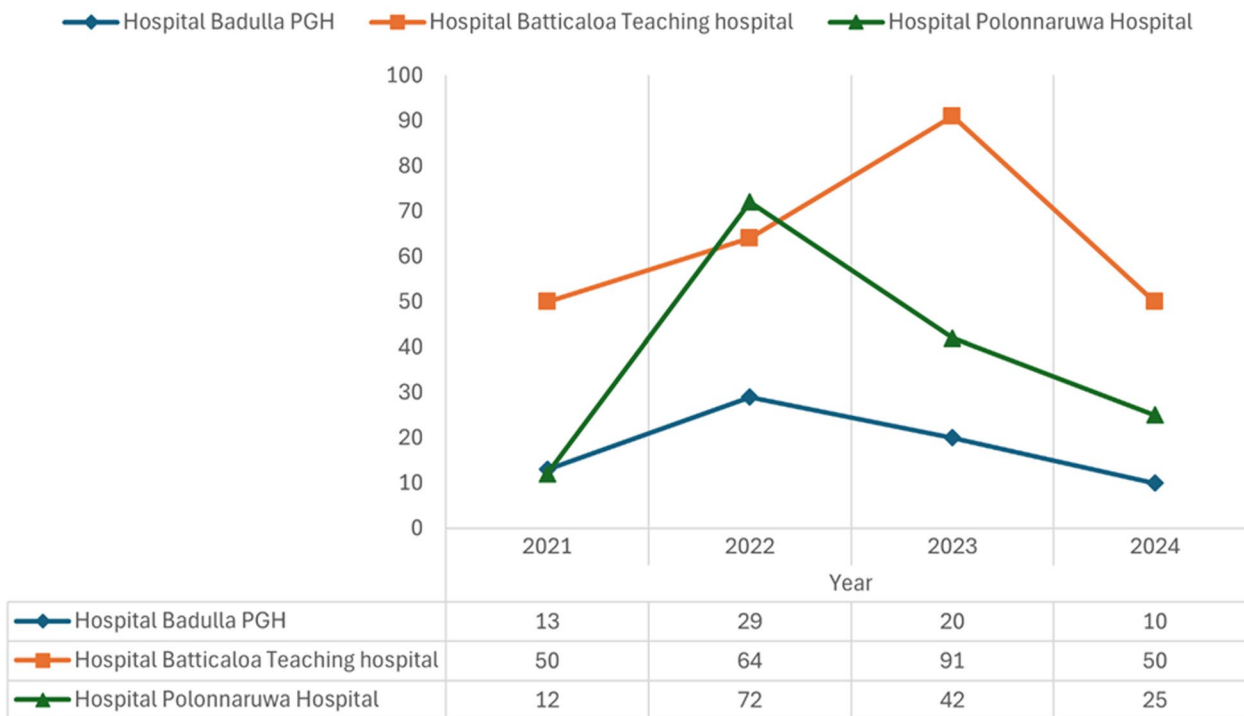


Fig. 6 Variation of snake bites across the 4-year study period (2020–2024) (n=454)

coincide with the agricultural seasons and monsoon periods, suggesting that increased agricultural activities and changes in snake behaviour due to weather conditions contribute to the higher incidence of bites during these months [14]. Over the 4-year study period, there was an increasing trend in snake bite incidences during the first three years, followed by a slight decline in the last year. However, these variations were not statistically significant across different hospitals, indicating that the trends might be influenced by broader environmental and societal factors rather than localized hospital data.

The hemotoxic and neurotoxic snake bites, especially from species like the Russell’s viper and kraits, underscores the critical need for effective antivenom and medical care in paediatric cases [15]. The significant gender disparity highlights the necessity for targeted educational programs focusing on preventive measures, particularly for boys who are at higher risk. Additionally, the seasonal peaks in snake bites call for heightened awareness and preparedness during these periods, including ensuring adequate antivenom supplies and medical staff training. This study is limited by the lack of detailed clinical outcomes data limits the ability to assess the full impact of snake bites on the paediatric population, including long-term morbidity and mortality. Future research should

aim to address these limitations to provide a more holistic understanding of paediatric snake bites in Sri Lanka.

Limitations

This study has several limitations that must be acknowledged. Firstly, the reliance on hospital-based medical records for data collection may have led to underreporting, as cases managed outside hospital settings or in private facilities were not included. The study did not include detailed clinical outcomes data, limiting the assessment of long-term morbidity and mortality among the paediatric population affected by snake bites. The geographic and seasonal patterns observed may also be influenced by regional differences in healthcare access and reporting practices, which were not controlled for in this study. Furthermore, the data were collected from nine governmental hospitals, which may not fully represent the broader paediatric population across Sri Lanka. Additionally, the study does not provide comprehensive epidemiological information on the full burden of paediatric snake bites in the country. Future research should aim to address these limitations and include a broader range of data sources to provide a more comprehensive

understanding of the epidemiological patterns and outcomes of paediatric snake bites in Sri Lanka.

Conclusion

This study provides an overview of selected epidemiological patterns of paediatric snake bites in Sri Lanka, revealing significant age, gender, and temporal trends. These findings emphasize the need for targeted public health interventions and further research to understand the underlying factors contributing to these patterns.

Acknowledgements

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Author contributions

K.D. designed the study, carried out data collection following appropriate methodology, analysed data, and wrote the manuscript. D.C. designed the study, analysed data and wrote the manuscript. N.S., V.T., M.H., T.D., S.B. collected and analysed data. All authors reviewed and approved the final manuscript.

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Availability of data and materials

The data that support the findings of this manuscript are available from the medical records departments of the nine hospitals included in the study. However, restrictions apply to the availability of these data, which are used under license for the current report and so are not publicly available. Data are, however, available from the authors upon reasonable request and with permission of the medical records departments of the nine hospitals included in the study.

Declarations

Ethics approval and consent to participate

Permission to carry out the study was obtained from the Ethics Review Committee, Post-graduate Institute of Medicine, University of Colombo (ERC/PGIM/2024/029). The study was entirely based on hospital based medical records and had no direct contact with human participants. Therefore, consent to participate was not applicable. The study procedures were done in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

- Gutiérrez JM, Calvete JJ, Habib AG, Harrison RA, Williams DJ, Warrell DA. Snakebite envenoming. *Nat Rev Dis Primers*. 2017;3:17063. <https://doi.org/10.1038/nrdp.2017.63>. Erratum in: *Nat Rev Dis Primers*. 2017;3:17079. <https://doi.org/10.1038/nrdp.2017.79>.
- Mohapatra B, Warrell DA, Suraweera W, Bhatia P, Dhingra N, Raju M, et al. Snakebite mortality in India: a nationally representative mortality survey. *PLoS Negl Trop Dis*. 2011;5(4):1–8.
- Harrison RA, Hargreaves A, Wagstaff SC, Faragher B, Lalloo DG. Snake envenoming: a disease of poverty. *PLoS Negl Trop Dis*. 2009;3(12): e569. <https://doi.org/10.1371/journal.pntd.0000569>.
- Kasturiratne A, Wickremasinghe AR, De Silva N, Gunawardena NK, Pathmeswaran A, Premaratna R, et al. The global burden of snakebite: a literature analysis and modelling based on regional estimates of envenoming and deaths. *PLoS Med*. 2008;5(11):e218–e218.
- Kshirsagar VY, Ahmed M, Colaco SM. Clinical profile of snake bite in children in rural India. *Iran J Pediatr*. 2013;23(6):632–6.
- Pach S, Le Geyt J, Gutiérrez JM, Williams D, Maduwage KP, Habib AG, Gustin R, Avila-Agüero ML, Ya KT, Halbert J. Paediatric snakebite envenoming: the world's most neglected 'Neglected Tropical Disease'? *Arch Dis Child*. 2020;105(12):1135–9. <https://doi.org/10.1136/archdischild-2020-319417>.
- Dayasiri MBKC, Maduwage K. Envenomation and poisoning. In: Rajindrajith S, Mettananda S, Abeyagunawardena A, editors. *Concise textbook of pediatrics*. Kurunegala: Samudra Medical Publications; 2022.
- Jayawardana S, Arambepola C, Chang T, Gnanathanan A. Prevalence, vulnerability and epidemiological characteristics of snakebite in agricultural settings in rural Sri Lanka: a population-based study from South Asia. *PLoS ONE*. 2020;15(12): e0243991. <https://doi.org/10.1371/journal.pone.0243991>.
- Karunanayake RK, Dissanayake DMR, Karunanayake AL. A study of snake bite among children presenting to a paediatric ward in the main Teaching Hospital of North Central Province of Sri Lanka. *BMC Res Notes*. 2014;7:482. <https://doi.org/10.1186/1756-0500-7-482>.
- Rathnayaka RMMKN, Ranathunga PEAN, Kularatne SAM. Epidemiological and clinical features of hump-nosed pit viper (*Hypnale hypnale* and *Hypnale zara*) envenoming in children. *PLoS Negl Trop Dis*. 2022;16(12): e0011013. <https://doi.org/10.1371/journal.pntd.0011013>.
- Ediriveera DS, Kasthuriratne A, Pathmeswaran A, Gunawardene NK, Jayamanne SF, Murray K, et al. Evaluating spatiotemporal dynamics of snakebite in Sri Lanka: monthly incidence mapping from a national representative survey sample. *PLoS Negl Trop Dis*. 2021;15(6): e0009447. <https://doi.org/10.1371/journal.pntd.0009447>.
- Shyna KP, Sudhakaran K, Mohammed MTP. A clinical profile of poisonous snake bite in children of North Kerala, India. *Int J Contemp Pediatr*. 2018;5:310–3.
- Pattanaik B, Mahapatra C, Karthika IK, Satapathy AK, John J, Das RR, Dwivedi B, Mahapatro S, Gulla KM. Clinical, laboratory profile and outcomes in children with snakebite from Eastern India. *J Fam Med Prim Care*. 2023;12(8):1588–92. https://doi.org/10.4103/jfmpc.jfmpc_1965_22.
- Akani GC, Ebere N, Franco D, Eniang AE, Petrozzi F, Politano E, Luiselli L. Correlation between annual activity patterns of venomous snakes and rural people in the Niger Delta, southern Nigeria. *J Venom Anim Toxins Incl Trop Dis*. 2013;19:2. <https://doi.org/10.1186/1678-9199-19-2>.
- Sharif M, Amin MR, Barshan AD, Hasan MJ, Faiz MA. Optimizing survival in Russell's viper bite cases in low-resource setting: two case reports. *J Med Case Rep*. 2024;18(1):56. <https://doi.org/10.1186/s13256-024-04354-0>.

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