



## Short communication

## Mortality due to snakebite envenomation in Costa Rica (1993–2006)

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## ABSTRACT

The mortality due to snakebite envenomation in Costa Rica for the period 1993–2006 was investigated by a retrospective analysis. There were 48 fatalities due to snakebites during this period. Mortality rates ranged from 0.02 per 100,000 population in 2006 to 0.19 per 100,000 population in 1993. Case fatality rates in the period 1993–2000 ranged between 0.18% (2000) and 1.15% (1993). The highest numbers of fatal cases occurred in the provinces of Puntarenas and Limón, in low-land humid regions where the species *Bothrops asper* ('terciopelo') is distributed and agricultural activities predominate. The most affected age groups were those of 20–29, 40–49 and 50–59 years, and fatal cases predominated in males over females by a ratio of 5:1.

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Snakebite envenomations represent a relevant, albeit neglected, public health issue on a global basis (Theakston et al., 2003; Gutiérrez et al., 2006a; WHO, 2007). It has been estimated that 2.5 million cases of envenomation occur every year with, at least, 125,000 deaths (Chippaux, 1998). Snakebite accidents are frequent in Latin America, mainly affecting young agricultural workers (Fan and Cardoso, 1995; Gutiérrez, 1995; Warrell, 2004). The vast majority of snakebites in this region are inflicted by species of the family Viperidae, especially by those classified within the genus *Bothrops* (Fan and Cardoso, 1995; Gutiérrez, 1995; Warrell, 2004). In addition, few accidents are caused by bites of coral snakes (family Elapidae, genus *Micrurus*) (Bolaños, 1982; Gutiérrez, 1995).

In Costa Rica, viperid snakes are classified in the genera *Agkistrodon* (one species), *Bothriechis* (four species), *Bothrops* (one species), *Cerrophidion* (one species), *Crotalus* (one species), *Lachesis* (two species), and *Porthidium* (four species) (Campbell and Lamar, 2004). Most snakebite cases in this country are inflicted by *Bothrops asper* (Bolaños, 1982), locally known as 'terciopelo'. The family Elapidae comprises four species of *Micrurus* in Costa Rica, and one

species of sea snake, the pelagic sea snake *Pelamis platurus* (Campbell and Lamar, 2004). Several investigations have documented the incidence of snakebite envenomation in this country (Bolaños, 1982; Arroyo et al., 1999; Sasa and Vázquez, 2003) which, in the decade 1990–2000, ranged from 12 to 19 cases per 100,000 population per year, with a descending trend (Sasa and Vázquez, 2003). In addition, snakebite mortality was assessed for the period 1952–1993, and a conspicuous descending trend was also documented (Rojas et al., 1997). Owing to the relevance of this health issue, the present investigation was performed to follow-up the mortality due to snakebite envenomation in Costa Rica for the period 1993–2006.

Deaths due to snakebite envenomation occurring in Costa Rica from 1993 to 2006, and total population of the country and of each province, were retrospectively recorded from Area de Servicio de Información del Instituto Nacional de Estadística y Censos (INEC) of Costa Rica, where all deaths in the country are reported. The mortality rates were estimated for every year, both for the whole country and for each province. The case fatality rate was estimated for the period 1993–2000, based on the data on incidence presented by Sasa and Vázquez (2003). The number of deaths per 'cantón' (local political division) was also recorded. In addition, mortality was stratified by age and gender.

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The total number of deaths due to snakebites for the period 1993–2006 was 48. The number of deaths per year ranged from 1 case (years 1997, 2000 and 2006) to 6 cases (years 1993 and 2003). Mortality rates ranged from 0.02 per 100,000 population in 2006 to 0.19 per 100,000 population in 1993 (Fig. 1). When the information on the total number of snakebite cases in the period 1993–2000 was considered, the case fatality rates were estimated. Case fatality rates for these years were: 1993: 1.15%; 1994: 0.74%; 1995: 0.92%; 1996: 0.35%; 1997: 0.20%; 1998: 0.64%; 1999: 0.94%; and 2000: 0.18%.

The highest number of total fatalities and of mortality rate were observed in the provinces of Puntarenas and Limón (Table 1). In four years (1998, 1999, 2000 and 2006) all deaths occurred in the province of Puntarenas, whereas in 1996 the only two fatalities occurred in the province of Limón (Table 1). When distribution of fatal cases was analyzed by ‘cantones’, the local political divisions, those with highest number of fatal cases were Golfito (7 cases) and Corredores (6 cases) in the southern Pacific region of the province of Puntarenas. The ‘cantones’ of Pococí (province of Limón), Turrialba (province of Cartago) and Puriscal (province of San José) presented three fatal cases each. Males were affected more than females, by a ratio of 5:1 (40 vs 8 cases, respectively). Distribution of fatalities by age group evidenced two peaks, one in the group of 20–29 years and another in the groups ranging from 40 to 49 and 50 to 59 years, although there were fatal cases in all age groups (Fig. 2).

A previous investigation had documented a drop in mortality due to snakebite envenomation in Costa Rica from the decade of 1950 (with a rate as high as 4.83 per 100,000 population in 1953) to the first years of the decade of 1990 (with rates of 0.2 per 100,000 population) (Rojas et al., 1997). Our present results clearly show that mortality rates remain at low levels (below 0.2 per 100,000 population and, in half of the years, below 0.1 per 100,000

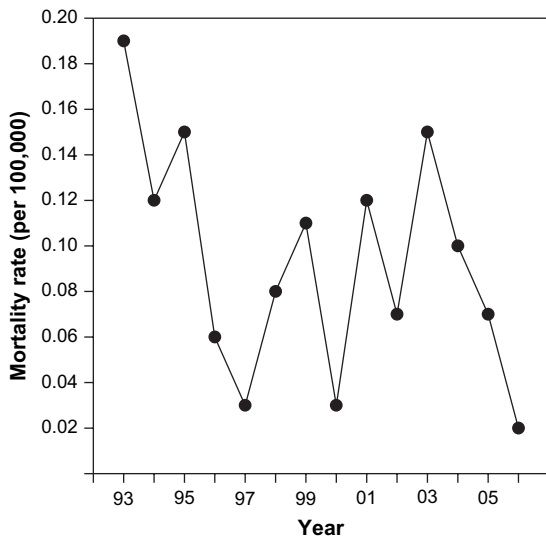
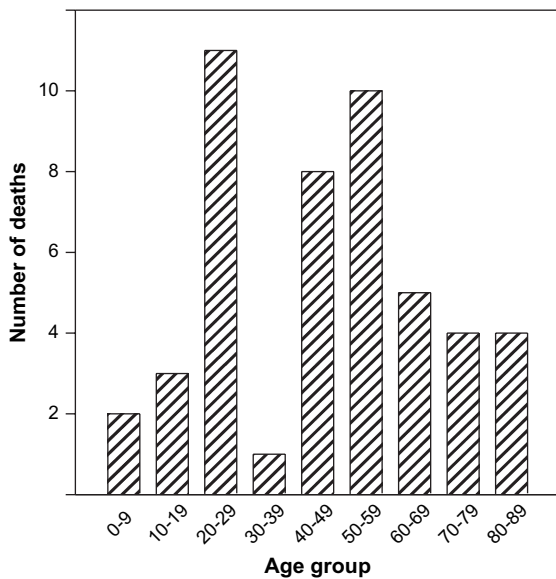


Fig. 1. Mortality due to snakebite envenomation in Costa Rica for the period 1993–2006. Mortality rate is expressed per 100,000 population per year.

Table 1  
Total number of deaths and mortality rates due to snakebite envenomations in Costa Rica, according to province<sup>a</sup>

Province	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Alajuela		1 (0.17)	1 (0.17)								1 (0.13)				3
Cartago	1 (0.27)	1 (0.27)	1 (0.26)												3
Guanacaste		1 (0.38)											1 (0.34)		2
Heredia			1 (0.37)						1 (0.27)						2
Limón	2 (0.83)		1 (0.39)	2 (0.76)					3 (0.83)	1 (0.28)	1 (0.27)	2 (0.53)			12
Puntarenas	1 (0.28)	1 (0.27)	1 (0.27)			3 (0.76)	4 (0.99)	1 (0.27)		2 (0.52)	4 (1.02)	1 (0.25)	1 (0.25)	1 (0.24)	20
San José	2 (0.17)				1 (0.08)				1 (0.07)			1 (0.07)	1 (0.07)		6
<b>Total</b>	<b>6</b>	<b>4</b>	<b>5</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>4</b>	<b>1</b>	<b>5</b>	<b>3</b>	<b>6</b>	<b>4</b>	<b>3</b>	<b>1</b>	<b>48</b>

<sup>a</sup> Results are presented as absolute number of deaths per province per year; values in parentheses correspond to mortality rates (per 100,000 population per year).



**Fig. 2.** Distribution of fatal cases of snakebite envenomation in Costa Rica (1993–2006) according to age group.

population) for the period 1993–2006. When case fatality rates were estimated for the period 1993–2000, they ranged between 0.18% and 1.15%, with values below 1% for most of the years. In contrast, a case fatality rate of 3.3% had been reported for Costa Rica in 1979 (Bolaños, 1982). Thus, the reduction has occurred both in mortality and case fatality rates in this country.

The low mortality and case fatality rates described for this pathology in Costa Rica are likely to be the consequence of the sustained efforts performed in confronting snakebite envenomation as a public health problem. A continuous improvement in the access to health care in this country has been documented (Rosero-Bixby, 2004). In addition, the local production of antivenoms, and their widespread distribution to hospitals and clinics (Caja Costarricense del Seguro Social, unpublished information), ensures the nationwide accessibility of this drug. Furthermore, the development of uniform treatment protocols and algorithms has been achieved in the last decades (Gutiérrez, 1995; Gutiérrez et al., 2006b). Finally, continuous education programs on the diagnosis and treatment of these envenomations, both at medical and nursing schools, and health facilities, are also likely to have contributed to the reduction of the impact of these envenomations, a hypothesis that requires further investigation.

Despite the overall low mortality observed, it is pertinent to analyze regions where the highest number of fatal cases occurs, in order to identify remaining risk factors associated with mortality. As previously described for the period 1952–1993, in the period 1993–2006 the provinces of Puntarenas and Limón presented 41.7% and 25%, respectively, of all fatalities. These provinces also have the highest incidence of snakebite cases (Arroyo et al., 1999; Sasa and Vázquez, 2003). Even within these provinces, there are regions that show highest vulnerability. In the province of Puntarenas, the ‘cantones’ of Golfito and Corredores, in

the southern Pacific region of the country, include 27% of the total number of fatalities for this period. This geographical distribution of incidence and mortality closely correlates with low-land humid regions where the species *B. asper* is abundant (Solórzano and Cerdas, 1988; Sasa and Barrantes, 1998). These are regions where agricultural activities predominate, thus increasing the likelihood of encounters between snakes and people. In contrast, the province of Guanacaste, which includes mostly tropical dry forests where *B. asper* is not distributed, has a very low incidence of snakebites (Arroyo et al., 1999; Sasa and Vázquez, 2003) and the lowest mortality rate, together with the province of Heredia (this work). It is concluded that low-land humid regions devoted to agricultural activities and where *B. asper* is distributed present the highest risk of snakebite accidents and deaths.

Age distribution of fatal cases for the period 1993–2006 evidences a bimodal pattern, with a peak at 20–29 years and another at 40–59 years. Such pattern differs from that for the period 1972–1993, in which there was a peak in the age group of 10–19 years (Rojas et al., 1997). A peak at 10–19 years was also described for the total number of snakebites cases in Costa Rica during the decade 1990–2000 (Sasa and Vázquez, 2003). Whether our findings are highlighting a change in the trends of snakebite mortality, in terms of age group affected, remains to be determined in future studies. Furthermore, the predominance of males over females increased, from a ratio of 3.6:1 (in the period 1972–1993) to a ratio of 5:1 (in the period 1993–2006).

In conclusion, this study documents the mortality due to snakebite envenomation in Costa Rica for the period 1993–2006. At the same time, it highlights potentially vulnerable regions where the majority of fatal cases for this period occurred. A more detailed analysis of such cases is required, in order to design interventions that would further reduce the impact of this relevant public health problem in this country.

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### Conflict of interest

The authors declare that there are no conflicts of interest.

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