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Snake bite envenomation in Ecuador

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ABSTRACT

The aim of this study was to evaluate the burden of snake bite in Ecuador and to identify the difficulties of snake bite management in Ecuadorian health facilities. A survey based on national health statistics was carried out in Ecuador to estimate the overall incidence and mortality due to snake bites. During the period 1998–2007, the average annual incidence and mortality was respectively 11 and 0.5 per 100 000 inhabitants. The at-risk population was represented mainly by males aged 10–54 years. Snake bite incidence increased during the rainy season and El Niño. According to one data source, the majority of snake bites occurred in the coastal region (56%) compared with the Amazonian rainforest (11%) and the highlands (33%). This geographical variation in snake bite incidence may reflect the distribution of venomous snakes and human population densities and activities. This preliminary national survey on the incidence of the envenomings due to snake bite in Ecuador showed a stable incidence over the time period studied but was heterogeneous in the three geographical regions of Ecuador. The incidence and mortality were higher in the lowland humid regions where *Bothrops* species are abundant.

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1. Introduction

Snake bite remains a frequent medical emergency in most tropical countries.¹ The highest burden of snake bite occurs in Asia and sub-Saharan Africa.^{2,3} The actual incidence of snake bite is difficult to estimate but it could reach 5.5 million cases a year, involving 20 000–130 000 deaths a year. The data concerning Latin America are scarce and limited due to a poor record of cases. Improved epidemiologic data would facilitate the rationalization of snake bite management by health services.⁴

Epidemiologic information about snakebites in Ecuador is scarce, and only a few studies have been reported. Most of the authors agree that it is necessary to develop practical protocols of treatment, improve medical training and develop a marketing approach for newer and better

antivenoms. Owing to the relevance of this health issue, the preliminary investigation was performed to analyze the incidence of snake bites in Ecuador in the main three geographical regions, and to identify the difficulties of snake bite management in Ecuadorian health facilities. This is the first study conducted on this aspect.

2. Methods

Ecuador is a tropical country of Latin America bordered by Colombia in the north, Perú in the east and south, and by the Pacific Ocean to the west; it has a total area of 283 560 km² 50% of which is Amazonian rainforest. The country has three main geographic regions plus an insular region, the Galápagos Islands in the Pacific Ocean: La Costa, the lowland coastal region in the western part of the country; La Sierra, a high-altitude belt running north to south along the center of the country; and La Amazonía, in the eastern part of the country, covering the Amazon rainforest area. During the period of the study, the average

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Table 1
Snake bite incidence and mortality in Ecuador (1998–2007)

Year	Reported snake bites		Deaths (case–fatality rate) ^b
	MSP ^a	INEC ^b	
1998	1542		
1999	1380		
2000	1311		
2001	1402	1240	14(1.13)
2002	1405	1472	12(0.82)
2003	1428	1518	13(0.86)
2004	1699	1555	7(0.45)
2005	1557	1387	4(0.30)
2006	1526	1349	4(0.30)
2007	1470	1378	7(0.50)
Total	14720	9899	61(0.62)

^a Source: Ministry of Health (MSP), 1998–2007.⁶^b Source: Instituto Nacional de Estadísticas y Censos (INEC), 2001–2007.⁵

population was 13 million people: 50% in the coastal region, 45% in the highlands and 5% in the Amazonian forest; 36% of the population live in rural areas.

A first set of data was obtained from the National Register of Hospital Admission/Discharges and the National Mortality Register, both held by the National Institute of Statistics and Censuses [Instituto Nacional de Estadísticas y Censos (INEC)].⁵ The data covered a seven year period from 2001 to 2007.

A second set of data was collected from the Epidemiological Surveillance System of the Ministry of Public Health [Ministerio de Salud Pública (MSP)].⁶ The data covered a 10 year period from 1998 to 2007.

We used the International Classification of Diseases, 10th edition, for the extraction of snake bites (ICD Code=T63.0) from the data bases.⁷ The annual prevalence, incidence and mortality are expressed per 100 000 inhabitants and the case–fatality rate is expressed as a percentage.

3. Results

According to INEC data, 9899 snake bites occurred between 2001 and 2007 representing 92.47% of reported accidents involving venomous animals. Snake bites accounted for 24.22% of all poisonings and represented 0.2% of the total consultations or hospitalizations. The MSP reported 14 720 snake bite envenomings between 1998 and 2007 (Table 1). The average annual incidence of envenomings was approximately 11.15 per 100 000 inhabitants, corresponding to 30 cases per 100 000 rural population.

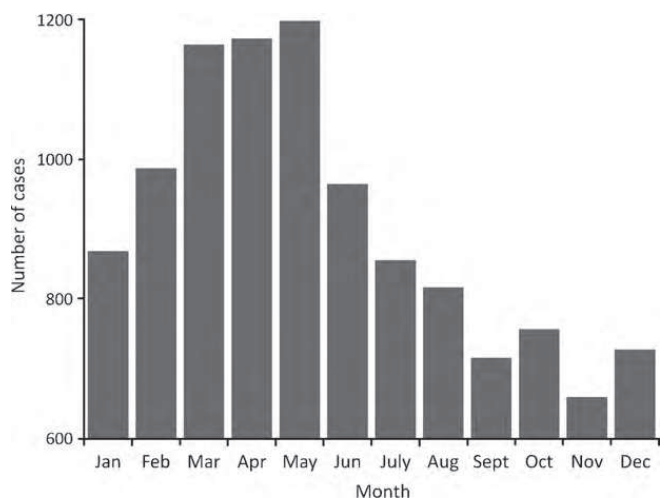
The INEC notified 61 deaths between 2001 and 2007. The case–fatality rate was 0.62% (Table 1) and the annual mortality was 0.052 per 100 000 inhabitants.

Males were more exposed than females (6310 males vs. 3589 females; sex-ratio 1.75:1). Adults aged 10–54 years were more frequently envenomed than children or older people; 28.05% of the envenomings involved children younger than 15 years although they represent 33% of the total population of Ecuador (Table 2).

The seasonal incidence of snakebites increased from January to June which corresponds to the rainy season (Figure 1). According to MSP data, the geographical distribution showed 8256 (56%) snake bites in the coastal region,

Table 2
Distribution of snake bite envenomation by age in Ecuador (2001–2007)

Age group (years)	Total	%
0–4	450	4.55
5–9	992	10.02
10–14	1335	13.49
15–19	1299	13.12
20–24	1074	10.85
25–34	1699	17.16
35–44	1441	14.56
45–54	1115	11.26
≥55	494	4.99
Total	9899	100.00

Source: Instituto Nacional de Estadísticas y Censos.⁵**Figure 1.** Monthly distribution of snake bite in Ecuador (2001–2007). Source: Instituto Nacional de Estadísticas y Censos (INEC).⁵

4900 (33%) in the Amazonian rainforest and 1564 (11%) in the highlands.

4. Discussion

The two data sources gave similar results: the INEC reported 10 487 snake bite envenomings between 2001 and 2007, whereas the MSP reported 9899 cases for the same period, with an overall agreement of 95%. However, some discrepancies between the two reporting systems were observed; the MSP reporting system seemed more sensitive than the INEC system.

Previous surveys carried out in Ecuadorian Indian communities showed high annual incidence and mortality of 1500 and 130 per 100 000 respectively.^{8,9} Touzet,¹⁰ studying native Indian communities from Ecuadorian Amazonia, confirmed the high incidence of snake bite and complexity of therapeutic seeking behaviour. More recently, a study of 142 patients in the Province of Morona Santiago reported that 90% of the patients recovered without sequelae; the case–fatality rate was 2.9%.¹¹

Data from hospital records may fail to reflect the actual incidence or severity of the envenomings. Many bites are asymptomatic,^{12,13} and most victims do not attend hospital. In addition, many patients would rather go to traditional healers, either by personal choice, or because

medical facilities are remote and therapeutic resources are insufficient.^{8,10}

Our results indicate that mortality is low in Ecuador, which can be explained either by good management of the envenomings or poor reporting of the fatalities. Improving treatment of snake bite in Ecuador is likely to be the consequence of sustained efforts made by health authorities leading to better access to health care. In addition, the local production and importation of antivenoms, and their widespread distribution to hospitals and clinics, facilitated their availability and appropriate treatment for snake bite in health facilities.¹⁴ Furthermore, the development of appropriate treatment protocols and algorithms has been achieved in the last decade. Finally, continuous education programs on the diagnosis and treatment of envenomations, both at medical and nursing schools, also contributed to the reduction of complications; a similar situation has been documented in Costa Rica.¹⁵ However, the impact of antivenom availability and improvement of therapeutic protocols needs further investigation. Surveys should assess the time taken from being bitten to seeking and receiving treatment as well as the overall use of antivenoms to check the adequacy of antivenom stocks for the number of envenomings. However, low mortality could also be the consequence of an underreporting of deaths, particularly in the Amazonian region, where health facilities are scarce.

Snake bites mainly involve young farmers as already mentioned by several authors in Latin America,^{15–17} resulting in high social and economic impacts. This aspect should be analyzed in Ecuador to estimate the social cost of snake bite. Duration of hospital stay, and incidence and severity of sequelae should also be studied.

In addition to the higher snake bite incidence during the rainy season (Figure 1), a peak in snake bite incidence was observed in 2004, according to both INEC and MSP records. This peak corresponded to El Niño Southern Oscillation (ENSO) which caused floods in the coastal provinces and may have pushed the snakes away from their usual habitats, artificially increasing the risk of accidents elsewhere.

In Latin America, most snake bites are due to vipers belonging to the genus *Bothrops* and affiliated genera.^{18–22} *Bothrops* bites can produce severe inflammatory, hemorrhagic syndromes and/or extensive necrosis, sometimes necessitating amputations. In Ecuador, 40 different species of venomous snakes have been identified.²³ Species distribution according to altitude may explain the low incidence in the highly populated highland zone (under three envenomings per 100 000 inhabitants). Most of the venomous snake species live far away from human habitats and are mainly present in the poorly populated areas of the Amazonian forest. Despite the low density of human population, the annual incidence exceeds 120 envenomings per 100 000 inhabitants, which is close to the annual incidence of 150 cases per 100 000 inhabitants observed in Sucúa, a community of the Amazonian area.¹¹ Our results are also consistent with those already published for Ecuador.^{9,10} In the highly populated and agricultural coastal area, the incidence was approximately 13 envenomings per 100 000 inhabitants reflecting poor contact between snakes and humans. This could reflect a low density of snakes due to particular environmental conditions.

In conclusion, this preliminary national survey on the incidence of the envenomings due to snake bite in Ecuador showed a stable incidence over the time period studied but was heterogeneous in the three geographical regions. The incidence and mortality were higher in the lowland humid regions where *Bothrops* species are abundant. In these regions, agricultural activities predominate, increasing the risk of snake–human encounters. The low mortality, which may be due to underreporting in remote areas, seemed more likely to be a result of the improvement in the medical management of snake bite, in particular the accessibility of antivenoms thanks to local production.

Authors' contributions: FGA conceived and designed the project and sought the data from the Ministry of Health; FGA and JPC analysed and interpreted the data; FGA drafted the manuscript which was revised and finalized by JPC. Both authors read and approved the final manuscript. FGA and JPC are guarantors of the paper.

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Ethical approval: Not required; the study concerned retrospective analysis of a database.

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