

EPIDEMIOLOGICAL PROFILE OF SNAKEBITES IN MOROCCO

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ABSTRACT: The present work aims to find the epidemiological profile of snakebites in Morocco through a retrospective study of 1,423 snakebite cases that occurred between 1992 and 2007. Data were obtained from medical charts of envenomation at the Poison Control and Pharmacovigilance Center of Morocco.

Results revealed that 86% of the snakebites had occurred in rural areas and that males were significantly more affected than females at a sex ratio of 23:20. Furthermore, 35% of the bites happened during the summer, with a peak of 215 cases in June (15.1%). We also discovered that 67.3% of the patients were bitten during the day. The age group that comprised the most agriculturally active persons, from 20 to 44 years old, was the most affected by snakebites (551 cases). In terms of evolution, patients who were at least 60 years of age (8.89%) as well as those who were less than 10 years old (7.50%) presented higher mortality.

According to clinical severity grades, the data revealed a 70% predominance of grade 2 cases (430). Deaths had occurred only in patients with grades 3 and 4. Furthermore, grade 4 patients presented 100% mortality whereas grade 3 registered 10.7%. The distribution of snakebites according to administrative regions in Morocco showed a predominance of the Souss-Massa-Daraa region both in terms of frequency (32%) and mortality (72.1%).

Our study clearly displayed the severity and extent of the snakebite problem in the country, thus revealing that public health authorities should give more attention to this serious situation.

KEY WORDS: snakebites, epidemiology, mortality, Morocco.

CONFLICTS OF INTEREST: There is no conflict.

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INTRODUCTION

Envenomations are frequently encountered throughout the world. It is estimated that globally at least 421,000 envenomations and 20,000 deaths occur each year due to snakebites (1). Although infrequent in Europe and North America, snake envenomations represent actually a public health concern in many developing countries, where up to 5 million bites are annually reported, leading to 45,000 deaths (2, 3). One million snakebites occur annually in sub-Saharan Africa, resulting in almost 20,000 deaths, whereas 4 million accidents are reported in Asian countries that led to almost 80,000 deaths (4, 5). Venomous snake accidents are more frequent in Australia, the habitat of some of the world's most poisonous snakes (6). Approximately 30% of the 3,000 snake species across the globe are venomous and considered dangerous to humans (7). Moreover, some species (e.g. king cobra) are capable of causing death within ten minutes (8).

The Egyptian cobra, *Naja haje*, is the only representative of the Elapidae family in north Africa. Furthermore, this species is represented in the Moroccan Sahara by the subspecies *Naja haje legionis* (Figure 1), whose presence appears to be increasingly infrequent in the Agadir-Ouarzazate-Laâyoune triangle, where it had been prominent until the last century, reaching even Figuig in the east, environs of Essaouira in the northwest, Oued Assag in the southwest and Aïn Timellousa (near the Mauritania boundaries) in the southeast (9). The puff adder, *Bitis arietans* (Figure 2), is found in Morocco along the strip starting in Taliouine, going through Bou-Jerif (west of Guelmin), Tarfaya, Laâyoune, Lemsid and extending up to Boudjour (9). In the regions of Marrakech and Haouz, the most common snake is *Coluber hippocrepis* and the most dangerous one is *Vipera mauritanica* (10).

Snakebites lead to various clinical pictures, depending on the snake species involved and the envenomation severity (11, 12). Snake toxins, containing numerous protein enzymes, may be divided into three groups: cytotoxic (Viperidae), neurotoxic (Elapidae) and hemotoxic (Colubridae) venoms (13). The cytotoxic effect leads to local pain, edema and tissue necrosis with possible coagulopathy, hypovolemic shock, renal failure and death (Figure 3). The neurotoxic outcome consists of somnolence, visual disorders and respiratory distress. The hematological toxicity can manifest through bleeding that may develop into disseminated intravascular coagulopathy (14).

In this context, the present work aimed to find the epidemiological profile of snakebites in Morocco by means of a retrospective study of all snakebite cases that occurred between 1992 and 2007.



Figure 1. Egyptian cobra (*Naja haje legionis*), environs of Fort Bou-Jérif, west of Guelmim, Morocco (photo by M. Aymerich, 2006).



Figure 2. Puff adder (*Bitis arietans*), environs of Fort Bou-Jérif, west of Guelmim, Morocco (photo by M. Aymerich, 2006).



Figure 3. A 28-year-old patient admitted to the hospital after a snakebite in the region of Ouarzazate (south of Morocco).

MATERIALS AND METHODS

The present work consists of a retrospective epidemiological study based on a sample of 1,423 cases of snakebites occurred that in Morocco from 1992 to 2007. Data were obtained from envenomation charts of the Poison Control and Pharmacovigilance Center of Morocco (Toxicovigilance System).

We employed the geographic information system ArcGIS® (ESRI, USA) to obtain the geographic distribution of snakebite frequency and lethality. Analysis was carried out using Excel® (Microsoft, USA) and the statistical software SPSS® (SPSS Inc., USA). Descriptive statistics comprised characteristics and frequencies of the studied variables with the purpose of finding the epidemiological profile of snakebites in our series. On the other hand, analytic statistics was based on an association of tests including chi-square (χ^2) for the comparison of absolute frequencies; Z-test (ε) for the comparison of relative frequencies; and relative risk (RR) to measure the association between the presence or absence of a factor and the occurrence of an event.

Studied variables were patient-related (sex, age), snakebite-related (time and place of snakebites) and evolution-related (clinical grade, death). The number of valid data (active n) is mentioned for each variable in the Results section.

The clinical gradation of snakebites and envenomations is crucial for evaluating and managing the condition of each victim (15). According to the patient condition at the time of admission, it was classified as follows (16):

- **Grade 0:** bite without envenomation (absence of edema or local reaction).
- **Grade 1:** minor envenomation (local edema, absence of general signs).
- **Grade 2:** moderate envenomation (regional edema in the affected limb and/or moderate general symptoms: moderate hypotension, malaise, vomiting, abdominal pain and diarrhea).
- **Grade 3:** severe envenomation (extensive edema reaching the torso and/or severe general symptoms: prolonged hypotension, shock, anaphylactoid reaction and visceral trouble).
- **Grade 4:** extremely severe envenomation (apparent systemic involvement with blood-tinged secretions, renal failure, coma and death).

The specific lethality for a variable (region, month of bite, time of bite, age group and grade) was calculated by dividing the number of deaths in a given category by the total number of cases in this same category, and multiplying this ratio by 100.

RESULTS

The study was based on 1,423 cases of snakebites that occurred between 1992 and 2007; of which 749 patients were males (53%) and 652 were females (47%). The sex ratio, of 23:20, was very significant ($\chi^2 = 6.72$; $p < 0.01$). Moreover, the snakebites were significantly more frequent in rural areas, comprising 384 cases (86%). In urban areas, in contrast, only 57 cases were registered, representing 14% of the accidents ($\chi^2 = 209.09$; $p < 0.001$).

The snakebite distribution, by administrative region of Morocco, revealed a significant predominance of the Souss-Massa-Daraa region with 447 cases (31.4%), followed by the Marrakech-Tensift-Al Haouz region with 353 cases (24.8%) and the Meknès-Tafilalt region with 169 cases (11.9%) (Figure 4). The snakebite dissemination among the Moroccan provinces revealed that Essaouira was the most affected locality with 321 cases (22.6%), compared to d'Agadir Ida-Ou-Tanane (18.4%) and Tiznit (11.7%).

Additionally, the results showed that snakebites were more recurrent during the hot period (Figure 5). In fact, 35% of the cases had occurred in summer and 34% in spring with a peak of 215 cases in June (15.1%).

Regarding time, we found that most patients (67.3%) were bitten during the day ($\chi^2 = 50.85$; $p < 0.001$). The 20-44 age group, including the most agriculturally active population, was most affected by snakebites, with 551 cases (39.7%), followed by the 10-19 years age group with 414 cases (29.8%). In addition, the results revealed a predominance of grade 2 that comprised 70% of the cases (430), compared to grades 3 and 0, respectively with 105 and 50 cases (Figure 6).

The number of deaths caused by snakebites in our study was 61, out of a valid total of 1,078 cases, which makes 5.66%. Table 1 presents the specific lethality and relative risks of death for the studied variables, notably sex, age, season and grade.

Table 1. Distribution of specific lethality and relative risk (RR) according to sex, age, season and grade

	Deaths	Total	Specific lethality (%)	RR	Confidence interval (95%)	
Sex (n = 1074)						
Female	36	652	5.52	1.631	0.965	2.757
Male	25	749	3.34	0.613	0.363	1.036
Age (n= 1067)						
< 10 years	10	143	6.99	1.314	0.651	2.655
10-19 years	24	320	7.50	1.601	0.939	2.731
20-44 years	14	418	3.35	0.454	0.246	0.837
45-59 years	4	96	4.17	0.710	0.252	2.003
≥ 60 years	8	90	8.89	1.735	0.797	3.778
Season (n = 1077)						
Autumn	9	175	5.14	0.887	0.429	1.835
Winter	11	149	7.38	1.401	0.712	2.758
Spring	19	376	5.05	0.836	0.479	1.460
Summer	22	377	5.84	1.052	0.614	1.802
Grade (n = 459)						
Grade 0	0	25	0	1.080	1.051	1.109
Grade 1	0	12	0	1.077	1.050	1.105
Grade 2	0	323	0	1.308	1.191	1.435
Grade 3	8	75	10.67	1.791	0.772	4.155
Grade 4	24	24	100	54.375	27.367	108.035

The distribution of deaths according to gender showed that females presented a significantly higher specific lethality than males ($\epsilon_{obs} = 1.99$). Similarly, the death risk among females was 1.6 times higher than in males (Table 1).

Specific lethality for age groups peaked in patients who were at least 60 years old (8.89%) and in those who were aged less than 10 years (7.50%). However, the difference among age groups was statistically not significant. Unsurprisingly, the two

highest death risks were, respectively, observed in patients aged more than 60 and less than 20 years (Table 1). This could be due to the fact that the children and the elderly are physically weaker and more vulnerable to envenomation in comparison with adults.

Depending on the season, augmented specific lethality and relative risk were observed in winter with 7.38% and 1.4 respectively (Table 1). Nevertheless, seasons did not differ significantly.

In terms of evolution, deaths occurred only in patients with grades 4 and 3, comprising respectively 24 and 8 deaths (Table 1). Thus, grade 4 patients recorded 100% lethality whereas grade 3 patients registered 10.67% mortality, so that the difference was highly significant ($\epsilon_{obs} = 8.14$). It is worth noting that the risk of death is 54.4 times higher in patients admitted with grade 4.

Finally, Figure 7 presents the geographic distribution of lethality caused by snakebites in Morocco from 1992 to 2007. The Souss-Massa-Daraa region was the most affected by mortality, with 44 deaths (72.13% of all snakebites), and a specific lethality of 11.28%, which was significantly higher than the other regions.

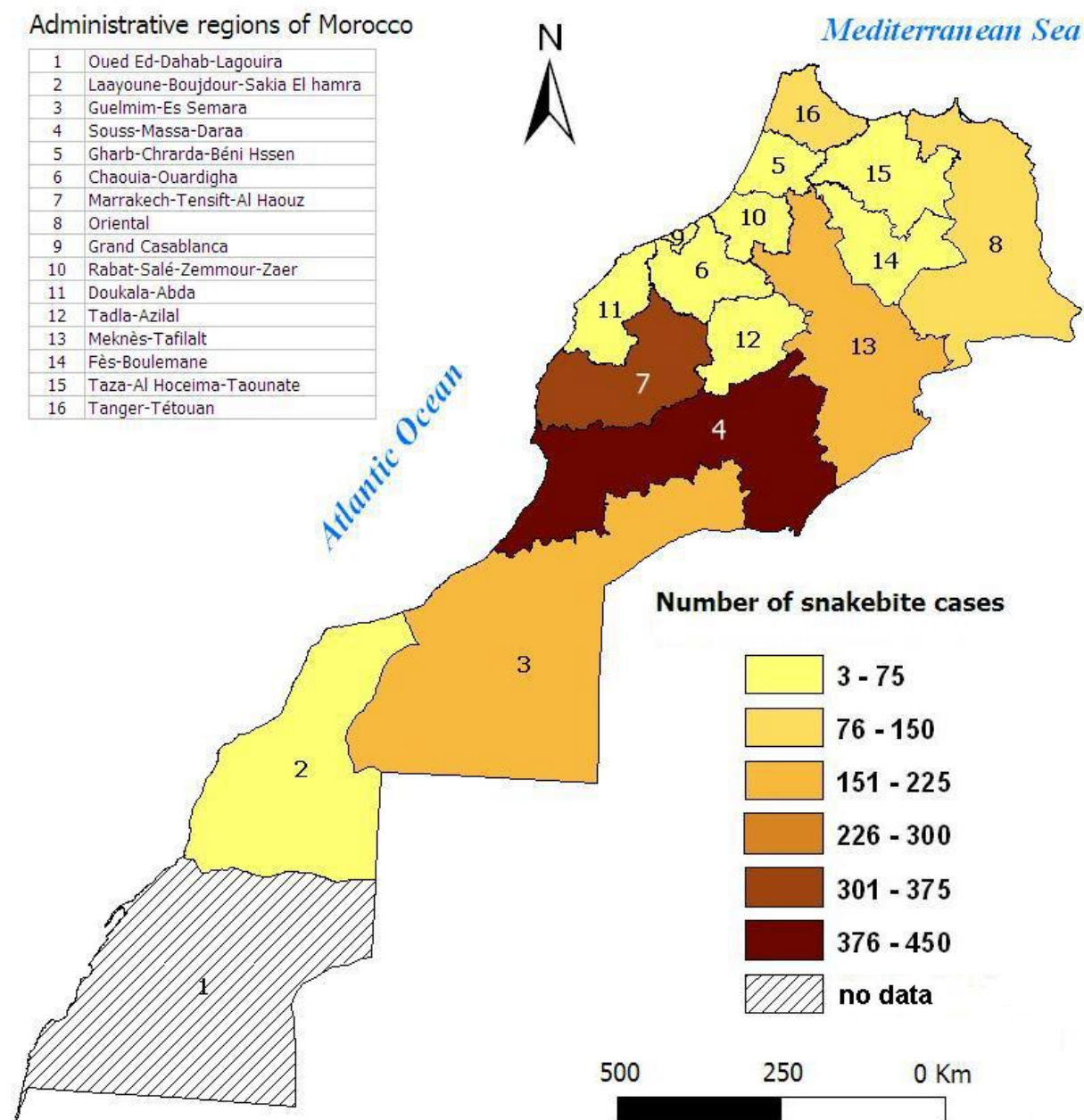


Figure 4. Distribution of snakebites by administrative region of Morocco.

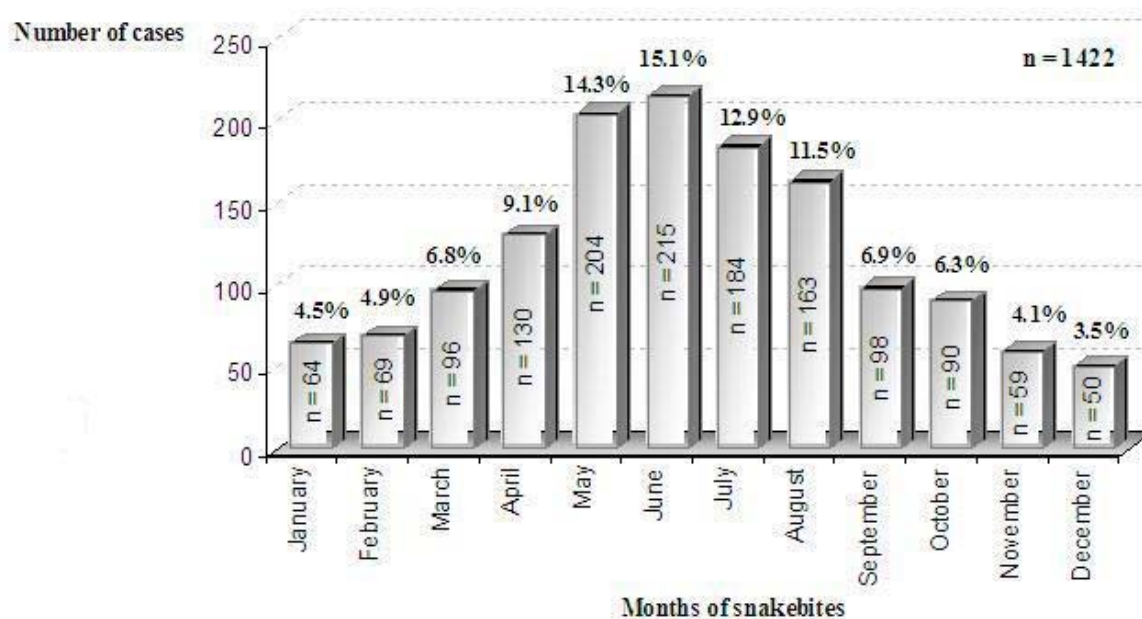


Figure 5. Distribution of snakebites according to the months of the year.

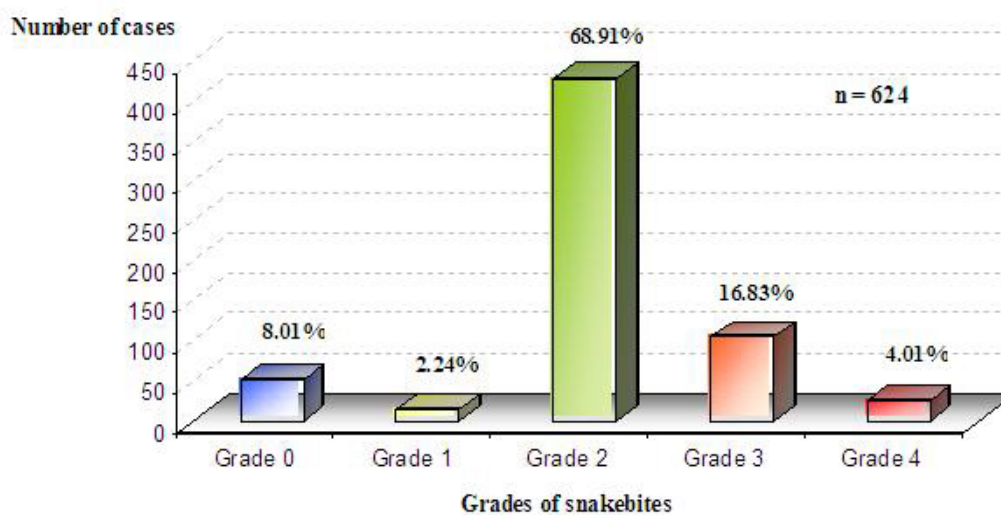


Figure 6. Distribution of snakebites by clinical grade.

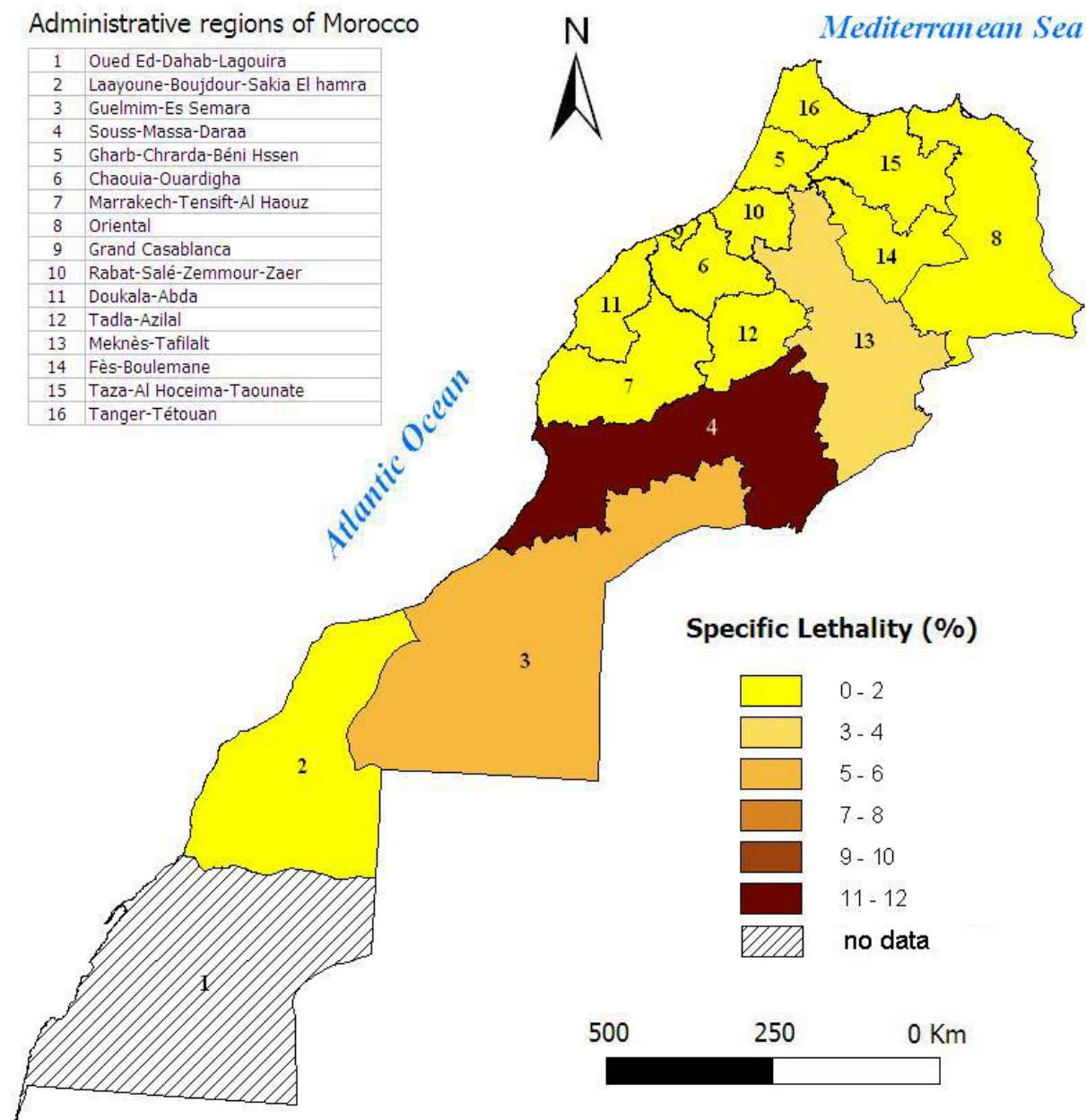


Figure 7. Distribution of snakebite specific lethality by administrative region of Morocco.

DISCUSSION

The present work showed that snakebites represent a serious public health problem in central regions of Morocco, especially in Souss-Massa-Daraa and Marrakech-Tensift-Al Haouz. The higher incidence in these two regions could be explained by their large population, but also by the diverse fauna of snakes living there (13, 14). Furthermore, the climate in this area, that varies from semiarid to arid, may play an important role in this distribution of snakes and snakebites.

Bites were more frequent during the hot period between May and July, which can be explained by hibernation of snakes in the winter (17). This result corroborates some studies in Saudi Arabia and Brazil (18-20), but differs from others by Tchoua *et al.* (21), Paula Neto *et al.* (22) and Pacheco *et al.* (23), in which snakebites were reported more common between November and April.

In addition, although snake activity is generally nocturnal, most bites in our study happened during the daytime, unlike the night prevalence reported in other studies (18, 20). The smaller number of cases at night may be explained by the fact that human activity is mainly diurnal or that, in some regions, the staff responsible for recording admitted cases are absent during the night.

This work also demonstrated that young adults and adolescents are more affected by snakebites, mainly due to their greater exposure through outdoor activities, particularly agricultural ones (22, 24-26). For the same reason, males were more afflicted with bites than females. Similar results have been reported by many studies in Africa and Asia (18, 21, 26-28).

As to the mortality provoked by snakebites, our results revealed an average specific lethality of 5.66%, far higher than those encountered in the literature (27, 29). Moreover, though considered to be mild in adults, viper bites were responsible for six deaths among victims older than 20 years of age in our study (30).

It is important to recognize that clinical signs are always connected with the envenomation degree (31, 32). Indeed, as reported by other groups, envenomations due to snakebites are rare, and less than 10% of these accidents are serious (31, 32). In our series, grade 2 patients were prevalent, comprising 70% of the cases without any death, whereas patients with grades 3 and 4 were few and comprised all deaths recorded in the studied period. In fact, grades 3 and 4 result either from an untreated grade 2 envenomation or from a very delayed admission to the hospital (30, 32).

In conclusion, although antivenoms are being produced by various laboratories on every continent, the burden of snakebite envenomation that causes both morbidity and mortality, still has a great impact on the population and on health care systems, particularly in Africa, Asia, Oceania and Latin America (33). Consequently, public health authorities, in Morocco and elsewhere, should give more attention to this serious problem.

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