

## RISK FACTORS CAUSED BY SCORPION STINGS AND ENVENOMATIONS IN THE PROVINCE OF KELÂA DES SRAGHNA (MOROCCO)

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**ABSTRACT:** The present study aims to elucidate the risk factors involved in deaths caused by scorpion envenomation. A retrospective study was carried out in the province of Kelâa des Sraghna from 2003 to 2004. The hospital charts of scorpion envenomation cases treated in the Essalama Hospital in Kelâa des Sraghna were exhaustively analyzed. Our study contains 31 cases of death among 470 hospitalization cases. Most stings had occurred during the hot period peaking in July and August (54.6%). Moreover, the scorpion stings occurred at night in 60.1% of the cases, between 6:00 pm and 6:00 am. In addition, all age groups were affected by envenomation, with a higher frequency in children aged less than 15 years (68.3%). The envenomation rate (class II + class III) was 70.9%. The statistical analysis of the data shows that being less than 15 years old, having been stung during the night and belonging to class III are risk factors that aggravate vital prognosis of hospitalized patients. Furthermore, clinical severity factors, elicited by relative risk analysis, are cardiovascular, respiratory and neurological vital distresses, with relative risks of 14.84, 11.92 and 48.33, respectively. The results of our study clearly displayed the severity and extent of the scorpion envenomation problem. Thus, great attention must be paid to this region of Morocco by the national health authorities.

**KEY WORDS:** scorpion, Morocco, epidemiology, Kelâa province of Sraghna.

**CONFLICTS OF INTEREST:** There is no conflict.

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## INTRODUCTION

Accidents related to scorpion stings constitute a factual problem of public health in several countries in Africa, the Americas and the Middle East, where the mortality caused by this arthropod exceeds those provoked by other venomous animals (16). In Africa, there are about 30,000 envenomations and 5,000 deaths per year (18). In Morocco, scorpion stings represent the most frequent cause of intoxication, 30 to 50% of all intoxications reported in the Poison Control and Pharmacovigilance Center of Morocco (CAPM) (22).

The average mortality rate is 0.041‰ in the province of Kelâa des Sraghna and 0.025‰ in the Marrakech-Tensift-EI Haouz region which includes this province. Moreover, Kelâa des Sraghna province presents 40% of the deaths caused by scorpion envenomation in the entire Marrakech-Tensift-EI Haouz region and 20% of all the Moroccan territory.

The studied province presents elevated concern in relation to this problem due to its dry and arid climate, rocky relief and the presence of dangerous scorpion species including *Androctonus mauritanicus* (Pocock, 1902), *Hottentotta franzwernerii gentili* (Pallary, 1924) and *Buthus malhommei* (Vachon, 1949) (Figures 1, 2 and 3).



**Figure 1.** *Hottentotta franzwernerii* (by Eric Ythier).



**Figure 2.** *Androctonus mauritanicus* (by Abdelmajid Soulaymani).



**Figure 3.** *Buthus malhommei* (by Eric Ythier).

The current study aimed to determine the factors that can influence the evolution of scorpion envenomation in Kelâa des Sraghna province. In the same manner, we tried to elicit the epidemiological and clinical factors affecting the severity of this pathology in order to improve patient management and to reduce morbidity and mortality caused by these scorpion venoms.

## MATERIALS AND METHODS

The province of Kelâa des Sraghna, presenting 10,070 km<sup>2</sup> total area, is 700 meters above sea level (latitude: 32°N; longitude: 7°W). It is part of the Marrakech-Tensift-Al Haouz region (one of the 16 Moroccan regions) which includes four provinces (Marrakech, Al Haouz, Chichaoua, Kelâa des Sraghna and Essaouira) and has a surface area of 31,460 km<sup>2</sup> (Figure 4). Moreover, the approximate total populations for this region in 2003 and 2004 were 3,064,000 and 3,105,000 inhabitants respectively. For the province Kelâa des Sraghna, the population was 752,000 inhabitants in 2003 and 760,000 inhabitants in 2004.



**Figure 4.** Geographic location of Kelâa des Sraghna province.

This study was based on a sample of 470 hospitalized patients admitted between January of 2003 and December of 2004, using special hospital charts produced by the CAPM. It consisted of an exhaustive follow-up of all patients stung by scorpions and admitted to the provincial hospital.

The hospitalization charts contained patient demographics and medical history; the date, time and place where the sting occurred; and the time of initial consultation.

A clinical test was used in order to classify the patient status into three classes: class I (local symptoms), class II (tremor, sweating, nausea, vomiting etc.), and class III (cardiovascular, respiratory or neurological distresses).

The charts were filled out in the hospital by the responsible doctor and then were transmitted to the CAPM. The obtained data were analyzed in the Laboratory of Genetics and Biometrics, in the Faculty of Sciences of Kenitra. The studied parameters were:

- sting conditions (scorpion species, date, place and time);
- demographic characteristics of stung patients (sex and age);
- time elapsed between the sting and the arrival at the hospital;
- rate of envenomated patients, which corresponds to the ratio between patients of classes II and III to the total patient number.

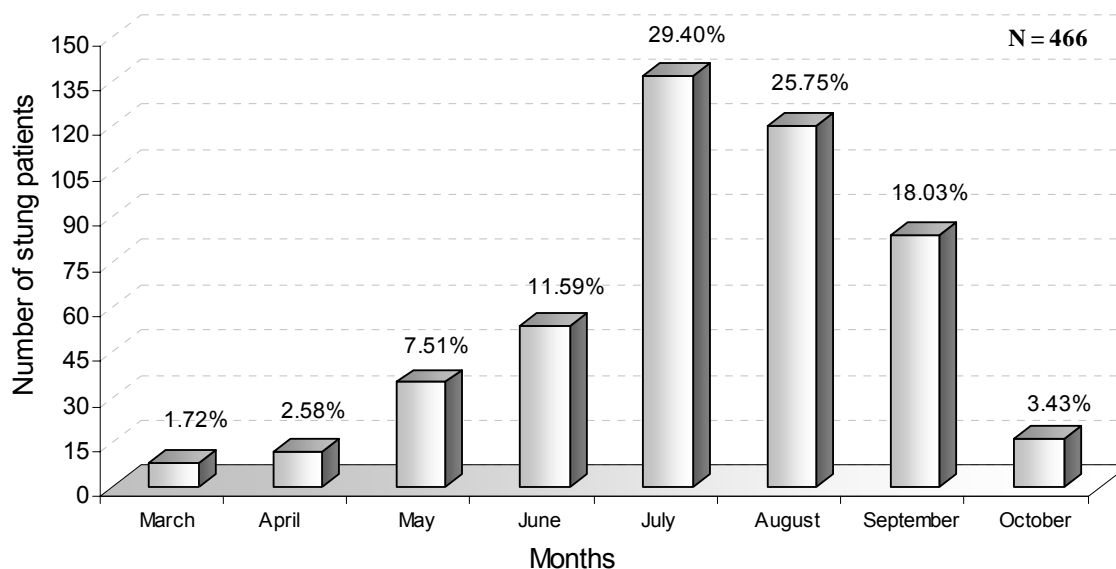
**The statistical analysis concerned:**

- intrahospital rate of specific lethality, which refers to the ratio between deaths caused by scorpion stings and the total number of hospitalized cases;
- the chi-square ( $\chi^2$ ) test, which compares the frequencies observed and expected in each category to verify whether all the categories contain the same proportion of values or if each one contains a proportion of values specified by the user – the differences were considered significant when associated probabilities were less than 5%;
- the relative risk (RR) estimate, which measures the association between the presence or absence of a factor and the occurrence of an event. There is a significant difference in the occurrence of some event if the 95% confidence interval for the relative risk ratio does not include 1.

## RESULTS

### Characteristics of Hospitalized Population in Kelâa des Sraghna Province

The present study showed that most stings occurred during the summer, presenting the two highest frequencies in July (29.40%) and August (25.75%) (Figure 5). This peak period is mainly explained by the thermophilic nature of scorpions.



**Figure 5.** Number of scorpion stings per month in Kelâa des Sraghna province during the period of 2003 and 2004.

The characteristics of hospitalized patients, admitted to the hospital after a scorpion envenomation, are represented in Table 1. The results showed that most stings happened at home, frequently between 6:00 pm and 6:00 am (60.6%). The average age was  $15.31 \pm 16.71$  years and the male-to-female ratio was 244:226.

The time elapsed between the sting and hospital admission was between 10 minutes and 12 hours with a mean of  $2.07 \pm 1.52$  hours. Moreover, 29.1% of patients were stung without being envenomated (class I), 66.2% suffered a class II envenomation and 4.7% presented a class III. The envenomation rate was 70.9%.

Furthermore, the research indicated that class I is characterized by the constant presence of pain, local or locoregional, with variable intensity. The systemic signs of class II envenomation were: vomiting (52.4%), fever (24.3%), tachycardia (9.3%), digestive pain (11.9%) and sweating (7.1%). On the other hand, class III patients manifested: cardiovascular (2.5%), respiratory (1.6%) and neurological (0.7%) distresses. These three failures happened simultaneously in 4.75% of the cases.

The intra-hospital lethality was 6.59%, including 31 deaths among the 470 hospitalization cases.

**Table 1.** Characteristics of the hospitalized patients in Kelâa des Sraghna province (2003-2004)

<b>Sex of patients n= 470</b>	Male 51.9%		Female 48.1%					
<b>Age of patients n= 470</b>	< 15 year 68.3 %				≥ 15 years 31.7 %			
<b>Time of the sting n= 470</b>	6 am – 6 pm 39.4%				6 pm – 6 am 60.6%			
<b>Admission class n= 450</b>	Class I 29.1%		Class II 66.2%		Class III 4.7%			
<b>Clinical signs n= 470</b>	Vomiting 52.4%	Fever 24.3%	Tachycardia 9.3%	Digestive pain 11.9%	Sweating 7.1%	CD 2.5%	RD 1.6%	ND 0.7%
<b>Evolution n= 466</b>	Recovery 93.3 %					Death 6.7%		

CD: cardiovascular distress; RD: respiratory distress; ND: neurological distress.

### **Influence of Epidemiological and Clinical Factors on Patient Evolution**

The results regarding specific lethality for admission classes and age groups are displayed in Table 2. These data show that specific lethality was non-existent in class I patients. Therefore, these patients presented no need for hospitalization. For class II and class III patients, lethality was, respectively, 5.03% and 33.33%.

With regard to age groups, the specific lethality was inversely proportional to patient ages. In fact, it was much higher in children (14.28%, 15.27% and 10.29; respectively, for the age groups 1-4, 5-9 and 10-14 years) in comparison with patients who were aged 15 years or more (0.9%). We should note that 96.8% of the deaths happened in children.

**Table 2.** Specific lethality rate of envenomated patients according to age and severity class

	Admission classes			Age groups			
	I	II	III	0-5	5-10	10-15	≥ 15 years
Number of deaths	<b>0</b>	<b>15</b>	<b>7</b>	<b>12</b>	<b>11</b>	<b>7</b>	<b>1</b>
Specific lethality (%)	0	5.03	33.33	14.28	15.27	10.29	0.90
Number of patients (n)	131	298	21	84	72	68	111

The evaluation of relative risk (RR) factors related to patients or to the sting circumstances revealed elements that can aggravate vital prognosis in patients (Table 3). Only the age group, the admission class and the time of the sting presented significant association with death; relative risks were respectively: 18.77 (CI<sub>95%</sub>: 2.53-139.49); 10.83 (CI<sub>95%</sub>: 5.99-19.56) and 2.75 (CI<sub>95%</sub>: 1.09-6.91). Thus, being aged less than 15 years, being stung during the night and belonging to class III are risk factors that worsen vital prognoses of hospitalized patients.

**Table 3.** Epidemiological severity factors related to scorpion stings and relative risks in envenomated patients

		Number	Death (%)	RR	CI <sub>95%</sub>	χ <sup>2</sup> (5%)	p
Sex	Male	183	9.84	1.17	0.55-2.46	0.16	0.69
	Female	152	8.55				
TE	≥ 1 hour	196	8.67	1.04	0.33-0.26	0.006	0.94
	< 1 hour	48	8.33				
Age	< 15 years	217	13.82	<b>18.77</b>	2.53-139.49	15.33	<b>&lt; 0.001</b>
	≥ 15 years	118	0.85				
Time of the sting	6 pm – 6 am	208	12.02	<b>2.75</b>	1.09-6.91	4.99	<b>0.025</b>
	6 am – 6 pm	127	4.72				
Admission class	Class III	67	41.79	<b>10.83</b>	5.99-19.56	85.14	<b>&lt; 0.001</b>
	Class II	579	6.63				

TE: time elapsed between the sting and the arrival at the hospital; RR: relative risk.



Furthermore, the relative risk analysis revealed clinical severity factors including cardiovascular, respiratory and neurological vital distresses, which presented relative risks, respectively, of 14.84 (CI<sub>95%</sub>: 4.09-53.88); 11.92 (CI<sub>95%</sub>: 2.48-57.33) and 48.33 (CI<sub>95%</sub>: 4.78-488.25) (Table 4). The other systemic signs were not significantly related to death, as shown by the chi-square test and the confidence interval of the relative risk.

**Table 4.** Clinical severity factors in envenomated patients

		Number	Death (%)	RR	CI <sub>95%</sub>	$\chi^2$ (%5)	p
<b>Vital distress</b>							
Cardiovascular	Yes	11	45.45	<b>14.84</b>	4.09-53.88	21.22	<b>&lt; 0.001</b>
	No	301	5.32				
Respiratory	Yes	7	42.86	<b>11.92</b>	2.48-57.33	19.54	<b>&lt; 0.001</b>
	No	304	5.92				
Neurological	Yes	4	75	<b>48.33</b>	4.78-488.25	20.07	<b>&lt; 0.001</b>
	No	308	5.84				
<b>General signs</b>							
Sweating	Yes	27	14.81	2.69	0.83-8.74	2.94	0.09
	No	264	6.06				
Digestive pain	Yes	49	12.24	2.28	0.83-6.27	1.77	0.18
	No	243	5.76				
Vomiting	Yes	209	7.65	1.66	0.54-5.11	0.79	0.37
	No	84	4.76				
Tachycardia	Yes	38	7.89	1.19	0.33-4.27	0.07	0.79
	No	253	6.72				
Fever	Yes	99	6.06	0.82	0.31-2.22	0.15	0.70
	No	193	7.25				

## DISCUSSION

The current research constitutes the first Moroccan epidemiological study that describes scorpion envenomations in the province of Kelâa des Sraghna. In this province, mortality provoked by scorpion stings is mainly due to the presence of buthid scorpions. The Buthidae family comprises the most dangerous scorpion species (5) and includes *Androctonus mauritanicus*; *Hottentotta franzwernerii gentili*, which is endemic to Morocco; and *Buthus malhommei*.

The stings in Kelâa des Sraghna are most frequent in July and August, which concurs with the results found in other places throughout the world. Indeed, the periods that present predominance of scorpion stings were reported in different countries as follows: Mexico, from April to July (11); Tunisia, from July to September, presenting the peak in August (7); however, in Brazil stings occur uniformly throughout the year, with a slight increase in August (10). These small temporal variations may be due to environmental conditions (17). The limitation of these events to the summer is explained by the thermophilic nature of the scorpion, which is widely supported by several studies (1, 13, 19, 20, 24). Additionally, the stings occurred particularly between 6:00 pm and 6:00 am (60.1% of the studied cases) because of the nocturnal activity of this arachnid (2, 4, 6, 8, 14, 21).

In the present study, children younger than 15 years old presented a high mortality rate. This child vulnerability to scorpion stings was also reported by Islami (9) in Taroudant province, Touloun *et al.* (25) in southwestern Morocco and Soulaymani *et al.* (23) in other regions. According to the literature, this mortality can be explained by the immaturity of both physiological systems and body's defenses and by the ratio between venom dose injected and body weight (12). However, this hypothesis has never been confirmed by consistent cause-effect studies.

In our research, none of class I patients with local signs progressed to death. In agreement with available sources, these patients presented an average circulating venom dose of  $17.82 \pm 1.9$  ng/mL (3), whereas patients admitted with classes II and III had  $37 \pm 10.8$  ng/mL (3), which explains the higher number of deaths in classes II and III.

Moreover, the highest lethality observed in class III patients was due to vital failures that characterize this group. In fact, numerous studies have shown that scorpion venom induces a massive sympathetic activation by acting on pre-synaptic sympathetic terminals, creating high plasma concentrations of noradrenaline, which causes myocardial dysfunction and pulmonary edema (15).

## **CONCLUSIONS**

Scorpion stings and envenomations are very frequent in the province of Kelâa des Sraghna. This study permitted us to elicit the epidemiological profile of hospitalized stung patients in this province and to emphasize some aggravating factors leading to

an elevated rate of intrahospital lethality, such as age, time of the sting and admission class.

The present findings clearly displayed the severity and the extent of the scorpion envenomation problem. Thus, great attention must be paid to this region by the Moroccan health authorities. In fact, if we consider that this hospital is the only resort for stung patients of Kelâa des Sraghna and that the period of high scorpion activity corresponds to the typical schools vacation period (July and August), it would be necessary to reinforce the medical staff and to improve intensive care equipment to obtain a better management of this pathology.

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