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An epidemiological study on scorpion envenomation in the Zagora oases (Morocco)

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ABSTRACT

Objective: To determine epidemiological features of scorpion stings in the oases of Southern Morocco: Zagora Province.

Methods: A three-year prospective descriptive survey was performed to obtain epidemiological data on scorpion stings, including information on epidemiological characteristics of patients stung, and gathered information on scorpion species distribution. The following information was recorded for each scorpion sting: demographics of stung patients (age, gender, geographical location), circumstances of the sting (location, time, date, activity at the time), and many traditional medical attention. A questionnaire was completed for every stung patient. Concomitantly with the epidemiological survey, a systematic sampling of scorpions based on observations and direct captures *in situ* was applied.

Results: There were 50 cases of death among 1053 cases studied. Most cases of death were recorded among children (under 15 years) (64%). The average age of victims was (23.00 ± 15.36) years. The scorpion sting occurred in 34.37% of cases between 18:00 and 24:00, and it coincided with the warm period and particularly between June and September (70%). The stings were principally in hands and feet (897 cases, 85.71%). The majority of victims had chosen traditional remedies (69.61%), and only 22.79% had received modern treatment while 1.33% of cases did not receive any treatment. The scorpion species involved were yellow in 179 cases and black in 815 cases. In 59 cases the scorpion involved was not identified.

Conclusions: Our data constitute a preliminary descriptive study and suggest that scorpion envenomation is an important problem in the studied area.

1. Introduction

Scorpion envenomation is a real public health problem in many parts of the world, especially in North Africa, Central America, South America, the Middle East and India[1-4], with over 1.2 million cases of scorpion stings and 3250 deaths each year worldwide[5]. Among the 1500 species described, venoms of at least 25 species are of medical importance for humans and the majority of those species belong to *Buthus, Parabuthus, Mesobuthus, Tityus, Leiurus, Androctonus* and *Centruroides* genera of Buthidae family[5].

Scorpion stings in Morocco is the leading cause of poisonings with a rate of 30%–50% of all the poisoning cases reported to the Poison Control Center of Morocco mainly in the south and central-south provinces of the country, where the highest lethality rate was reported[6]. However the works done so far have rarely addressed the Moroccan Sahara and pre-Saharan areas, such as Zagora oases. This area is known by the presence of five species of scorpions including dangerous species like *Hottentotta gentili* (*H. gentili*), *Androctonus amoreuxi* (*A. amoreuxi*) and *Androctonus liouvillei* (*A. liouvillei*)[4]. The presence of this dangerous wildlife may suggest a high incidence of scorpion envenomation.

To assess the epidemiological situation in the province of Zagora we conducted this study which aimed to investigate morbidity and mortality indicators by using a prospective study over three years (2010–2013).

2. Materials and methods

2.1. Studied area

The oasis of Zagora Province belongs to the region in southeast of Morocco (Figure 1), and extends over an area of 23000 km^2. These oases are involved in the maintenance of biodiversity, which are

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characterized by their strong specialization precisely due to the effect of isolation and their wealth. These environments are good shelters for animal communities in general and in particular species of scorpions.

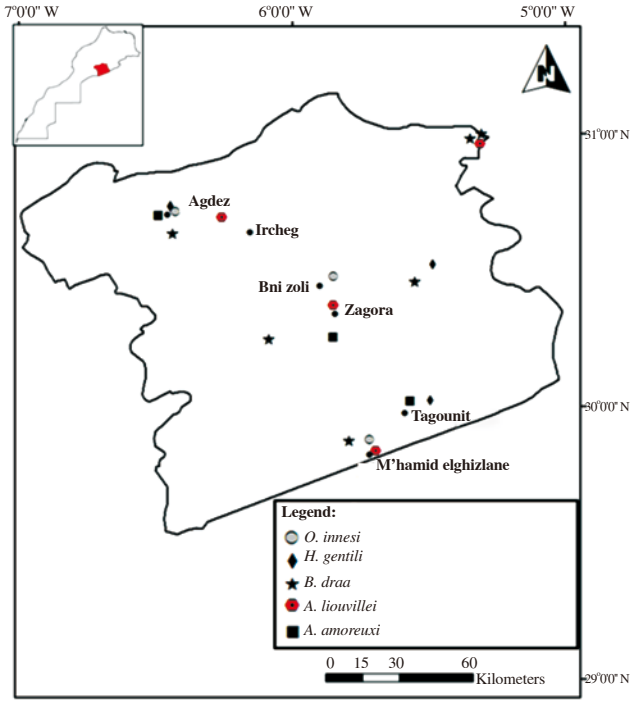

Figure 1. Geographic location of studied oases and scorpion distribution in the Zagora Province.
O. innesi: *Orthochirus innesi*; *B. draa*: *Buthus draa.*

The population of the province of Zagora rises, according to the 2004 census, from 240 566 to 283 368 inhabitants, and is located in rural areas. The climate in these areas is classified under Saharan bioclimatic stage. The average annual rainfall is very low and decreases from north to south (108 mm in Agdez, 74 mm in Zagora) with high temperatures (40–42 °C).

2.2. Inventory of scorpion fauna

A systematic sampling of scorpions, based on observations and direct captures *in situ* was applied. In each habitat, areas suspected for housing scorpions (under rocks, pieces of wood, *etc*.) were systematically explored. Species identification was based on appropriate identification keys.

2.3. Epidemiological study

We performed a three-year prospective descriptive survey to obtain epidemiological data on scorpion stings, including information on epidemiological characteristics of patients stung, and gathered information on scorpion species distribution.

The following information was recorded for each scorpion sting: demographics of stung patients (age, gender, geographical location), circumstances of the sting (location, time, date, activity at the time), and many traditional medical attention. A questionnaire was completed for every stung patient.

3. Results

3.1. The scorpion fauna inventory

The systematic inventory, according to the identification of a set of 75 specimens, consists of five species, belonging to the Buthidae family and four genera, *Androctonus* (Ehrenberg, 1828), *Buthus* (Leach, 1915), *Hottentota* (Birula, 1908) and *Orthochirus* (Karsch, 1891). These surveys revealed the presence of dangerous species such as *H. gentili*, *A. amoreuxi* and *A. liouvillei* (Figures 1 and 2).

3.2. The epidemiological study

A total of 1 053 subjects were recruited during the period of three years, and among these there were 50 cases of death (4.74%); children younger than 15 years old presented a high mortality rate (64% of death cases).

Figure 2 lists species of scorpions present in the studied area. Most of scorpion stings were caused by the black scorpion with 77.39% of total stings (Table 1). With respect to age groups, the 16–45 age group were the most affected (63.34%) compared to other groups (25.35% for the less than 15 years group, and 11.30% for the over 46 age group) (Table 1).

Table 1
Epidemiological characteristics of patients stung by a scorpion.

Epidemiological characteristics			Number of patients (n = 1 053)	%
Sex	Male		695	66.00
	Female		358	44.00
Age	Less than 15 years		267	25.35
	16–45 years		667	63.34
	Over 46 years		119	11.30
Part of body where sting occurred	Hand		523	49.66
	Foot		374	35.51
	Arm		21	2.00
	Thigh		24	1.27
	Leg		18	1.71
	Head/neck		40	3.79
	Stomach/back		53	5.03
Circumstances where stings occurred	Working		575	54.60
	Resting/sleeping		338	32.10
	Others		140	13.29
Accident location	Indoors		447	42.45
	Near house		154	14.62
	Field		412	39.12
	Others		40	3.80
Species of scorpion	Yellow scorpions	*A. amoreuxi* *B. draa*	179	16.99
	Black scorpions	*A. liouvillei* *O. innesi* *H.* gentili	815	77.39
	Unknown		59	5.60
Treatments	Traditional		733	69.61
	Traditional + modern		66	6.26
	Modern		240	22.79
	None		14	1.33

The average age of victims was (23.00 ± 15.36) years. Seventy percent of the accidents took place in hot months (temperature close to 42 °C) from June to September, of which 26.73% of stings occurred in July (Figure 3). The stings mainly occurred at night between 6 p.m. and midnight (34.37%) when the victims were asleep, and second occuring time was ranging from early morning at 6 a.m. to 12 a.m. (26.68%) (Figure 4). About 54.60% patients were stung when doing farm work, 32.10% were stung when resting or sleeping, and 13.29% were stung when doing other activities. About 42.25% of stings occurred

Figure 2. Scorpions present in the studied area.
a: *H. gentili* (Pallary, 1924); b: *A. liouvillei* (Pallary, 1924); c: *O. innesi* (Simon, 1910); d: *A. amoreuxi* (Audouin, 1826); e: *B. draa* (Lourenço & Slimani, 2004).

indoors and 39.12% in the field (Table 1). In all, 85.17% of stings were at the extremities; particularly the hands. This frequency was clearly different from that in the head and the neck (3.79%) (Table 1). The location of occurring stings with lowest rate (1.27%) was on the thigh. Scorpion stings records in both sexes were almost similar and there were no significant differences between sexes across all age groups (Table 1). The majority of patients have chosen traditional remedies (69.61%), and only 22.79% have received modern treatment while 1.33% of cases did not receive treatment (Table 1).

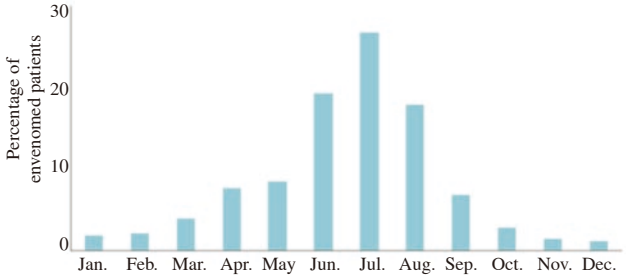

Figure 3. Distribution of scorpion stings cases per month in Zagora Province oases.

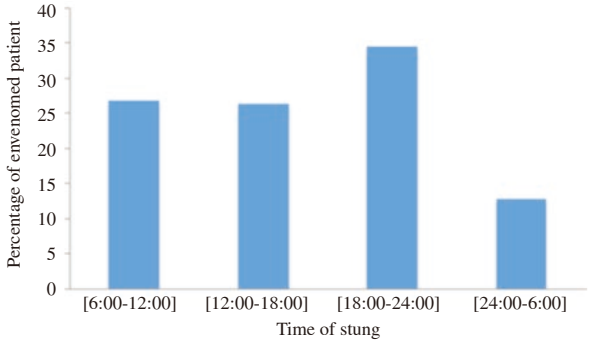

Figure 4. Distribution of scorpion stings cases according to time of day in Zagora Province oases.

4. Discussion

This study characterizes the epidemiology of scorpion stings and established the relationship between the epidemiology of scorpion envenomation and the major scorpion species in the south-eastern oasis of Morocco (province of Zagora).

During three years of study, we have collected 1 053 cases of scorpion envenomation with 50 cases of death (4.74%). 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 Hellal *et al*.[7] in Algeria and Touloun *et al*. in Southern-Western Morocco[8]. 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[6]. Men are more frequently stung by the scorpions than women. Corroborating with this finding, Dabo *et al*. also reported that the majority (54.6%) of victims were male in the north of Mali[9]. However, other studies from Turkey have reported no preference in regard to the gender of the affected persons[10], whereas other study conducted in Texas, USA have reported higher proportion of female cases[11]. In our study, higher proportion of males can be explained by the fact that they can be attacked within the house room and also outside, because the majority of the people leave to work in the field and are directly exposed to these poisonous animals.

Scorpions are most active during the warmer months. In our survey the most cases of scorpion envenomation (70%) were recorded between June and September. Thus, our data are consistent with those in the literature; in a retrospective study carried out in the South Tunisia region, the majority of the cases were recorded during the hot period peaking in July and August[12]. In Texas, scorpion stings were most frequently reported in May and June[11]. Another study from Iran confirms that the greatest

number of stings occurred in the summer[13].

Most epidemiological studies have shown that the afflicted body parts are mostly the extremities (hand and foot)[14]. In parallel we found that 85.17% of the investigated patients were stung in their extremities. This could be explained by the probability that the feet are not covered during sleep, farming and wood gathering in the countryside especially as the population had principal activity, agricultural work.

Most accidents with scorpions take place in houses (42.45%) when people are sleeping or doing farm work in the field (39.12%).

It is interesting to note that most patients turn to traditional medicine (69.61%), and few victims directly consult the nearest hospital (22.79%). This can be explained by the patients' poor information on the pathology and the scarcity or even absence of health facilities in rural areas, which make the population, even close to health centers, to make use of preventive or control curative methods closely related to traditional medicine. The use of traditional care for the treatment of scorpion stings was also observed in Colombia, where 42% of patients received traditional treatment before being admitted to health centers[15].

The scorpion-fauna of Zagora Province is characterized by the presence of five species of scorpion belonging to the Buthidae family. In terms of public health, important scorpion species are identified as *A. amoreuxi*, *H. gentili* and *A. liouvillei*.

In our study, identification of scorpions has shown that 815 stings (77.39%) were inflicted by black scorpions (*A. liouvillei*, *H. gentili* or *O. innesi*) and 179 stings (16.99%) by yellow scorpions (*A. amoreuxi* or *B. draa*). The toxic effects of *A. amoreuxi* is well known and studied; it has a subcutaneous lethal dose (LD_{50}) of 0.75 mg/kg[15], which indicates the high toxicity of this species. In spite of the fact that there is no data about the LD_{50} of *A. liouvillei* and *H. gentili*, several case of deaths caused by *A. liouvillei* and *H. gentili* were reported by the epidemiologic study conducted in Southwestern Morocco, which makes them become some toxic species of scorpion[8].

Our data constitute a preliminary descriptive study that will help in developing interventions to prevent scorpion stings, which should take local epidemiological features into consideration. These data can also be used to determine those population groups which are most in need of education regarding the prevention and treatment of scorpion stings.

Conflict of interest statement

We declare that we have no conflict of interest.

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