ORIGINAL PAPER

Incidence and severity of scorpion stings in Algeria

Laïd Y (1, 2), Boutekdjiret L (1), Oudjehane R (1), Laraba-Djebari F (3, 4), Hellal H (2, 5), Guerinik M (2, 6), Griene L (2, 7), Alamir B (2, 8, 9), Merad R (10), Chippaux JP (11, 12)

(1) National Institute of Public Health, Environmental Health Unit, Algiers, Algeria; (2) National Committee on Control of Scorpion Envenomations (CNLES), Algeria; (3) Laboratory of Cellular and Molecular Biology, School of Biological Sciences, University of Science and Technology – Houari Boumediene (USTHB), Algiers, Algeria; (4) Institute Pasteur in Algeria, Algiers, Algeria; (5) General Administration of Prevention and Health Promotion, Algiers, Algeria; (6) Service of Surgical Emergencies, Mustapha Teaching Hospital, Algiers, Algeria; (7) Service of Hormonology, Pierre and Marie Curie Center, Algiers, Algeria; (8) National Center of Toxicology, Algiers, Algeria; (9) Department of Toxicology, Bab El Oued Teaching Hospital, Algiers, Algeria; (10) Algerian Society of Toxicology, Algiers, Algeria; (11) Center for the Study and Research of Malaria Associated with Pregnancy and Childhood (Cerpage), Cotonou, Benin; (12) Institute of Research for Development (IRD – UMR 216 "Mother and child facing tropical diseases"), Cotonou, Benin.

Abstract: Scorpion stings are a public health problem in the Maghreb region. In Algeria, epidemiological data were collected over the past twenty years by the Algerian health authorities. This study is an analysis of morbidity and mortality data collected from 2001 to 2010. Annual incidence and mortality due to scorpion envenoming were 152 ± 3.6 stings and 0.236 ± 0.041 deaths per 100,000 people (95% CI), respectively. The risk of being stung by a scorpion was dramatically higher in southern areas and central highlands due to environmental conditions. Incidence of envenoming was especially higher in the adult population, and among young males. In contrast, mortality was significantly higher among children under 15 years, particularly ages 1-4. Upper limbs were more often affected than lower limbs. Most stings occurred at night, indoors and during the summer. Data collected since 2001 showed a reduction of mortality by nearly 50%, suggesting that the medical care defined by the national anti-scorpion project is bearing fruit.

Key words: scorpion, stings, envenoming, deaths, epidemiology, management, Algeria.

INTRODUCTION

Scorpion stings are a public health issue in many tropical and subtropical regions of the world. They have been identified for many years in Algeria and in other countries of the Maghreb (1-5). In Algeria, the most dangerous scorpion species that are of medical interest include *Androctonus australis* and *Leiurus quinquestriatus*, and are found mostly in the southern highlands and in the Atlas and Hoggar mountain ranges. Other species also causing fatalities or threats to life are *Androctonus aeneas, Buthus occitanus* and *Buthacus arenicola*, found respectively in the southern highlands, in the northern Sahara, Hoggar and in the Tassili (5-7).

It is now recognized that a more detailed analysis of epidemiological data, including incidence, mortality, at-risk population and the circumstances of the stings, would lead to better management of envenomations in vulnerable populations. However, the data available to date do not fully meet the expected objectives of health personnel.

The health information system regarding scorpion stings in Algeria has been operational since 1986. It was revised in 1997 following a ministerial decree establishing a national interdisciplinary committee for control of scorpion envenomation. The national program for controlling scorpion envenoming has been operational since 1997 throughout the country. This device resulted in improved availability of epidemiological data. The present study aims to provide an overview of the epidemiological situation of scorpion envenomations in Algeria, an analysis that might lead to recommendations for improving the national program (2, 4).

METHODS

Algeria is characterized by a mixed landscape, according to the topography and climate, presenting the following three major geographical regions defined by two mountain ranges parallel to the coast, from north to south: Tell, Highlands and South Algeria or Sahara.

Epidemiological data were collected in each health facility on standardized forms transmitted to the Ministry of Health and the National Institute of Public Health where they were subsequently registered on a computer database and analyzed. A portion of this information has been available since 1991.

The notification system available in health facilities was established in 1986 and has been gradually improved since 1997. The current system consists of four standardized forms filled out by the nursing staff:

- an individual record of the patient stating his demographic data (name, age, gender, address, occupation), the circumstances of the accident (date, time, site of the accident, activity at the moment of the sting), site of the sting and clinical symptomatology at presentation;
- a form describing symptoms and treatment giving clinical progression and prescribed treatment;
- a death statement detailing demographics, circumstances of the accident, sting site, location of initial management, clinical evolution of envenomation between the arrival at the health facility and death, and the place of death;
- a monthly synthetic file summarizing all cases of scorpion stings and subsequent deaths in health facilities in every wilaya (regional administrative unit).

National incidence and mortality were calculated for the 1991-2010 period, based on the population census of 2008 (available from http://www.ons.dz/collections/pop1_national.pdf, accessed November 20, 2011), corrected by applying an annual population growth rate of 1.2% over the period. Incidence and mortality estimates were based on scorpion stings and consequent fatalities in each of the three geographical regions and 48 wilayas of Algeria between January 2001 and December 2010, in relation to the average population in 2004 (8).

A trend line giving the best correlation coefficient (R^2) was calculated based on the observed data. The confidence interval and significance level were 95% and 0.05, respectively. Trend curves and correlation tests were calculated using Microsoft Excel® 2010.

RESULTS

Health services have recorded 486,419 scorpion sting cases between 2001 and 2010, i.e. an annual average of 48,642 ± 1,517 stings treated in health facilities in Algeria (Table 1). Incidence and mortality predominated in the south and highlands (Tables 2, 3, 4, Figures 1 and 2).

Epidemiological analyses of the 2001-2010 period showed that scorpion stings were more frequent in the male population (57% versus 43% in females). The incidence was greater in adult whereas mortality was significantly higher among children under 15 years, and more particularly between 1 and 4 years (Figures 3 and 4). Stings were located predominantly on the limbs (91%), mainly the upper limbs (Figure 5).

The seasonal distribution of stings showed a peak in summer (Figure 6). Stings were more frequent in the evening and the morning (Figure 7) and occurred indoors (56.6%).

DISCUSSION

The health information system has partially incorporated the occurrences of scorpion stings and deaths from scorpion envenomation since 1986.

While reporting of scorpion envenomation cases was still neither binding nor systematic, nor centralized, an increase was registered in the number of recorded cases between 1991 and 1998 (Figure 8). However, significant reductions were achieved in the case fatality rate from 1991 to 2002 (Figure 9) and mortality after 2001 (Figure 10), according to the International Seminar on the scorpion envenomation in Ghardaïa in 1989 and launch of a pilot study regarding the control of scorpion stings (training, information, awareness, control of scorpion populations) in 1990 in the wilaya of Biskra (2). In addition, regular meetings organized by the committee that have provided recommendations since 1997 led to a decrease in the number of cases and stabilization of the data.

Accordingly, all indicators have stabilized over

Table 1. Scorpion stings and deaths between 1991 and 2010

Year	Stings	Deaths	Case fatality rate (%)
1991	22972	106	0.46
1992	23774	103	0.43
1993	26588	108	0.41
1994	29145	139	0.48
1995	28855	89	0.31
1996	26563	110	0.41
1997	35497	128	0.36
1998	37161	104	0.28
1999	50722	149	0.29
2000	47521	108	0.23
2001	48436	116	0.24
2002	44351	81	0.18
2003	48971	64	0.13
2004	44775	68	0.15
2005	47742	70	0.15
2006	48616	62	0.13
2007	52168	76	0.15
2008	49843	67	0.13
2009	51943	54	0.10
2010	49574	68	0.14
Total	815217	1870	0.23

the last 10 years, suggesting that data collection became reliable and robust. The gradual improvement of data collection between 1991 and 2000 may suggest that the increased incidence is attributable to a mechanical effect. The reduction in mortality and lethality was probably achieved thanks to better management of patients in health facilities. However, it also should be emphasized that we analyzed only the data of the ten last years (2001-2010). A detailed annual report of the epidemiological situation and a report on the epidemiological characteristics of deaths due to scorpion envenomation from 2001 to 2010 are now accessible on the website of the National Institute of Public Health (3), and are likely to facilitate the follow-up of the control program and maintain the motivation of health personnel.

Nevertheless, it is likely that some stings could not be recorded. In Morocco 40% of stung patients turn to traditional medicine (9). Whereas in Algeria, the stability of indicators, especially after 2001, suggests that most of the envenomed patients made use of the health services. On the other hand, the possibility that some forms could not be filled out because of the workload of health personnel is negligible. This leads to the conclusion that the available data are reliable and representative.

Between 2001 and 2010, the annual average of scorpion sting incidence in Algeria was 152 ± 3.6 stings per 100,000 population. During the same period, the annual mortality was 0.236 ± 0.041 deaths per 100,000 inhabitants. However, the distribution of stings and deaths was very uneven. The southern and central highlands showed higher incidence and mortality than observed in

Table 2. Regional incidence and mortality (2001-2010)

Region	Wilaya	Population (2004)	Mean incidence	Mean mortality
	Médéa	872176	134	0.1
	Tlemcen	935782	36	0.01
	Bouira	687570	32	0
	Béjaïa	942237	17	0
	Tizi Ouzou	1228968	15	0
	Aïn Defla	715826	15	0
	Tipaza	556808	12	0
	Mascara	744015	9	0
	Guelma	475135	8	0
	Sidi Bel Abbès	583352	5	0
	Relizane	697858	4	0
Tell	Oran	1351698	2	0
	Jijel	621695	1	0
	Chlef	929406	0	0
	Blida	865044	0	0
	Alger	2874046	0	0
	Skikda	862536	0	0
	Annaba	623538	0	0
	Mostaganem	689771	0	0
	Boumerdès	712552	0	0
	El Tarf	389775	0	0
	Aïn Témouchent	365514	0	0
Total Tell		**18725302**	**13**	**0.01**

(table continues)

Table 2 (continued). Regional incidence and mortality (2001-2010)

	Naâma	139368	1091	2.94
	Biskra	621835	1071	1.22
	El Bayadh	183717	822	2.12
	M'Sila	865554	537	0.89
	Djelfa	849289	486	0.98
	Tiaret	788998	190	0.23
	Tébessa	594937	165	0.13
	Tissemsilt	285550	119	0
Central Highlands	Batna	1044707	118	0.16
	Khenchela	356172	90	0.11
	Bordj Bou Arreridj	600757	83	0.07
	Saïda	306924	35	0.1
	Mila	732092	11	0
	Sétif	1424132	9	0
	Souk Ahras	403871	9	0
	Oum El Bouaghi	564611	8	0
	Constantine	896196	0	0
Total Central Highlands		**10658710**	**223**	**0.35**
	Illizi	36596	1194	5.19
	El Oued	536457	1186	1.38
	Adrar	424939	1122	0.96
	Tamanrasset	147155	935	3.33
South	Ouargla	477646	890	1.97
	Ghardaïa	325503	850	0.92
	Laghouat	343442	518	0.99
	Tindouf	29435	297	0
	Béchar	246281	261	0.12
Total South		**2567454**	**875**	**1.34**
Total Algeria		**31951466**	**152**	**0.23**

the Tell region. In the former two, the abundance of scorpions resulting from the hot dry climate and conservation of the natural environment, may explain the high incidence, inversely proportional to the density of the human population (Figure 11). However, scorpion stings also occur in towns, even inside homes (5). The adaptation of some species to a human environment has already been reported (10).

Mortality, especially when expressed as a case fatality rate, results from several factors: toxicity of the species responsible for the sting, delayed treatment, quality of care, with the

Table 3. Incidence and mortality in the Highlands (2001-2010)

Wilaya	Population (2004)	Mean incidence	Mean mortality
Naâma	139368	1091	2.94
Biskra	621835	1071	1.22
El Bayadh	183717	822	2.12
M'Sila	865554	537	0.89
Djelfa	849289	486	0.98
Tiaret	788998	190	0.23
Tébessa	594937	165	0.13
Tissemsilt	285550	119	0
Batna	1044707	118	0.16
Khenchela	356172	90	0.11
Bordj Bou Arreridj	600757	83	0.07
Saïda	306924	35	0.1
Mila	732092	11	0
Sétif	1424132	9	0
Souk Ahras	403871	9	0
Oum El Bouaghi	564611	8	0
Constantine	896196	0	0
Total Highlands	**10658710**	**223**	**0.35**

Table 4. Incidence and mortality in the South (2001-2010)

Wilaya	Population (2004)	Mean incidence	Mean mortality
Illizi	36596	1194	5.19
El Oued	536457	1186	1.38
Adrar	424939	1122	0.96
Tamanrasset	147155	935	3.33
Ouargla	477646	890	1.97
Ghardaïa	325503	850	0.92
Laghouat	343442	518	0.99
Tindouf	29435	297	0
Béchar	246281	261	0.12
Total South	**2567454**	**875**	**1.34**
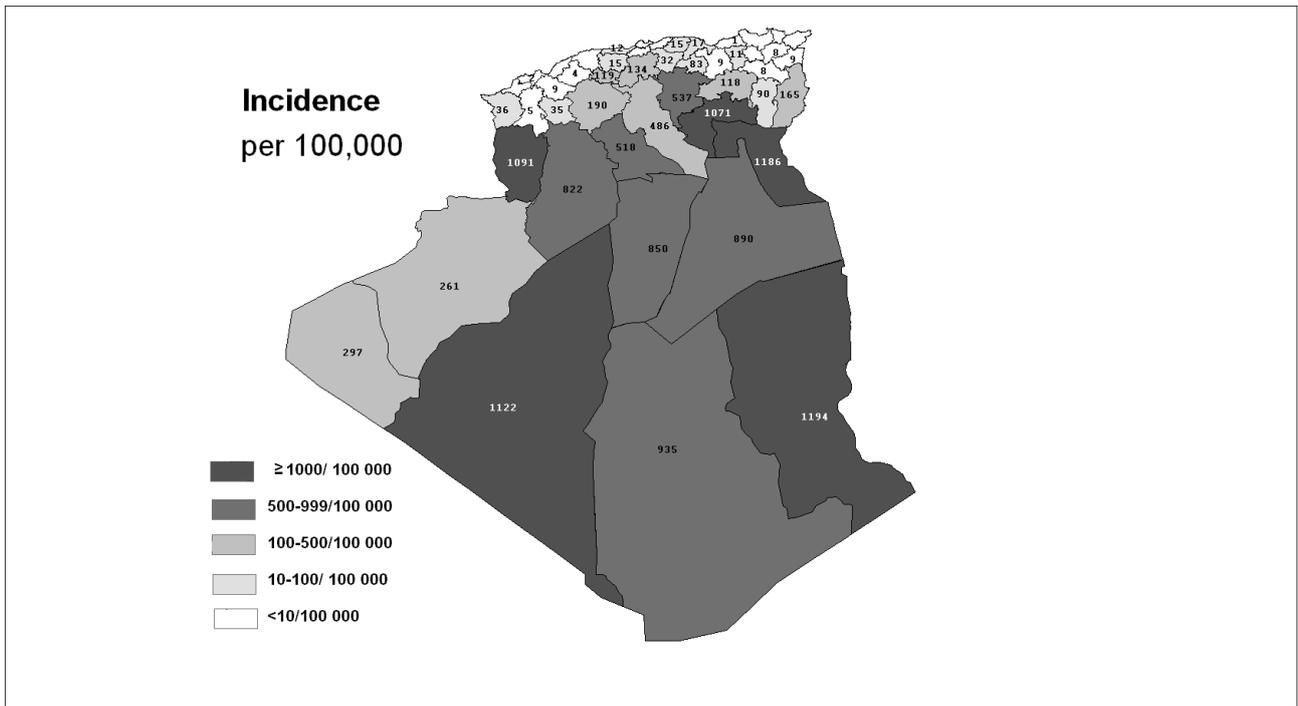
Figure 1. Geographical distribution of annual incidence of scorpion stings in Algeria (2001-2010).
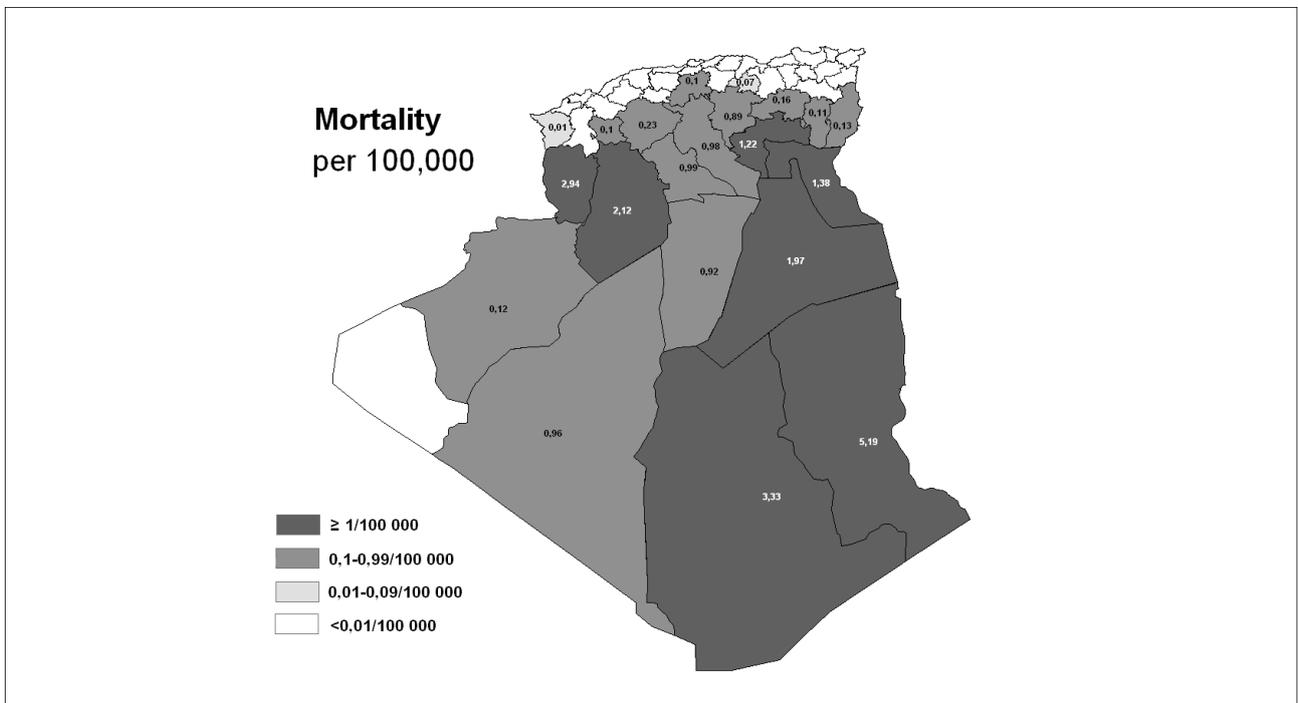
Figure 2. Geographical distribution of annual mortality due to scorpion stings in Algeria (2001-2010).
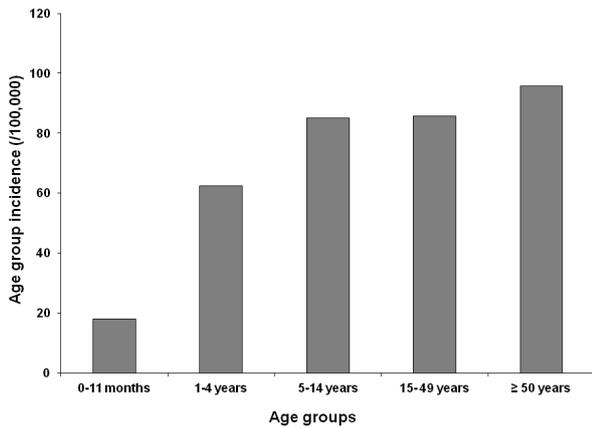
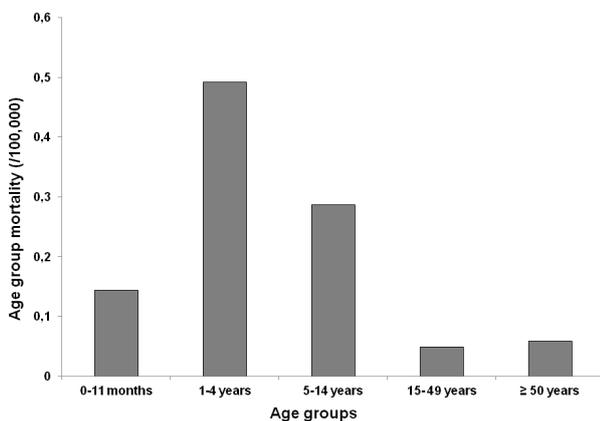**Figure 3.** Incidence of scorpion stings according to age.

Figure 5. Incidence of scorpion stings according to anatomical site.

Figure 4. Mortality due to scorpion stings according to age.
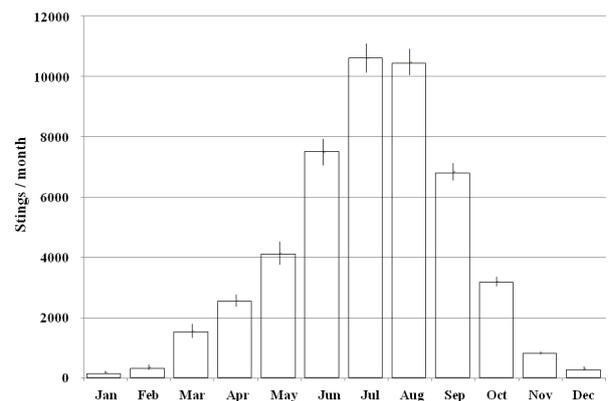
Figure 6. Seasonal incidence of scorpion stings.

latter being dependent on equipment from health facilities (resuscitation equipment particularly), experience of health personnel and the supply of appropriate immunotherapy. The data did not contain details on the first two factors (species in question and consultation time). Although the other factors were not documented by the national health information system and thus had to be evaluated *a posteriori*, they constitute the precise basis of the strategy for controlling scorpion stings.

The stability of the mortality from 2002 suggests that the actions against scorpionism had reached their limit (Figures 9 and 10). It is therefore necessary to investigate the factors that are poorly documented (species involved and, most importantly, late treatment) in order to consider needed improvement. In addition, the use of immunotherapy should be better investigated. In Algeria, the treatment protocol developed in 1999 by consensus at a seminar workshop in Biskra includes systematic administration of monovalent scorpion antivenom associated with symptomatic treatment (analgesics, corticosteroids).

Admission to the intensive care unit is required if the patient shows predictive signs of severity (4, 11, 12). This strategy is the result of the remarkable tolerance of antivenoms composed of purified
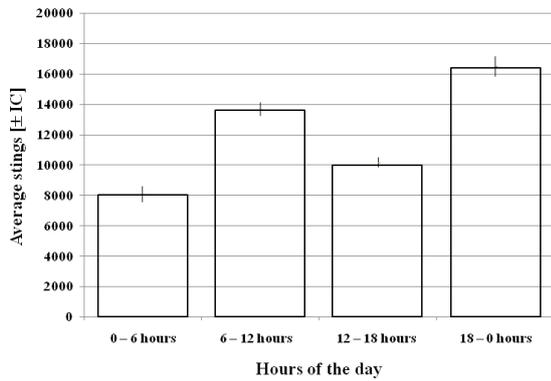
fragments of immunoglobulins F(ab')2 (12, 13). However, their use and clinical efficacy need to be better documented. The availability and use of antivenom (including route of administration) in peripheral health structures are poorly known. The efficiency and rapid use of the antivenom might promote a beneficial neutralization of the neurotoxins before their binding to their targets. Immunotherapy could be also associated with the symptomatic treatment according to the symptoms observed by the physicians, in order to shorten significantly the duration of envenomation (14-16).

The sting circumstances and the at-risk populations of the present study are in agreement with those described in the literature (5), thus confirming that emergency care is a priority in childhood cases for reducing mortality, which remains high in this population group.
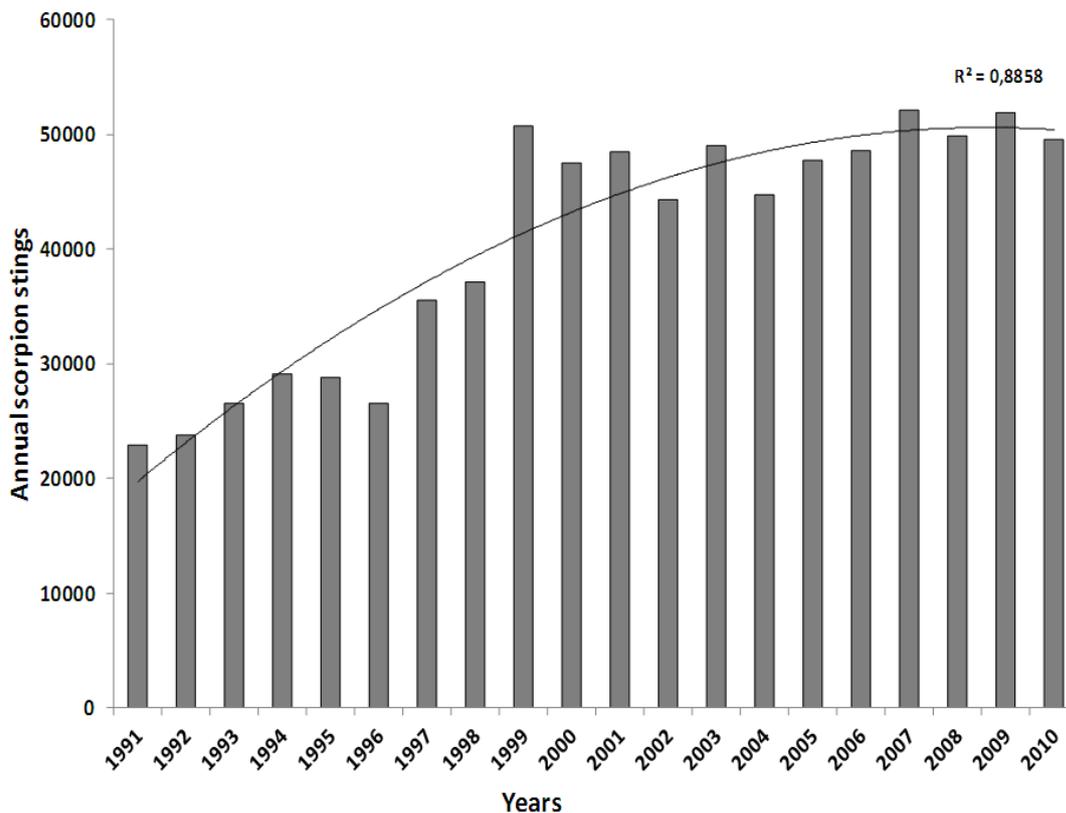

Figure 7. Daily distribution of scorpion sting incidence.

Figure 8. Trend of annual incidence of scorpion stings in Algeria from 1991 to 2010.
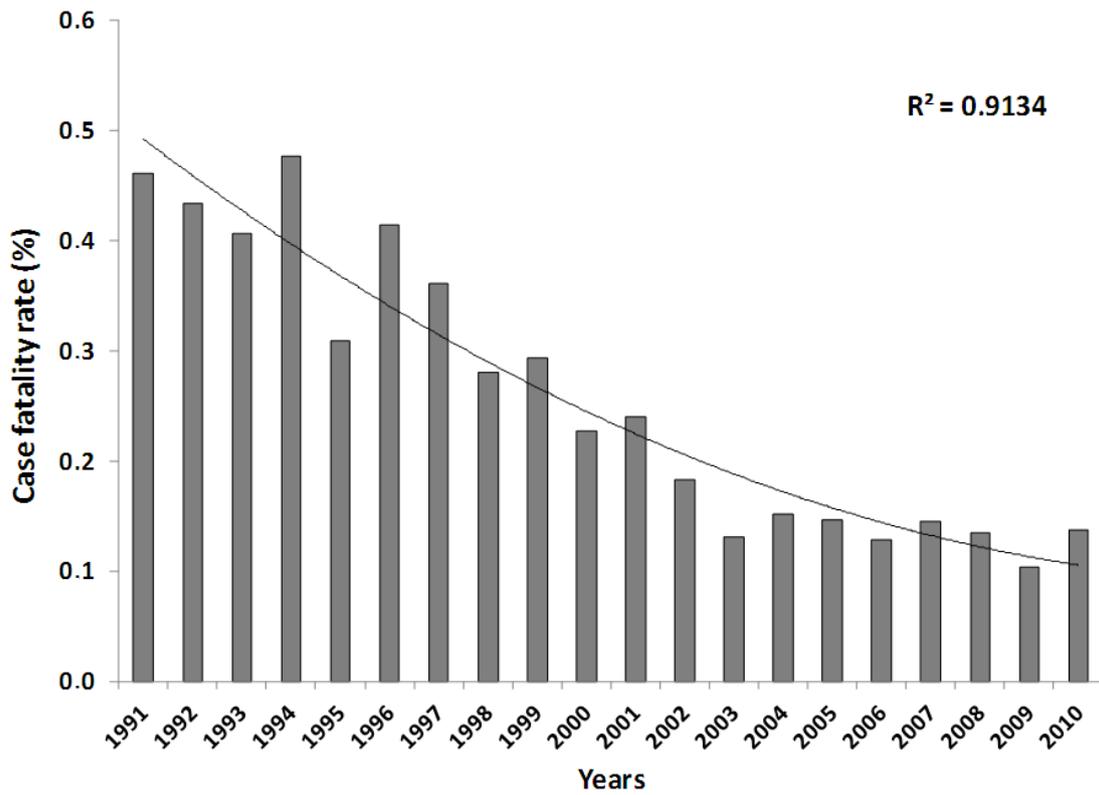
Figure 9. Trend of annual case fatality rate due to scorpion stings in Algeria from 1991 to 2010.
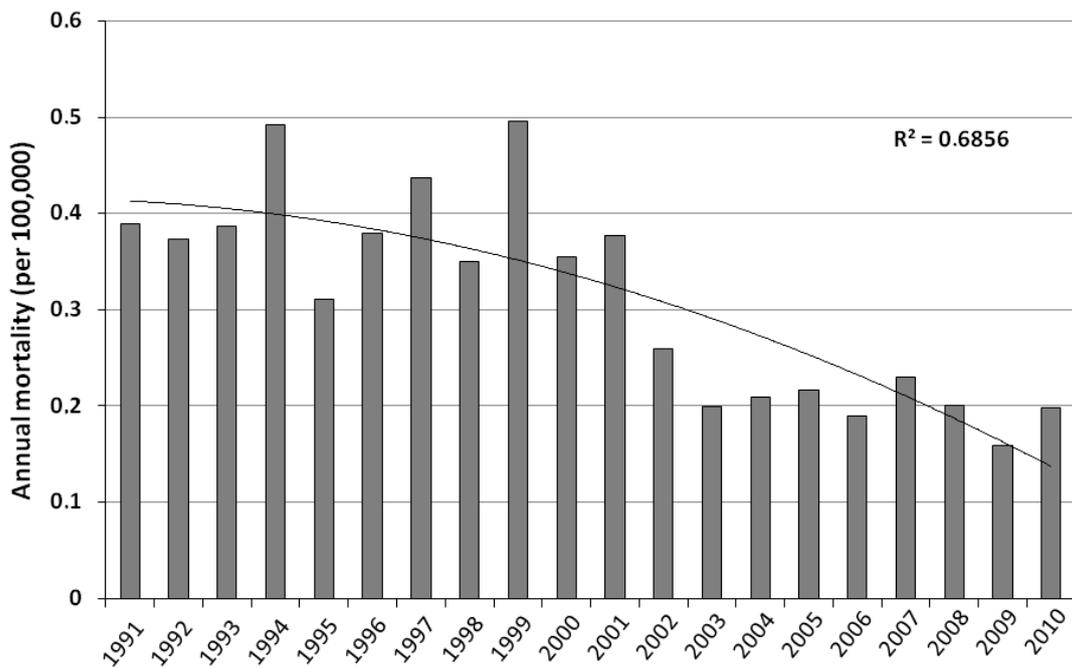

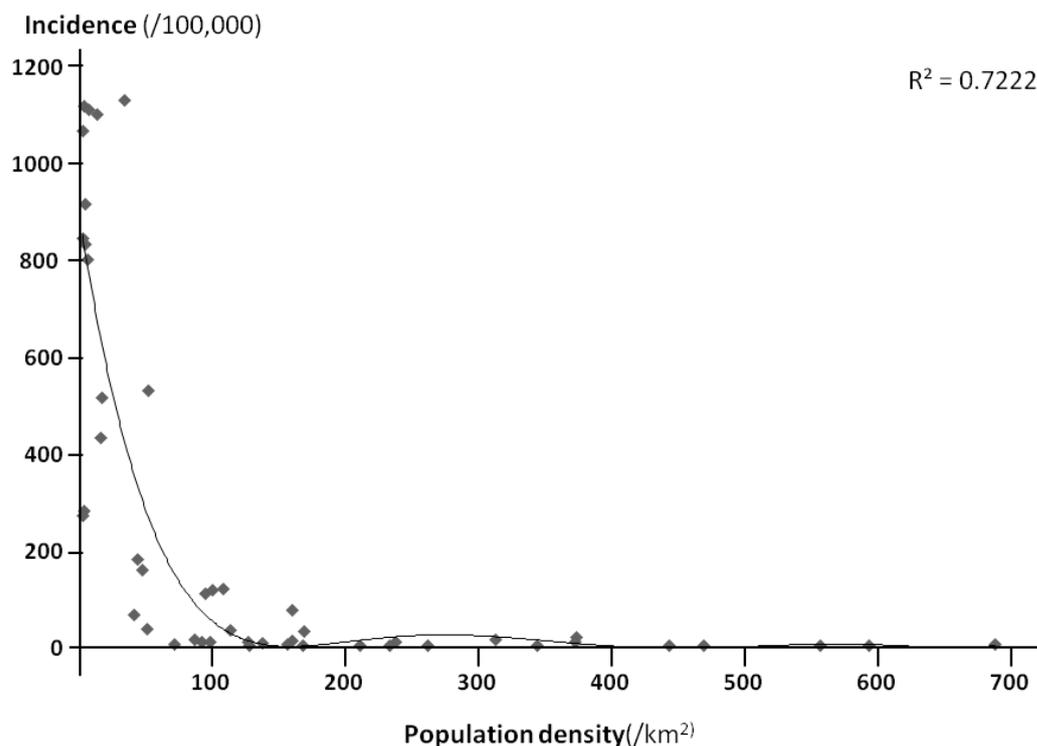**Figure 10.** Trend of annual mortality due to scorpion stings in Algeria from 1991 to 2010.

Figure 11. Relationship between scorpion sting incidences and human population densities in Algeria (2001-2010).

CONCLUSIONS

The present study showed that scorpion stings are a public health issue in Algeria as in all countries of the Maghreb region and the Middle East. There was a clear gradient in the incidence of scorpion stings -and mortality- from north to south linked both to the climate and population density. The incidence and mortality were highest in the southern part of the country, which is due to both environmental conditions and more difficult access to care in these regions, especially on account of scattered health facilities. The health information system that has been implemented in Algeria seems to be efficient and can properly analyze epidemiological data on scorpion stings. However, this information system must be improved in order to include some missed parameters, especially the species involved and conditions of case management (17). The results showed that the program against scorpionism has helped reduce the annual mortality by half (0.395 versus 0.207 per 100,000 population) between 1991 and 2010. Additional information must still

be collected, including data on the performance of antivenoms and how they are used by health personnel. Furthermore, the stagnation of the incidence for several years requires a review of the prevention strategy.

COPYRIGHT

SUBMISSION STATUS

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

FINANCIAL SOURCE

CORRESPONDENCE TO

Youcef Laïd, INSP, 4 Chemin El Bakr, El Biar,

Alger, Algérie. Phone: +213 21 94 52 71. Email: youceflaid@yahoo.fr.

REFERENCES

1. Balozet L. Le scorpionisme en Afrique du Nord. Bull Soc Pathol Exot. 1964;57(1):33-8.

2. Benguedda AC, Laraba-Djebari F, Ouahdi M, Hellal H, Griene L, Guerenik M, et al. Expérience de quinze années de lutte contre l'envenimation scorpionique en Algérie. Bull Soc Pathol Exot. 2002;95(3):205-8.

3. Envenimation scorpionique. Caractéristiques épidémiologiques des décès par envenimation scorpionique en Algérie [Internet]. Institut National de Santé Publique Alger; 2011. [cited 2012] Available from: http://www.ands.dz/insp/monographie_2002_2010.pdf

4. Hellal H, Guerinik M, Griene L, Laid Y, Mesbah S, Merad R, et al. Données épidémiologiques sur l'envenimation scorpionique en Algérie. Bull Soc Pathol Exot. 2012;105(3):189-93.

5. Chippaux JP, Goyffon M. Epidemiology of scorpionism: a global appraisal. Acta Trop. 2008;107(2):71-9.

6. Vachon M. Etudes sur les scorpions, Institut Pasteur d'Alger. Alger; 1952. 482p.

7. Goyffon M. Le scorpionisme en Afrique sub-saharienne. Bull Soc Pathol Exot. 2002;95(3):191-3.

8. Ministère de la Santé, de la Population et de la Réforme Hospitalière Alger, 2011. Available from http: //www.sante.gov.dz*/aff_population.php.

9. Touloun O, Slimani T, Boumezzough A. Epidemiological survey of scorpion envenomations in southwestern Morocco. J Venom Anim Toxins. 2001;7(2):199-218.

10. Goyffon M. Le rôle de l'homme dans l'expansion territoriale de quelques espèces de scorpions. Bull Soc Zool Fr. 1992;117(1):15-9.

11. Mendil A, Adi-Bessalem S, Saidi H, Sami-Merah S, Hammoudi-Triki D, Laraba-Djebari F. Les anticorps polyvalents: leur utilisation en immunothérapie antiscorpionique. Deuxième Workshop Biotechnologie en Santé Humaine, 08 - 10 novembre 2009, USTHB, Faculté des sciences biologiques, Laboratoire de biologie cellulaire et moléculaire en partenariat avec l'ANDRS. Available from http://www.usthb.dz/fbiol/IMG/pdf/WSBCM.pdf.

12. Sami-Merah S, Hammoudi-Triki D, Martin-Eauclaire MF, Laraba-Djebari F. Combination of two antibody fragments F(ab´)2/Fab: an alternative for scorpion envenoming treatment. Int Immunopharmacol. 2008;8(10):1386-94.

13. Laraba-Djebari F, Hammoudi D. Purification et caracterisation des fragments F(AB')2 a partir d'un sérum anti-scorpionique. Arch Inst Pasteur Algérie. 1999;63(1):7-24.

14. Krifi MN, Amri F, Kharrat H, El Ayeb M. Evaluation of antivenom therapy in children severely envenomed by *Androctonus australis garzonii* (Aag) and *Buthus occitanus tunetanus* (Bot) scorpions. Toxicon. 1999;37(11):1627-34.

15. Hammoudi-Triki D, Ferquel E, Robbe-Vincent A, Bon C, Choumet V, Laraba-Djebari F. Epidemiological data, clinical admission gradation and biological quantification by ELISA of scorpion envenomations in Algeria: effect of immunotherapy. Trans R Soc Trop Med Hyg. 2004;98(4):240-50.

16. Chippaux JP. Emerging options for the management of scorpion stings. Drug Des Devel Ther. 2012;6:165-73.

17. Instruction n 04/MSPRH/DP du 04 mars 2012. Available from http://www.sante.dz/inst_env_scorp.pdf