

R E V I E W

Scorpion Stings in Saudi Arabia: An Overview

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Abstract. *Background and aim of the work:* Scorpion sting envenomation is an important cause of morbidity and mortality among incidents caused by envenomations, especially in children and elderly, worldwide. In Saudi Arabia, it is an important issue as the climate and the desert terrain are ideal for scorpions' habitat. The aim of this review is to emphasize on the importance of scorpion stings in Saudi Arabia and provide updates regarding scorpion types and epidemiological aspects of scorpion stings in Saudi Arabia. *Methods:* A literature review of articles on scorpions and scorpion stings in Saudi Arabia. *Results:* In Saudi Arabia, at least 28 species of scorpions are identified. An estimated 14,500 scorpion stings are annually documented in various regions of Saudi Arabia. Most of the cases of scorpion envenomation recover completely with treatment in Saudi Arabia. People who live in the desert terrain, such as nomads or shepherds, are the population at highest risk for scorpion stings. The highest incidence of scorpion stings is reported during the summer season. *Conclusion:* Scorpions are found to inhabit all the regions of the country. The incidence of scorpion stings in Saudi Arabia seems to be significant. However, the mortality rate is low in Saudi Arabia. There are insufficient studies regarding this topic, and as such, it is clear that there is a lack of information regarding autopsy findings of scorpion sting deaths in Saudi Arabia. (www.actabiomedica.it)

Key words: "Scorpions", "species", "scorpionism", "sting", "envenomation", and "Saudi Arabia"

Introduction

Scorpion sting envenomation is an urgent medical problem that could be life-threatening, especially in children and elderly people with respiratory and cardiovascular disorders (1). The epidemiology of scorpion stings is poorly understood worldwide (2). Approximately 1.2 to 1.5 million scorpion stings occur yearly resulting in 2,600 deaths (3, 4).

In 2014, more than 16,000 reports of scorpion stings were received by Poison Control Centers in the United States (US) (5). With 11,500 exposures recorded annually, Arizona documented the highest rate of scorpion envenomation in the US (6). In Saudi Arabia, between 1993 and 1997, the total number of

scorpion stings reported was 72,168. It was reported that Al-Medina Al-Munawara had the highest rate of scorpion stings with 24,053 cases (33.33%), followed by 11,058 cases (15.32%) in Baha. Noticeably, the largest region, Eastern province, reported 1,502 cases only (2.08%) (7).

Globally, around 1,500 species of scorpions exist, of which 50 are venomous sub-species of scorpions, with Buthidae family being the most toxic of all families (8). Scorpion envenomation accounts for considerable morbidity and mortality (9). In addition to local symptoms, for instance, redness, pain, burning, and swelling, scorpion sub-species have venom variability between them, and these are toxic complex structures comprising of mixture of cardiac toxins, nephrogenic

toxins, hemolytic toxins and neurogenic toxins, which increase a substantial danger of causing serious and usually deadly clinical consequences, attributed to neurological, cardiovascular, hematological, and renal side effects. The commonest causes of death are loss of cardiac function and pulmonary congestion (10). Clinical presentation of scorpion envenomation relies on the dosage of the toxin, victim's age, stinging season, and most importantly the duration between getting stung and receiving medical assistance. Other important contributing factors include the gender of the victim and initial treatment at the scene of getting stung (11).

The present review provides some insight regarding the epidemiology of scorpion stings in Saudi Arabia and species of scorpions that are common in different regions of Saudi Arabia, and emphasizes the need for further research on such an important topic.

Methods

We conducted a literature review of articles on scorpions and scorpion stings in Saudi Arabia. The literature search was performed using PubMed, Scopus, and Web of Science databases (Tables 1, 2, and 3, respectively) on the third of November, 2020 by 5 reviewers independently and any discrepancies pertaining to the inclusion criteria or data were finalized in consultation with another reviewer. The focus was on articles that addressed scorpions in Saudi Arabia and scorpion stings or envenomation in the population residing in Saudi Arabia. Articles published in languages other than English were not included. There was no set time frame due to the limited number of studies regarding this topic in Saudi Arabia. The search string included a combination of key words related to scorpions, and scorpion stings and envenomation in Saudi Arabia (Tables 1-3).

Results

Forty-two articles were initially identified and after screening 11 were included to be analyzed (Figure 1). Table 4 illustrates the studies that were included in the present review.

The results are sorted into 2 main categories, namely, common scorpion species in Saudi Arabia, and epidemiological features of scorpion stings in Saudi Arabia, followed by a discussion of the clinical aspects.

Common scorpion species in Saudi Arabia

In a study of scorpion families in the Kingdom of Saudi Arabia, at least 28 species of scorpions were identified. These belong to three families (Buthidae, Hemiscorpidae, and Scorpionidae) and are found to inhabit all the regions of the country (Table 5) (12, 13).

Epidemiology of scorpion stings in Saudi Arabia

Scorpion stings are common in Saudi Arabia because of the country's terrain, climate, and social propensities. It is estimated that approximately 14,500 envenomations are annually documented in various regions of Saudi Arabia (14). An epidemiological study reported that the highest incidence of scorpion stings (64.3%) was noticed during the summer season, followed by the spring months (14.1%) and winter months (10.6%). Most scorpion sting cases were seen in the month of June (21.5%) in the summer and least cases were seen in December (1.5%) in the winter (15).

During the five-year period from 1999 to 2003, a total number of 6,465 scorpion stings were reported in Qassim province with nearly one half of the cases in the age group of 11-30 years (16). An overall male predominance for scorpion stings with a male-to-female ratio of about 2:1 was observed. During the study period, no deaths due to scorpion stings were reported (16).

In Al-Jouf province, 1,449 cases of scorpion stings presented over a two-year duration (2005-2006) to the various emergency departments of medical centers and hospitals in the province were analyzed (15). Majority of the patients were male (77.3 %) and the spectrum of age ranged from 15 to 30 years in 44.2% of patients. Daytime stings outnumbered the nighttime stings with a ratio of 3:2. Uncovered limbs happened to be the most common site for stings representing 88.6% of the stings. *Leiurus quinquestriatus* and *Androctonus crassicauda* were the most common culprit scorpions identified (15).

Table 1. Search strategy at PubMed

Search terms	Search details	Search results (number of items found)
(scorpion) AND (sting OR envenomation) AND (incidence OR prevalence OR clinical presentation OR epidemiology OR forensic OR medicolegal OR autopsy) AND (Saudi Arabia OR Kingdom of Saudi Arabia OR KSA)	("scorpion stings"[MeSH Terms] OR ("scorpion"[All Fields] AND "stings"[All Fields]) OR "scorpion stings"[All Fields] OR "scorpionism"[All Fields] OR "scorpion s"[All Fields] OR "scorpionic"[All Fields] OR "scorpions"[MeSH Terms] OR "scorpions"[All Fields] OR "scorpion"[All Fields] OR "scorpiones"[All Fields]) AND ("bites and stings"[MeSH Terms] OR ("bites"[All Fields] AND "stings"[All Fields]) OR "bites and stings"[All Fields] OR "sting"[All Fields] OR "stings"[All Fields] OR "sting s"[All Fields] OR "stinging"[All Fields] OR ("envenomated"[All Fields] OR "envenomating"[All Fields] OR "envenomation"[All Fields] OR "envenomations"[All Fields] OR "envenomed"[All Fields] OR "envenoming"[All Fields] OR "envenomings"[All Fields] OR "envenomization"[All Fields])) AND ("epidemiology"[MeSH Subheading] OR "epidemiology"[All Fields] OR "incidence"[All Fields] OR "incidence"[MeSH Terms] OR "incidences"[All Fields] OR "incident"[All Fields] OR "incidents"[All Fields] OR ("epidemiology"[MeSH Subheading] OR "epidemiology"[All Fields] OR "prevalence"[All Fields] OR "prevalence"[MeSH Terms] OR "prevalance"[All Fields] OR "prevalences"[All Fields] OR "prevalence s"[All Fields] OR "prevalent"[All Fields] OR "prevalently"[All Fields] OR "prevalents"[All Fields]) OR ("ambulatory care facilities"[MeSH Terms] OR ("ambulatory"[All Fields] AND "care"[All Fields] AND "facilities"[All Fields]) OR "ambulatory care facilities"[All Fields] OR "clinic"[All Fields] OR "clinic s"[All Fields] OR "clinical"[All Fields] OR "clinically"[All Fields] OR "clinicals"[All Fields] OR "clinics"[All Fields]) AND ("present"[All Fields] OR "presentation"[All Fields] OR "presentations"[All Fields] OR "presented"[All Fields] OR "presenter"[All Fields] OR "presenter s"[All Fields] OR "presenters"[All Fields] OR "presenting"[All Fields] OR "presents"[All Fields])) OR ("epidemiologies"[All Fields] OR "epidemiology"[MeSH Subheading] OR "epidemiology"[All Fields] OR "epidemiology"[MeSH Terms] OR "epidemiology s"[All Fields]) OR ("forensic medicine"[MeSH Terms] OR ("forensic"[All Fields] AND "medicine"[All Fields]) OR "forensic medicine"[All Fields] OR "forensics"[All Fields] OR "forensic"[All Fields] OR "forensically"[All Fields]) OR ("medicolegal"[All Fields] OR "medicolegally"[All Fields]) OR ("autopsied"[All Fields] OR "autopsy"[MeSH Terms] OR "autopsy"[All Fields] OR "autopsies"[All Fields])) AND ("saudi arabia"[MeSH Terms] OR ("saudi"[All Fields] AND "arabia"[All Fields]) OR "saudi arabia"[All Fields] OR ("saudi arabia"[MeSH Terms] OR ("saudi"[All Fields] AND "arabia"[All Fields]) OR "saudi arabia"[All Fields] OR ("kingdom"[All Fields] AND "saudi"[All Fields] AND "arabia"[All Fields]) OR "kingdom of saudi arabia"[All Fields]) OR "KSA"[All Fields])	15

Table 2. Search strategy at Scopus

Search terms	Search results (number of items found)
(scorpion) AND (sting OR envenomation) AND (incidence OR prevalence OR clinical presentation OR epidemiology OR forensic OR medicolegal OR autopsy) AND (Saudi Arabia OR Kingdom of Saudi Arabia OR KSA)	5

Table 3. Search strategy at Web of Science

Search terms	Search results (number of items found)
(scorpion) AND (sting OR envenomation) AND (incidence OR prevalence OR clinical presentation OR epidemiology OR forensic OR medicolegal OR autopsy) AND (Saudi Arabia OR Kingdom of Saudi Arabia OR KSA)	18

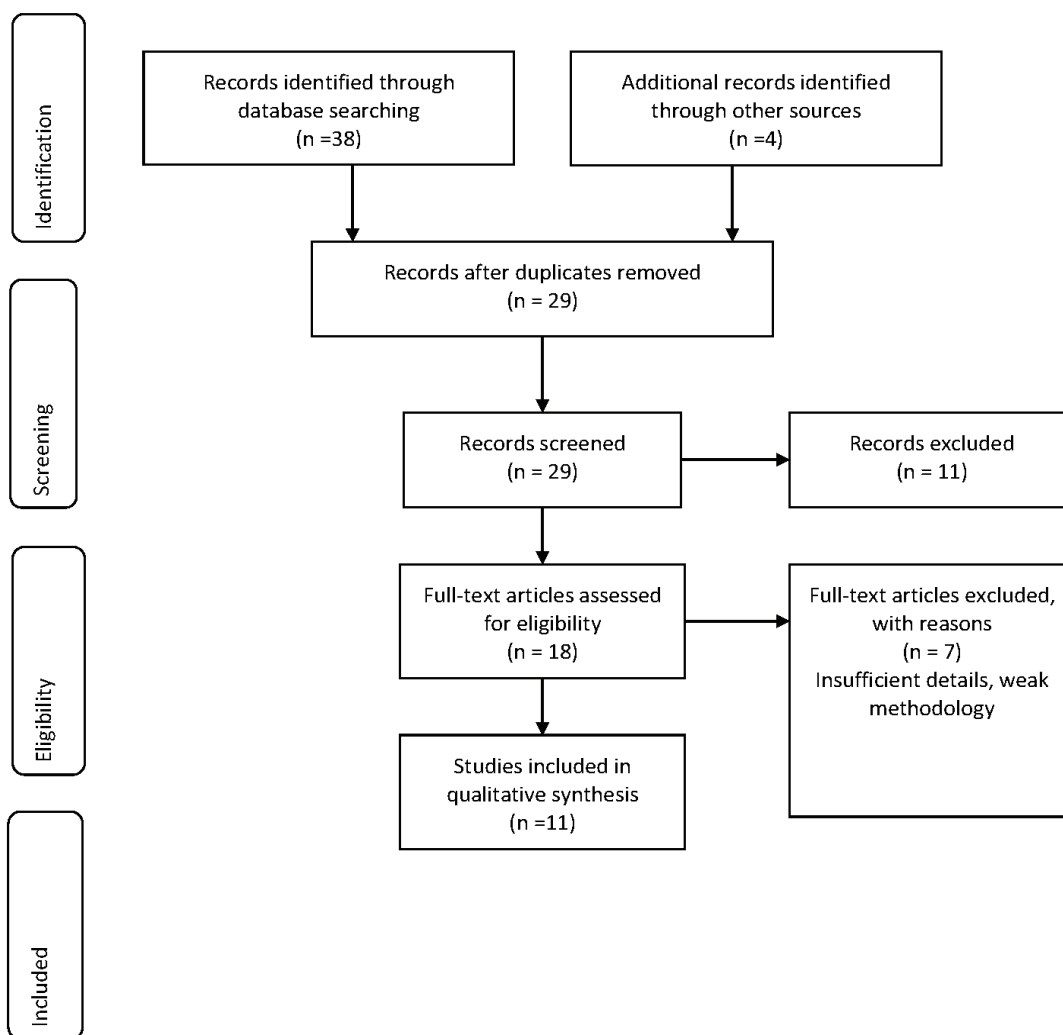


Figure 1. Flowchart (www.prismastatement.org) depicting the selection of articles

Since scorpions are primarily classified by the general population on the basis of color, a larger number of scorpions were assigned to yellow scorpions when compared to black scorpions and in some situations

patients were unable to recall the color characteristics of scorpions (14).

People who live in the desert terrain, such as nomads or shepherds, are the population at highest

Table 4. Articles that met the inclusion criteria

Year of publication	Duration of the study analysis	Origin of data	Journal	Title of article
2003	1993-1997	Saudi Arabia	Journal of Venomous Animals and Toxins Including Tropical Diseases	Epidemiological study of scorpion stings in Saudi Arabia between 1993 and 1997 (7)
2013	Not specified	Saudi Arabia	Egyptian Journal of Natural History	A review of the scorpion fauna of Saudi Arabia (12)
2009	2007-2008	Saudi Arabia	Journal of Venomous Animals and Toxins Including Tropical Diseases	New additions to the scorpion fauna of Riyadh region, Saudi Arabia (13)
2007	1999-2003	Saudi Arabia	Toxicon (official journal of the International Society on Toxinology)	Scorpion stings in Qassim, Saudi Arabia: a 5-year surveillance report (14)
2008	2005-2006	Saudi Arabia	Annals of Saudi Medicine	Epidemiological aspects of scorpion stings in Al-Jouf province, Saudi Arabia (15)
2012	2006-2008	Saudi Arabia	Saudi Medical Journal	Clinical aspects and frequency of scorpion stings in the Riyadh region of Saudi Arabia (16)
2004	1986-2000	Saudi Arabia	Saudi Medical Journal	Scorpion sting syndrome in a general hospital in Saudi Arabia (17)
2008	Not specified	Saudi Arabia	Saudi Medical Journal	Role of prazosin on cardiovascular manifestations and pulmonary edema following severe scorpion stings in Saudi Arabia (20)
1993	1990-1991	Saudi Arabia	Annals of Emergency Medicine	Scorpion envenomation in eastern Saudi Arabia (25)
1990	1983-1986	Saudi Arabia	Toxicon (official journal of the International Society on Toxinology)	Do changes in body temperature following envenomation by the scorpion <i>Leiurus quinquestriatus</i> influence the course of toxicity? (26)
1991	1988-1989	Saudi Arabia	Annals of Saudi Medicine	Hematological and biochemical findings in scorpion stung children (28)

risk for scorpion stings (14). Those who camp in the desert for recreational activities especially during the weekends are also vulnerable to scorpion stings (14). Fatalities from scorpion stings are rarely reported in Saudi Arabia (17, 18). It is clear that there is a lack of scorpion sting envenomation related autopsy articles published from Saudi Arabia.

The management of scorpion sting envenomation is not cheap in Saudi Arabia, with an average direct cost of mild to moderate scorpion sting case being around 4,615 Saudi Riyals (SR), and in severe cases of scorpion stings it can cost up to 17,638 SR per case (19).

Discussion

Upon arrival to the hospital, scorpion sting patients are grouped into two main categories, namely, local and systemic groups, depending on the presentation of clinical manifestations observed. The local manifestations include locally fixed pain, numbness, swelling, redness, and tingling sensation. The systemic manifestations include hypertension, tachycardia, dysphoria, shivering, emesis, headache, and abdominal pain. Some studies suggest that scorpion venom poorly penetrates the blood brain barrier. However, it is important to refer to the high penetration occurrence

Table 5. Common scorpion species found in Saudi Arabia by region (12, 13)

Region	Family	Species
Eastern (Abqaiq, Ad-Dammam, Al-Ahsa, Al-Jubail, Al-Jubail, Al-khubar, Al-Qatif, An-Nu'ayriyah, Hafar Al-Batin, Qaryat Al-Ulya, Ras Tanurah)	Buthidae	Androctonus crassicauda Androctonus bicolor Buthacus leptochelys Buthacus yotvatenensis nigroaculeatus Leiurus quinquestriatus Orthochirus innesi Vachoniolus minipectinibus
Central (Al-Dawadmi, Ad-Dir'iyah, Afif, Al-Aflaj, Al-Ghat, Al-Hariq, Al-Kharj, Al-Majma'ah, Al-Muzahimiyah, Al-Quway'iyah, Al-Riyadh, As-Sulayyil, Az-Zulfi, Durma, Hawtah Bani Tamim, Huraymila, Ramih, Shaqra, Thadig, Wadi Ad-Dawasir)	Buthidae	Androctonus bicolor Androctonus crassicauda Buthacus leptochelys Buthacus yotvatenensis nigroaculeatus Compsobuthus arabicus Compsobuthus wernerii Leiurus quinquestriatus Orthochirus innesi
	Scorpionidae	Scorpio maurus kruglovi
	Hemiscorpiidae	Hemiscorpius arabicus Hemiscorpius lepturus
Northern (Ar'ar, Rafha, Turaif, Hafr-Albatin)	Buthidae	Androctonus crassicauda Apistobuthus pterygocercus Buthacus leptochelys Buthacus yotvatenensis nigroaculeatus Compsobuthus arabicus Compsobuthus wernerii Leiurus quinquestriatus Orthochirus innesi Orthochirus scrobiculosus
	Scorpionidae	Nebo hierichonticus Scorpio maurus kruglovi Scorpio maurus palmatus
Southern (Aseer, Jazan, Najran, Al-Baha)	Buthidae	Androctonus bicolor Androctonus crassicauda Buthacus leptochelys Buthacus leptochelys Butheolus arabicus Butheolus gallagheri Butheolus thalassinus Compsobuthus wernerii Hottentotta jayakari Leiurus quinquestriatus Orthochirus innesi Parabuthus liosoma Vachoniolus minipectinibus
	Scorpionidae	Scorpio maurus fuscus Nebo hierichonticus

(Continued)

Region	Family	Species
Western (Jeddah, Medinah, Mecca, Yanbu, Al-Taif)	Scorpionidae Buthidae	Scorpio maurus fuscus Androctonus amoreuxi Androctonus australis Androctonus crassicauda Buthacus leptochelys Buthacus leptochelys Compsobuthus arabicus Compsobuthus weneri Leiurus quinquestriatus Orthochirus innesi Parabuthus liosoma
	Scorpionidae Scorpionidae Scorpionidae	Nebo hierichonticus Scorpio maurus kruglovi Scorpio maurus

among infants and young children (20). Majority of the patients present with local manifestations that predominantly include pain, followed by redness and swelling. Distal limbs are the most common anatomic sites for scorpion stings and the least affected is the torso (14, 15).

In a study conducted on American military personnel in eastern Saudi Arabia, the most prevalent local clinical features identified were pain and erythema in 100% and 63% of cases, respectively. The most prevalent systemic clinical features were tachycardia and hypertension in 72% and 58% of cases, respectively (21).

Full recovery is reported in most of the cases of scorpion sting envenomation in Saudi Arabia (15, 22). This can be attributed to the excellent healthcare delivery system in Saudi Arabia and also to the Ministry of Health's establishment of the national hospitalization records on scorpionism (15).

Multiple studies from Saudi Arabia and abroad have reported systemic manifestations in about one-fourth of the cases, majority of them being mild (15, 16, 23, 24). Pain was considered as the prevailing characteristic of stings by most of the scorpion species, including those commonly considered to be non-harmful (25, 26). Initially scorpion envenomation leads to severe debilitating pain at the sting site, which then radiates along the dermatomes correspondingly and progressively decreases within 24 hours (26). Extreme local pain without any systemic manifestations is a pointer of lesser or harmless scorpion sting

(26). On the other hand, if the patient is suffering from pain that resolves or diminishes quickly, but with some systemic manifestations present, it may be indicative of envenomation by a strongly venomous or a lethal scorpion (27).

Regarding cardiotoxicity, ECG changes show the most significant findings related to myocardial ischemia, specifically inferior and anterior infarctions. This is brought about by the venom of the following scorpions: *B. minux*, *B. occitonus*, *A. umoreuxi* and *L. quinquestriatus* (20). In another study, it was reported that all patients who presented with pulmonary edema developed ECG abnormalities. Most ECG abnormalities recorded were sinus tachycardia and conduction defects, followed by T wave changes. Besides, clinical examination and ECG showed features of myocarditis in all patients who suffered cardiotoxicity (17). A study showed high rates of children who were admitted due to scorpion stings with impaired left ventricular systolic emptying. But it was often a temporary effect. However, if there was documentation of reduced systolic emptying, unfortunately, it was associated with less favorable outcomes (18).

Central nervous system manifestations including seizures and irritability were mainly observed in infants and young children (28). Hyperglycemia, leukocytosis, hyponatremia, and hyperkalemia were certain laboratory findings reported in scorpion sting envenomation cases (20).

Furthermore, a disturbance of core body temperature was reported as both hyperthermia and

hypothermia which were linked to raise the victim's responsiveness to scorpion venom's toxic effects especially a cardiac toxin. Thus, correcting the core body temperature was an effective measure in the management of patients (29). Hypothermia was associated with severe toxicity or fatality (20).

Important preventive measures against scorpion stings such as using protective footwear, using flashlight at night, and removing scorpions from sleeping and living areas indoors are vital in decreasing the risk of scorpion stings. Furthermore, the indoor use of insecticides such as lindane or dieldrin keep scorpions away from houses (30).

Conclusion

Scorpions are found to inhabit all the regions of the country. The incidence of scorpion stings in Saudi Arabia seems to be significant. However, very few cases of deaths from scorpion sting envenomation have been reported in Saudi Arabia. There are insufficient studies regarding this topic, and as such, it is clear that there is a lack of information regarding autopsy findings of scorpion sting deaths in Saudi Arabia. It is recommended that further in-depth studies should be conducted to update the epidemiological data regarding scorpion sting envenomation in Saudi Arabia at the national, regional, provincial, and local levels.

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Conflicts of interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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