

**Scorpion composition and scorpionism in a high-risk area, the southwest of Iran**

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**Abstract**

**Background:** Scorpions are usually defined as predatory arachnids having venomous and painful stings. Scorpionism is considered as one of the health and medical problems in undeveloped tropical and subtropical countries in the world that endangers thousands of people annually.

**Objective:** This study was done for identification of scorpion fauna and scorpionism location in a high-risk area in southwest of Iran.

**Methods:** This study was carried out in Andimeshk district located in Khuzestan province which has the highest frequency of scorpionism in Iran. In total, 4 urban and 15 rural areas with various climates and topography were selected for monthly scorpion collection in 2016. Additionally, clinical data was obtained from questionnaires over a 5-year period (2012 to 2016) which were completed by physicians and health staff in hospitals and health centers. The data were analyzed by IBM-SPSS Version 20.

**Results:** A total of 850 scorpion samples with the most frequency in rural areas were collected. Eight species belonging to three families; Buthidae, Scorpionidae and Hemiscorpiidae were identified. *A. crassicauda* was the dominant species followed by *H. lepturus*. The largest collection due to scorpion's activity was recorded in summer. The five-year prevalence of scorpion sting were 9.1/1000 inhabitants. The highest frequency of scorpionism was observed in the male age group of 25-34 years. Most cases had been treated with polyvalent scorpion antivenom within 6-12 hours of the sting.

**Conclusion:** Based on the findings, six species of medically important scorpions that were previously reported from Iran were also collected and caught in this study area. The findings of this study can be useful for policymakers at the Andimeshk Healthcare Center to prevent scorpionism and provide appropriate treatment for scorpionism cases.

**Keywords:** Scorpion, Scorpionism, Andimeshk, Iran

**1. Introduction**

Scorpions are usually defined as predatory arachnids of the phylum arthropoda, class Arachnida and order Scorpionida. Their body length can be between 3 and 18 cm morphologically. The body of a scorpion is very tough

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and its toxic device is set on the end of its tail and contains two toxic glands, which are located in the thick chitin (1). Scorpions, as nocturnal creatures, are found in deserts, mountains, caves and also under rocks. When disturbed, they have been known to accidentally sting and endanger human lives (2). Only 25 scorpion species are lethal to humans, despite this, scorpions have caused fear among mankind since ancient times; often people think this creature is a killer to humans and their domestic animals. Scorpion venom is a protein material and is more used for catching insects and self-defense (1). Most species of this order of arachnids are only skilled predators for insects and small animals (3). The first documented report on a checklist of Iranian scorpions was the black scorpion *Androctonus crassicauda*, in Kashan, which was presented in 1807 by Olivier (4). Then, other researchers including Birula in 1903 reported two families (Scorpionidae & Buthidae), 12 genera and 24 species of scorpions. Kovarik classified them into three families, 18 genera, 23 species and 17 subspecies (5, 6). Nowadays, scorpionism is one of the health and medical problems in undeveloped tropical and subtropical countries in the world, and endangers thousands of people annually. At present, scorpionism is a major health problem in South Africa, the Middle East, South America, Mexico and the Indian subcontinent. It was evaluated that about 1.2 billion people worldwide, live in areas where there is probability of scorpionism and about one million people are injured due to scorpion stings per year. This health problem has ultimately caused about 0.27 % of mortality in the world annually (7). The deadliest scorpions, which live in North Africa and the Middle East, belong to the genus *Buthus*, *Leiurus*, *Androctonus* and *Hottentotta*. In South Africa, the deadliest scorpion is *Tityus*, in India it is *Mesobuthus* and in Mexico, *Centruroides* (8). Reported cases of scorpionism are variable in different geographical areas and different countries according to lifestyle, socio-economic status, housing, health-care quality and scorpion species to each area (9). Iran is located at 25-40 degrees' northern latitude which makes the country the most temperate zone on earth. Thereby, species' diversity and distribution of scorpions in Iran with regard to geographical location and climatic condition in each region is relatively impressive, but information about the exact biological characteristics and geographical distribution in the country can be inaccurate and limited (10). Deaths due to injury from scorpion stings are recorded in all regions of the country and approximately 75% of patients who have died from scorpion stings are reported from the three provinces of Khuzestan (which include Ahvaz, Andimeshk, and other cities), Sistan & Baluchestan and Kerman (11). According to the literature reviews, although there were some scientific and valuable studies about scorpions in some areas of Khuzestan province (12-14), research on the scorpions' fauna and the epidemiology of their stings in Andimeshk district have been poorly investigated, as we only found one study of this area; the samples of this study were collected in 2001 (15). Bearing in mind the need for more information on scorpion species and lack of published papers about the epidemiological aspects of scorpionism in this area, this study was done for identification of scorpion fauna and scorpionism location. The findings of this investigation can be useful for risk management of scorpionism and prevention of this health problem in the future.

## **2. Material and Methods**

This descriptive-analytic study was conducted in Andimeshk district located in Khuzestan province. Andimeshk district, is located in the north of Khuzestan province in the Southwest of Iran and has landmass of approximately 53,120 km<sup>2</sup> (9.4% of Khuzestan Province) with hot regions that are suitable for scorpion growth and reproduction. Its population is 167,126. This area includes hilly areas, plains and foothills in rural and urban areas. The area has a temperate climate and relatively warm humid summer, and is located between 32°27' N latitude and 48°21' E longitude. The elevation of the study area ranges to 176 meters above sea level. The mean annual temperature in the area is between 12 °C and 42 °C, and the mean precipitation is 402.5 mm annually. Also, its soil type is clay, and vegetation includes tamarisk shrubs and thorns.

### **2.1 Scorpion collection and identification**

Scorpion collection was done during four seasons in 2016. Totally, 4 urban and 15 rural areas with variable climate and topography were selected for monthly scorpion collection through random cluster sampling. In each of the counties, 2-3 points were selected as sampling locations. The choice of locations was also considered plain or mountainous. Twenty-four locations were determined for scorpion collecting. Beginning at sunset and continuing for two hours, scorpions were searched for in plains and mountains with dense cover of weed such as camel thorn. Scorpions' nests could be located due to the semi-circular opening and existence of soil near to it. To entice the scorpions out of their nests, the nests were filled with water. The fleeing scorpions were then collected by the tail with long-handled tongs. Also, rocks were displaced with a metal lever in order to collect scorpions that may be sheltered under them. Another method was to use UV light to search for them. Spraying people's yards with water two hours before sunset, and then exploring the corners of the yard was another method. In warehouses, Pyrethroid spray was used to encourage the scorpions to leave their shelters. We also explored, under carpets, behind curtains, and around cupboards. The collected species were transferred to glass jars containing 70% ethanol, and labeled with

the collector's name, the location and the date of sampling. In a laboratory at the Department of Medical Entomology and Vector Control at the School of Public Health, Tehran University of Medical Sciences, scorpions were identified using a stereo microscope and Farzanpay's key of identification (16).

### 2.2 Clinical data collection

The clinical data was obtained using questionnaires from the 5 years between 2012 and 2016. They were formerly prepared by the Iranian Center for Disease Control (CDC), and had been completed by physicians and health staff at hospitals and health centers, and collected at the Health Center of Khuzestan Province. The various data including patients' sex, age, residence, site of sting and antivenom injection status were derived from the questionnaires. IBM-SPSS Version 20 was used for analyzing the gathered data. Also, the frequency of scorpions and human scorpion sting cases was determined. The five-year prevalence of scorpion stings was calculated based on the number of scorpion sting cases to mean population ratio from 2012-2016. In order to observe ethical considerations, demographic identification of patients remained hidden using code numbers (approval number: 930324, Kerman University of Medical Science).

## 3. Results

### 3.1. Scorpion fauna

In total, 850 samples were collected from urban and rural areas (Figure 1). Eight species belonged to 3 families; Buthidae, Scorpionidae and Hemiscorpiidae were identified and are shown in Table 1. Two species including *Hottentotta zagrosensis* (4.6%) and *Buthacus macrocentrus* (3.9%) were reported for the first time from this area. *Androctonus crassicauda* (27.3%) was the dominant species followed by *H. lepturus* (22.1%). Most of the captured scorpions were collected from rural areas 793 (93.3%) with the frequency of females and males at 421 (53.1%) and 372 (46.9%) respectively. A further, 57 scorpions out of all captured specimens were collected in an urban area (Andimeshk district) with the frequency of females and males at 36 (63.2%) and 21 (36.8%) respectively. In total, the lowest population size was seen in *Buthacus macrocentrus* in rural and urban areas (Table 2). Most of the collected samples were found indoors, in yards, around the houses, and warehouses respectively. The most collected due to scorpion activity was recorded in summer 420 (49.4%), followed by spring 311 (36.6%) then Autumn 60 (7.1%) and finally winter 59 (6.9%).



**Hottentotta zagrosensis Buthacus macrocentrus Androctonus crassicauda Mesobuthus eupeus**  
**Figure 1.** Scorpion collected by victims, pasted on epidemiological questionnaire form, Andimeshk district, southwest Iran.

**Table 1.** Distribution and scorpion species composition in counties of Andimeshk district, southwest Iran, 2016

Sites	Species; n (%)								Total
	Mesobuthus eupeus	Androctonus crassicauda	Hemiscorpius lepturus	Odontobuthus doriae	Scorpio maurus	Hottentotta saulcyi	Hottentotta schach	Buthacus macrocentrus	
Mazou	32	65	39	15	23	12	9	13	208 (24.5)
Sorkhakan	23	51	23	12	10	24	6	17	166 (19.5)
Bidroobe	21	44	25	7	5	8	11	2	123 (14.5)
Hoseyniye	11	27	31	10	6	19	8	1	113 (13.3)
Chamgolak	10	17	41	0	13	17	3	0	101 (11.9)
Andimeshk	4	19	0	4	10	18	2	0	57 (6.7)
Azadi	14	9	29	15	12	3	0	0	2 (9.6)
Total	115 (13.5)	232 (27.3)	188 (22.1)	63 (7.4)	79 (9.3)	101 (11.9)	39 (4.6)	33 (3.9)	850 (100)

### 3.2. Scorpionism

The five-year prevalence of scorpion sting involved 9.1/1000 inhabitants (1.522/167.126). Most of whom were male (58.3%). The highest frequency of scorpionism belonged to the age group of 25-34 years old (17.1%), and

older than 65 years had the lowest (3.3%). The most reported cases were scorpion stings in the legs (45.1%) and then hands (33.1%) (Table 3). Although there were a very small number of patients without antivenom injection, most of them had been treated with polyvalent scorpion antivenom (87.9%). A large number (44.4%) were treated within 6-12 hours after being stung. No deaths were reported due to scorpion sting during the study.

**Table 2.** The scorpions captured according to species, sex and geographical area, Andimeshk district, southwest Iran, 2016

Species	Captured scorpions; n (%)	Sex; n (%)		Geographical area; n (%)	
		Male	Female	Rural	Urban
<i>Androctonus crassicauda</i>	232 (27.3)	72 (31.1)	160 (68.9)	213 (91.8)	19 (8.2)
<i>Hemiscorpius lepturus</i>	188 (22.1)	79 (42.0)	109 (58.0)	188 (100)	0 (0.0)
<i>Mesobuthus eupeus</i>	115 (13.5)	39 (33.9)	76 (66.1)	111 (96.5)	4 (3.5)
<i>Hottentotta saulcyi</i>	101 (11.9)	52 (51.5)	49 (48.5)	83 (82.2)	18 (17.8)
<i>Scorpio maurus</i>	79 (9.3)	39 (49.4)	40 (50.6)	69 (87.3)	10 (12.7)
<i>Odontobuthus doriae</i>	63 (7.4)	19 (30.2)	44 (69.8)	59 (93.7)	4 (6.3)
<i>Hottentotta zagronesis</i>	39 (4.6)	22 (56.4)	17 (43.6)	37 (94.9)	2 (5.1)
<i>Buthacus macrocentrus</i>	33 (3.9)	13 (39.4)	20 (60.6)	33 (100)	0 (0.0)
Total	850 (100)	335 (39.4)	515 (60.6)	793 (93.3)	57 (6.7)

**Table 3.** Scorpion sting site among the studied cases, Andimeshk district, southwest Iran

Sting site	Number of patients in 2012-2016					Total	
	2012	2013	2014	2015	2016	n	%
Head & trunk	90	66	90	48	38	332	21.8
Hand	154	134	68	86	62	504	33.1
Leg	166	134	152	112	122	686	45.1
Total	410	167	310	246	222	1522	100

#### 4. Discussion

In this study, 8 scorpion species were captured from rural and urban areas of Andimeshk district in Khuzestan province southwest Iran. The results of this entomological study have shown that two species of scorpions including *Hottentotta zagronesis* and *Buthacus macrocentrus* are reported for the first time from this area. Some species of scorpions such as *Hemiscorpius kashkayi* have been collected in recent studies in Andimeshk district, but they were not found in this present study (17). One of the possible reasons for not reporting this scorpion species can be the morphological similarity of *H. kashkayi* in comparison to *H. lepturus*. Perhaps this resemblance has made it more difficult for researchers to detect *Hemiscorpius kashkayi* and was also difficult for previous researchers to recognize this species. *Androctonus crassicauda*, *M. tamulus*, *M. eupeus*, *Parabuthus liosoma*, *Buthus occipitanus* and *Leiurus quinquestriatus* are recognized as medically important scorpion species in the Middle East (18). To date, 64 species of scorpions belonging to three families (*Buthidae*, *Scorpionidae* and *Hemiscorpiidae*) have been reported in Iran (19) along with 12 species of medically important scorpions (20). With this situation, Iran has the most number of scorpions among Middle Eastern countries (21), and there may be more yet to be discovered (22). Of the 12 medically important scorpions in Iran (23), *Orthochirus scrobiculosus*, *Apistobuthus pterygocercus*, *Mesobuthus caucasicus*, *Hemiscorpius acanthocercus*, *Compsobuthus matthiesseni* were not found in this study. In the current study, *H. lepturus* was collected from indoors and outdoors. This scorpion was captured from under rocks, crevices and barrows of mud walls, under tree barks and anywhere that had moist soil. *Hemiscorpius lepturus* is the most dangerous scorpion in some areas of Iran such as Khuzestan, the hot and humid province in the south west (12). The species is responsible for deaths of many people in hot and humid provinces annually, not only in Khuzestan but also in Hormozgan. Severe and fatal hemolysis, acute renal failure, necrotic and deep ulcers, ankylosis of the joints, temporary and permanent psychosis and deaths are complications observed following *H. lepturus* stings (24). The heat and humidity can be considered as limited factors for breeding places of this species. In many areas of the country, the annual average temperature is high and the required humidity is not suitable for this scorpion. For this reason, this scorpion species has limited geographical extent (13). The present study demonstrated that *M. eupeus*, as an important scorpion species, was collected with the most abundance in various climates in rural as well as urban areas in Andimeshk district. Previously, researchers had captured *H. lepturus* in a number of areas in Iran, in a variety of climates and weather conditions from snowy highlands to tropical regions. Existence of this species in different countries such as Afghanistan, Armenia, Central Asia, China, Iraq, Turkey and Oman can confirm its adaptation to various climatic conditions (25, 26). According to the results of the present study, *O. doriae* was observed in the

Andimeshk district. It has been proven previously that this species of scorpion has a widespread geographical distribution in Iran (27, 28). Along with *H. lepturus*, it is placed in the most dangerous scorpion group (9). In this present study, *O. doriae* was collected in all rural and urban areas. Similarly, it was captured from rural areas in Ilam province, west of Iran (29). *Androctonus crassicauda*, as another medically important species has been reported from Iran, Egypt, Jordan, Syria, Turkey, Iraq, Saudi Arabia and Azerbaijan (30) and was also collected in our field study. *Androctonus crassicauda* is called the black scorpion, known as a non-digging species with a size up to 12 cm in length. The results of previous studies indicated 28% of scorpionism cases belonged to this scorpion in the west of Iran (31, 32). Severe pain in patients and more deaths in infants due to its sting have been observed (33). *Hottentotta saulcyi* was also collected in this study. Type locality and repository of this species was Mosul, Iraq. But it can be found in the Iranian provinces of Chaharmahal & Bakhtiyari, Hamadan, Hormozgan, Ilam, Kermanshah, Khuzestan, Kohgiluyeh & Boyer-Ahmad, and Lorestan (34) as well as in neighboring Afghanistan, Iraq, and Turkey (6, 35, 36). The other species captured in this area was *Buthacus macrocentrus*. Its distribution in Iran includes Bushehr province, Chahak district; Hormozgan and Khuzestan provinces (14, 37). This species has also been recorded in Iraq, Israel, Jordan, Syria, and Turkey (35, 38, 39). Although the study area has a desert climate, various small climates and different geographical locations were chosen; Andimeshk district, Chamgolak and Azadi have semi-desert climate with plain topography, Bidroobe, Mazou and Sorkhakan are mountainous rural areas. The plain regions had the highest number and variety of collected species and the lowest belonged to the mountainous area. It seems that various climates and altitudes can affect the amount of scorpion species. Review of the literature confirms this assessment too. A study on association between scorpion composition and altitude in Argentina has shown that the low altitudes had the most diverse and greatest abundance, but no clear pattern has been identified in high altitudes (40). The genus *Androctonus* and *Mesobuthus* are found in various climates and different altitudes from 5m to heights of 2000m (41). Similarly, *M. eupeus* and *A. crassicauda* were collected from both plain and mountainous regions in the current study. Also, from a research in Algeria, it can be inferred that scorpionism is a climatology dependent accident (42). This study showed that most scorpions' activity was recorded in summer. This result has been reported in similar studies in Iran and is in agreement with the results of other countries such as Greece and Asian tropical countries (25, 31, 42-46). In Algeria, a research showed that the temperature and sunshine as climate variables affected scorpion activity (42). In addition to scorpion fauna investigation, in the second part of this present study, we studied the variables of scorpion sting cases in Andimeshk County, separately. According to the results of many studies which have been done, most scorpionism cases were male (45, 47). Our result is similar too, unlike other research which has shown a higher frequency in females. The high numbers of women who work as farmland laborers, as well as the lack of knowledge about scorpion stings have been expressed as the reasons for these results (25, 43). The results of our study have revealed that the age group of 15-24 years is considered as a high risk group, and literature reviews have indicated similar results (9, 25, 43). Some researchers have determined that age can be a risk factor and they believe that the more scorpionism among young people is due to their work out of the home (43). But some studies have shown a slight difference to these results. An age group of 21-30 years old was presented as the worst affected age group in a research on scorpionism in the Riyadh region of Saudi Arabia (48). However, this may be due to a difference in the classification of age groups. Hands were sting sites with the most incidences recorded in similar studies (9, 25, 43) as well as ours. In contrast, other studies have indicated the highest frequency of scorpion stings at the lower limbs. Wearing sandals or going barefooted during walking especially at night, have been expressed as the reason for this result (48). This difference may be concerned with socio-economic structure, as discussed in a Turkish study (49). In our study, most of the patients were treated with scorpion antivenom, although some of them were not treated at all. Similar results from many countries involved with scorpionism such as Iran, Saudi Arabia, Mexico, Argentina and Morocco (25, 48) have been reported, although treatment of all patients was also recorded in some of the papers (9). This difference in results is at issue (50). Some characteristics in patients such as having no systemic manifestations and low levels of catecholamines can give reason for prescription without antivenom. Nevertheless, some researchers have stressed the necessity for the compilation of a standard protocol for patients' treatment with antivenom and drugs (51). Early access to a health center following scorpion sting can be considered as a crucial factor in the prevention of death (52). Some researchers have also expressed that serotherapy should be administered immediately after scorpion sting for sufficient effectiveness. They have also stated that antivenom injection should be carried out regardless of the time elapsed between sting and treatment (53). Our study indicated that most patients received medical care within 6 hours from the time of sting. Comparable results can be seen in research conducted in various parts of Iran (25), although some results have recorded antivenom injection within three hours of the accident (9). Furthermore, an elapsed time of less than 30 minutes has been reported in an urban area in Saudi Arabia (48). Type of region (rural or urban), topography and geographical location, difficulty in access to medical services due to locality, expanding status of health system and cultural-economic structure can be seen as the

effective factors of this issue. The authors suggest an impact assessment of the mentioned variables on elapsed time between scorpion sting and medical attention in the study area or in other regions.

### 5. Conclusions

Six medically important scorpion species that were previously reported from Iran were also collected and caught in this study area. The findings of this study can be useful for policymakers in the Andimeshk Healthcare Center to prevent scorpionism, and provide appropriate treatment for scorpionism cases. The resident's awareness promotion for the prevention of scorpionism is recommended. Further clinical studies are also suggested.

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### Conflict of Interest:

There is no conflict of interest to be declared.

### Authors' contributions:

All authors contributed to this project and article equally. All authors read and approved the final manuscript.

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