

# Epidemiology of scorpion envenomation in the Southeast of Turkey

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Received: 2020-08-07.

Accepted: 2020-09-19



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## Abstract

**Introduction:** The aim of this study was to report the epidemiological features of scorpion envenomation in the southeast of Turkey.

**Material and methods:** In this study, records of 312 patients admitted to emergency department between 2018-2019 due to scorpion sting were retrospectively analyzed. General characteristics (age, sex), epidemiological data, complaints to the hospital, physical examination and laboratory findings, treatment approaches, complications and prognosis were evaluated.

**Results:** The mean age of the patients included in the study was  $35.4 \pm 22.7$  years. Of the patients included, 106 were female and 89 were male. On the other hand, 126 patients were in stage 1, 60 in stage 2 and 9 in stage 3. When the sting sites were examined, it was seen that 3 of them were stung from head and neck, 45 of them were trunk, 72 of them were upper extremity and 75 of them were stung from lower extremity part. Eight patients had chest pain, 26 had nausea and vomiting, 5 had shortness of breath, 3 had priapism and 33 had agitation / sweating. 76 patients were treated with antivenom and 28 patients received alpha blocker. Of the patients, 151 were followed in the emergency department, 39 were admitted hospital, and 5 were followed in the intensive care unit. Only 2 deaths was recorded (1%).

**Conclusion:** Conscious intervention to be applied in scorpion stings, which is still an important health problem for our country, needs to be informed of our people and information of health personnel should be updated.

**Key words:** scorpion sting, envenomation, epidemiology

J Clin Med Kaz 2020; 6(60):56-62

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## Introduction

Scorpion sting is a current and serious health problem worldwide. Although 1500 scorpion species have been identified on earth, the venom types of only about 50 species are considered to pose a threat to humans [1]. Of these venomous scorpion species; *Leiurus quinquestriatus* and *Androctonus crassicauda* are available in the Middle East, *Tityus serrulatus* and *Centruroides* spp. are available in Central and South America, and *Buthus tamulus* and *Palamneus* spp. are available in India commonly [2].

In Turkey, 16 different scorpion species have been identified. *Mesobuthus gibbosus* (Anatolian

yellow scorpion) and *Mesobuthus eupeus* (Eastern yellow scorpion) from the *Buthidae* family, *Euscorpis carpathicus* (Carpathian Scorpion) from the *Euscorpiidae* family, and *Calchas nordmanni* (Artvin Scorpion) from the *Luridae* family are particularly the commonly available species in our country. The most deadly scorpion species in our country is *Leiurus quinquestriatus* from the *Buthidae* family [3].

Several factors are involved in the manifestation of the signs and symptoms of scorpion envenoming. These signs and symptoms develop variably based on several factors including the scorpion species; the age, size, and

the nutritional status of the scorpion, the number of stings, the quantity of the released venom, the needle depth, the molecular structure of the toxin, the location of the sting, the age of the victim, the health condition of the victim, the bodyweight of the victim relative to the received quantity of the specific toxin, and the treatment effectiveness. The differences in the clinical course occur mainly depending on the released quantity of the venom and the bodyweight of the individual [4]. Clinical findings can manifest in a wide range, varying from local pain and paresthesia to death. The major causes of death are thought to be pulmonary edema and respiratory arrest; as well as cardiovascular toxicity, resulting from excessive release of catecholamines from the adrenergic and noradrenergic nerve endings [5,6].

The aim of this study was to report the epidemiological and clinical features of scorpion envenomation in southeast Turkey.

## Material and methods

In this study, hospital records of 312 patients admitted to the Emergency Department due to scorpion sting envenomation in the period from January 2018 to January 2019 were retrospectively reviewed. The general characteristics (age, sex) of the patients, epidemiological data, the complaints at hospital admission, the findings from the physical examination and laboratory tests, treatment approaches provided to the patients, developing complications, and the disease prognosis were evaluated.

Diagnosis of scorpion sting envenoming is made based on the history of contact with the scorpion and the clinical findings. The clinical severity of each case was evaluated using Abroug's classification [7]. The Abroug's classification grades the clinical severity of the scorpion sting envenomation as follows:

Grade I: Pain and/or paresthesia at the scorpion sting site; tingling, numbness, and minor swelling in the surrounding skin area (local symptoms).

Grade II: Fever, chills, tremor, excessive sweating, nausea, vomiting, diarrhea, hypertension, and priapism (systemic symptoms ± local symptoms)

Grade III: Cardiovascular, respiratory, and/or neurologic distress (complications).

Standard protocols are available in the emergency department of our hospital for patients presenting with scorpion stings. In these patients, the following diagnostic tests are performed including the complete blood count, serum biochemistry tests for the basic parameters, venous blood gas tests, and electrocardiography. Patients with respiratory symptoms undergo chest X-rays, additionally. Cardiology consultation is performed in patients with suspected heart failure, pulmonary edema or myocarditis, in patients with arrhythmia, and in patients with elevated troponin-I levels. "Autonomic storm" is considered when the following symptoms are found in the physical examination; including tachycardia, cold and pale hands and feet, hypertension, hypersalivation, and sweating. Prazosin (0.03 mg / kg) is given to these patients orally or via a nasogastric catheter. Patients with heart failure or pulmonary edema are treated according to standard treatment protocols. Scorpion antivenom is administered intravenously (IV) to patients with severe systemic symptoms. A skin test is performed before giving the scorpion antivenom. For the skin test, an antivenom volume of 0.1 mL is diluted with 0.9% saline in a 1:10 ratio. A volume of 0.2 mL from this solution is injected intradermally in the forearm. After injecting the same amount of 0.9% saline to the other arm via the same route of administration, the patient waits for 10 minutes. In the absence

of an allergic reaction, one ampoule of antivenom (5 mL) in 50 mL of 0.9% saline is intravenously administered in 30 minutes. In case the systemic findings persist after one hour following the first antivenom infusion, the antivenom administration is repeated. All scorpion sting patients receive tetanus prophylaxis.

The study was approved by the local ethical committee.

## Statistical analysis

Descriptive statistics were used to summarize the data collected for this study. The continuous variables were tabulated using the mean ± standard deviation or the median and quartile width (IQR); depending on the distribution characteristics of the data. The categorical variables were summarized as numbers and percentages. The normality test of the numerical variables was carried out using the Kolmogorov Smirnov test. The comparison of two independent groups was carried out using the independent samples t-test when the numerical variables were normally distributed. The Mann-Whitney U test was used to compare two independent groups when the data were not normally distributed. To compare more than two independent groups; one-way ANOVA was used for the normally distributed numerical variables and the Kruskal Wallis test was used for the normally distributed numerical variables. Differences between the groups were evaluated by the Tukey test when parametric tests were used to analyze the data. When the non-parametric tests were used for the statistical analyses, the Dwass-Steel-Critchlow-Fligner test was used for evaluating the differences between the groups. For the statistical analyses; Jamovi [Jamovi project (2019) and Jamovi (Version 1.0.7)] software were used after retrieving them from <https://www.jamovi.org>. Additionally, the JASP Team computer software (2019, Version 0.11.0.0) was used. The statistical significance was considered at a p-value of <0.05.

## Results

In this study, the data from 312 patients were examined. Of these patients, 117 had missing data or their anamneses were indecisive; therefore, the study was carried out on 195 patients.

Table 1 presents the descriptive statistics of the patient demographic characteristics and the developing complications after the scorpion sting. The mean age of the patients included in the study was 35.4±22.7 years. Of the patients included in the study, 106 were females and 89 were males. According to the Abroug's classification, 126 patients had Grade I envenomation, 60 had Grade II, and 9 had Grade III envenomation. A review of the sting sites revealed that 3 patients had stings in the head and neck area, 45 had stings in the trunk, 72 had stings in the upper extremities, and 75 had stings in the lower extremities. Eight patients had chest pain, 26 had nausea and vomiting, 5 had shortness of breath, 3 had priapism, and 33 had agitation or sweating. Antivenom was administered to 76 patients and an alpha-blocker was administered to 28 patients. Of the patients; 151 were followed up in the emergency department, 39 in the inpatient clinics, and 5 were followed up in the intensive care unit. Of the study patients, 2 were recorded dead (1%). These patients were 1 and 5 years old and they were graded III according to Abroug's classification. Of these patients, one of them was a one-year-old girl admitted due to a scorpion sting in the neck on the right side. The vital parameters of the patient at admission were as follows: The blood pressure was 60/30 mmHg, the pulse was 158 beats/min, the oxygen saturation (SaO<sub>2</sub>) was 87, and the body temperature was 37.1°C. She had shortness of breath and vomiting; as well as, sweating secondary

Table 1

Some of the demographic and clinical characteristics of patients.

	Mean±SD / Count (%)
<b>Age</b>	35.4 ± 22.7
<b>Gender (%)</b>	
Female	106 (54.4)
Male	89 (45.6)
<b>SBP (mm Hg)</b>	127.3 ± 24.9
<b>DBP (mm Hg)</b>	74.3 ± 17.6
<b>Pulse (beats/min)</b>	85.7 ± 17.5
<b>Oximetry (%)</b>	97.1 ± 1.8
<b>Grade (%)</b>	
Grade 1	126 (64.6)
Grade 2	60 (30.8)
Grade 3	9 (3.7%)
<b>Sting Site (%)</b>	
Head-neck:	3 (1.5)
Trunk	45 (23.1)
Upper Extremity	72 (36.9)
Lower Extremity	75 (38.5)
<b>Chest Pain (%), positive</b>	8 (4.1)
<b>Nausea and Vomiting (%), positive</b>	26 (13.3)
<b>Shortness of breath (%), positive</b>	5 (2.6)
<b>Priapism (%), positive*</b>	3 (1.5)
<b>Agitation/Sweating (%), positive</b>	33 (17.0)
<b>Alpha-Blocker (%), positive</b>	28 (14.4)
<b>Venom (%), positive</b>	76 (39.0)
<b>The clinic the patient was followed up in</b>	
<b>Emergency Room</b>	151 (77.4)
Inpatient Clinic	39 (20.0)
ICU	5 (2.6)
<b>Mortality (%)</b>	2 (1.0)

\* The incidence of priapism in males was 8.9% SBP: Systolic blood pressure; DBP: Diastolic blood pressure; ICU: Intensive care unit

to sympathetic nervous system discharge. An alpha-blocker was given orally to the patient at a dose of 0.03 mg/kg. The scorpion anti-venom infusion was started by intravenous administration. She was transferred to the pediatric intensive care unit because no improvement was observed in her general condition. The review of the data revealed that the patient died in the intensive care unit in the 6th hour after admission to the emergency department. The vital parameters of the 5-year-old male patient were as follows: His blood pressure was 75/40 mmHg, his pulse was 150 beats/minute, SaO<sub>2</sub> was 88, and the body temperature was 36.7°C. The patient had spontaneous emesis and shortness of breath. An intravenous infusion of scorpion antivenom was started to the patient. Because the lung auscultation revealed bilateral basal crackles and there was accompanying hypoxemia, oral alpha-blocker treatment at a dose of 0.03 mg/kg was started via the nasogastric catheter. During the follow-up of the patient, the advanced airway was placed due to worsened pulmonary edema and developing respiratory depression. Then, the patient was transferred to the pediatric intensive care unit. The review of the patient data revealed that the patient died in the fourth hour after his admission to the emergency department.

Table 2 presents the values of some of the vital parameters,

emergent complications, treatments given to the patients, and the laboratory test results by the age groups of the patients admitted to the emergency department due to scorpion sting. Since it was observed that mortality occurred in the patients younger than 6 years old in our study, we considered the age of 6 years as the cut off value to group the patients by age. The measured values of the mean systolic and diastolic blood pressure were statistically significantly higher in the patients older than 6 years of age compared to the patients ≤6 years old ( $p < 0.001$  for both the systolic and diastolic blood pressure). However, the mean pulse rate was lower in the former group compared to the latter ( $p = 0.001$ ). The oxygen saturation (SaO<sub>2</sub>) levels were not statistically significant between the two age groups ( $p = 0.160$ ).

The rates of nausea-vomiting, shortness of breath, and agitation/sweating complaints were significantly higher in the patients ≤6 years old compared to those >6 years old ( $p = 0.025$ ,  $p = 0.007$ , and  $p = 0.006$ , respectively). The rates of chest pain and priapism were not statistically significantly different by the age groups ( $p = 0.567$  and  $p = 0.177$ , respectively).

The rates of treatment with an alpha-blocker and antivenom were statistically significantly higher in patients ≤6 years old compared to those >6 years old ( $p = 0.002$  and  $p < 0.001$ , respectively).

In patients ≤6 years old; the levels of AST, LDH, CKMB, and PLT and the WBC counts were significantly higher compared to those >6 years old ( $p < 0.05$  for each). The creatinine and hemoglobin levels were significantly lower in the patients ≤6 years old compared to the older ones ( $p = 0.001$  for each). The levels of the other laboratory test parameters were not statistically significant between the two age groups ( $p > 0.05$ ).

Table 3 shows the vital parameters, complications, administered treatments, and the results of some of the laboratory parameters by the grades of clinical severity in the patients admitted to the emergency department due to scorpion stings. The pulse rate of the patients in the Grade III was significantly higher compared to the pulse rate of the patients in the Grade I and II ( $p = 0.005$ ). The SaO<sub>2</sub> levels were significantly higher in the Grade I patients compared to those found in the Grade III patients ( $p = 0.018$ ). The other vital parameters examined in the study were not statistically significantly different by the severity grades ( $p > 0.05$  for each). The rates of emerging complications were significantly higher in the Grade III patients compared to the Grade I and II patients ( $p < 0.001$  for each). When the treatments administered to the patients were compared by the clinical severity grades, it was observed that alpha-blocker and antivenom treatments were significantly more common in the Grade III patients compared to the Grade I and II patients ( $p < 0.001$  for each).

The glucose levels of the Grade II patients were significantly higher compared to the Grade I patients ( $p = 0.016$ ). The test results of the remaining parameters were not statistically significantly different by the clinical severity grades ( $p > 0.05$  for each).

Table 4 shows the vital parameters, complications, administered treatments, and the results of some of the laboratory parameters by the area of sting in the patients admitted to the emergency department due to scorpion stings. The mean DBP was significantly higher in the patients where the sting site was the head and neck area compared to the patients having the sting site in the upper extremities ( $p = 0.020$ ). The means of the measured values of the other vital parameters were not statistically significantly different by the sting site ( $p > 0.05$  for each). The differences in the clinical severity grades, emergent

Table 2

Comparison of some of the vital parameters, emergent complications, administered treatments, and laboratory parameters by the age groups

	Age		p-value
	>6 (n=176)	≤6 (n=19)	
SBP (mm Hg) (median [IQR])	130.0 [120.0-140.0]	80.0 [75.0-90.0]	<0.001
DBP (mm Hg) (median [IQR])	76.0 [68.0-85.2]	50.0 [40.0-50.5]	<0.001
Pulse (beat/min) (median [IQR])	82.0 [74.0-88.0]	118.0 [105.5-130.0]	<0.001
Oximetry % (median [IQR])	97.0 [96.0- 98.0]	98.0 [97.0-99.0]	0.160
Chest Pain (%), positive	7 (4.0)	1 (5.3)	0.567
Nausea Vomiting (%), positive	20 (11.4)	6(31.6)	0.025
Shortness of Breath (%), positive	2 (1.1)	3(15.8)	0.007
Priapism (%), positive	6 (3.4)	2 (10.5)	0.177
Agitation/Sweating (%), positive	25 (14.3)	8 (42.1)	0.006
Alpha- blocker (%), positive	20 (11.4)	8 (42.1)	0.002
Venom (%), positive	57 (32.4)	19 (100.0)	<0.001
Glucose (mg/dL) (median [IQR])	105.0 [91.0-125.2]	107.0 [99.0-117.0]	0.763
AST (U/L) (median [IQR])	20.0 [16.0-24.2]	32.0 [26.0-35.5]	<0.001
ALT (U/L) (median [IQR])	17.0 [13.0-23.2]	18.0 [15.5-20.0]	0.750
LDH (U/L) (median [IQR])	224.5 [190.0-276.0]	317.0 [263.5-366.0]	<0.001
CK-MB (ng / ml) (median [IQR])	2.3 [2.0-4.3]	4.3 [3.0 - 5.2]	0.001
Creatinine (K/uL) (median [IQR])	0.7 [0.6-0.8]	0.5 [0.5-0.5]	<0.001
PLT (10e3/ul) (median [IQR])	245.5 [206.0-274.0]	298.0 [238.0-430.0]	0.001
WBC (10e3/ul) (median [IQR])	8.8 [7.4-11.0]	11.4 [9.9-14.9]	<0.001
HGB (g/dL) (median [IQR])	13.9 [12.8-14.9]	12.6 [11.9-13.2]	<0.001
INR (median [IQR])	1.1 [1.0-1.2]	1.1 [1.0-1.2]	0.363

Descriptive statistics non conforming to a normal distribution were presented as median [IQR] and they were analyzed with the Mann-Whitney U test. Descriptive statistics were presented in numbers (%) for the categorical variables and the Pearson Chi-Square or Fisher Exact tests were used in the statistical analysis. The p-values indicated with bold characters were considered statistically significant (p<0.05). IQR: Interquartile Range  
SBP: Systolic blood pressure DBP: Diastolic blood pressure ICU: Intensive care unit

Table 3

Comparison of some of the vital parameters, emergent complications, administered treatments, and laboratory parameters by the clinical severity grades

	Grade			p-value	p-value*
	Grade 1 (n=126)	Grade 2 (n=60)	Grade 3 (n=9)		
SBP (mm Hg) (median [IQR])	128.0 [120.0-136.8]	129.0 [109.0- 147.0]	132.0 [80.0-160.0]	0.988	-
DBP (mm Hg) (median [IQR])	72.0 [65.0-81.0]	80.0 [62.8-87.8]	84.0 [50.0-95.0]	0.483	-
Pulse (beat/min) (median [IQR])	82.0 [74.0-88.0]	85.0 [77.8-100.0]	110.0 [87.0-130.0]	0.005	Grade 1, Grade 2 <Grade 3
Oximetry % (median [IQR])	98.0 [97.0- 98.0]	97.0 [96.0- 98.0]	95.0 [95.0- 97.0]	0.018	Grade 1> Grade 3
Chest Pain (%), positive	1 (0.8)	2 (3.3)	5 (55.6)	<0.001	-
Nausea Vomiting (%), positive	1 (0.8)	21 (35.0)	4 (44.4)	<0.001	-
Shortness of Breath (%), positive	0 (0.0)	0 (0.0)	5 (55.6)	<0.001	-
Priapism (%), positive	0 (0.0)	6 (10.0)	2 (22.2)	<0.001	-
Agitation/Sweating (%), positive	2(1.6)	26 (43.3)	5 (55.6)	<0.001	-
Alpha- blocker (%), positive	8 (6.3)	11 (18.3)	9 (100.0)	<0.001	-
Venom (%), positive	13 (10.3)	54 (90.0)	9 (100.0)	<0.001	-
Glucose (mg/dL) (median [IQR])	101.5 [90.0-120.5]	115.0 [97.0-134.2]	105.0 [86.0-160.0]	0.016	Grade 1 < Grade 2
AST (U/L) (median [IQR])	20.0 [16.0-26.0]	21.5 [18.0-25.0]	26.0 [22.0- 36.0]	0.173	-
ALT (U/L) (median [IQR])	18.0 [13.0-23.8]	16.0 [12.0-23.0]	19.0 [17.0-21.0]	(0.362)	-
LDH (U/L) (median [IQR])	224.0 [186.0-283.0]	240.5 [202.8-289.9]	281.0 [250.0-380.0]	0.057	-
CK-MB (ng / ml) (median [IQR])	2.3 [2.0-4.2]	2.7 [2.0-4.6]	4.0 [2.3-6.3]	0.080	-
Creatinine (K/uL) (median [IQR])	0.7 [0.6-0.8]	0.7 [0.6-0.8]	0.7 [0.6-0.9]	0.813	-
PLT (10e3/ul) (median [IQR])	256.0 [219.0-277.8]	239.0 [196.0-290.2]	223.0 [180.0-255.0]	0.383	-
WBC (10e3/ul) (median [IQR])	8.9 [7.4 - 11.0]	8.9 [7.5-11.4]	13.8 [7.8-14.0]	0.274	-
HGB (g/dL) (median [IQR])	13.6 [12.4-14.6]	13.9 [13.1-14.9]	13.5 [12.3-14.0]	0.275	-
INR (median [IQR])	1.1 [1.0-1.1]	1.1 [1.0-1.2]	1.4 [1.1-1.6]	0.008	Grade 1 < Grade 3

Descriptive statistics non conforming to a normal distribution were presented as median [IQR] and they were analyzed with the Mann-Whitney U test. Descriptive statistics were presented in numbers (%) for the categorical variables and the Pearson Chi-Square or Fisher Exact tests were used in the statistical analysis. The p-values indicated with bold characters were considered statistically significant (p<0.05). IQR: Interquartile Range, \*: Dwass-Steel-Critchlow-Fligner test was used.

Table 4

Comparison of some of the vital parameters, emergent complications, administered treatments, and laboratory parameters by the site of the sting

	Sting Site			p	Post-hoc p-value*
	Head-Neck-Trunk (n=48)	Upper extremity (n=72)	Lower extremity (n=75)		
SBP (mm Hg) Mean ± SD	133.5 ± 25.6	123.7 ± 25.6	126.8 ± 23.2	0.123	
DBP (mm Hg) Mean ± SD	80.2 ± 17.9	70.6 ± 18.4	74.0 ± 15.8	0.020	Head-Neck-Trunk> Upper Extremity
Pulse (beats/min) Mean ± SD	86.4±16.0	86.8±18.1	84.2±17.9	0.641	
Oximetry % Mean ± SD	96.9 ± 1.9	97.2 ± 1.6	97.1 ± 1.9	0.554	
Grade (%)					
Grade 1	26 (54.2)	46 (63.9)	54 (72.0)	0.103	
Grade 2	18 (37.5)	25 (34.7)	17 (22.7)		
Grade 3	4 (8.3)	1 (1.4)	4 (5.3)		
Chest Pain (%), positive	3 (6.2)	2 (2.8)	3 (4.0)	0.597	
Nausea Vomiting (%), positive	10 (20.8)	9 (12.5)	7 (9.3)	0.181	
Shortness of Breath (%), positive	2 (4.2)	1 (1.4)	2 (2.7)	0.743	
Priapism (%), positive	4 (8.3)	3 (4.2)	1 (1.3)	0.132	
Agitation/Sweating (%), positive	12 (25.0)	12 (16.7)	9 (12.2)	0.182	
Alpha-Blocker (%), positive	11 (22.9)	7 (9.7)	10 (13.3)	0.124	
Venom (%), positive	24 (50.0)	28 (38.9)	24 (32.0)	0.136	
Glucose (mg/dL) Mean ± SD	117.7 ± 29.2	124.4 ± 85.6	110.5 ± 31.1	0.258	
AST (U/L) Mean ± SD	21.6 ± 9.7	22.3 ± 7.2	22.8 ± 8.0	0.76	
ALT (U/L) Mean ± SD	20.9 ± 12.3	20.5 ± 9.8	17.9 ± 9.1	0.172	
LDH (U/L) Mean ± SD	227.5 ± 70.3	249.4 ± 75.7	262.6 ± 83.5	0.046	Head-Neck-Trunk <Lower Extremity
CK-MB (ng/ml) Mean ± SD	2.2 [2.0, 4.4]	2.7 [2.0, 4.5]	2.6 [2.0, 4.3]	0.704	
Creatinine (K/uL) Mean ± SD	0.7 ± 0.2	0.7 ± 0.2	0.7 ± 0.1	0.486	
PLT (10e3/ul) Mean ± SD	244.6 ± 53.2	257.3 ± 70.2	258.7 ± 92.4	0.424	
WBC (10e3/ul) Mean ± SD	9.3 ± 2.7	9.9±3.3	9.9 ± 4.1	0.395	
HGB (g/dL) Mean ± SD	14.0 ± 1.6	13.7 ± 1.5	13.7 ± 1.6	0.532	
INR Mean ± SD	1.1 ± 0.2	1.1 ± 0.2	1.1 ± 0.2	0.552	

Descriptive statistics were presented as mean ± SD for the variables conforming to a normal distribution and the independent samples t-test was used for the statistical analysis. Descriptive statistics not conforming to a normal distribution were presented as median [IQR] and the Mann-Whitney U test was used for the statistical analysis. Descriptive statistics were presented in numbers (%) for the categorical variables and the Pearson Chi-Square or Fisher Exact tests were used in the statistical analysis. The p-values indicated with bold characters were considered statistically significant ( $p < 0.05$ ). IQR: Interquartile Range, SD: Standard Deviation, \*: The Tukey test was used.

complications, and the administered treatment methods were not statistically significant by the sting sites ( $p > 0.05$  for each). The LDH levels of the patients having the sting in the head, neck or trunk were significantly lower compared to those found in the patients having the scorpion sting in the lower extremity ( $p = 0.046$ ). However, the differences between the tested values of other laboratory parameters were not statistically significant by the sting site ( $p > 0.05$  for each, Table 4).

## Discussion

Because our country, Turkey, is located at latitudes close to the equator, it is a habitat for scorpions. *Mesobuthus gibbosus* and *Androctonus crassicauda* species are available in Turkey [3]. Scorpion species living in our country are mostly non-toxic. Scorpion envenomation is observed most commonly in the following geographical regions in Turkey; including Southeast Anatolia, Aegean region, Central Anatolia, and Mediterranean regions. Exposure occurs commonly in the uncovered body areas, especially in summer. Scorpion stings often cause local symptoms. However; they may cause life-threatening clinical pictures to develop especially in children and old individuals. Although scorpions do not pose any threats to humans, they do attack people to defend themselves. People are often exposed to scorpion stings in fields, picnic areas, and forests.

Women may be more susceptible to the same amount of scorpion venom compared to men because their body weight is lower. Some studies in the literature report that scorpion stings are more common in women [8,9]; however, a study reports that it is more common in men [10]. In our study, scorpion stings were more common in women than in men (54.4% vs 45.6%).

Humans experience scorpion stings most commonly in the extremities because they are the most commonly exposed body parts available for scorpions. Epidemiological studies confirm this fact, reporting that scorpion stings are more common in the extremities [11,12]. In line with the literature, scorpion stings were observed in the extremities in 75.4% of the patients in our study.

It is known that toxins of some animal species such as of scorpions, spiders, and snakes cause priapism [13]. Priapism is rarely observed in scorpion stings [14]. Bosnak et al. [15] reported priapism at a rate of 1.9% in their study published in 2009. In our study, priapism was observed in 1.5% of the patients.

Prazosin exerts its antivenom effect through antagonizing the activated specific ion channels by the scorpion venom. Since the introduction of prazosin to the clinical practice, scorpion venom-related death rates have decreased to frequencies smaller than 1% [16,17]. Biswal et al. reported that the case-vs-fatality

rates in scorpion stings decreased from 13% to 3% in children after the introduction of prazosin as the first-line treatment method [18]. In our study, the need for prazosin use was 14.4% and the case-vs-fatality rate was 1%.

In our country; because of the polyvalent venom characteristics, only the venom of *Androctonus crassicauda* species is used in antivenom production to be used in scorpion envenomation caused by any scorpion species [15].

The received dose of the venom relative to the body weight and the specific scorpion species are the major determiners of the prognosis. The clinical symptoms become manifest in five hours after the scorpion sting and they resolve in one or two days. The first complaint is pain, which develops rapidly at the area of the sting. Pain is thought to occur due to serotonin in the venom [19,20].

Scorpion toxins are peptide neurotoxins. They often act on the Na<sup>+</sup> channels along with several other ion channels, causing overstimulation in the autonomic nervous system. Envenomation in scorpion stings depends on many factors such as the scorpion species, age of the victim, size of the scorpion, and whether the vesicle of the sting is full or empty [21].

Severe cases of scorpion envenomation have been reported by several studies in the literature. Release of excessive quantities of catecholamines, angiotensin II, glucagon, and cortisol was reported in those articles, occurring due to an autonomic effect due to envenomation. Also, changes in insulin secretion in the human body have been reported [2,22]. These hormonal changes lead to myocardial damage, cardiovascular disorders, peripheral circulatory disorders, and pulmonary edema; along with many other clinical manifestations. Either in combination or individually, the emergent signs and symptoms cause impending death because of resulting energy loss syndrome or due to insufficient use of the metabolic substrates by the vital organs and impairments in the organ systems [22].

In scorpion stings, death results from the respiratory and circulatory failure occurring in the first 24 hours. The mortality

rate is reported in the range from 5.2% to 8.3% in children [23]. Söker et al. [24] reported the mortality rates in the range from 8% to 12.5%. In the study of Kaya et al., this rate was found out to be 3.1% [25]. In our study, 2 (1%) patients died. Regarding the low mortality rate in our study, we can suggest that the rate was low because of the provision of better care to the patients owing to the advances in medical technology and improved hospital facilities.

## Limitations

Our study has some limitations. The first is the limited number of patients and the conduct of the study at a single center. Additionally, although diagnosis of scorpion sting envenoming is made based on the history of contact with the scorpion and the clinical findings, the scorpion species causing the envenomation have not been confirmed in any of the patients. As it was a retrospective study; there was some lack of data, including missing information about the elapsed time from the incident to patient admission. These deficiencies limited the extent of our study outcomes.

## Conclusion

In conclusion; a structured intervention is critical to apply in patients suffering from scorpion envenomation, which is still a major public health concern for our country, Turkey. Therefore, it is necessary to raise public awareness and provide refreshment training to healthcare service providers in our country.

**Disclosures:** There is no conflict of interest for all authors.

**Acknowledgements:** None.

**Funding:** None.

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