The Open Public Health Journal

Content list available at: https://openpublichealthjournal.com

Epidemiological Investigation and Sensitivity of Surveillance System in the Report of Scorpion Stings in the Southeast of Iran using the Network Scale-up Method

Hossein Dehghan[1] , Alireza Bahonar[2], Sina Heydari[3] , Reza Faryabi[1] , Faezeh Sadat Ghorshi Nasab[4], Esmat Rezabeigi-Davarani[5] and Salman Daneshi[1,*]

[1]*Department of Public Health, Jiroft University of Medical Sciences, Jiroft, Iran*

[2]*Department of Food Hygiene and Quality Control, Division of Epidemiology & Zoonoses, Faculty of Veterinary Medicine, University of Tehran, Tehran, Iran*

[3]*Department of Orthopedics, School of Medicine, Imam Khomeini Hospital, Jiroft University of Medical Science, Jiroft, Iran*

[4]*Student Research Committee, Jiroft University of Medical Sciences, Jiroft, Iran*

[5]*Student Research Committee, Faculty of Management and Medical Information Sciences, Kerman University of Medical Sciences, Kerman, Iran*

Abstract:

Introduction:

Scorpion sting is one of the most common health problems in tropical and subtropical regions, including the south of Iran. The information regarding it can be useful to correctly measure the incidence and mortality rates due to scorpion stings and to identify the high-risk groups to allocate the necessary resources and facilities in case of scorpion stings. This study aimed to investigate the epidemiological characteristics of scorpion stings and quantify the actual cases of scorpion stings in southern areas of Kerman province.

Materials and Methods:

The cross-sectional study was performed using the annual epidemiological data of 3210 scorpion stings registered by the health vice-chancellor of Jiroft University of Medical Sciences in 2020. In addition, the actual cases of scorpion stings were quantified using an indirect estimation method. The network scale-up estimation method was quantified using the average number of people respondents know in anonymous groups and the average size of the individual network of the respondents, and finally, the proportion of people in the high-risk group in the society.

Results:

In this study, 240 people (128 men and 112 women) with an average age of 34 years were interviewed. On average, the size of the network for each interviewee was equal to 30 (minimum 26 and maximum 34). Male and female network sizes were almost equal. Based on this information, the total number of people stung by scorpions was estimated to be 3023 people with a 95% confidence interval (2861, 3250), of which 2176 people (72%) were from the rural areas, and the rest were from urban areas. In this study, the ratio of males to females for scorpion stings was 0.9.

Conclusion:

The results of the network scale-up estimation method showed that there is no significant difference between the data recorded in the university health department and the network scale-up method. Therefore, it reduces the possibility of undercounting based on the recorded data and shows that the health system is fully alert in discovering and identifying cases. While the most important strength of the collected health data is their accuracy, and this is a feature that should not be neglected.

Keywords: Epidemiological investigation, Sensitivity, Surveillance system, Scorpion stings, Network scale-up method, High-risk.

1. INTRODUCTION

Scorpions belong to an order of arachnids with an evolutionary history of about 450 million years [1]. They are nocturnal arthropods and spend the day in safe places, such as cracks in walls, under rocks, and among bushes. Scorpions are not aggressive and only sting when harassed [1]. Many species of scorpions have been identified, of which about 20 species are of special importance in terms of medicine and health [2]. Scorpion stings are one of the major problems in tropical and subtropical regions [3]. The severity of the clinical effects of a

* Address correspondence to this author at the Department of Public Health, Jiroft University of Medical Sciences, Jiroft, Iran; Tel: 03443310916; E-mail: salmandaneshi008@gmail.com.

scorpion sting depends on the genus and species of the scorpion, the season of the sting, the physiological conditions of the animal, the number of stings and the amount of venom injected, as well as the age and health status of the stung case and the location of the sting [4], which causes a wide range of symptoms. Complications, including local skin reactions and neurological, cardiovascular, respiratory problems, and death, impose a large health burden on the health of society [2].

Different geographical regions differ in terms of the type of scorpion [5]. The most dangerous scorpions are found in South America, the Middle East, North Africa, South Africa, and India [1, 6]. The situations of scorpion stings are different according to the standard of living, the status of providing healthcare services, and the dominant species of the region [7]. [The country of Iran is very diverse in terms of the presence of scorpion species due to its climatic conditions and is among the countries where dangerous species have been reported [8, 9]. Iran ranks second in the world in terms of venomous animal stings after Mexico. Scorpion stings in Iran are the most important type of venomous stings, with an average of 50,000 cases and about 20 deaths per year [10, 11]. However, it is estimated that the actual number of these stings is 2 to 2.5 times this number [10]. Scorpion stings are one of the common problems in tropical and subtropical regions [10]. Deaths caused by scorpion stings occur in all regions of the country, but about 75% of them occur in the provinces of Khuzestan, Sistan and Baluchistan, Kerman, and Hormozgan. The venom of scorpions that live in desert climates or southeastern Iran is more dangerous than similar samples in cold and humid regions due to the higher concentration of the venom [11]. Special ecological and climatic characteristics in the southern regions of Iran have caused the diversity of scorpion species and their adaptation in these regions, and these characteristics have made these regions a suitable habitat for scorpions [12]. Especially among the southern regions of Iran, the southern region of Kerman province, due to its location at the contact point of two eastern and paleo-polar geographical regions and having favorable weather conditions, vegetation, and soil texture, is one of the areas prone to the habitat of venomous animals, especially scorpions. The existence of marginalization around cities, rural lifestyle, and excessive scale-up of cities have been considered major aspects [13].

The situations of scorpion stings and the resulting casualties in different regions of the world are different according to the way and place of life, social and economic status, the level of health and treatment services, and the type of scorpion. In African and Middle Eastern countries, such as Saudi Arabia, Morocco, Turkey, Jordan, Algeria, Egypt, Iraq, Sudan, South Africa, and Madagascar, as well as in South and Central American countries, such as Brazil, Mexico, Argentina, Venezuela, Guyana and Trinidad, scorpion stings are the main problem in terms of health and treatment [14]. For effectively managing injuries and health problems, apart from having a strong care system and plan for service delivery, we certainly need information on incidence and mortality rates, but even developing countries do not record accurate information [15]. Among the different methods, network scale-up method estimation is a desirable method because it does not require a specific information source and also does not require direct contact with the studied population [16 - 18]. At the same time, multiple group sizes can be estimated in a single study [19]. This method can also be used to estimate all types of damages [17].

Considering that probably not all cases of scorpion stings are referred to emergency centers and other health care centers, the contamination rate may not be reported correctly; as a result of this, their number will be low. Despite several limitations, the results of the current descriptive study can be used to prevent and reduce scorpion stings in the southern regions of Iran and neighboring countries. This study can be useful for identifying the number of cases and groups at risk of being stung against this crisis and training caregivers and health personnel as well as allocating the necessary resources and facilities in cases of scorpion stings. Therefore, considering that to provide better and more appropriate services, we need to have complete information about the level of pollution. In this study, we used the network scale-up method to compare the information recorded in the health system with the information obtained from the network scale-up method. We then provided the information obtained to policymakers and public health planners to allocate resources in their programs and optimize prevention levels.

1.1. Targets

The present study was conducted to report the epidemiological aspects of scorpion stings according to age, occupation, month, duration of 24 hours of scorpion stings, and the location of the sting in the southern regions of Kerman province from 2020 to 2021.

2. MATERIALS AND METHODS

2.1. The Study Area

The southern regions of Kerman province (Jiroft, Kohnouj, Anbarabad, Manojan, Rudbar, Faryab, and Qalaganj cities) are under the supervision of the Jiroft University of Medical Sciences (Fig. **1**). According to the report of the JMU Health Department, the population covered by JMU in 2021 was equal to 716,143 people. The population of these areas comprises three groups: urban, rural, and nomadic groups. The southern regions of Kerman province, with an area of more than 3,858,000 hectares, are located at a distance of 55 to 63 longitude and 27 to 32 latitudes with a minimum height of 143 meters on the southern edge of the Jazmurian hole and the highest point at the height of 3884 meters in Bahr Asman and Jabal Barez mountains. The climate of the studied area was cold and dry in the highlands, hot and humid in the plains, and hot and dry in the southern parts.

Fig. (1). The study area includes the cities of Jiroft, Kohnouj, Anbarabad, Manojan, Rudbar, Faryab, and Qaleganj, south of Kerman province, south Iran.

2.2. Scorpion Stings Data

All the epidemiological information on scorpion sting cases that were recorded in the JMU health system from March 30th, 2020, to March 30th, 2021, was included in the research. In this retrospective cross-sectional study, the epidemiological data of 3210 cases of scorpion stings were statistically analyzed. The data included demographic and personal information, such as age, gender, geographic location, sting site, time of sting, and antidote consumption.

2.3. Network scale-up Estimation Method

This cross-sectional study estimated the number of patients and deaths using the network scale-up method. The study population was all native people of the mentioned cities. The method was designed in such a way that based on the information received from comprehensive health centers, the mentioned cities were divided into 4 areas, including low risks, moderate, above average, and severe. Twenty households were randomly selected from each area, and informed consent was obtained from each household if each member over 18 years of age was willing to respond and the desired person was included in the study. If people were not present at home or did not want

to answer, they were selected and replaced from the nearest house on the left side of their residents willing to participate in the study. Information on the number of cases and deaths was collected by asking how many people were infected within the three houses on the right and three houses on the left of their residence (along with gender and age) with a scorpion sting. Finally, the number of cases and deaths caused by it were estimated using relevant parameters and the network scale-up method.

2.4. Data Modeling

The modeling method was performed using the proportion of people in the high-risk group in society based on the average number of people who know the respondents in hidden groups and the average size of the respondents' network. The logic of this method is that if the average prevalence of a disease in the social network of a random sample of respondents is 2%, the prevalence of the disease in the entire community is also 2%, which includes two stages:

1. Estimation of the average size of the respondents' network.

2. Asking the respondents about the number of people they

know in the size of the desired subgroup [20].

Its formula is as follows:

$$\frac{e}{t} = \frac{\sum_i m_i}{\sum_i \hat{c}_i}$$

Ê is the estimated size of the target population, m is the number of people from the target population that the respondent knows have been stung, c is the size of the respondent's network based on average household size, and t is the total population in the study area [21, 22].

2.5. Research Ethics

Patient information was confidential. Also, anonymous information was extracted using code. This study was approved by the Research Ethics Committee of Jiroft University of Medical Sciences (Code of Ethics, IR. JMU. REC. 2019. 083).

2.6. Data Analysis

Descriptive and inferential statistical methods were used to describe and analyze the data. The data were in the form of the number of cases of incidence and mortality based on the studied variables, and if necessary, their non-parametric equivalents were used. All analyses were performed at a significance level of P<0.5. 05 and SPSS version 19 software were used for analysis.

3. RESULTS

3.1. Epidemiological Data

According to the results provided by the health vice-chancellor of Jiroft University of Medical Sciences, in 2018, 3210 cases of scorpion stings were recorded, and in terms of demographics, more scorpion stings have been reported in women than in men. Based on this, it has been reported that the ratio of male to female was 0.9, and this ratio was reported in the age groups of 0-4 years, 10-14 years, 1.18, and 1.13, and in other groups, more cases of scorpion stings in women than men were reported. Most cases of scorpion stings were related to the age group of children (less than 10 years old), with a frequency of 734 cases (22.87%). The results of the investigation of the time interval between the sting and the visit and recovery in the medical centers showed that most of the scorpion sting cases in the south of Kerman province were referred to the medical centers within a time interval of less than 1. 5 hours (56.51%) (Table **1**). Regarding the location of scorpion stings, the most frequent cases were in hands and feet, with a frequency of 1397 (43.52%) and 1293 (40.28%), and the lowest frequency was related to the head and neck, *i.e.*, 26 (0.8%) (Fig. **2**). The sting cases occurred mainly in spring (1101) (34.30%), summer (1202) (37.45%), and then autumn (625) (19.47%), and the lowest rate was related to winter (282) (8.78%) (Fig. **3**). According to the type of residential houses in the villages, most cases of scorpion stings have occurred in the rural areas, with a ratio of 3.93 to the village (Fig. **3**). In warm seasons, scorpion stings were reported more during the night (from dusk to sunrise), while in winter, these cases were more common during the day.

3.2. Estimation of Network Scale-up

In this study, 240 people (128 men and 112 women) with an average age of 34 years were interviewed. On average, the network size of each interviewee was 30 (minimum 26 and maximum 34). Male and female network sizes were almost equal. Based on this information, the total number of people stung by scorpions was estimated to be 3023 people with a 95% confidence interval (2861, 3250), of which 2176 people (72%) belonged to rural areas, and the rest were from urban areas. Moreover, 66.52% of them were men, and 47.33% of them were women, according to which the incidence rate in men and women was 358, 270, and 638% per thousand people.

Table 1. Demographic and epidemiological characteristics of patients stung by scorpions from March 30th, 2020, to March 30th, 2021.

| Age (Yr)	Female	Male	Male/Female	Total (%)
0-4	144	170	1.18	314 (9.79)
5-9	221	199	0.9	420 (13.08)
10-14	145	164	1.13	309 (9.63)
15-24	242	252	1.04	494 (15.39)
25-34	276	257	0.93	533 (16.60)
35-44	220	184	0.84	404 (12.59)
45-54	161	128	0.79	289 (9.00)
55-64	125	81	0.65	206 (6.42)
>65	83	78	0.94	161 (5.01)
Unknown	75	5	0.07	80 (2.49)
Total	1692	1518	0.9	3210 (100)
The time interval between scorpion sting and treatment	< 1.5 hour			1814 (56.51)
	Between 1.5 to 3 hours			978 (30.47)
	> 3 hours			418 (13.02)
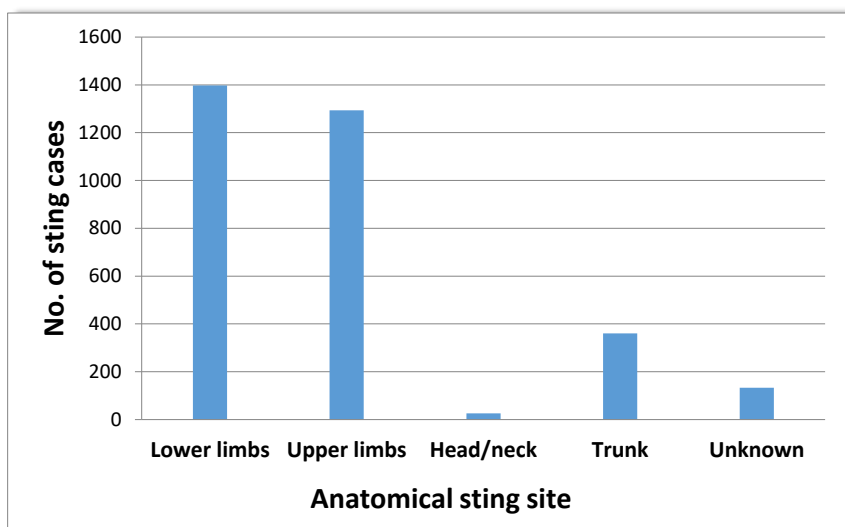
Fig. (2). Anatomical sting site characteristics of scorpion stung patients, March, 2020 to March, 2021.
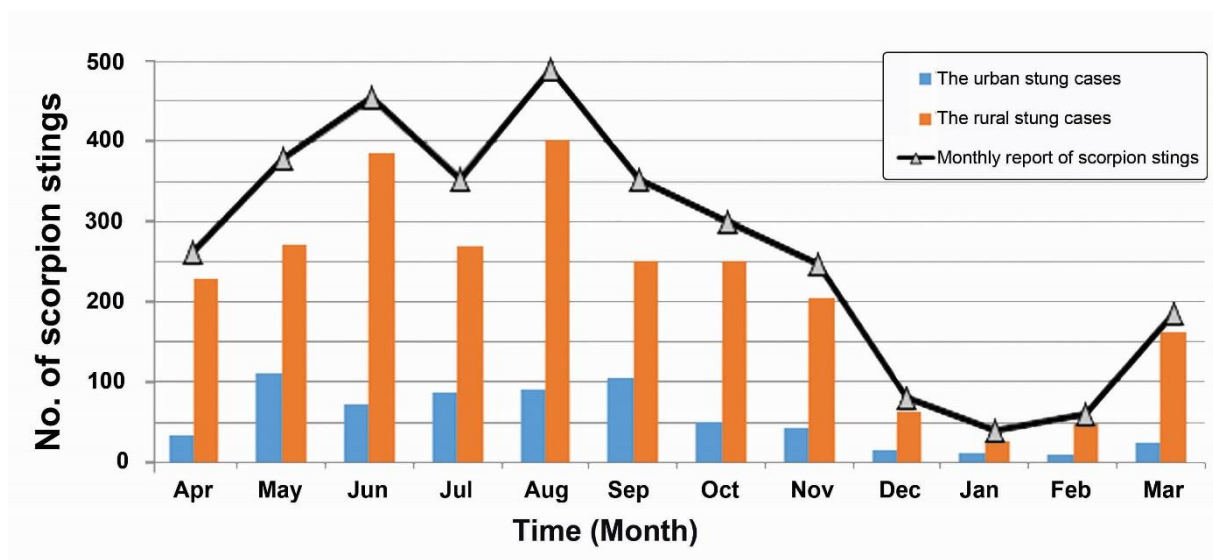
Fig. (3). The monthly reports of scorpion sting cases and the separate sting cases in urban and rural areas in the south of Kerman province from March, 2020, to March, 2021.

4. DISCUSSION

The present study reported more cases of scorpion stings in women than men. In a similar study, Daneshi *et al.* (2015) reported more cases of scorpion stings in women of Kerman City [23]. However, in the study by Nazari *et al.* (2014) [24] and Amiri *et al.* (2022) [25], more scorpion stings were reported in men in the northwest and west of Iran. These differences could mostly be related to cultural differences, people's jobs, types of houses, and their lack of permeability against scorpions.

Amiri Qanat Saman *et al.* (2022) stated that 63.8 of scorpion stings were reported in the interior of residents' homes, especially in resting places of people in the southeast of Iran. It is reported to be unsafe for scorpion entry in most cases. Children and housewives are more likely to be harmed in such an environment [13]. In the current research, the percentage of scorpion stings in the age group of fewer than 14

years was more in men, and in other groups, more scorpion stings in women than in men, and at the same time, most cases have been reported. Scorpion stings have been reported in children less than 10 years of age.

In the present study, most of the scorpion sting cases were referred to medical centers within a time interval of fewer than 1.5 hours (56.51%). Observing this feature is especially important in the case of scorpion stings with Gadim scorpions (local name of *Hemiscorpius lepturus*), which do not dig and easily enter the house from under the seam of the door and window. The shape of the sting in these scorpions is small, delicate, and without pain. This factor can lead to the carelessness of the cases stung by Gadim scorpion and not paying attention to going to medical centers. At the same time, the toxic compounds of the *Hemiscorpius* species are cytotoxic and deadly, especially in children, if there is a delay in referring to medical centers [11, 26 - 28].

According to the anatomical sting site of the scorpion, we reported mainly on the hands and feet [84%]. This feature was similar in all epidemiological studies conducted in Iran [5, 23, 26, 29, 30]. This characteristic somehow means that people can encounter scorpions while wearing shoes, unintentionally touching hands or feet with scorpions while walking or picking up objects [23, 25]. In this case, observing tips, such as shaking shoes before wearing, putting shoes in a shoe rack, shaking clothes and bedding before using, and using gloves and boots during agriculture, can prevent scorpion stings [13].

The epidemiologic data showed that sting cases mainly reached to peak at the beginning of the hot season. Other epidemiological studies on scorpion stings in Iran and worldwide also mentioned the same results [23, 25, 31, 32]. In general, the weather conditions of the southern regions of Iran, especially in the hot seasons and the coolness of the interior of the houses, cause scorpions to enter the houses and shelter them inside the houses, subsequently leading to scorpion stings [13]. In addition, the activity of scorpions also begins when the weather warms up in spring [6].

In the present study, most cases of scorpion stings were reported in villages with a ratio of village to city (93.3). In addition, the results showed that in the hot seasons of the year, scorpion stings are mainly reported during the night. While in winter, the cases were more during the day. These results were consistent with the data presented in a study conducted by Daneshi *et al.* (2015) [23]. The results of the network scale-up estimation method showed that there is no significant difference between the data recorded in the university health department and the network scale-up method. Therefore, it reduces the possibility of insufficient data and shows that the health system is fully alert in discovering and identifying cases. While the most important strength of the collected health data is their accuracy, and this feature should not be underestimated [15].

On the other hand, our study demonstrated that the network scale-up method is a reliable method for solving health issues and problems. It is also a suitable method for planning and making policies in the health system and distribution of facilities. However, the quantity and quality of these data have always been discussed in terms of being up-to-date, complete, and correct [16]. This problem is especially evident in developing countries. Developing countries do not have a proper collection system for many reasons, including lack of proper infrastructure, lack of sufficient personnel, lack of monitoring systems, such as data quality control, and problems related to personnel, such as rapid movement and lack of relevant personnel [17].

Basic problems in data collection systems that exist in non-emergency situations can appear more acutely in emergencies [18]. Albuquerque *et al.* (2009) studied the knowledge of indigenous Mexicans about the first steps after a scorpion sting and reported it to be very low. When people who had a history of being stung by a scorpion were asked what they should do after being stung by a scorpion, a significant number of them admitted that they did not know about this. Of these, 35.3% did not seek medical care after being stung by a scorpion. This suggests the number of reported cases of scorpion stings is much higher than what government agencies have recorded [33].

In the south of Iran, knowledge of the early symptoms of scorpion stings, especially in the case of Gadium scorpions, can help in timely diagnosis and referral of people stung by scorpions to medical centers and receiving antidote for scorpion stings before the onset [13]. The resident actions of southeastern Iran against scorpion stings were investigated by Amiri Ghanat Saman *et al.* (2022). They cited that more than 60% of scorpion sting cases were referred to the hospital quickly [13]. The epidemiologic data of the present study showed that more than 56% of scorpion sting cases were referred to a hospital one hour before the scorpion sting happened.

The purpose of this study was to investigate the quality of recorded data, which showed that indirect methods could be considered as an alternative method in places where data is not collected or the quality of data is very low. It is a rough guide for planning and evaluation [34, 35]. Collecting such statistics is useful in identifying people at risk and planning for harm reduction. Also, the belief of the natives of the region in traditional treatment in cases of scorpion stings may cause them not to go to medical centers and as a result, not to register cases of scorpion stings [13].

The network scale-up method can cover these small numbers. Gheshlaghi *et al.* (2010) estimated the actual number of venomous stings in Iran to be between 2 and 2.5 times higher than the recorded figures [4], but in this research, the number of cases was estimated using the network scale-up method. It largely corresponded to the number of registered cases. According to the present research, considering the estimation of hidden groups, including the estimation of AIDS and high-risk groups [22, 36], abortion [37], and the network of Iranians, the network scale-up method has been used in Iran. It was found that the results of these investigations and the figures announced by the Ministry of Health of Iran were highly consistent.

The present study is the first study in Iran, in which the network scale-up method was used to estimate the scorpion sting population. Previously, studies were conducted in Mexico on the estimation of damages caused by natural disasters [22]. In addition, this method has also been used to estimate the number of American casualties in the Iran-Iraq war [38]. Investigating the damage caused by the crisis is the strength of the network scale-up method, but the weaknesses of this method should also be considered. One of the disadvantages of this method, especially in this study, is the recall bias.

Considering that a lot of time has passed since the sting, some people may not remember some questions correctly, and the problem is the small number. Another disadvantage of this method in some studies is that a person may not be aware of all the behavior of his friends and social network, and it is called "non-transparent behavior" [14]. Considering the nature of the research subject, we did not witness this type of error. In general, according to the advantages and disadvantages mentioned in this method as well as the nature and objectives of the study, it seems that the network scale-up method can be

considered a helpful method for estimating damages and health problems. This method creates an accurate information recording system to provide the best services to patients after a crisis.

CONCLUSION

Considering the high number of scorpion stings in the region, the first step in reducing the number of scorpion stings is to provide the necessary training and sufficient information about scorpions. In addition, adequate knowledge of pre-hospital measures and a quick visit to the hospital can greatly reduce the complications caused by scorpion stings. Considering that the south of the country is prone to scorpion stings, the question has always been raised about whether all cases are recorded or not. In many studies, the network scale-up method has been proposed as a suitable method for examining injuries and health problems. To allocate resources, we need to have information related to the events, which seems to be an alternative method to estimate the load caused by such damages.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Ethics Committee of the University of Medical Sciences, Jiroft, Iran (Ethics code: IR. JMU. REC. 2019. 083).

HUMAN AND ANIMAL RIGHTS

No animals were used in the studies that are the basis of this research. All human procedures followed were in accordance with the guidelines of the Helsinki Declaration of 1975.

CONSENT FOR PUBLICATION

Informed consent was obtained from all participants of this study.

AVAILABILITY OF DATA AND MATERIALS

All the data and supportive information are provided within the article.

STANDARDS OF REPORTING

STROBE guidelines were followed in this study.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

REFERENCES

[1]   Sedaghat MM, Salahi-Moghaddam A, Dehghani R. Mapping the distribution of some important scorpions collected in the past five decades in Iran. 2012; 4: 258-94.

[2]   Chippaux JP, Goyffon M. Epidemiology of scorpionism: A global appraisal. Acta Trop 2008; 107(2): 71-9.
[http://dx.doi.org/10.1016/j.actatropica.2008.05.021]   [PMID: 18579104]

[3]   Hui Wen F, Monteiro WM, Moura da Silva AM, *et al.* Snakebites and scorpion stings in the Brazilian Amazon: identifying research priorities for a largely neglected problem. PLoS Negl Trop Dis 2015; 9(5): e0003701.
[http://dx.doi.org/10.1371/journal.pntd.0003701] [PMID: 25996940]

[4]   Gheshlaghi F, Yaraghi A, Hashemi ES. An Epidemiological study on scorpionism in Isfahan province. Majallah-i Danishkadah-i Pizishki-i Isfahan 2010; 28(114): 885-91.

[5]   Shahbazzadeh D, Amirkhani A, Djadid ND, *et al.* Epidemiological and clinical survey of scorpionism in Khuzestan province, Iran (2003). Toxicon 2009; 53(4): 454-9.
[http://dx.doi.org/10.1016/j.toxicon.2009.01.002] [PMID: 19708123]

[6]   Araújo CS, Candido DM, Araújo HFP, Dias SC, Vasconcellos A. Seasonal variations in scorpion activities (Arachnida: Scorpiones) in an area of Caatinga vegetation in northeastern Brazil. Zoologia 2010; 27(3): 372-6.
[http://dx.doi.org/10.1590/S1984-46702010000300008]

[7]   Dehghani R, Hoseindoost G, Bidgoli NS, Zamani M, Ghadami F. Study on pests of residential complex and student dormitories of Kashan University of Medical Sciences, Iran. J Entomol Res 2017; 41(3): 311-6.
[http://dx.doi.org/10.5958/0974-4576.2017.00050.0]

[8]   Fatani A. Snake venoms and scorpion venom research in the Middle East: A Review. Cliical Toxinology Asia Pac Africa 2015; pp. 327-55.
[http://dx.doi.org/10.1007/978-94-007-6386-9_38]

[9]   Bosnak M, Ece A, Yolbas I, Bosnak V, Kaplan M, Gurkan F. Scorpion sting envenomation in children in southeast Turkey. Wilderness Environ Med 2009; 20(2): 118-24.
[http://dx.doi.org/10.1580/07-WEME-OR-098RR3.1]   [PMID: 19594203]

[10] Dehghani R, Fathi B. Scorpion sting in Iran: A review. Toxicon 2012; 60(5): 919-33.
[http://dx.doi.org/10.1016/j.toxicon.2012.06.002] [PMID: 22750221]

[11] Dehghani R, Kamiabi F, Mohammadi M. Scorpionism by *Hemiscorpius* spp. in Iran: A review. J Venom Anim Toxins Incl Trop Dis 2018; 24(1): 8.
[http://dx.doi.org/10.1186/s40409-018-0145-z] [PMID: 29507581]

[12] Hanafi-Bojd AA, Sharififard M, Jahanifard E, Navidpour S, Vazirianzadeh B. Presence probability of *Hemiscorpius lepturus* Peters, 1861 using maximum entropy approach in the western areas of Zagros Mountains, Iran. Vet World 2020; 13(2): 296-303.
[http://dx.doi.org/10.14202/vetworld.2020.296-303]   [PMID: 32255972]

[13] Amiri Qanat Saman I, Dehghan H, Rahimi T, *et al.* Knowledge, attitude and practice of residents in the southeastern Iran in related to scorpion and scorpion stings. In: J Clin Nurs. 2022; B1: pp. (1-2)209-19.

[14] Bavani MM, Rafinejad J, Hanafi-Bojd AA, *et al.* Spatial distribution of medically important scorpions in north west of Iran. J Arthropod Borne Dis 2017; 11(3): 371-82.
[PMID: 29322054]

[15] Zolala F. Data collection after massive natural disasters (focusing on Bam earthquake, Iran). Disaster Prev Manag 2010; 19(5): 541-7.
[http://dx.doi.org/10.1108/09653561011091878]

[16] Ezoe S, Morooka T, Noda T, Sabin ML, Koike S. Population size estimation of men who have sex with men through the network scale-up method in Japan. PLoS One 2012; 7(1): e31184.
[http://dx.doi.org/10.1371/journal.pone.0031184] [PMID: 22563366]

[17] Bernard HR, Killworth PD, Johnsen EC, Shelley GA, McCarty C. Estimating the ripple effect of a disaster. Connections 2000; 24(2): 30-4.

[18] Snidero S, Morra B, Corradetti R, Gregori D. Estimating the number of foreign bodies injuries in children with the scale-up method. ASA Proceedings of the Joint Statistical Meetings.

[19] Salganik MJ, Fazito D, Bertoni N, Abdo AH, Mello MB, Bastos FI. Assessing network scale-up estimates for groups most at risk of HIV/AIDS: evidence from a multiple-method study of heavy drug users in Curitiba, Brazil. Am J Epidemiol 2011; 174(10): 1190-6.

[http://dx.doi.org/10.1093/aje/kwr246] [PMID: 22003188]

[20]   Saidel T, Loo V, Salyuk T, Emmanuel F, Morineau G, Lyerla R. Applying current methods in size estimation for high risk groups in the context of concentrated epidemics: lessons learned. jHASE-. J HIV AIDS Surveill Epidemiol 2010; 2.

[21]   Reddy A. Estimating the size of populations at high risk of HIV in Bangladesh using a bayesian hierarchical model. 2010.

[22]   Bernard HR, Hallett T, Iovita A, *et al.* Counting hard-to-count populations: The network scale-up method for public health. Sex Transm Infect 2010; 86(Suppl_2)(Suppl. 2): ii11-5. [http://dx.doi.org/10.1136/sti.2010.044446] [PMID: 21106509]

[23]   Daneshi S, Rezabeigi S, Razzaghi A, Zeinali M, Arefi S. The epidemiological analysis of scorpion stings in Kerman 2012-14. Pejouhandeh 2016; 21(1): 35-9.

[24]   Nazari M, Bahrami D, Davari B, Salehzadeh A. Epidemiological survey of scorpion sting cases and identification of scorpion fauna in Hamadan city, Iran [2013]. Avicenna Journal of Clinical Medicine 2015; 22(3): 255-62.

[25]   Amiri M, Lordjani N, Asgarpour H. Epidemiological study of scorpion sting in Lordegan City during the years 2014-2017. J Community Health Res 2018; 7(1): 57-61.

[26]   Moosavy SH, Shahi M, Rafinejad J, Zare S, Madani A, Navidpour S. Epidemiological aspect of scorpion sting in Bandar Abbas, Iran, during 2009-2011. Electron Physician 2016; 8(4): 2286-90. [http://dx.doi.org/10.19082/2286] [PMID: 27280006]

[27]   Shahi M, Davoodian P, Davaridolatabadi N, Shahi M. A cause of hematuria following *Hemiscorpius acanthocercus* [Scorpiones: Hemiscorpiidae] Sting in South of Iran. Hormozgan Med J 2020; 24(1): e95481.

[28]   Shahi M, Rafinejad J, Az-Khosravi L, Moosavy SH. First report of death due to Hemiscorpius acanthocercus envenomation in Iran: Case report. Electron Physician 2015; 7(5): 1234-8. [PMID: 26435822]

[29]   Rafizadeh S, Rafinejad J, Rassi Y. Epidemiology of scorpionism in Iran during 2009. J Arthropod Borne Dis 2013; 7(1): 66-70. [PMID: 23785696]

[30]   Kassiri H, Kasiri A, Kasiri E, Abdian P, Matori F, Lotfi M. Epidemiological characteristics and incidence rate of definite scorpion stings in Mahshahr County, Iran: Multivariate analysis of 1 635 cases. Asian Pac J Trop Dis 2015; 5(1): 80-4. [http://dx.doi.org/10.1016/S2222-1808(14)60632-0]

[31]   Boubekeur K, L'Hadj M, Selmane S. Demographic and epidemiological characteristics of scorpion envenomation and daily forecasting of scorpion sting counts: The case of Touggourt in Algeria. Epidemiol Health 2020; 42: e2020050. [http://dx.doi.org/10.4178/epih.e2020050] [PMID: 32660217]

[32]   Benmosbah M, Guegueniat P, Mayence C, *et al.* Epidemiological and clinical study on scorpionism in French Guiana. Toxicon 2013; 73: 56-62. [http://dx.doi.org/10.1016/j.toxicon.2013.05.025] [PMID: 23791738]

[33]   Albuquerque CMR, Barbosa MO, Iannuzzi L. Tityus stigmurus (Thorell, 1876) (Scorpiones; Buthidae): Response to chemical control and understanding of scorpionism among the population. Rev Soc Bras Med Trop 2009; 42(3): 255-9. [http://dx.doi.org/10.1590/S0037-86822009000300004] [PMID: 19684971]

[34]   Roces MC, White ME, Dayrit MM, Durkin ME. Risk factors for injuries due to the 1990 earthquake in Luzon, Philippines. Bull World Health Organ 1992; 70(4): 509-14. [PMID: 1394785]

[35]   Wen J, Shi YK, Li YP, *et al.* Risk factors of earthquake inpatient death: A case control study. Crit Care 2009; 13(1): R24. [http://dx.doi.org/10.1186/cc7729] [PMID: 19243616]

[36]   Daneshi S, Haghdoost A, Baneshi M, Zolala F. The estimated frequency of spinal cord injury, amputation [Hands and Feet] and death in the bam earthquake using the network scale up method. Majallah-i Ipidimiyuluzhi-i Iran 2014; 10(3): 9-14.

[37]   Rastegari A, Baneshi MR, Haji Maghsoudi S, *et al.* Estimating the annual incidence of abortions in Iran applying a network scale-up approach. Iran Red Crescent Med J 2014; 16(10): e15765. [http://dx.doi.org/10.5812/ircmj.15765] [PMID: 25558379]

[38]   Moody J. Fighting a hydra: A note on the network embeddedness of the war on terror. Struct Dyn 2005; 1(2): 1. [http://dx.doi.org/10.5070/SD912003275]