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Epidemiological analysis of snakebite victims in southwestern Iran

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ABSTRACT

Objective: To investigate the prevalence of snakebites and associated epidemiologic factors in Khorram-shahr County, Iran, between 2013 and 2017.

Methods: This was a cross-sectional descriptive-analytical study. Information was collected and recorded *via* questionnaires. Snakebite data included gender, age, occurrence regions, bite site, time of being bitten, month and season. Data were analyzed by *Chi*-square and *t*-tests with SPSS version 18.

Results: A total of 102 cases of snakebites occurred in Khorram-shahr County of Khuzestan Province, southwestern Iran. There were 75 men (73.5%) and 27 women (26.4%), without significant difference in incidence. The highest frequency of snakebites was observed in the age group of 41-50 years with 28 cases (27.4%). In total, 58 cases (56.9%) occurred in urban areas and 44 cases (43.1%) in rural areas. No statistically significant difference was observed between the age groups or residential areas. Snakebites occurred in May with 19 cases (18.6%), spring with 45 (44.1%) and summer with 45 (44.1%). The results showed significant difference among different seasons and months of the year. Snakebites were in feet in 62 cases (60.8%) and hands in 36 cases (35.3%) which were bitten more than other organs, respectively, with significant difference among different bite sites in the body. The highest and lowest frequencies of snakebites were observed between 18:00 and 24:00 with 43 cases (42.2%) and between 6:00 and 12:00 with 14 cases (13.7%), with a significant difference among different hours of the day.

Conclusions: Useful information about snakebites, venomous snakes, their hazards, prevention of bites and the importance of early hospital referral and treatment of victims should be provided to people using different educational tools.

1. Introduction

Snakebites are one of the health problems in many countries, which can cause torment, discomfort and death. Injuries caused by snakebites are a significant public health problem leading to serious complications[1]. Snakes are divided into three categories, namely venomous, semi-venomous and non-venomous. In venomous

snakes, the fangs are positioned along the upper jaw at the front.

In semi-venomous snakes, the fangs are located along the upper jaw at the rear of a snake's mouth. Non-venomous snakes do not have any fangs. There are about 2 900 known species of snakes in the world[2]. There are 69 known species of snakes in Iran, including 36 non-venomous, 25 venomous and 8 semi-venomous

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species[3,4]. They are found in vast areas of Iran, especially in the desert regions. Regardless of the snake species, incidence of snakebites varies from countries, and depends on different factors such as climate, ecological parameters, biodiversity, distribution of venomous snakes, human population density, economic activities and types of dwellings[5]. The incidence of venomous snakebites is between 1.2 and 5.5 million per year worldwide, resulting in approximately 20 000-94 000 deaths and tens of thousands of disabled people. Most of the above events happen in rural tropical areas of Sub-Saharan Africa, South America and Asia[6,7]. It is estimated that 50% of these snakebites are venomous, resulting in 100 000 deaths per year[8]. In India, an estimated 200 000 persons per year are affected by snakebites, with an estimated mortality rate of 35 000-50 000 per year[9]. According to a report by the Iranian Ministry of Health and Medical Education, an estimated 4 500-7 000 persons fell prey to snakebites with a mortality rate of 3-9 cases and average annual incidence of 6.9 per 100 000 population between 2001 and 2010[3,10].

Snakebites are associated with many complications and with loss of many potential years of life[3]. They cause pain and infections, either locally or systemically, that result in shock, acute kidney injury, coagulation disorders in the vascular system and damage to the heart muscle[3]. The majority of snakebite complications are due to consequences of hemorrhagic venoms or complications of neurotoxic venoms that are accompanied by secondary bacterial infections. Bacterial infections are also observed after non-venomous snakebites. Abscess is the most common manifestation of infections accompanying snakebites. It is believed that bacterial infections are the cause of death in some cases[11-19].

Regarding the high incidence of snakebites in Khorram-shahr and the lack of a relevant study in this county, the present research aimed to investigate the incidence rate of snakebites and their associated epidemiological factors from 2013 to 2017. Results of the current study can be considered in designing snakebite prevention and management programs to reduce its incidence rate in this region.

2. Materials and methods

The coastal county of Khorram-shahr located between 30°26'23"N Latitude and 48°09'59"E longitude with the elevation of 4 meters above sea level. Khorram-shahr has a population of 133 099. The climate in Khorram-shahr is called a desert climate. There is virtually no rainfall during the year. In Khorram-shahr, the average annual temperature is 24.9 °C. Precipitation here averages 181 mm. The precipitation varies 39 mm between the driest month and the wettest month. The variation in temperatures throughout the year is 23.4 °C. With an average of 35.5 °C, August is the warmest month. The lowest average temperatures in the year occur in January, when it is around 12.1 °C.

This cross-sectional descriptive-analytical study was conducted

from 2013 to 2017. The participants were the patients who suffered snakebites and referred to the disease control and prevention unit at the health center of Khorram-shahr County. The university research review committee revised the research proposal according to the rule and regulation. Accordingly, the study was approved by the Ethics Committee of Ahvaz Jundishapur University of Medical Sciences (ID: AJUMS.REC.1398.042, Approval Date: 2019.4.13). Participation was fully voluntary and informed written consent was obtained from directors and each study participant. All information obtained was kept confidential. All the victims received the antivenin. The study included all patients whose snakebite was confirmed through interview and clinical trials. Epidemiological data collected by the means of research-made questionnaires were analyzed with SPSS software version 18. Reliability was confirmed by testing on 15 patients using Alfa Cronbach index of 85 percent. The information included gender, age, occurrence regions, bite site, month and season. Data were analyzed by *Chi*-square and *t*-tests with SPSS version 18. *P*-values <0.05 were considered statistically significant.

3. Results

One hundred and two cases of snakebite were reported from 2003 to 2017, and the largest number was 28 in 2014. Findings showed that snakebite cases among men were nearly triple that among women. In total, 27 (26.5%) cases were in females and 75 (73.5%) in males. The paired *t*-test results showed that there was a significant difference between genders in snakebite incidence ($P < 0.001$).

The highest frequency of snakebite cases was observed in the 41-50 year-old age group with 28 cases (27.4%). The lowest frequency was recorded among children younger than 11 years of age with 7 cases (6.9%). The *Chi*-square test results showed there were no statistically significant differences in frequency of snakebites among the age groups ($P > 0.05$). Based on residential areas, 58 snakebite cases (56.9%) happened in urban areas and 44 cases (43.1%) in rural areas, with no significant difference between urban and rural areas ($P > 0.05$).

The most numbers of snakebite cases were reported in May with 19 cases (18.6%) and in September with 17 cases (16.7%). The seasonal distribution of snakebite cases was equal in spring and summer, each with 45 cases (44.1%), autumn with 9 cases (8.8%) and winter with 3 cases (2.9%). The *Chi*-square test results showed a significant difference among various months of the year ($P < 0.001$).

According to the results, 60.8% of the bites were on the legs with 62 cases and 35.3% on the hands with 36 cases, with a significant difference in the frequency of snakebite incidents among the different parts of the body. The highest and lowest frequencies of snakebites were observed between 18:00 and 24:00 with 43 cases (42.2%) and between 6:00 and 12:00 with 14 cases (13.7%), with a significant difference among different hours of the day (Table 1).

Table 1. Frequency distribution of snakebite cases in Khorram-shahr County, Khuzestan Province, southwestern Iran from 2013-2017[n (%)].

Variables	2013	2014	2015	2016	2017	Total	P-values
Genders							
Female	5 (23.8)	8 (27.6)	3 (21.4)	6 (30.0)	5 (27.8)	27 (26.5)	<0.001
Male	16 (76.2)	21 (72.4)	11 (78.6)	14 (70.0)	13 (72.2)	75 (73.5)	
Seasons							
Spring	11 (52.4)	13 (44.8)	5 (35.7)	11 (55.0)	5 (27.8)	45 (44.1)	<0.05
Summer	9 (42.8)	15 (51.7)	6 (42.9)	6 (30.0)	9 (50.0)	45 (44.1)	
Autumn	0 (0.0)	1 (3.5)	3 (21.4)	2 (10.0)	3 (16.7)	9 (8.8)	
Winter	1 (4.8)	0 (0.0)	0 (0.0)	1 (5.0)	1 (5.5)	3 (2.9)	
Age groups (years)							
0-10	1 (4.8)	1 (3.4)	3 (21.4)	0 (0.0)	2 (11.1)	7 (6.9)	>0.05
11-20	3 (14.3)	3 (10.3)	2 (14.3)	2 (10.0)	1 (5.6)	11 (10.8)	
21-30	2 (9.5)	4 (13.8)	2 (14.3)	4 (20.0)	8 (44.4)	20 (19.6)	
31-40	5 (23.8)	6 (20.7)	3 (21.4)	6 (30.0)	2 (11.1)	22 (21.6)	
41-50	8 (38.1)	9 (31.1)	4 (28.6)	4 (20.0)	3 (16.7)	28 (27.4)	
>50	2 (9.5)	6 (20.7)	0 (0.0)	4 (20.0)	2 (11.1)	14 (13.7)	
Residential areas							
Urban	14 (77.8)	12 (41.4)	6 (42.9)	11 (55.0)	12 (66.7)	58 (56.9)	>0.05
Village	4 (22.2)	17 (58.6)	8 (57.1)	9 (45.0)	6 (33.3)	44 (43.1)	
Biting sites							
Hand	7 (33.3)	11 (37.9)	5 (35.7)	7 (35.0)	6 (33.3)	36 (35.3)	<0.001
Leg	13 (61.9)	16 (55.2)	9 (64.3)	12 (60.0)	12 (66.7)	62 (60.8)	
Neck and head	0 (0.0)	0 (0.0)	0 (0.0)	0 (0)	0 (0.0)	0 (0.0)	
Trunk	1 (4.8)	2 (6.9)	0 (0.0)	1 (5.0)	0 (0.0)	4 (3.9)	
Biting time							
0:00-6:00 am	4 (19.0)	7 (24.1)	3 (21.4)	6 (30.0)	3 (16.7)	23 (22.5)	<0.01
6:00-12:00 am	2 (9.5)	4 (13.8)	1 (7.2)	2 (10.0)	5 (27.8)	14 (13.7)	
0:00-6:00 pm	4 (19.0)	4 (13.8)	5 (35.7)	7 (35.0)	2 (11.1)	22 (21.6)	
6:00-12:00 pm	11 (52.4)	14 (48.3)	5 (35.7)	5 (25.0)	8 (44.4)	43 (42.2)	
Months							
April	4 (19.0)	3 (10.3)	2 (14.3)	2 (10.0)	0 (0.0)	11 (10.7)	<0.001
May	3 (14.3)	6 (20.7)	3 (21.4)	4 (20.0)	3 (16.7)	19 (18.6)	
June	4 (19.0)	4 (13.8)	0 (0.0)	5 (25.0)	2 (11.1)	15 (14.7)	
July	3 (14.3)	6 (20.7)	2 (14.3)	1 (5.0)	3 (16.7)	15 (14.7)	
August	4 (19.0)	4 (13.8)	2 (14.3)	2 (10.0)	1 (5.6)	13 (12.7)	
September	2 (9.6)	5 (17.3)	2 (14.3)	3 (15.0)	5 (27.8)	17 (16.7)	
October	0 (0.0)	1 (3.4)	2 (14.3)	0 (0.0)	2 (11.1)	5 (4.9)	
November	0 (0.0)	0 (0.0)	1 (7.1)	2 (10.0)	0 (0.0)	3 (2.9)	
December	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (5.5)	1 (1.0)	
January	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
February	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (5.5)	1 (1.0)	
March	1 (4.8)	0 (0.0)	0 (0.0)	1 (5.0)	0 (0.0)	2 (2.0)	
Total	21	29	14	20	18	102	

4. Discussion

Snakebites are one of the problems faced by the Iranian health system. Similar with many other countries in the world, Iran lacks comprehensive and evidence-based clinical guidelines for snakebite treatment. Since physicians lack adequate knowledge about this problem, they are not interested in the treatment of patients and referring to higher levels of care. As the majority of the snakes responsible for the bites are not identified, it is essential to have a good knowledge of local snakes and access to the related antivenins in high-risk regions. Although antivenins are not necessary for many cases of snakebites, general and specialist physicians, especially at the frontline of medical service provision, should be familiar with general principles of snakebite diagnosis

and treatment, particularly with correct prescription of antivenins and management of probable complications. This is because incorrect snakebite diagnosis and treatment may result in severe complications or even death thereby exposing the physician to malpractice lawsuits and their legal consequences.

Results of the present research showed a statistically significant difference in the frequency of snakebites between genders in that snakebite incidents among males were nearly three times higher than among females. In a study in Ardabil, Farzaneh *et al.* reported that males accounted for 76.1% of snakebites, which is consistent with the findings of the present study[20]. Kassiri *et al.* reported in their study in Mahshahr that 84.7% of snakebite victims were males[21]. In a 10-year retrospective survey in Northwest Iran, Eslamian *et al.* reported that males constituted 77.6% of snakebite victims[22]. Other studies also reported that higher snakebite

incidents happened among males. Researches of Dehghani *et al.* and Kassiri *et al.* reported that male accounted for 96% in Kashan and 92.1% in the counties of northern Khuzestan Province of snakebite victims, respectively[3,23]. The higher frequency of snakebites among males is due to their greater involvement in outdoor activities that increases the risk of snakebites.

The highest number of snakebites occurred in the 41-50 year-old age group (27.4%). Lots of researches have commonly reported that snakebites mostly happened among adults[3,24]. Moreover, a study showed that the majority of snakebite victims occurred in the age group of 15-24 and 35-44 year-old in Kashan[3]. In the east of Ahvaz County, Kassiri *et al.* reported that the largest number of snakebites happened in the age group of 21-30 year-old[25]. The higher frequency of snakebites among middle-aged men was due to their greater involvement in outdoor activities, nocturnal activity with low light and lack of protective covers due to hot daytime climate that put them at greater risk of being bitten by snakes. In the present study, the lowest number of snakebites was observed in the age group of less than 11 years. But snakebites in children are a medical emergency and more common among rural boys in summer. Since there is no difference in the amount of venom injected during the bite between children and adults and children are smaller in body size and lighter in body weight, the likelihood of local and systemic complications and even mortality is greater among children and they should be treated more carefully[26-28].

According to results of the 2016 Census in Iran, 79% (135 328) and 21% (35 646) of Khorram-shahr population lived in urban and rural areas, respectively. In this study, incidence of snakebites was higher in urban areas. In a study in Kashan, Dehghani *et al.* reported that rural areas accounted for 68% of all snakebites cases[3]. The reason for this difference with this study is attributed to the difference between urban and rural population in different geographical areas. Snakebites in rural areas are more common among male agricultural and animal-husbandry workers[3]. In addition, the recorded incidence of snakebites in some rural areas is lower than the actual one because residents of these areas mostly rely on home remedies instead of visiting healthcare centers[29].

An objective of this study was to investigate monthly and seasonal incidence of snakebites during the year. Snakes are cold-blooded creatures and more active in warm seasons. Results of the present research supported this physiological characteristic of snakes. In this study, the frequency of snakebites was higher in summer and spring. In Kassiri's study, the majority of snakebites in the east of Ahvaz County happened in spring (26.7%) and autumn (25.2%)[25]. Most of the snakebites in Dehghani's research in Kashan occurred from May to April[3]. In Kassiri's study in Khuzestan Province, most cases of snakebites happened in May and September and there were no reported snakebites in February and January[23]. In the present study, the majority of snakebites happened in May. Most incidents of snakebites in Mahshahr County happened in spring and summer in Kassiri's study[21].

According to findings of the present research, the legs were the most frequently affected body part with 62 cases (60.8%). In North

Khuzestan, the legs injuries accounted for 59.6% of snakebite incidents[23]. This can be attributed to the presence of snakes under grass, herbs and stones.

In the present study, the majority of snakebites (42.2%) happened between 18:00-24:00. Although the time of being bitten during the course of the day is important, it is often neglected in studies and the results of these studies are sometimes inconsistent. For example, a study conducted by Ebrahimi *et al.* in south Iran showed that the snakebites often happened between midnight and 6 am (32%)[30], whereas Kassiri *et al.* in Abadan County, reported that the majority of bites (45%) happened at time period of 6-12 am during night[31]. These discrepancies are probably due to differences in lifestyle and the various snake species present in different regions.

It is necessary to introduce health education programs for personal protection, in order to prevent possible injuries from snakes, especially for the men that reside in rural areas. Also, based on these results, snakebites are considered an important public health problem in Khorram-shahr County. It is suggested that management and treatment at primary health care centers can be prospering by the first aids and antivenin injection.

One of the important limitations of this research was absence of data about snake species. Cognition of snake species in this emergency could lead to more accurate deductions. Researches with greater people including population from various geographic regions might lead to a more exact deduction. This research just focused on Southwest of Iran. Present study was limited by the inaccessibility of several lab and clinical information because of research design.

Conflict of interest statement

The authors report no conflict of interest.

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Authors' contribution

H.K. responsible for the manuscript preparation, developing the study idea and abstracted data, and is the scientific advisor, technical advisor, data analyzer, corresponding author. I.K., S.K., N.K. and M.L. contributed to preparation of research project, cooperation in doing field work, abstracted data and collecting the data.

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