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Original article

The burden of bites and stings management: Experience of an academic hospital in the Kingdom of Saudi Arabia

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ABSTRACT

Purpose: The main aim of this study is to estimate the economic burden and prevalence of bites and stings injuries in Saudi Arabia.
Methods: A retrospective, cross-sectional study was conducted at King Saud University Medical City (KSUMC) for all bites and stings cases presented to the Emergency Department (ED) between the period June 2015 and May 2019.
Results: A total of 1328 bites and stings cases were treated in the ED at KSUMC. There were 886 insect bites and stings cases, 376 animal bites, 22 human bites, 34 scorpion stings, and ten snakebites. Most cases were reported in April - June. Females account for 62% of the reported cases, and the mean age was 24 years old. The total management cost of bite and sting cases during the study period was 3.4 million Saudi Riyal (SR). The spending cost of the management of animal bites was the highest as it cost 1,681,920.76 SR, followed by insect's management costing 1,228,623.68 SR.
Conclusion: Bites and stings have a considerable health care burden on our society. Although the vast majority of the cases were not associated with a severe life-threatening condition, many were visit ED and associated with high medical costs. Increased awareness of the hazards of animal-related injuries, especially during spring and summer, where most cases take place may lower its incidence and decrease EDs visits.

1. Introduction

Bites and stings are a common source of injuries seen in the emergency department (ED). Substantial trauma, tissue damage, infection, allergies, rabies exposure, disability, psychological effects, and rarely death may result from bites and stings (Langley, 2009; Sinclair and Zhou, 1995; Christian et al., 2009). Bites and stings continue to cause a major public health challenge, and the clinical sequelae of bites and stings can extend far beyond simple wound management (Moosavy et al., 2016). Identification of people bitten and stung remains a challenge and incomplete (Patronek and Slavinski, 2009). Previous data indicate that most animal bites to humans in Saudi Arabia have involved snakes, dogs, cats, rodents, and foxes (Organization, 1992). Rabies is endemic in some animals in the Arabian Peninsula, and feral dogs were the primary cause of human Rabies (Memish et al., 2015).

Snake bites remain life-threatening injuries and mostly requires intensive care management (Williams et al., 2010; Warrell, 2010; Gold et al., 2002). Fifty-one species of snakes have been recorded in Saudi Arabia, and nine of these are venomous. Snakes were reported in Riyadh area, mainly *Walterinnesia aegyptia, Atractaspis microlepidota, Cerastes gasperettii*, and *Echis coloratus* (Gasperetti, 1988; Al-Sadoon et al., 2017). Poisonous snakes in Saudi Arabia

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are *Cerastes creates gasperettii, Vipera berus, Echis pyramidum,* and *Walterinnesia aegyptia* (Al-Sadoon, 2015). Additionally, Scorpion stings is a challenging public health problem in Saudi Arabia, with thousands stung by scorpions with an average of 4 cases per 1000 inhabitants annually (Al-Asmari and Al-Saif, 2004; Jahan et al., 2007; Jarrar and Al-Rowaily, 2008; Al-Sadoon and Jarrar, 2003).

Insects bites and stings are a coman injureis and many patients visitng the ED complaining about allergic reaction to insest bites or stings. Insect stings are also an important cause of anaphylaxis (Moffitt, 2003). Medical implication and social nuisance through poisonous and severely painful insect sting is also set by Samsum ant, *Brachyponera* (*Pachycondyla*) *sennaarensis.* Its sting also constitute anaphylactic shock in some of the cases. Samsum ant in various provinces of Saudi Arabia. *B. sennaarensis* is a harmful insect in human settlements. Infestations of *B. sennaarensis* are immense in the spring and summer seasons and the ants construct nests in moist places and in cracks of cemented structures, but infestation is declined in winter (Al-Khalifa et al., 2015).

Bites and stings may lead to costly healthcare utilization, starting from ED visits, hospitalization, and death (Al-Sadoon and Jarrar, 2003; Abrahamian and Goldstein, 2011). The current epidemiology of bites and sting injuries in Riyadh province is highly required to enhance the public health interventions toward its prevention.

Few studies reviewed the epidemiology for bites and stings in a different region in Saudi Arabia and often focusing on snakes and scorpion cases (Jarrar and Al-Rowaily, 2008; Malik, 1995; Neale, 1990). Identification of the common stings and bites in our region, as well as the cost associated with it, is crucial in the plan for management and to reduce health resources. However, up to our best knowledge, no study reviewed the epidemiological along with the total expenditure of management to these injuries in the region. The primary objective of this study was to estimate the prevalence of bites and stings that lead to ED visits and hospitalization in Riyadh, Saudi Arabia. The secondary objective was to estimate the direct medical cost and health care resources associated with the management of bite and stings injuries. This study will help to understand the epidemiology of bites and stings injuries and associated costs.

2. Material and methods

A retrospective, cross-sectional - prevalence based cost study was conducted at King Saud University Medical City (KSUMC) for all bites and stings cases presented to its ED between the period June 2015 and May 2019. KSUMC is large tertiary care with more than 1800 beds that provides health care services to a large population in Riyadh, which is the capital and largest city of Saudi Arabia, with a population of over 7 million. The patient population is composed mainly of Saudi citizens who are predominantly residents of the capital city of Riyadh; also, it serves as a national referral center.

2.1. Data sources

Data were retrospectively identified all bites and stings cases from the electronic health care records (EHR) for the period 2015–2019 at KSUMC. The retrieved data included demographic information such as patient's age, gender, types of bites, or stings.

The severity score was assessed based on the Poisoning Severity Score (PSS), this scoring system was developed by European Association of Poisons Centers and Clinical Toxicologists (EAPCCT) (Persson et al., 1998). The score ranging from 0 to 4 as follows: 0 for an asymptomatic patient, 1 for mild symptoms, 2 for prolonged symptoms, 3 for Severe or life-threatening symptoms and 4 for death (Persson et al., 1998). Additionally, all direct cost data related to each case were collected and calculated from the payers' perspective, and therefore only direct medical costs were included. The cost analysis was based on the patient's length of stay at the hospital, plus the cost of the interventions provided to the patient, including medications and vaccinations. The costs were estimated based on all resources required for the management of bites and stings, including ED visit, laboratory, medications, and admission. The estimated cost/day was extracted from the Business Center at KSUMC according to the patient location area (ED, ICU, and Ward admission). The cost is presented in Saudi Riyals; however, in order to make international comparisons, we converted the costs to USD.

The average total costs per each patient were calculated for each type of bites and stings separately. Total direct medical cost per patient = (average number of visits × visit fees) + (average number of tests × fees for each test) + (number of medications prescribed in the course of treatment × fees of every unit of medicine) + (average number of hospitalization days × fees for each day admission) + (average number of diagnostic services × fees for each diagnostic service) + (average number of other services × fees for each course of service). An average number of health services (visits, tests, diagnostic services) was calculated as the total number of visits divided by the total number of patients receiving those services.

2.2. Study population

The study included all bites and stings cases presented to KSUMC-ED between 1 June 2015 till 31 May 2019. Types of bites and stings included in this study were; animals, humans, snakes, insects, and scorpions.

2.3. Statistical analysis

Descriptive statistics (frequency and percentages) were used to summarize the categorical variables (sex, marital status, nationality, bites and stings types, severity score) and all costs. Means and standard deviations were calculated for continuous variables (age). All statistical analyses were conducted using the Statistical Analysis Software, version 9.2 (SAS® 9.2).

2.4. Ethical consideration

Before commencing the study, approval was granted by the Institutional Review Board (IRB) of the King Saud University Health Colleges as project E-17-2351. All the research activities were carried out in compliance with fundamental ethical principles and policies of the IRB. Confidentiality and privacy of all data were maintained throughout the study period.

3. Results

From June 2015 to May 2019, there were 1328 reported cases treated in ED at KSUMC for injuries related to bites and stings. Table 1. shows the main characteristics of the cases, frequency and percentage distributions of bites and stings, arrival time to ED, and their outcomes. Analysis by sex reveals that 823 (62%) of the reported cases were females. The mean age was 24 years old, and most of the cases (48%) arrived at the ED in less than six hours. There were 886 insect bite and sting cases, which account for highest number of cases in our study, followed by 376 animal bites and 34 scorpion stings. Moreover, there were a total of ten snakebites reported, and only one out of the ten died. The severity of the cases was measured based on PSS, and we found that the majority (94%) of bites and stings cases were mild, and only about 5% of the cases

Table 1
Summary of demographic characteristics of the cases

Variables	Frequency N(%)
N	**1,328**
l	
Age	
Mean (SD)	24 (17.3)
Pediatric (less than 14)	454 (30%)
Adult (14 or more)	874 (70%)
Gender	
Male	505 (38%)
Female	823 (62%)
Time to treatment	
Early (<6 hrs)	642.8 (48.4%)
Delayed (≥6 hrs)	245.3 (18.4%)
Unknown	439.8 (33%)
Follow up visit	
Yes	346.8 (27%)
No	972.7 (73%)
Disposition	
Discharge	1,268 (95.49%)
Admission	59 (4.43%)
Death	1 (0.08%)
LoS Avg.(SD)	6.62 (17.9)

were considered severe. The snake and scorpion cases among the highest severity, which account for 20% and 7% of their cases (see Table 2).

The most common site of bites was the upper extremity (48.2%), followed by the lower extremity (41%) and head (7.4%). Almost 96% of the cases were discharged after receiving the appropriate treatment at ED, and only 32 cases (2.4%) with severe complications got admitted to the hospital. Forty percent of snakebites cases were admitted to hospital, and only 3% of insect bites required hospitalization. The duration of hospitalization ranged from 1 to 23 days and averaged at six days. The yearly incidence of bites and sting cases indicated that there was an increase in the number of cases each year (Fig. 1). The majority (78%) of cases, were bites and stings injuries that occurred during the night time, and 16% occurred at daytime, while 6% were not reported.

The seasonal percentage and incidence of cases demonstrate a considerable variation throughout the year. Most of the cases took place during summertime (May-July) and again during the winter (Oct-Dec). The seasonal distribution of the cases is represented in Fig. 2. Most cases were reported in May (165 cases), followed by April (150 cases), then June (144 cases), while February (52 cases) got the least reported cases.

The average cost per case was highest for snake bites (26,460 SR), followed by human bites (5,638 SR) and Scorpion stings (4,615 SR), while insect stings were the lowest at (1,387 SR) per case (Table 3). The cost was significantly high with severe cases. The cost of severing snake bites cases was associated with the higher cost (46,143.00 SR) per case following by severing animal cases (23,832.16 SR) and sever scorpion cases which cost around (17,638.19 SR) per case. Diagnostic tests and medication costs were accounted for the highest utilization in bites and stings patients.

The total cost of managing bite and sting cases during the four years was 3,429,629 SR (903,063 USD). 1,681,921 SR was the cost spent on the management of animal bites. While 1,228,624 SR for the management of insect stings and the cost spent on the management of snake bites was 238,140 SR. Cost analysis was presented in detailed in Table 3.

4. Discussion

Bites and stings cases indicate a high burden of diseases, with a total of 1,328 cases occurred during the study period. The mean age was 24, which is similar to what has been reported in different studies (Al-Sadoon et al., 2017; Jarrar and Al-Rowaily, 2008; Al-Sadoon and Jarrar, 2003). Overall, in this study, 62% of the patients were females. Previous international studies demonstrated that males were more likely to be victims, as they are more likely to be outdoors (Anil et al., 2010; Graham and McCurdy, 2004). However, this difference is probably due to the high number of insect bites and stings cases reported in this study, which occur mostly in females. They were superficial stings that caused moderate to severe itching and skin manifestations that warrants them to seek medical assurance. The Saudi culture embraces and enjoys socializing and sitting on the floor and yards, with that, although they were not witnessed, they are most likely to be ants.

The bites and stings were commonly encountered during night time. This probably because many of the patients were staying late nights, and sleeping outdoors in the desert is a common activity in Saudi Arabia. Also, because snakes, scorpions, and insects are more active at night due to the hot climate (Agrawal et al., 2001). On the

Table 2
Characteristics and distribution of the bites/stings cases

Variables	Snake N(%) N = 10	Insect N(%) N = 886	Animal N(%) N = 376	Human N(%) N = 22	Scorpion N(%) N = 34
Number of cases	M = 6(0.6) F = 4(0.4)	M = 249(0.28) F = 638(0.72)	M = 214(0.57) F = 162 (0.43)	M = 9(0.45) F = 12(0.54)	34 M = 28(0.82) F = 6(0.17)
Types	Nonvenomous = 4(0.4) Venomous = 5(0.6)	Ant = 82(0.093) unspecified Insect = 804(0.907)	Cat bite = 284(0.76) Dog bite = 44(0.12) Rat bite = 19(0.05) Hamster bite = 9(0.02) Squirrel bite = 5(0.01) Horse bite = 4(0.01) Monkey bite = 4 (0.1)) Australian Lizard bite = 1(0.003) Camel bite = 1(0.003) Lion bite = 1(0.003) Tiger bite = 1(0.003) Unknown = 3(0.01)		Nonvenomous = 32 (0.94) Venomous = 2 (0.06)
Severity score					
Mild	4 (0.4)	836 (94.3)	366 (0.93)	21(0.95)	32 (0.94)
Moderate	3 (0.3)				
Sever	2 (0.2)	50 (0.056)	10 (0.03)	1(0.05)	2 (0.06)
Death	1 (0.1)	0	0	0	0

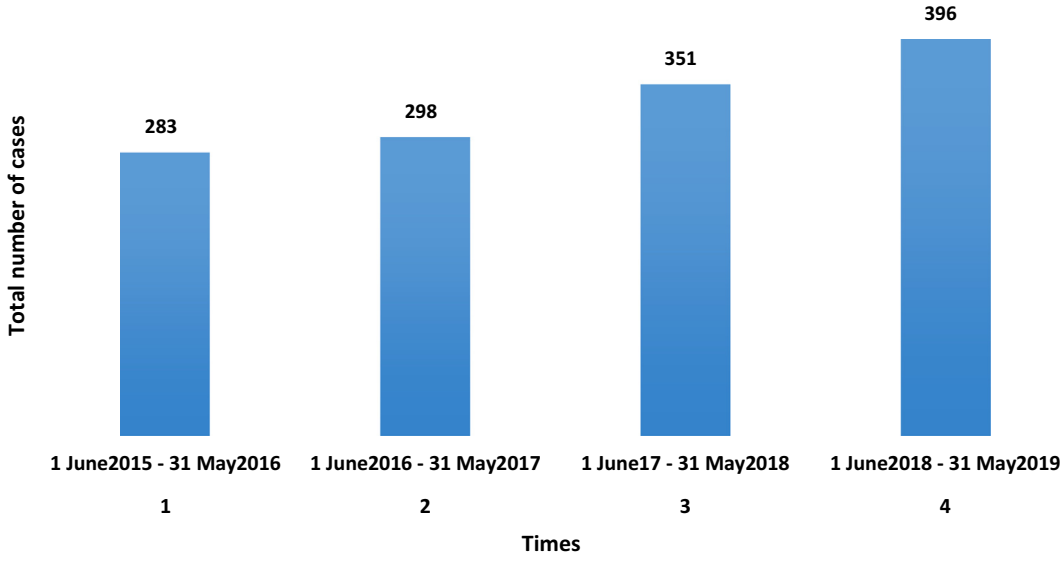

Fig. 1. Frequency of bite cases by years.

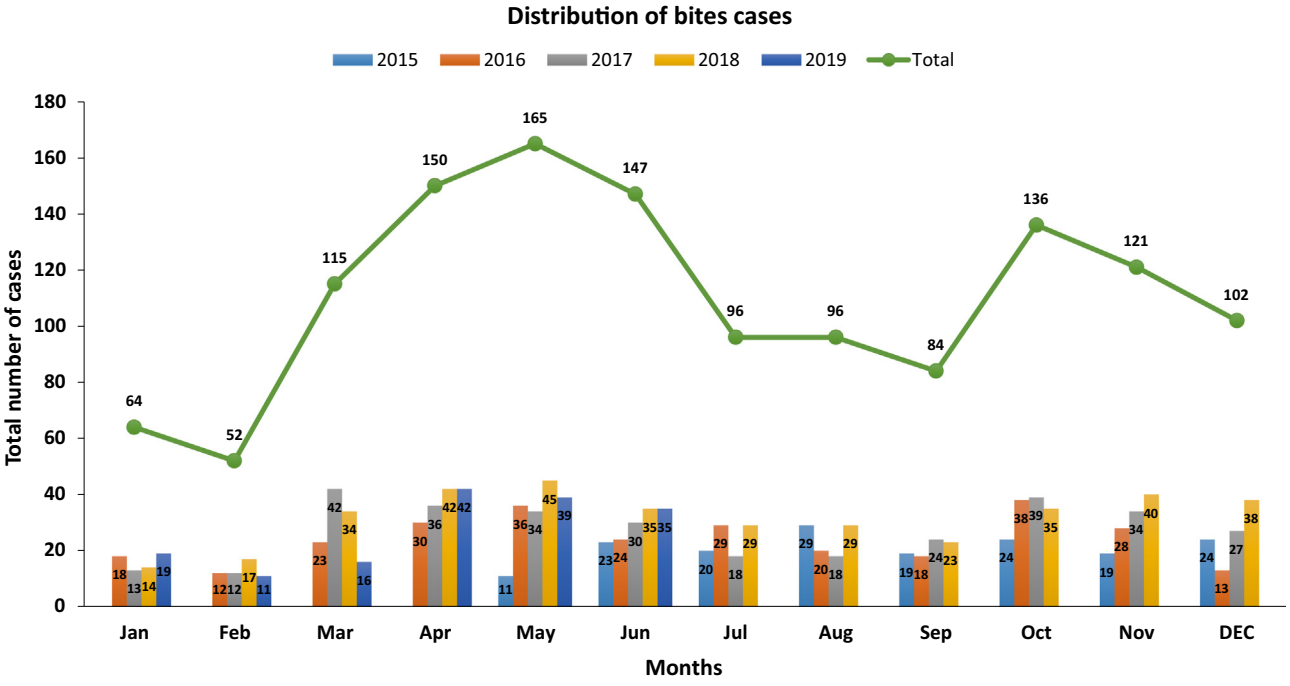

Fig. 2. Seasonal distribution of bites cases.

other hand, the majority of cases in this study presented to the ED within six hours of the injury. Few cases presented after 12 h, which can worsen the condition and need more intensive and costly treatment. This may be due to a lack of awareness about the need for early management. Further study is needed to understand such behaviors.

The prevalence of insect bites in this study is very high (66.6%) compared to other types of bites and stings in this study. This finding is in agreement with other studies conducted in the US. Where they reported that insect bites were the common animal-related injuries (Nogalski et al., 2007). Majority of insect cases were complain about allegies. Althought, ant allergy is also a rare clinical problem involving local to systemic reaction and life-threatening anaphylaxis. The black ants (samsum), are considered health hazard in many parts of Saudi Arabia and the World. Cases with history of recurrent anaphylaxis following black (samsum) ant stings in Saudi Arabia have been reported in the literature (Al-Shahwan et al., 2006). Morphology and ultrastructure of the venom gland of queens and workers of the samsum ant *Brachyponera sennaarensis*, which is known for its very painful sting (Billen and Al-Khalifa, 2018).

Furthermore, in our study the occurrence of cat bites 281 cases (75%) is much higher than dog bites 41 cases which only account for (11%) of the total animal bites. This finding is inconsistent with other reports which have shown dog bites incidence of up to 90% of all animal bites cases. This can be attributed to the culture of avoiding having dogs, leaving more cats to be the most popular choice as home pets. However, cat bites can be severe and involve

Table 3
Total and mean direct health care costs per patient of different bites and stings by severity category, prices in 2019 Saudi Riyals.

	Total direct cost (SAR)	Mean costs (SAR)	SD (SAR)
Snake			
Mild	15,005	3,750	645
Moderate	87,707	29,444	12,089
Sever	92,286	46,143	13,010
Death	43,142	43,142	–
Total	**238,140**	**26,460**	**19,368**
Insect			
Mild	832,974	996	333
Sever	395,650	7,915	1,642
Total	**1,228,624**	**1,387**	**1,687**
Animal			
Mild	1,443,599	3,944	735
Sever	238,322	23,832	4,783
Total	**1,681,921**	**4,473**	**3,363**
Human			
Mild	112,550	5,374	1,290
Sever	11,494	11,494	–
Total	**124,044**	**5,638**	**1,792**
Scorpion			
Mild	121,624	3,878	853
Sever	35,276	17,751	1,968
Total	**156,900**	**4,615**	**3,382**
Total cost	**3,429,629**	**2,583**	**7,572**

*SD = Standard Deviation, SAR = Saudi Riyal.

infections more than dog bites, and this also indicates how necessary is the early treatment to reduce the likelihood of infection spreading to deeper structures such as bone and joint infection (Griego et al., 1995; Benson et al., 2006; Quirk, 2012).

When observed, the seasonal variation of the cases, bites and stings injuries were more prevalent during spring and summer months, similar findings have been stated in other studies (Kama et al., 2019). That is because people tend to go outdoors for camping and picnicking in mountain and desert during this period (Mosbech and Bay-Nielsen, 1991).

The majority of bites and stings cases in this study were mild, and patients were treated and released from the ED. Although the majority of the cases were mild, they went to the ED and sought medical help associated with high medical costs. This is consistent with literature were animal-related injuries required hospitalization in only 1.8–2.7% of the cases (Nogalski et al., 2007; Langley et al., 2014). Hospital stay ranged from 1 to 23 days; this is lower than what is reported in other studies were duration hospitalization ranged from 2 to 68 days (Nogalski et al., 2007; Kama et al., 2019). This is mainly because most of the cases were mild, and they arrive early at the hospital.

There were more than 50 species of snake in Saudi Arabia; about 20% of them are venomous (Al-Sadoon, 2015). In this study majority of cases were recovered and cured with only one patient died as a complication of snakebites. This mainly because those patients arrived in a reasonable time frame and receive the appropriate medical intervention and supportive care, in addition to the availability of poly antivenom targeting the local venomous snakes. This is in agreement with several studies that demonstrate the low mortality rate (0.3%) from snake bites in Saudi Arabia (Al-Sadoon, 2015; Al Durihim et al., 2010). Due to the nature of this study, we don't have detailed information about the snake species involved with each case, so it is hard to conclude the actual cause of death. Still, we noted that the patient did arrive more than 6 h, which consider a little late compared to the other cases.

Majorities of bites and stings injuries occurred in upper and lower extremities, which is similar to other studies that found most of the cases were on upper hand or arms, and approximately 27.5% were on legs (Langley et al., 2014). As those areas were often left uncovered, this indicates that increase awareness about the importance of wearing long sleeve shirts, full pants and, shoes or boots can prevent many bits and sting cases. Also, Appling insect repellent may prevent many insect bites.

Bites and sting cases indicate a high economic burden where the total cost of managing bite and sting cases during the study period was 3,429,628 SR. The cost of snake bites cases was associated with the higher cost range from 3,000 SR per case for mild cases to 46,143.00 SR per case for severe cases, followed by severe animal bites (23,832.16 SR) and severe scorpion cases which cost around (17,638.19 SR) per case. A US-based study estimated that the cost of treating snakes bites range from $242 to $1,813,253, with an average of $86,333 per case. On the other hand, the cost associated with the management of scorpion stings ranged from $905 to $253,511, with an average of $31,322 per case. For wasp and bees, the cost ranged from $117 to $746,799, with an average of $20,598 (Forrester et al., 2018). Another study conducted in Iran demonstrated that the cost of treatment snake bites was $ 2,104 (7,890 SR) per case, and scorpion stings cost 1192$ (4470SR) (Mashhadi et al., 2017). There are additional expenses for bites and stings injuries that we are not included in this study, such as non-medical and indirect medical costs like lost earnings due to work absences, as we did not have the necessary data to calculate such cost. In the USA, it has been estimated that indirect medical costs in the form of lost productivity can cost $5,674,230,000 annually (Langley et al., 2014). However, as many of the cases in our study were not severe, the impact of these costs could be low.

Our study indicates that diagnostics tests and medications accounted for a large share of the health care cost of treating bites and stings. This result is in line with the literature where they demonstrated the treatment of snake bites and scorpion stings is effective but expensive. Therefore, considering the value of all medical health resources used in the treatment and diagnosis of bites and stings when developing a treatment protocol would result in a more appropriate and efficient cost-saving strategy. This cost can be further reduced by establishing awareness programs about bites and stings, emphasizing the importance of wearing shoes, and sleeping indoors will be effective preventive steps. The findings of this study would be of use for decision making in planning specific interventions to mitigate such cases. National epidemiological, social, and economic data are required to explore the burden of bites and stings on the health care system in Saudi Arabia, which will help the decision making in prioritizing health resources.

4.1. Limitations

This was a retrospective study, which is associated with some inherent biases in such a study design. The data were calculated from only one academic institution for those who arrived in the ED with bites and stings injuries. Finding of this study may not reflect the treatment pattern and resource utilization in another institute who may use different guideline in treating bite and sting cases.

In this study, we did not include cases that untreated or those who were self-treated, which may underestimate the healthcare burden associated with bites and stings. A national survey would provide a better understanding of the problem and could help generate a more thorough discussion of these issues.

Another limitation is that majority of insect bite cases were classified as an unspecific insect, as in many cases, patients may be bitten but not seen the insect, or it may be due to a limitation of the documentation of the source of insect bites in our data. This information is essential, especially in the case of anaphylaxis.

Despite these limitations, this study provides a better understanding of the magnitude and economic burden of bites and stings.

5. Conclusion

Bites and stings represent a common burden in Saudi Arabia. Although a majority of cases were not serious, many cases required admission in hospital wards and intensive care units. Findings from this study may guide decision-makers about the importance of providing a public education campaign about how to deal with animal-related injuries and when to seek emergency care focus on the people who were frequently injured, and develop policies to mitigate such injuries. This will lead to reduce the number of injuries treated in EDs and accordingly reduce the hospital cost needed to treat and manage the injury result from bite or sting.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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