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RESEARCH ARTICLE

Epidemiological Characteristics, Injuries, and Rabies Post-exposure Prophylaxis among Children in Kerman County, Iran During 2019-2021

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Abstract:

Introduction:

Animal bites are important in all ages because of the physical and psychological damage, wound infection, and the risk of transmitting rabies. This study aimed to determine the epidemiological characteristics of animal bites, injuries, and surveillance of animal-bite injuries among children under 12 years who visited rabies treatment and prevention centers in Kerman.

Methods:

This was a descriptive and analytical cross-sectional study. Data about all children under 12 years old who had been bitten by an animal and visited rabies treatment or prevention centers in Kerman, Iran, during 2019 and 2021 were inquired. The data was analyzed by the Chi-square test and Fisher's exact test in SPSS24 software.

Results:

620 boys and 313 girls had been bitten by animals. The average incidence of the animal bite was calculated at 246 cases per 100,000 people. The mean and standard deviation age of the injured children was 7.68±2.98 years. The place of the child's residence and the location the biting happened were 91.1% and 89.5% in urban areas, respectively. 67.6% of the attacking animals were dogs and half of those dogs had owners. 42.5% of children had been injured in their hands. 31.5% of children did not attend the next round of vaccinations but came after the follow-up. The time interval between the bite and the time to visit the rabies treatment center for vaccination was longer in the second year of the study. (The delay for vaccination was more in the second year) and not coming to receive the next vaccinations was more in the second year of the study. There was a significant difference between the injured in the first year and the injured in the second year (p-value<0.05).

Conclusion:

The incidence of animal bites among children in Kerman city is high, showing the importance of planning for control and prevention.

Keywords: Rabies, Humans, Bites and stings, Animals, Child, Epidemiology.

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1. INTRODUCTION

Animal bites are important in all ages because they cause physical and psychological injury, wound infection, and rabies transmission [1]. Rabies is one of the diseases caused by animal bites. It causes death after acute and fatal encephalitis [2, 3]. The rabies virus is usually transmitted through the bite of infected animals, but it can also be transferred through licking wounds or mucous membranes, grasping, scratching, and inhaling contaminated air [4].

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The incidence of animal bites has been reported differently in different parts of the world according to the sensitivity of the care system in identifying animal bite cases, the availability of health service centers, the level of awareness of the population, and the climatic diversity and animal species of each region. For example, in Kenya, 289 per hundred thousand [5], in Brazil, 258 per hundred thousand (dog bite) and 41 per hundred thousand (cat bite) [6] and in Uganda 21 per hundred thousand [7] were reported.

The overall average incidence of animal bites is 250 per 100,000 people, with 6.8 deaths per 1 million people worldwide [8].

According to the World Health Organization, more than 2.5 billion people worldwide are at risk of rabies [9]. Rabies virus transmission has been reported in 150 countries [10] and rabies incidence in humans has been reported in more than 100 countries [11]. About 59,000 people die each year from rabies worldwide, with more than 95% of deaths occurring in Asia and Africa, and 40% of rabies victims are under the age of 15 [10]. The disease has caused a loss of 1.74 million years of healthy life in children under 15 years [12]. Animal bites in children is important, especially in developing countries where human rabies is still a public health problem [13]. However, despite the preventability of rabies and the availability of effective and safe vaccines, this disease is still a health problem in many countries worldwide [14]. Annually, more than ten million people in different parts of the world are treated for rabies after animal bites [9]. On average, 40 to 60 percent of rabies vaccinations worldwide are performed on children under 15 years old [15].

Rabies is one of the major public health problems in Middle Eastern countries, including Iran [16]. In Iran, the incidence of animal bites is 180 per 100,000 people, and the incidence of rabies is less than 0.1 cases per million people [8]. In studies conducted in Tabas [17], Khorramshahr [18] and Ilam [19], most of the people who animals bit were children. In a study conducted by Maleka *et al*. in 2017 in Galikesh, most of the bitten children were in the age group of 6 to 15 years old [20]. Various studies have shown that children are more likely to be bitten by animals than adults [21] because of their smaller torso, inability to defend themselves or flee or recognize dangerous situations, and getting injured, especially on their head and face [22]. According to available reports, the psychological and social consequences of animal bites and residual scars can greatly affect the child's and his family's life [23].

The incidence of animal bites has increased in recent years in Iran and rabies incidence and death have been reported in a number of provinces, including Kerman [12]. A very important limiting factor in planning for disease control and surveillance is the lack of sufficient data. The study of animal bites epidemiology is important in different regions of the country due to demographic differences, climatic diversity and different animal diversity [18]. The growing trend of stray dogs and the increased number of animal bites in Iran [10] remind us of the need to pay more attention to rabies. The results of studies about the epidemiology of rabies can help managers in decision-making and can help in designing prevention and control programs for this health problem.

Therefore, this study was performed to determine the epidemiological characteristics of animal bites, injuries, and surveillance of animal-bite among children under 12 years who visited rabies treatment and prevention centers in Kerman.

2. MATERIALS AND METHODS

The present study was a cross-sectional descriptive-analytical study. The data was collected from April 1, 2019, to the end of March 2021. All children under 12 years old who had been bitten by an animal and visited rabies treatment and prevention centers in Kerman were included.

There are 2 rabies prevention and treatment centers in Kerman city and 12 centers in rural and urban areas around Kerman. The employees of these centers respond to clients 24 hours a day. According to national guidelines, data is routinely recorded in each center in the national excel form. Due to the fact that the data is registered online in the portal of the Ministry of Health, all parts must be completed and no missing data was found. The data recorded by the covered centers are routinely checked by the person in charge of the rabies prevention program at the headquarters of the city health center, and if there is wrong data recorded, researchers correct the incomplete or wrong data by calling the injured person. In order to conduct this research, after receiving the code of ethics from the Kerman University of Medical Sciences, the first author obtained the final data of the whole city in the form of an Excel form from the headquarters of prevention and combating diseases of Kerman Health Center, and extracted the data related to children that were recorded in a researcher-made checklist and finally recorded in SPSS software version 24.

The variables included in this study were nationality, age, gender, place of residence and place the biting incident happened (according to city and village), month and time of bite occurrence, type of invasive animal, vaccination status of invasive animal, incident description, number of bitten limbs, type of injury, need to receive immunoglobulin, the time interval in hours and days between the time of bite and vaccination and receiving immunoglobulin, absence from treatment, injection or non-injection of the tetanus vaccine. Significance levels were considered less than 0.05. Quantitative data were displayed as mean and standard deviation and qualitative data were presented as absolute and relative frequency through graphs and statistical tables. Chi-square and Fisher's exact test was used to analyze data.

This study was approved by the Ethics Committee of Kerman University of Medical Sciences (Ethics Approval Number: IR.KMU.REC. 1400.322).

3. RESULTS

From April 2019 to March 2021, 933 children under the age of 12 years old had been bitten by animals and visited rabies prevention and treatment centers in Kerman, Iran. The number of animal bites in the first and second years of the study was 497 and 436, respectively. The incidence rate of animal bites in the first year of study (April 2019 to March 2020) and in the second year of study (April 2020 to March

2021) was 262 and 231 per 100,000 children under twelve years of age, respectively. The average incidence of the animal bite was calculated at 246 cases per 100,000 people. The mean age of the injured was 7.68±2.98 years old. 99 (10.6%) children were in the age group of fewer than 3 years old, 225 (24.1%) children were in the age group of 4 to 6 years old and 609 (65.3%) children were in the age group of 7 to 12 years old. Other demographic information, the type of invasive animal, and the time of the bite are presented in Table **1**.

Most children had been bitten by dogs (Table **1**). From 632 dogs who had bitten children, 431 (68.2%) had owners (396 domestic dogs, 29 guard dogs, and 6 herd dogs) and 201 (31.8%) were stray dogs. Only 212 (49.9%) of the owned dogs had been vaccinated. 164 (69.2%) cats were stray cats and 73 (30.8%) had owners. From the 73 cats which had an owner, only 4 (5.5%) cats were vaccinated.

More bites were reported in summer and spring. Also, most cases of bites happened in September and the lowest numbers were in March (Fig. **1**).

The frequency of the accident, injured limb, type of injury, and the number of wounds are shown in Table **2**. In 6 (0.6%) children, the wound was sutured due to the severity of the injuries, and 5 of these severe injuries were reported in children under 6 years old. A statistically significant relationship existed between the affected organ and age group (P<0.0001). Head, face, and neck injuries were 20% in children under 3 years old, 12% in children 4 to 6 years old and 6.4% in children 7 to 12 years old.

868 (93%) injured persons had been referred to rabies treatment and prevention centers in the first 48 hours after being bitten. Of the total cases of animal bites, 553 (59.2%) people needed immunoglobulin injection, of which 381 (68.9) people had been injected with immunoglobulin before 12 hours Table **3**.

Table 1. Demographic information, type of invasive animal, and bite time.

Variable		Number (Percentage)	Variable		Number (Percentage)
Gender	Boy	620 (66.5)	Nationality	Iranian	862 (92.4)
	Girl	313 (33.5)		Non Iranian	71 (7.6)
Location	Urban	850 (91.1)	Location of the accident	Urban	835 (89.5)
	Rural	83 (8.9)		Rural	98 (10.5)
Invasive animal type	Dog	632 (67.7)	Time of incident	1 - 6 AM	22 (2.4)
	Cat	237 (25.4)		7 - 12 AM	259 (27.7)
	Hamster	44 (4.7)		1 - 6 PM	410 (43.9)
	Other	20 (2.1)		7 - 12 PM	242 (25.9)

Table 2. - Frequency of accident, injured limb, type of injury and number of wounds in injured children referred to rabies treatment and prevention centers in Kerman.

Variable	Classification	Number (Percentage)	Variable	Classification	Number (Percentage)
Description of the incident	Sudden attack of the animal	363 (38.9)	Injured limb	Hand (including fingertips to wrist)	394 (42.2)
	Playing with the animal	313 (33.5)		Lower limbs (including legs-buttocks)	295 (31.6)
	Feeding the animal	88 (9.4)		Hands (including forearm, arm, shoulder)	84 (9)
	Annoying the animal	77 (8.3)		Head, face and neck	86 (9.2)
	Defending against animal attack	57 (6.1)		Chest, abdomen, back	25 (2.7)
	Taking care of the animal	31 (3.3)		Two organs of the body	39 (4.2)
	When sleeping	4 (0.4)		Three organs and more	10 (1.1)
Type of injury	Puncture and scratching	573 (61.4)	Number of wounds	1	205 (21.9)
	Scratch	345 (36.9)		2	541 (57.9)
	Perforation	8 (0.8)		3	113 (12.1)
	Crushing a part of the body	6 (0.6)		>3	74 (7.9)
	Bone fracture	1(0.10)			

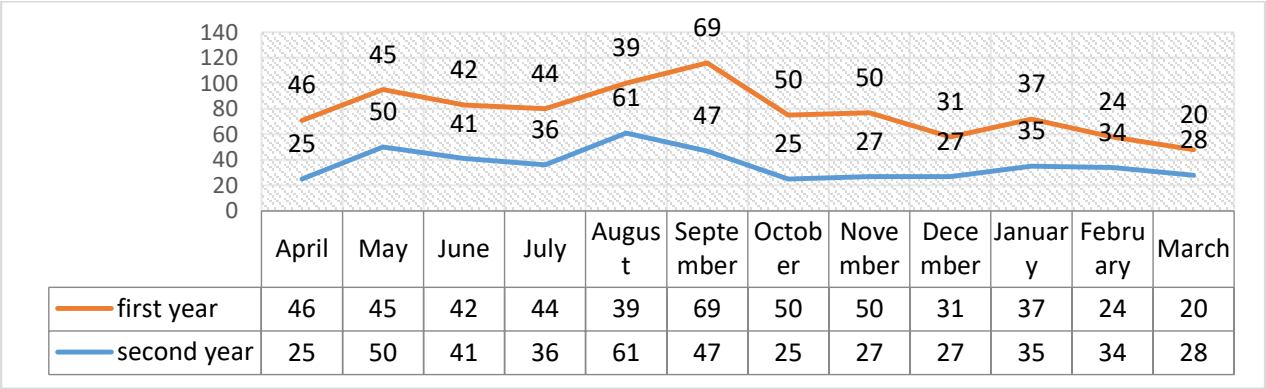

Fig. (1). Occurrence time by month among children under 12 years of age referred to rabies treatment and prevention centers in Kerman, From April 2019 to March 2021.

Table 3. The time interval between the bite and the first dose of the rabies vaccine and immunoglobulin.

Number (Percentage)	Variable		Number (Percentage)	Variable	
381 (68.9)	Less than 12 hours	The interval between the bite and the immunoglobulin injection	868 (93)	Less than 48 hours	The interval between the bite and the rabies vaccine injection
151 (27.3)	12 - 72 hours		52 (5.6)	48 - 72 hours	
21 (3.8)	4 - 7 days		12 (1.3)	4 - 10 days	
			1 (0.1)	11 - 20 days	

The time interval between the bite and the time to visit the rabies treatment center for vaccination was longer in the second year of the study (P = 0.03). The delay for vaccination was more in the second year, and not coming to receive the next vaccination was more in the second year of the study. There was a significant difference between the injured in the first year and the injured in the second year (P = 0.006).

There was no statistically significant relation between nationality and the time interval between the bite and receiving the first rabies vaccine (P = 0.72) or immunoglobulin (P = 0.28). There was no statistically significant relation between the residential location with the time interval between the bite and receiving the first dose of the rabies vaccine (P = 0.081) or immunoglobulin (P = 0.179).

294 (31.5%) of the injured did not come for the next round of vaccinations, and after follow-up and phone calls from the Rabies Treatment and Prevention Center staff, they came for the next round. In the first year of the study, 137 (27.5%) cases, and in the second year of the study, 157 (36%) cases came to receive the vaccine with follow-up by telephone.

96 (10.3%) injured had received 4 doses of vaccine. In 801 (85.9%) injured patients, after making sure that the animal was alive, there was no need for the fourth round of vaccine and three rounds of vaccine had been injected. For 36 (3.9%) people who were previously bitten by an animal and received a vaccine, two doses of booster vaccine were injected within 3 days after being bitten.

668 (71.6%) children had a history of tetanus vaccination and did not need to receive the vaccine again. 260 (27.8%) children with a history of tetanus vaccination and 5 (0.5%) children without a history of tetanus vaccine received the tetanus vaccine according to national protocols.

Antibiotics were prescribed for 859 (92%) injured children, and none of the children had a wound infection on their next visits to receive the vaccine.

According to the treatment measures, all the injured have recovered, and no deaths due to animal bites were reported during the two years under study.

4. DISCUSSION

The present study was performed on children under 12 years of age bitten by animals in Kerman for two years. According to the results of this study, the incidence of animal bites is high among children in Kerman.

Considering that children who frequently suffer surface scratches while playing with pets may not visit rabies prevention and treatment centers, the actual rate of animal bites in children is probably higher than the rate reported in the study.

In a study conducted by Nikbakht *et al*. in Babol, the incidence of animal bites in the population under 18 years of age between 2011 and 2015 per hundred thousand people was reported to be between 82.5 and 123.1, which shows an upward trend during the 5 years of study [24]. Probably, the difference

in the time and place of conducting the study is one of the reasons for the higher incidence of animal bites in the children of this study. In Kerman, due to long-term droughts due to the lack of water and food in the natural habitat of animals, the abundance of animals in the city has increased compared to the past, and this issue may be the reason for the high incidence of animals bites compared to Babol, which is one of the northern and the rainy cities. Also, the increase in people's awareness to refer to rabies prevention and treatment centers compared to the past may be a reason for the increase in incidence in this study.

According to the results, the incidence of animal bites was less in the second year of the study. The COVID-19 epidemic, quarantine, and people commuting less outdoors are probably the reasons for the lower frequency of animal bites in the second year of the study. Fear of Covid-19 may have also prevented parents from seeking medical services at rabies treatment and prevention centers.

In the present study, most cases of animal bites occurred in boys (66.5%). In other similar studies in Iran, including the study of Hatami *et al*. in Bushehr [25], Pourmarzi and Razi in Gilan [15] and Nikbakht *et al*. in Babol [24], animal bites were reported more in boys than girls. For cultural reasons, in Iran, girls go out less than boys. Also, boys travel more to high-risk areas and harass animals more than girls.

In this study, most children lived in the city and most bites occurred in urban areas. In a study from Tehran and its suburbs, most bites occurred in the city, which is consistent with the results of this study [26].

Probably, the reason is that the urban population is more than the rural population in the present study and the study conducted in Tehran. In the current study, the higher number of animal bite cases in urban areas can be attributed to the fact that the urban population is about 5 times higher than the rural population of the city, climate changes and numerous droughts in recent years, and animals moving closer to urban areas to search for food, the greater interest of urban families in the years and keeping of dogs at home and the lack of awareness of the city dwellers on the treatment of animals. Contrary to the results of the present study, in a number of studies, such as in Babol 73.1% [24] and Gilan 71% [15], animal bites occurred more often in rural areas. In the aforementioned studies that were conducted in the northern provinces of Iran, the reason is probably the high rural population in those regions compared to other regions of Iran. Also, if the houses in those areas are not fenced, there should be a closer connection with the natural environment and animals and the presence of rural children outside the house, which will have an effect on the incidence of animal bites in rural areas of the northern provinces.

According to the results of the present study, the mean age of the injured was 7.68 ± 2.98 years old. Most bites were in the age group of 7 to 12 years and decreased with age. In a study conducted in Babol, 46% of boys and 49% of girls who had been bitten by an animal were in the age group of 7 to 12 years [24]. In the study conducted in Gilan, 45.6% of children who were bitten by animals were in the age group of 5 to 9 years old [15]. In a study conducted in Galikesh, which examined all age groups that were bitten by animals, most bites were in the age group of 6 to 15 years old [20]. In a Thai study, the average age of children under 14 years old which had been bitten by animals was reported to be 6.7 years old [27]. In the study conducted by Tepsumethanon *et al*. in Thailand, 42.3% of those bitten by animals were in the age group of 10 to 14 years and 39.7% in the age group of 5 to 9 years old [28]. One of the most common reasons for animal bites in this age group is the presence of older children outdoors for various reasons, as well as passing beside dogs when going to school and provoking them. Probably more parental care for younger children could be a reason for the lower frequency of bites in that age group.

The highest frequency of animal bites in the present study was observed at the end of summer (September) and spring; the lowest was related to the end of winter (March). In a study conducted by Kasiri *et al*. in Khorramshahr on five years' data, the frequency of animal bites was more common in the spring [18]. In the study of Jannat Al-Makan *et al*., which was conducted in Kermanshah on four years' data, the prevalence of animal bites was higher in spring and then summer [9]. In other studies, conducted on children in Gilan and Babol, the frequency of animal bites were reported more in summer and spring [15, 24], which is consistent with the results of this study. This is probably due to the closure of schools, lower parental supervision, and more contact with animals. Children also spend more time outdoors due to pleasant weather.

According to the results of the present study, 44% of children were bitten between 13:00 - 18:00, and 28% of children between 7:00 until 12:00 am. In the study of Pourmarzi *et al*. in Gilan, most children were bitten between 12 and 18 pm [15].

In the study conducted by Nikbakht *et al*. in Babol, 47.2% of children were bitten between 12 until 18 pm and 30.5% between 6 am - 12 pm [24], which is consistent with the results of this study.

Most of the children studied were attacked by dogs. Every year, 59,000 human deaths occur from rabies worldwide, which 99% were from dog bites [10]. Similar to the results of the present study, in other studies conducted in Iran, most cases of animal bites were from dogs. For example, in the study of Ghanad and et.al in Ilam, 89% [29], Mohammadzadeh in Hamedan, 77% [30], Rahmanian in southern Iran, 68% [31], Hatami *et al*. in Bushehr, 79.6% [25] of the bites were from dogs. In the Nikbakht study in Babol, 87.1% and 80.6% of boys and girls were bitten by dogs, respectively [24]. Other epidemiological studies in other parts of the world indicate a higher percentage of animal bites by dogs [23, 32].

Considering that the urban population in most parts of Iran is more than the rural population and the relationship between urban dwellers with animals such as dogs, either as pets or as guard dogs, is more than other animals, the reason for the high rate of bites by dogs compared to other animals. Also, stray dogs are more than other animals, another reason for being bitten by this animal.

According to the results of this study, only half of the dogs and 5.5% of the cats were vaccinated. Vaccination of pets, especially dogs and cats, in Iran is essential due to the high

number of accidental bites.

According to the results of this study, the cause of the accident in most cases was a sudden attack of the animal and playing with the animal. In the study of Pourmarzi *et al*. most of the children had an accident while entering the dog kennel, and in the next rank, they were bitten while playing with or harassing the animal [15].

In the present study, the highest prevalence of injury was in the hand area. But, in a study conducted on children and adolescents in Babol, the node parts most injured were the upper limbs [24]. However, in some studies, the most affected organs were the legs and lower limbs. These differences might be due to the different ages of the participants in these studies [18, 29]. In adults, the legs are the first defense against the attacking animal. But, children may stimulate or caress animals with their hands and feed the animals, which makes their hands more prone to bites.

According to the results of this study, the highest rate of head, face and neck injuries was seen in children under 3 years of age, which is consistent with the study of Pourmarzi *et al*. in Guilan province [15]. A study by Pandey *et al*. in Nepal found that children were more prone to head and face bites [33]. In a study conducted in Babol, younger children were more injured in their upper limbs [24]. In the study of Hatami *et al*. conducted in Bushehr, the site of the bite in children under 5 years of age was in 41.5% of cases in the upper extremities [25]. In Nigeria, head injuries were reported to be the most common body part bitten among children [34]. This can be due to the short height of children under three years of age, and their inability to flee from the attacking animal.

According to the data of the present study, most of the injuries caused by animal bites were perforation and superficial scratches, and most children had 2 wounds or less in the injured limb. In 0.6% of children, the wound was sutured due to the severity of the injury, which was mostly related to children under 6 years old. In studies conducted in Mashhad and Babol, in more than 90% of cases, the wounds were superficial scratches [24, 35]. In the Pourmarzi study in Gilan province, 61% of children had a single wound and 1.2% of children were hospitalized due to the severity of injuries and 0.8% of children had sutured wounds due to the severity of injuries [15]. Children under 6 years of age may be more prone to severe injuries due to a lack of adequate defense or response skills during an animal attack.

In this study, most of the injured children received rabies vaccine and immunoglobulin in less than 48 hours and 12 hours, respectively. In a study conducted in Babol, 94.6% of children and adolescents visited medical centers without delay [24]. In the study of Pourmarzi and Raz in Gilan province, 13.8% of the subjects visited centers with a delay of 24 hours and more, and 5.5% with a delay of 48 hours and more, and the reasons for this delay were because the injury happened in the village, it was superficial or they were unaware of the need to do rabies vaccination after the bite [36]. Timely referral of rabies victims to rabies prevention and treatment centers indicates the high awareness and sensitivity about rabies in the community. For this reason, educational programs should be developed and implemented to inform people about rabies and the need for rabies vaccination after the accident.

31.5% of children did not visit the medical center for the next round of vaccinations but showed up after followed up. In the second year of the present study, there was more delay in the first visit and more absences to receive the next round of vaccines, which may be due to the prevalence of COVID-19, and parents not coming to vaccinate their children due to fear of COVID-19.

In the present study, 85.9% of the injured did not need to receive the fourth round of vaccine after making sure that the animal was alive, and three rounds of vaccine had been injected for them. In other similar studies, most of the victims only needed three doses of the anti-rabies vaccine [15, 24, 25]. According to national guidelines, if the attacking animal is a dog or cat and survives after ten days, the animal is not rabid and there is no need to inject the fourth round of vaccine [8].

According to the results of the present study, due to the implementation of the national vaccination program in Iran, most children had a history of tetanus vaccine injection and according to the national protocol, did not need to receive the tetanus vaccine again [15].

According to the results of this study, all patients recovered, and due to receiving antibiotics and washing and disinfecting the wounds, no case of wound infection was observed. No rabies deaths were reported during the two years of study.

5. LIMITATIONS

In this study, data recorded in the health sector were used. The researchers were not involved in data collection and were not aware of the accuracy of the information.

In this study, the incidence rate was calculated based on cases referred to rabies prevention and treatment centers. Because it is possible that children who are repeatedly scratched by pets may not refer to rabies prevention and treatment centers, so it is not possible to determine the actual incidence in an area.

CONCLUSION

This study showed that the incidence of animal bites was high in Kerman city and the main animals causing the bite were dogs, only half of which have owners. Animal bites can place a heavy financial burden on the healthcare system and psychological burden on the injured and their families. Therefore, common policies such as the extermination of stray animals, planning for vaccination of animals, as well as extensive education for the community for prevention of animal bites and, if bitten, timely referral to medical centers and receiving vaccination and immunoglobulin should be considered for prevention and control programs. Also, due to the high dog bites, it is recommended to vaccinate domestic dogs and leash dogs when going outdoors.

AUTHORS' CONTRIBUTIONS

E.D. and A.D. Concept, design, literature search, Data

acquisition and manuscript editing. A.M. and S.S. and R.R. Data analysis, statistical analysis, and manuscript editing. S.D. Supervision and manuscript review. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Ethics Committee of Kerman University of Medical Sciences (Ethics Approval Number: IR.KMU.REC. 1400.322).

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or research committees and with the 1975 Declaration of Helsinki, as revised in 2013.

CONSENT FOR PUBLICATION

All the participants volunteered to participate in the study, and secondly, Keeping in mind the principles of confidentiality and secrecy, participants were assured that all information would remain confidential and that the results would be reported in a general manner.

STANDARDS OF REPORTING

STROBE guideline has been followed.

AVAILABILITY OF DATA AND MATERIALS

The data supporting this study's findings are available from the corresponding author [S.D] upon reasonable request.

FUNDING

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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