

Original Research Paper

# Epidemiological Characteristic of Animal Bite and Direct Economic Burden of Rabies Vaccination in the Southern of Iran

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**Abstract:** The ever-increasing cases of animal bites caused by rabies, livestock losses, as well as economic damages are of utmost importance in developing countries. This study was conducted to determine the epidemiology and the direct economic burden of rabies vaccination in southern Iran in 2018. In this study, 375 cases of animal bites which were recorded in Rabies Treatment Centers of Larestan County, Iran were entered into the study by census method. The data were collected from the registered office profile of people who had referred to these centers. The variables examined included victims' demographic characteristics, bite specifications, spatial and temporal patterns, victims' clinical dimensions and vaccination costs. Of 375 registered cases, 83.7% of the cases were male and there was no statistically significant difference between the mean age of males ( $30.82 \pm 17.31$ ) and females ( $30.49 \pm 18.79$ ) ( $P = 0.895$ ). As well, 58.7% of the victims were residing in urban areas and farmers (25.6%) and students (23.9%) were the most frequent occupational groups suffering from animal bites (%) ( $p < 0.001$ ). The most cases of the bites i.e., 68% had been also produced by dogs and 64% of them were from the owned biting animals. As well, direct costs were estimated US\$ 9373 for vaccine, US\$ 24115 for rabies RIG and the US\$ 33488 cumulative economic burden in the studied period. In conclusion, it is found that the major cases of animal bites in Larestan County had been caused by dogs and owned biting animals which could impose a heavy burden on Iran's economy.

**Keywords:** Epidemiology, Animal Bites, Rabies, Economic Burden, Larestan

## Introduction

Rabies is known as one of the most dangerous viral zoonotic diseases that can infect all mammals (Tiembré *et al.*, 2018). Despite being preventable and given the existence of safe and effective vaccines, rabies has still remained a major health problem in numerous countries across the world (Kasem *et al.*, 2019; Banyard *et al.*, 2018). Considering the incidence rate of rabies in the world, Iran is one of the countries with a history of rabies occurring both in wildlife and domestic animals. The given disease is still recognized as one of the health-related and economic problems and almost infection cases with rabies are observed

more or less in all provinces in Iran (Abedi *et al.*, 2019; Hamta *et al.*, 2019).

According to Pasteur Institute of Iran, in the northern provinces of Iran foxes, jackals and dogs are carrying rabies. In the northwest and western provinces, wolves, the natural reservoir of rabies virus is also carriers. In the most cities and villages, urban rabies is common among stray dogs and cats. Therefore, in Iran, surveillance system carries out primary prevention (Post-Exposure Treatment-PET) for total animal bite cases, regardless of the animal's carrier status of rabies virus for prevention of rabies (Abedi *et al.*, 2019; Gholami *et al.*, 2017).

Post-exposure treatment-PET in Iran is such that the rabies vaccine is injected based on the WHO protocol,

which has been prepared with regard to the severity of the injury and the amount of contamination. Based on this, the people referred to include three groups: Group A: Calling or feeding animals, losing healthy skin that does not require vaccine and RIG. Group B: Include teeth of naked skin, small scabs without bleeding, who should receive a vaccine. Group C: Include deep wounds and exposure to bats that should receive vaccine and RIG. In Iran, the Essen Regimen is used for immunization, which consists of five injections of vaccine on days 0, 3, 7, 14 and 28, respectively. In cases where the animal, the dog and the cat are the owner and survive 10 days after the bite event, this means that the dog or cat is not carrying rabies at the time of the event and the patient does not receive the vaccine 14 and 28 (Abedi *et al.*, 2019).

Increased incidence rate of animal bites can also result in rising economic costs for the care and treatment of victims including the costs of vaccines and Rabies Immunoglobulin (RIG) in a way that its global costs have been estimated by one billion US dollars annually (Wangdi and Ward, 2012; Anyiam *et al.*, 2017).

Wangdi and Ward (2012) in Bhutan showed that the average direct medical cost of human post-exposure treatment was US\$ 35.65 per 5-dose Essen regimen per patient if rabies vaccine is used only. The cost would increase to US\$ 55.13 and US\$ 433.41 per patient when one dose of either Equine Rabies Immunoglobulin (ERIG) or human rabies immunoglobulin.

The PET costs and those for canine rabies prevention and control programs are similarly known as the most significant determinants of social costs of rabies in endemic countries. In addition, costs of PET in countries where in their healthcare systems are based on out-of-pocket payments and the major costs are directly payable by the public are extremely burdensome (Shwiff *et al.*, 2018; Le *et al.*, 2018).

The economic costs of animal bites can be divided into direct costs (vaccine, Rabies Immunoglobulin- RIG, syringe, disinfectants, staff salaries, etc.) and indirect costs (costs of transports by patients to receive PET and costs of losing income during visits) that can have a significant impact on disease control (Wangdi and Ward, 2012). In addition to the financial costs of animal bites prevention and treatment; socio-psychological consequences of bites and the remaining scars can also greatly affect the life of individuals and their families (Babazadeh *et al.*, 2016; Mbilo *et al.*, 2019).

Therefore, obtaining accurate information about the economic burden of animal bites can help decision-makers in different countries in terms of prioritization and estimation of the problem severity, cost-benefit achieved compared to other methods of reducing incidence rates of animal bites and allocation of resources, as well as fight against the disease. Accordingly, the purpose of this study was to determine

the epidemiology and the direct economic burden of rabies vaccination in Larestan in 2018.

## Methodologies

In this study, 375 cases of animal bite in a one-year period between 21st March 2018 to 20th March 2019 longitudinally in Larestan County located in the south Fars province, Iran were entered in to the study by a census method.

The animal bite clinics and treatment centers in this County had five units for the prevention of rabies, which provided health care and treatment services for all victims of animal bites. The data were collected through the information of the registered profiles of individuals who had referred to the Rabies Center of Larestan County. Normally, these forms included variables of age, gender, living place, type of biting animal, occupation, number of injury, bite site (hand, leg, body, face and head or neck), bite date, the number of receiving anti rabies vaccination and rabies immunoglobulin and tetanus vaccine. Data on the bitten subjects were extracted from rabies Surveillance System of the Health Deputy of Larestan University of Medical Sciences.

### Study Site

In the geographical place where this study is focused, people commonly did not keep pet dogs with themselves at the home like the western culture, but the dogs were usually used as guard at the house yard or with the sheep herds. No national rabies vaccination program was run in Iran for dogs and other pets. In urban regions, most people did not keep pet dogs and the most dogs in these regions were stray dogs.

### Animal Bitten Participants

The participants of this study included individual who referred to animal bite clinics and treatment centers due to fear of contracting rabies and/or other diseases from animal bites. All cases of animal bites in all age and sex groups referred to animal bite clinics and treatment centers in the study period were included in the study.

### Statistical Analysis

The data were analyzed by Statistical Package for the Social Sciences Version 17.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics (frequency and relative frequency), chi-square test and independent samples t-test at the significance level of 0.05 were used to analyze the collected data.

## Results and Discussion

In total, 375 bitten subjects with a mean age of (30.76±17.53) were registered and there was no

statistically significant difference between the mean age of males (30.82±17.31) and females (30.49±18.79) (P = 0.895). The bite rates in males were 83.7% among the various occupation, formers had at the highest bite rate (25.6%), followed by the students (24%) and the workers (14.67%). The most involved age group for the males and the females were 40-49 years old. The place of residence of 220 cases (58.7%) were urban regions. In terms of the place of bites, 203 cases (54.1%) occurred in urban regions. In this year, most of the cases of animal bites were in October (10.9%), December (10.4%) and January (9.9%), respectively (Fig. 1).

Most bites happened by dogs (68%), cats (26.9%) and horses (1.3%), respectively. In addition, only 34% of the animals were stray and 64% of them were owners (Table 1).

The upper extremities were the most frequent bite site (54.7%) followed by the lower extremities, trunk and head-face, respectively (Fig. 2).

In terms of the number of the wound, 214 (57.1%) of subjects had one lesions, 114 (30.4%) two and 47(12.5%) 3 and more had lesions. In term of Time (o'clock) animal bites 29.06% happened in early morning (between 5 to 10 am) and 27.2% at midday (between 11am to 3:00 pm).

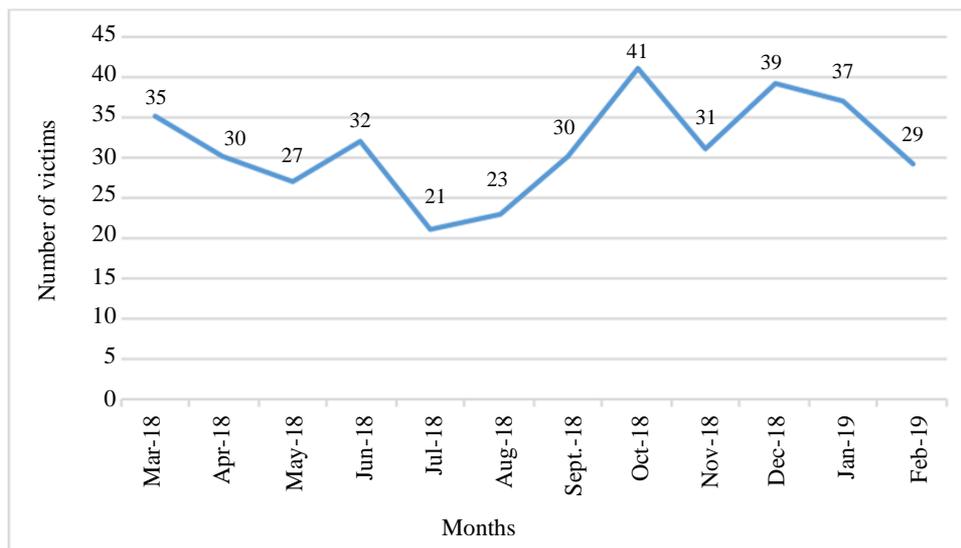
**Table 1:** Frequency distribution of animal bites cases by biter animals in Larestan county, Fars province, southern Iran

Variables		Frequency	Percentage	p-value*
Gender	Male	314	83.70	<0.001
	Female	61	16.30	
Occupation	Formers	96	25.60	<0.001
	Students	90	24.00	
	Workers	55	14.67	
	Private businessmen	48	12.80	
	Housewives	37	9.87	
	Public officers	18	4.80	
	Others	31	8.27	
Age	<4	8	2.10	<0.001
	9-May	27	7.20	
	19-Oct	74	19.70	
	20-29	84	22.40	
	30-39	86	22.90	
	40-49	96	25.60	
Place of residence	Urban	220	53.80	0.001
	Rural	155	41.30	
Place of bites	Urban	203	54.10	0.109
	Rural	172	45.90	
Season	Spring	90	24.00	0.132
	Summer	76	20.30	
	Autumn	102	27.20	
	Winter	107	28.50	
Animal species	Dog	255	68.00	<0.001
	Cat	101	26.90	
	Hours	5	1.30	
	Monkey (pet)	2	0.50	
	Sheep	1	0.30	
	Donkey	1	0.30	
	Hamster	3	0.80	
	Wild pigs	3	0.80	
	Fox	2	0.50	
	Wolf	1	0.30	
	Hedgehog	1	0.30	

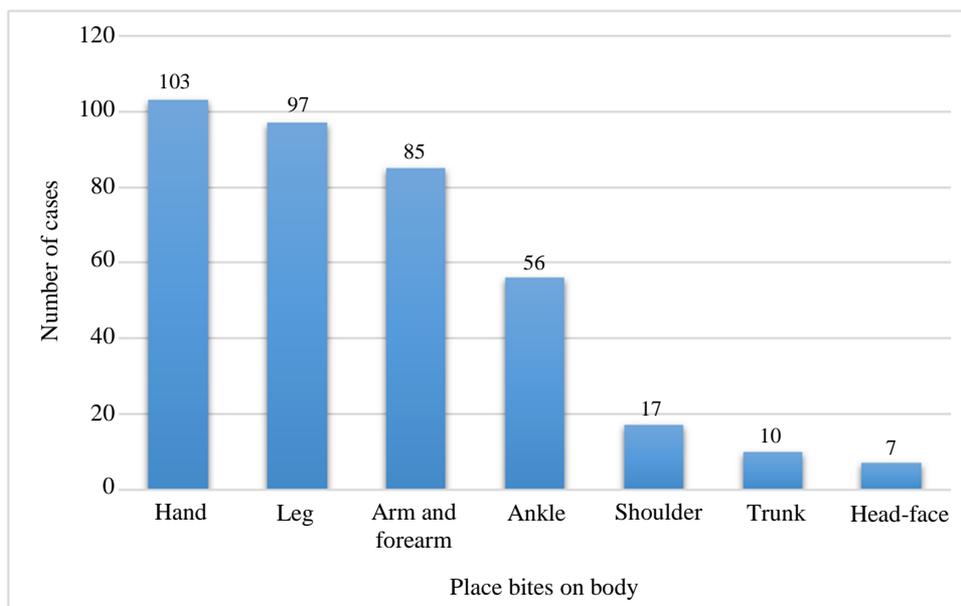
\*Chi- Square test

**Table 2:** Costs of rabies vaccination and RIG therapy for animal bite victims referred to animal bite clinics and treatment centers in Larestan county, Fars province, south of Iran (2018)

Number of vaccines and rabies RIG	Number of animal bite victims	Frequency vial of lyophilized vaccine and rabies RIG	Costs per vial (\$US)	Total price (\$US)
3 doses of vaccine	268	804	7	5628
5 doses of vaccine	107	535	7	3745
1 dose of RIG	109	371	65	24115
Total	-	-	-	33488



**Fig. 1:** Frequency of distribution of animal bites cases by month in Larestan county, Fars Province, South of Iran



**Fig. 2:** Frequency of distribution of animal bites cases by bite sites on the body in Larestan county, Fars Province, South of Iran

The cumulative incidence of animal bite during the study period was 170 per 100,000 population. No cases of human rabies were observed in our study.

#### Cost of Vaccination

The average direct medical cost of human rabies PET (including the cost of rabies vaccine without considering the costs of keeping, carrying, staff costs and the costs of syringes) was calculated.

The price of each vial of lyophilized rabies vaccine in Iran amount to US\$ 7 and US\$ 65 dollars for each vial of 300 IU RIG. According to the national instructions of

Iran, 300 IU of rabies RIG is needed for each 15 kg of the victim's weight. The direct costs of total vaccination for all the victims with three and five doses of rabies vaccine, cost of RIG therapy and total direct medical cost of human rabies PET were 9373, 2411 and 33488 dollars, respectively (Table 2).

#### Discussion

The results of this study revealed that the incidence rate of animal bites in the county of Larestan was estimated by 170 per 100,000 population in 2018.

According to the report by the Center of Disease Control and Prevention in 2018, the overall incidence rate of animal bites had reached 216 per 100,000 population. Naghibi *et al.* (2014) also reported this incidence rate by 203.4 per 100,000 population in Mazandaran Province, Iran, during 2007-2012. Besides, (Kassiri *et al.* 2014a) obtained an incidence rate of 282 per 100,000 individuals in the city of Ahvaz, Iran. In the study conducted by (Babazadeh *et al.*, 2016) in the city of Chaldoran in northwestern Iran, the incidence rate of animal bites was reported by 541 per 100,000 population. In another study in the city of Maku, Iran, the incidence rate was reported to be 250 per 100,000 individuals (Shamshirgaran *et al.*, 2017). The reason for the lower incidence rate of animal bites in the county of Larestan compared to the overall average incidence rate in Iran and other regions could be attributable to lack of suitable vegetation and its warm and dry weather conditions in a way that the temperature could reach above 50°C in the summer which in turn could lead to an inappropriate habitat for the life of animals, especially wildlife. In this study, the frequency of animal bites in the summer was reported lower than those in other seasons. In addition, residents did not use to keep dogs as pets in urban areas in the county of Larestan and they primarily had dogs as watchdogs or guarding ones in rural areas.

The findings of this study showed that men were more likely to suffer from animal bites than women (83.7%). In other investigations, gender distribution of animal bites was reported the same for example (Poorolajal *et al.*, 2015) in the city of Tehran, (Kassiri *et al.*, 2014b) in the city of (Shamshirgaran *et al.*, 2017) in the city of Tehran in Iran illustrated that 84.5, 75.4 and 79.16% of animal bite cases had occurred in men and they achieved similar results in this respect. In a similar study in the southern of India, the proportion of men was reported by 72.4% (Taylor *et al.*, 2017) which would be due to occupational exposure outside home and more contacts with risk factors (biting animals). In terms of occupational status in this study, farmers and students were more exposed to animal bites than other groups because of farmers' higher exposure to animals in rural environments. The reason for higher incidence rates of animal bites among students was that they were more likely to play with animals or tease them. In this regard, the findings of this study are consistent with the results of other studies (Kassiri *et al.*, 2014a-b; Babaeian-Moghaddam *et al.*, 2015).

Considering age groups, most animal bites had been occurred in men and women aged 40-49 years which was not in agreement with the results of other studies in a way that the age group of 10-30 years accounted for the most frequent victims (Babazadeh *et al.*, 2016; (Kassiri *et al.*, 2014a-b; Khazaei *et al.*, 2018). The

reason for such inconsistency could be the difference in demographic and sociocultural characteristics of the examined regions in terms of age at work and activity as well as occupational conditions such as agriculture and animal husbandry along with exposure to attacking animals.

In this study, most bites had been caused by dogs which were consistent with the results of other investigations (Kassiri *et al.*, 2014a; Poorolajal *et al.*, 2015; Ghaffari-Fam *et al.*, 2016). This could be owing to the greater coexistence of this animal with humans and its use as a watchdog. Other epidemiologic studies in other regions of the world had also indicated that a high percentage of animal bites had been from dogs (Smith, 2014; Lyu *et al.*, 2016).

Morters *et al.* (2013) reported in their study that Control measures for canine rabies include vaccination and reducing population density through culling or sterilization. Also (Taylor *et al.*, 2017) reported in their study that Integrating Dog Population Management (DPM) programs into rabies elimination programs could supplement the goal of breaking the rabies transmission cycle with the goal of stabilizing dog populations.

In the present study, most of the bite sites were observed in the hand (27.46%) which was in line with the results of other investigations in this field (Amiri *et al.*, 2020; Janatolmakan *et al.*, 2020). However, in a number of studies, the leg was reported as the most injured member (Abedi *et al.*, 2019; Kassiri *et al.*, 2014a; Sharafi *et al.*, 2016) this difference was due the difference in the anatomic categorization in these studies. Moreover, contrary to popular belief that most animal bites were caused by stray animals and given that every year significant costs were spent on the elimination of stray animals in most cases, the results of this study demonstrated that 64% of the animal bite cases had come from owned attacking animals.

The results of this study indicated that high costs (US\$ 33488) were spent on vaccinating the victims of animal bites against rabies and providing them with immunoglobulin (Table 1). However, this study only shows the costs of rabies vaccines and the immunoglobulin. If a broader viewpoint was taken adding the direct costs such as the material costs (syringe, needles, swabs, antiseptic, etc.) and overhead/operating costs (including staff salaries) and indirect patient costs such as transport costs, income loss and intangible costs like pain and suffering produced by animal bites injury; total costs caused by animal bites would be reported much more.

Accordingly, (Wangdi and Ward, 2012) in their study on costs of human and animal rabies control and prevention in Bhutan in 2012 showed that the total direct cost of rabies and various interventions between 2001 and 2008 was estimated to be \$US 1.03 million.

The direct cost for the intensified human pet was also estimated to be \$US 0.11 million per year with a cumulative estimated cost of \$US 0.70 million while the cost of mass dog vaccination with at least 70% coverage was estimated to be approximately \$US 0.21 million at the end of six years.

The limitation of this study is due to its retrospective design in which incomplete records of the victims may cause misclassification or the low quality of recorded data may lead to classification bias.

## Conclusion

The results of this study showed that the main cases of animal bites in the county of Larestan had been caused by dogs and owned animals which could impose a heavy burden on Iran's economy, healthcare system, the community and families. Therefore, conventional and common policies including stray animal elimination needed to be revised in the animal bites and rabies surveillance system and also planning for vaccination of owned animals and their control and containment as well as extensive education for the community on the prevention of animal bites should be considered as priorities for rabies prevention and control plan. Also, due to most bites occurred by dogs, it is recommended to consider vaccination of domestic dogs and they should have a collar during the day.

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## Authors Contributions

**Vahid Rahmaniian:** Design of study, proposal of study writing, data gathering, manuscript preparation, literature search and final revision of the study content, final approval of the version the manuscript.

**Heshmatollah Shakeri:** Organized the study, proposal of study writing, data gathering, manuscript preparation, literature search and final revision of the study.

**Abdolreza Sotoodeh Jahrom:** Writing, Analysis and interpretation of data, manuscript editing, final revision of the study content, final approval of the version the manuscript.

**Masihollah Shakeri:** Design of study, Analysis and interpretation of data literature search and final revision of the study content, final approval of the version the manuscript.

**Hekmatollah Khoubfekr:** Design of study, Analysis and interpretation of data literature search and final revision of the study content, final approval of the version the manuscript.

**Iman Hatami:** Data gathering, manuscript editing, literature search and final revision of the study content, final approval of the version the manuscript.

## Ethical Considerations

This study was performed in compliance with the Declaration of Helsinki ethical principles for medical research involving human subjects.

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