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# Healthcare utilization patterns and economic burden of animal bites: A cross-sectional study

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## ABSTRACT

**Objective:** To determine the healthcare utilization patterns and estimate the economic burden of animal bites in Golestan province, north part of Iran.

**Methods:** This cross-sectional study was performed based on the data of 12 181 animal-bite patients from Golestan province who were referred to the rabies prophylaxis centers between March 2019 and March 2020. The study was a societal perspective, and all patients were investigated by census method. The micro-costing method with a bottom-up approach as well as the human capital approach were used to estimate the economic burden.

**Results:** In our study, the economic burden caused by animal bites was estimated at \$1 383 639 (275 354 672 060 Rials). The largest share of costs was related to direct healthcare costs, direct non-healthcare costs, and indirect costs accounting for 91%, 5%, and 4%, respectively. In addition, the average cost of a animal-bite patient was estimated at \$113.5 (22 605 260 Rials) (The average cost of a case in type 2 and 3 exposures was \$45 and \$412.8, respectively). The largest share of direct healthcare costs was related to immunoglobulin, vaccine, and personnel expenses accounting for 61.3%, 19.8%, and 11.65%, respectively.

**Conclusions:** Our study shows that animal bites in Golestan province, north of Iran impose a high economic burden on the communities, especially the healthcare system, which indicates the need to review management and control programs of animal bites and rabies based on animal-bite patterns of the area.

**KEYWORDS:** Animal bites; Rabies; Economic burden

## 1. Introduction

Rabies is an acute viral disease that causes encephalomyelitis in

humans and all warm-blooded mammals. This disease is one of the most important and oldest zoonosis, and its importance lies on the high lethality (100%) and economic costs (vaccination costs, economic costs related to livestock losses, etc.).

Annually, 29 million animal-bite victims in the world are treated for rabies, and this virus kills approximately 59 000 people worldwide each year, with the majority of deaths occurring among the populations from Africa and Asia[1]. In the last 30 years in Iran, the number of animal bite has increased from 35 per 100 000 population in 1987 to 282 per 100 000 population in 2019. The incidence trend of animal bites in Golestan province, like the trend of the country in recent years, has experienced an ascending course, which has increased from 503 cases in 2011 to 652 cases per 100 000 population in 2019[2].

Even though rabies can be prevented by timely medical services, this disease is still a health dilemma in many countries around the world, especially in Asia and Africa. Asia, developing countries

### Significance

Rabies is an acute viral disease that causes encephalomyelitis in humans and all warm-blooded mammals. The high cost of rabies treatment imposes a heavy financial burden on healthcare systems. This study shows that animal bites impose a high economic burden on the communities, especially the healthcare system.

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mostly, carries a significant percentage of the burden of the disease, and the total cost caused by dog-transmitted rabies in central Asia and the Middle East is estimated at \$8.6 billion per year<sup>[1,3]</sup>. In Iran, while post-exposure prophylaxis (PEP) has greatly reduced the mortality rate from this disease, the high cost of rabies treatment imposes a heavy financial burden on healthcare systems<sup>[3]</sup>.

Studies in different countries have shown that the average cost of PEP is between \$6 and \$4000<sup>[1,4-10]</sup>. This difference between the costs of prophylaxis among countries is due to the diversity of healthcare systems, cost analysis from different perspectives (*e.g.*, provider or patient), cost components and calculation methods, and data collection used by relevant researchers<sup>[11,12]</sup>.

However, an exact calculation of a disease costing can provide valuable information about the resources needed for a particular service, evaluate financing and existing defects in service delivery, or achieve cost control for healthcare service providers, policymakers, and insurance organizations<sup>[13]</sup>. This study aims to determine the healthcare utilization patterns and estimate the economic burden of animal bites in this region.

## 2. Patients and methods

### 2.1. Ethical approval

This study was approved by the Research Ethics Committee of Iran University of Medical Sciences under the number of IR.IUMS.REC.1398.716. This research was conducted under the ethical principles and national norms and standards of medical research in Iran.

### 2.2. Study design and patients

This cross-sectional study was performed based on the data of 12181 animal-bite patients in Golestan province who were referred to rabies prophylaxis centers between March 2019 and March 2020. The perspective of the study was societal, and all animal-bite patients were examined by census method. This study was designed and conducted in three steps. In the first step, the healthcare utilization patterns of animal-bite cases was determined through health services and resources in the province. The data required to obtain healthcare utilization patterns of patients were collected from the registration offices and available database in the prevention centers and the health deputy of the province. In the second stage, the average cost of consuming resources and services per patient was calculated using the micro-costing method with a bottom-up approach. Then, in the third step, the average cost of each group was multiplied by the number of people in that group, and by aggregating the costs of the three groups, the economic burden caused by animal bites in Golestan province was estimated. In our study costs were reported in international dollars.

### 2.3. Grouping

In Iran, PEP services (is an immediate treatment of patients after rabies exposure) are provided free. Per the recommendations of the World Health Organization, the patients were divided into 3 groups based on the type of exposure. For the first group who have no injuries (touching or feeding animals, animal licks on intact skin), only soap and water washing services are provided; For the second group who have non-bleeding wounds (nibbling of uncovered skin, minor scratches or abrasions without bleeding), washing, disinfection, and vaccination services are provided; For the third group (single or multiple transdermal bites or scratches, contamination of mucous membrane or broken skin with saliva from animal licks,...), they also receive immunoglobulin beside washing, disinfection, and vaccination.

### 2.4. Cost estimation

The costs calculated to estimate the economic burden in this study included direct healthcare costs, direct non-healthcare costs, and indirect costs.

#### 2.4.1. Direct healthcare costs

Direct healthcare costs in this study include the costs of personnel, doctor's visit, vaccines, immunoglobulins, consumables, hospital service (dressings, medicine, hospitalization,...), transportation, energy, depreciation, and costs of support and management units. The time-movement study method was used to estimate the personnel costs and the time spent for each patient. Tariffs approved by the Ministry of Health were also used to calculate the cost of a doctor's visit. The Food and Drug Administration was inquired to estimate the cost of imported vaccines and immunoglobulins and to convert the dollar and euro rates to rial, the rate announced on the national exchange website was used. The direct line estimation method was used to estimate the depreciation cost. The support and management units studied in this study include administrative, financial, network development, management, and security units, which were assigned to each patient and treatment group after estimating the costs with the appropriate absorption rate.

#### 2.4.2. Direct non-healthcare costs

Direct non-healthcare costs calculated in this study include out-of-pocket costs for hospital franchises, wound dressing and medication, transportation costs, and informal home cares. Data from this section were collected from patients' records and interviews. The human capital approach was used to estimate the time value of informal caregivers, and considering the minimum salary approved by the Ministry of Cooperatives, Labor, and Social Welfare.

### 2.4.3. Indirect costs

The indirect costs calculated in this study included the costs of efficiency loss due to the patient's absence from work, the patients' companion absence from work, and the patient's disability. The human capital approach was used to estimate the lost costs of efficiency, and this cost was calculated for all patients (aged 15 to 64 years) and their companions. The time spent by patients to receive services was calculated through timekeeping, and the duration of absence from work was obtained based on an interview with patients. The calculated occupational groups were government employees, self-employed, workers, housewives, and students. To obtain the time value, the average salary received by government staff was used for government employees, the per capita GDP of every Iranian for self-employment, and the minimum wage approved by the Ministry of Cooperatives, Labor, and Social Welfare for workers, housewives, students in universities and schools. Besides, the minimum salary approved by the Ministry of Cooperatives, Labor, and Social Welfare was used to calculate the time value of patients' companions.

### 2.5. Statistical analysis

After data collection, the data were analyzed by using SPSS19, Excel 2015 software, and descriptive data were expressed as frequency, percentage or mean.

## 3. Results

In this study, the data of 12 181 animal-bite patients in Golestan province were analyzed. A total of 78.5% of animal bites occurred in males. The highest number was related to the age groups of 1 to 19 year, occupying 38%, in which the rate decreased with age. Besides, 67.6% of the residents were villagers. Our data shows that most cases of animal bites were from dogs (89%). This study also showed that 87% of patients received the incomplete vaccine, and 18.9% of patients received immunoglobulin. Table 1 shows the utilization patterns of resources and services (Table 1).

In this study, the costs of services to animal-bite patients were

calculated. The largest share of direct healthcare costs was related to immunoglobulin, vaccine, and personnel costs with 61.3%, 19.8 %, and 11.6%, respectively (Table 2).

Also in this study, the average cost of the animal bites was estimated to \$113.58 (22 605 260 Rials). Table 3 shows the estimated average cost per patient of 3 treatment groups based on exposure types.

**Table 1.** Utilization patterns of resources and services.

Services and resources	N	Percentage (%)
<b>1st group treatment services</b>	32	0.3
<b>2nd group treatment services</b>	9850	80.8
<b>3rd group treatment services</b>	2299	18.9
<b>Washing and disinfection</b>	12 181	100.0
<b>Rabies vaccine</b>		
No need for vaccines	32	0.3
Incomplete vaccine	10591	86.9
Full vaccine (4 times)	1 558	12.8
Rabies immunoglobulin	2299	18.9
DT vaccine	5 344	43.9
<b>Dressing in rabies prophylaxis centers</b>	190	1.6
<b>Antibiotics</b>	411	3.3
<b>Hospital services</b>	304	2.5

**Table 2.** Direct healthcare costs for each patient.

Services and resources	Average cost per patient (\$)	Percentage (%)
Personnel costs	12.10	11.60
Rabies vaccine	20.70	19.80
Rabies immunoglobulin	63.90	61.30
DT vaccine	0.10	0.10
Visit	0.73	0.70
Consumables*	0.83	0.80
Antibiotics	0.02	0.02
Wound dressing	0.01	0.01
Hospital services	0.60	0.60
Energy	0.20	0.20
Support units#	3.30	3.20
Transportation	0.04	0.04
Depreciation	1.77	1.70
Total	104.30	100.00

\*: Consumables include syringe, alcoholic cotton, washing serum, washing liquid, vaccine card, pamphlet, etc.; #: Support units include management, security, network development, administrative, financial, services units.

**Table 3.** Average estimated costs for patients of three treatment groups (\$).

Cost	Treatment group (based on the type of exposure)			Mean*
	1st group	2nd group	3rd group	
<b>Direct healthcare cost</b>	6.130	39.720	383.090	104.030
<b>Direct non-healthcare costs</b>				
Informal care	0.000	0.000	14.600	2.750
Transportation	0.760	2.350	2.400	2.350
Out-of-pocket payment**	0.000	0.001	1.000	0.189
Total	0.760	2.350	17.000	5.290
<b>Indirect cost</b>				
Patient absence from work (mean)	0.940	1.950	8.050	3.090
Accompanying person absence from work (mean)	1.290	1.010	1.460	1.090
Activity with disability (mean)	0.000	0.000	3.260	0.080
Total	1.320	2.950	12.700	4.260
<b>Average cost of an animal bite victim</b>	8.210	45.020	412.790	113.580

\*: The mean is calculated by considering the number of patients in three treatment groups; \*\*: included franchise of hospital services, medicine, dressing outside rabies prophylaxis centers.

Finally, the economic burden of animal bites in Golestan province was estimated at \$1 383 639 (275 354 672 060 Rials) per year according to the incidence rate of animal bites (624 cases per 100 000 persons). Direct healthcare costs also accounted for the largest share of the economic burden with 91%, followed by direct non-healthcare costs of 5% and indirect cost of 4%.

#### 4. Discussion

Our data showed that most cases of animal bites occurred in males (78.5%), and the highest share of bites (38%) belonged to the age group of 1 to 19 years. Dog accounted for 89% of all animal-bite cases. In most studies, dogs also had a high share of animal bites, which could be due to the high presence of dogs as domesticated animals in communities[14-16]. The higher share of men among the victims is owing to more contacts with animals due to occupational and non-occupational reasons[5,8,17]. According to international data, the largest share of animal-bite victims by dogs are children, which was consistent with the data of our study. The reason can be the curiosity and low prevention awareness of this age group[1,16].

In our study, the average cost of the animal bites was estimated at \$113.5, of which about 91.3% was paid by the public health system. The World Health Organization estimates that PEP costs in Asia are \$49 per animal-bite case[1].

In a study conducted in Pakistan, these costs were estimated at \$27.3[9]. In another study conducted on the four continents, the direct and indirect costs of PEP for the Asian were estimated at \$39.2 and \$13.57, respectively[4]. In some internal studies, these costs were less than half of our study[5,8,10,18]. These differences can be due to the distinct policies and management of rabies disease in each country, the choice of study perspectives, methods used in cost estimation, dimensions, and cost groups under consideration and study time.

Our study showed that the highest share of economic burden belongs to the group of direct healthcare costs (91%) and among the direct healthcare costs, the costs of immunoglobulin, vaccine, and personnel costs account for the highest share of costs with 61.3%, 19.8%, and 11.6%, respectively. In the study conducted in the four continents, direct costs in Asia accounted for 75% of costs, which was similar with our study[4]. According to the report of the World Health Organization and other studies, the highest economic share was related to the costs of premature death (54%) and the share of direct healthcare costs was in the second place (37%), which differs from the data of our study. This is because, in our study geography, premature death due to animal bites were not reported[17,19,20]. In other internal studies, the immunoglobulin and vaccine accounted for the largest share of direct healthcare costs, which was consistent with our study data[5,8].

In our study, the economic burden of animal bites was estimated at \$1 383 639 (275 354 672 060 Rials) a year. According to the World Health Organization and international studies, the largest share of the economic burden (excluding costs related to premature

death) is borne by the Asian continent. These data were in line with the data of other studies[17,19]. Also, the estimated economic burden in our study was higher than other internal studies[5,8,10]. The high economic burden of animal bites in Asia and consequently in Iran and especially in our region can be due to the type of animal-bite management, the high rate of animal bites, and the low share of vaccination of domestic animals, including dogs (dogs devoted the highest share of bites).

To conclude, this study showed that animal bites in Golestan province (north of Iran) imposed a high economic burden on the communities, especially the health system. Therefore, it is suggested that management and control programs of animal bites and rabies be reviewed based on epidemiological patterns in the area.

#### Conflict of interest statement

The authors report no conflict of interest.

#### Authors' contributions

V.B. prepared the synopsis, collected the data, and wrote the article. M.R.M. and M.J. also contributed to the literature search and data collection. A.R. did the economic analysis. I.M.A. supervised the whole project.

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