Spatial analysis of animal bites in Iran (2015−2020): A cross−sectional study

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ABSTRACT

Objective: To investigate the distribution pattern of animal bites in Mirjaveh, Iran from 2015 to 2020.

Methods: The data on animal bites were collected from the Department of Infectious Diseases, the provincial health center. Monthly climatic data on precipitation and temperature during the study period were also collected. The correlation between incidence and temperature, precipitation rate, land type, and altitude was also analyzed.

Results: The results showed that men were more affected by animal bites than women (76.4%, *P*<0.001), and the highest incidence rate occurred in the age group of 5-19 years. The incidence rate of animal bites was found to be correlated with temperature and altitude. An increase in temperature was associated with a rise in the incidence rate of animal bites. The number of animal bites increased until 2019, possibly due to an increase in the number of dogs in the area.

Conclusions: Targeted interventions should be implemented to reduce the incidence of animal bites, particularly among children, housewives, and students. Improving access to appropriate treatments, increasing public awareness of the hazards of animal bites, and increasing the number of vaccinated dogs in the area are essential strategies to be considered.

KEYWORDS: Animal bites; Epidemiology; Zoonotic disease; Iran

1. Introduction

The occurrence of animal bites and their subsequent health implications for both humans and livestock impose a significant financial burden on countries. This burden includes substantial expenditures on vaccines and serums for disease prevention resulting from such bites. It is important to note that animal bites can result in the transmission of diseases such as rabies, which can be fatal if left untreated[1]. Therefore, it is important to take preventive measures such as avoiding contact with stray animals, vaccinating pets, and seeking medical attention if bitten by an animal. Notably, rabies, a disease primarily transmitted through animal bites, remains a global concern. According to the World Health Organization, this disease is present in all the continents except Antarctica, but more than 95% of human deaths occur in Asia and Africa. Incidences of this disease

Significance

Animal bites pose a significant public health concern in Mirjaveh, Iran, with potential risks of zoonotic disease transmission. This research reveals a notable correlation between temperature and the incidence of animal bites, especially among young males. Understanding these patterns informs targeted interventions, emphasizing the importance of public health measures and climate-sensitive strategies in mitigating animal bite risks and reducing the burden of animal bite-related morbidity in the region.

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have been reported in more than 150 countries. Annually, more than 29 million people receive post-exposure vaccination worldwide[2]. Tragically, rabies claims the lives of approximately 50 000 to 60 000 individuals annually worldwide. As access to healthcare services becomes more readily available and public awareness about the risks of animal bites increases, there is a growing trend of people seeking care at rabies prevention centers[3].

Iran is one of the countries where rabies is found among both wild and domestic animals[4]. Rabies is considered a health and economic problem in Iran and almost all the provinces are somewhat involved[5]. According to the search results, the incidence rate of animal bites in Iran has increased in recent years[6]. A meta-analysis study on 34 national studies showed that the estimated incidence of animal bites in the country is 13.2 per 100 000 population. The study also revealed that the incidence of rabies in Iran is less than 0.1 cases per million people. The increase in the incidence rate of animal bites in Iran can be attributed to several factors, such as the reporting system, increased animal rabies cases, and increased public awareness about the risks of animal bites[7]. Another study conducted in Kerman County, Iran, from 2019 to 2021 found that the incidence rate of animal bites in children under 12 years of age was 262 and 231 per 100 000 in the first and second years of the study, respectively. However, the lack of sufficient data is a limiting factor in planning for disease control and surveillance in Iran. Animal bites and rabies are both serious public health problems in Iran, and there is a need for interventions aimed at reducing their incidence. Preventive measures such as vaccinating pets, staying away from wildlife, and seeking medical care after potential exposures are essential in reducing the risk of animal bites[8].

This study focuses on the spatial distribution of animal bites in Mirjaveh, a border region within the Sistan and Baluchestan Province in southeastern Iran. With a population of 66 216 in 2023, the Mirjaveh border crossing is the easternmost entry gate of Iran and the sole legal border in the southeast of the country. Both foreign and domestic tourists pass through this crossing, which connects Iran to the Indian subcontinent via railway. Mirjaveh serves as the primary crossing point between Iran and Pakistan, attracting Pakistani and Afghanistan immigrants. However, this border region is plagued by numerous health and economic issues. Sustain and Baluchistan province is among the provinces with the highest Gini coefficient and economic inequality. Insecurity and drought have historically driven the main residents of the region to migrate elsewhere. Comprising both urban and rural residents, Mirjaveh, like many other regions in the country, witnesses a recurring occurrence of animal bite cases. The primary objective of this research is to explore the temporal and spatial distribution of animal bites through the utilization of GIS techniques, while also considering the impact of climatic conditions. This endeavor aims to inform the implementation of necessary interventions by shedding light on the frequency and distribution patterns of these incidents in Mirjaveh between 2015 and 2020.

2. Subjects and methods

2.1. Study designs

This cross-sectional, descriptive, and analytical study was conducted to investigate the distribution of animal bites and the impact of factors such as temperature and precipitation on the incidence of animal bites in the east of Sistan and Baluchestan province, Mirjaveh during 2015-2020. This research was based on two datasets: Data related to patients with animal bites in Mirjaveh, which were collected from the Department of Infectious Diseases, provincial health center, daily from the beginning of 2015 to the end of 2020, and data related to climatic elements including precipitation and temperature during the study period. The central tendency and dispersion measures such as distribution by age, sex, nationality, year, month/season, and temporal/spatial frequency as well as climatic variables such as average monthly temperature and total monthly precipitation were used to examine the studied variables.

2.2. Ethics statement

The study was approved by the Research Ethics Committee of Kerman University of Medical Sciences (Code: IR.KMU.REC.1400.613).

2.3. Statistical analysis

The difference was determined by the chi-square test. The correlation was evaluated using Pearson and Spearman correlation coefficients. The data were analyzed using SPSS 22 and Excel software. Moreover, disease distribution maps were prepared for each year by transferring the geographic coordinates of the recorded animal bite cases in Mirjaveh to ArcGIS10 software.

3. Results

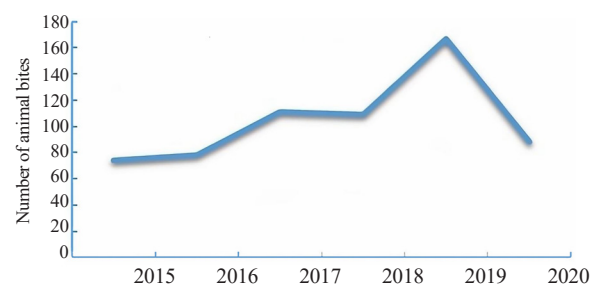### 3.1. Season and year distribution

Figure 1. Annual distribution of individuals with animal bites in Mirjaveh during 2015-2020.

A total of 627 animal bites were reported in Mirjaveh during the study period. The highest ($n=192$, 30.6%) and lowest ($n=106$, 16.9%) rates occurred in spring and winter, respectively. The number of animal bites was higher in summer. The number of animal bites in hot months was more than that in cold months. Moreover, the highest ($n=167$, 26.6%) and lowest ($n=74$, 11.8%) rates occurred in the years 2019 and 2015, respectively. Figure 1 indicates an upward trend from 2015 to 2019 and a decrease in 2020.

3.2. Age distribution

The mean age of patients was (22±17) years (median 15 and range 1-85). There was a statistically significant difference among different age groups ($P<0.001$), and it was shown that animal bites were more prevalent at younger ages (Table 1).

3.3. Baseline characteristics

The results show that more patients lived in rural areas (56.3% *vs*. 43.7%, $P=0.002$) and most were male (76.4%, $P<0.001$). The majority were students (34.1%, $n=214$) and children (17.1%, $n=107$) ($P<0.001$). Most of the study population were Iranian ($P<0.001$). The most common bite site was the legs/thighs (55.7%, $n=349$), followed by the hands (21.1%, $n=132$) ($P<0.001$). Dogs were responsible for the majority of bites (86.4%, $n=542$), followed by cats (11.0%, $n=69$) ($P<0.001$). Most bites were caused by domestic animals (79.2%, $n=497$), followed by stray animals (16.4%, $n=103$) ($P<0.001$) (Table 1).

3.4. Distribution of temperature

Correlation analysis showed a positive correlation between air temperature (°C) and the distribution pattern of animal bites in Mirjaveh ($r=0.78$, $P<0.001$). In the spatial distribution maps, the temperature was positively correlated with the incidence of animal bites (Figure 2).

3.5. Distribution of precipitation rate, land type, and altitude

As shown in Figure 3, the highest precipitation rate during the entire study period was 54.2 mm in January 2019, and the lowest rate was 0. Correlation analysis showed that the precipitation rate was negatively correlated with the incidence of animal bites ($r=-0.49$, $P=0.015$). The GIS maps revealed that the highest rate of animal bites occurred in the central part, Ladiz followed by Rig Malek. Most of the bite incidents occurred in agricultural lands and gardens, especially those located in the central part, the Ladiz district, and the outskirts of the city. Correlation analysis showed that the altitude was negatively correlated with the incidence of animal bites ($r=-0.39$, $P=0.026$).

Table 1. Baseline characteristics of animal bite cases ($n=627$).

Variables	n	%	χ^2	P
Age (Years)				
Less than 15	321	51.2	-	-
16-30	136	21.7		
31-45	93	14.8		
More than 46	77	12.3		
Locations				
Urban	274	43.7	325.06	0.002
Rural	353	56.3		
Sex				
Male	479	76.4	571.03	<0.001
Female	148	23.6		
Occupations				
Child	107	17.1	459.40	<0.001
Employed	28	4.5		
Student	214	34.1		
Housewife	83	13.2		
Self-employed	75	12.0		
Worker	62	9.9		
Farmer and rancher	26	4.1		
Other	32	5.1		
Nationality				
Iranian	496	79.1	608.19	<0.001
Non-Iranian	131	20.9		
Bite sites				
Head and face	35	5.6	794.12	<0.001
Neck	3	0.5		
Forearm and arm	86	13.7		
Legs/thighs	349	55.7		
Hands	132	21.1		
Chest, abdomen, and back	22	3.5		
Animal types				
Dog	542	86.4	802.57	<0.001
Cat	69	11.0		
Others	16	2.6		
Animal status				
Domestic	497	79.2	605.35	<0.001
Wild	27	4.3		
Stray	103	16.4		

4. Discussion

This study investigated the frequency of animal bites in human populations in all the urban and rural areas of Mirjaveh during 2015-2020. In total, 627 animal bites were reported in Mirjaveh, most of which occurred in the year 2019. Examining the distribution of bite cases in terms of sex revealed a significant difference between the two groups. According to the results, the incidence rate of animal bites was higher among men than women, which was consistent with the findings of the following studies. Nikbakht *et al*. reported that the incidence of animal bites was higher among men (82.8%) than women in Babol during 2010-2014[9]. Kassiri *et al*. found that the incidence of animal bites was higher among men (77.6%) than women during 2004-2008[10]. Rezaeinasab *et al*. indicated that the prevalence of rabies and animal bites was higher among men than women in Kerman during 1994-2003[11]. Furthermore, Patel reported that 80% of the animal bites occurred among men in Gujarat, India[12]. Possible reasons for this consistency could be
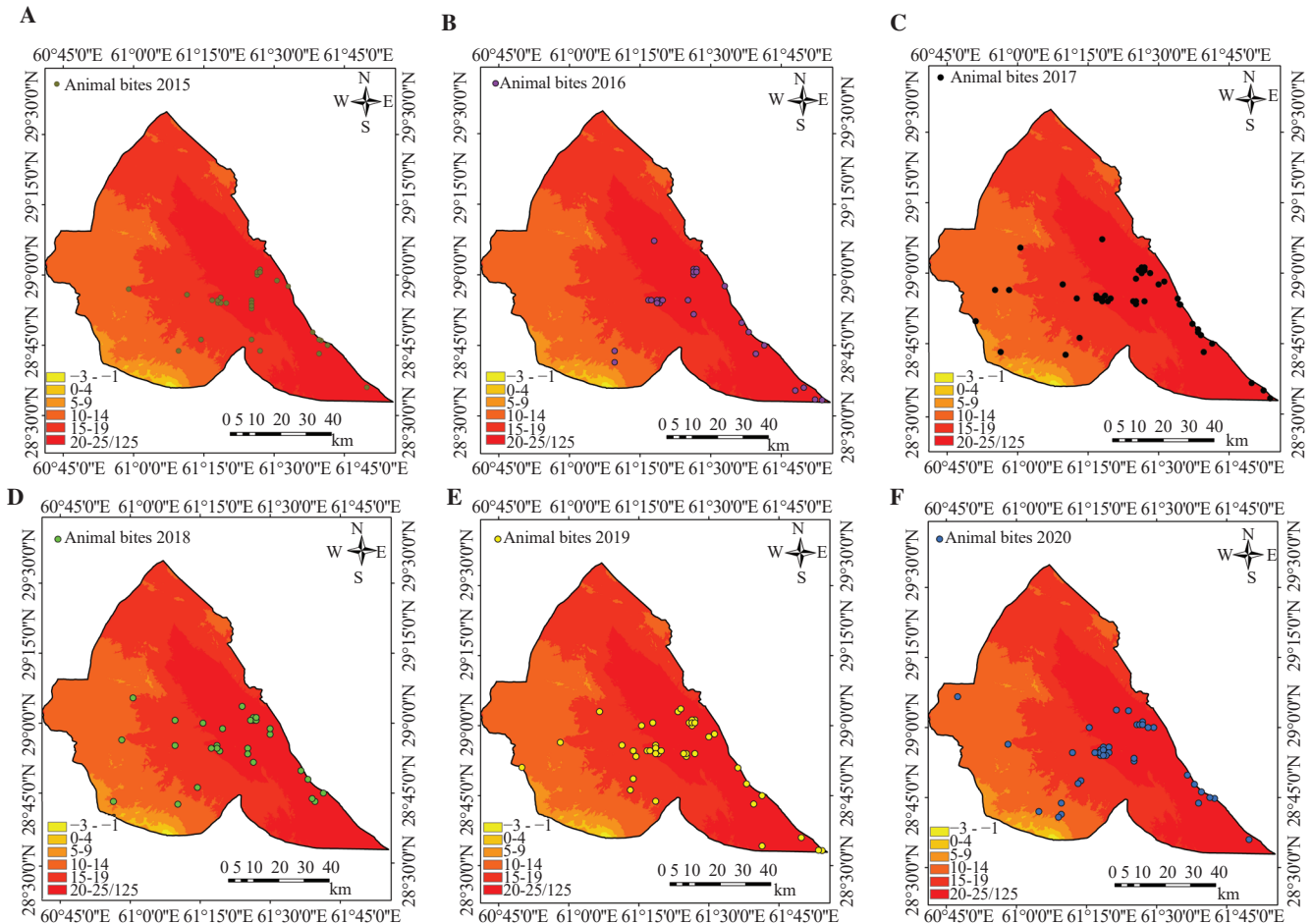
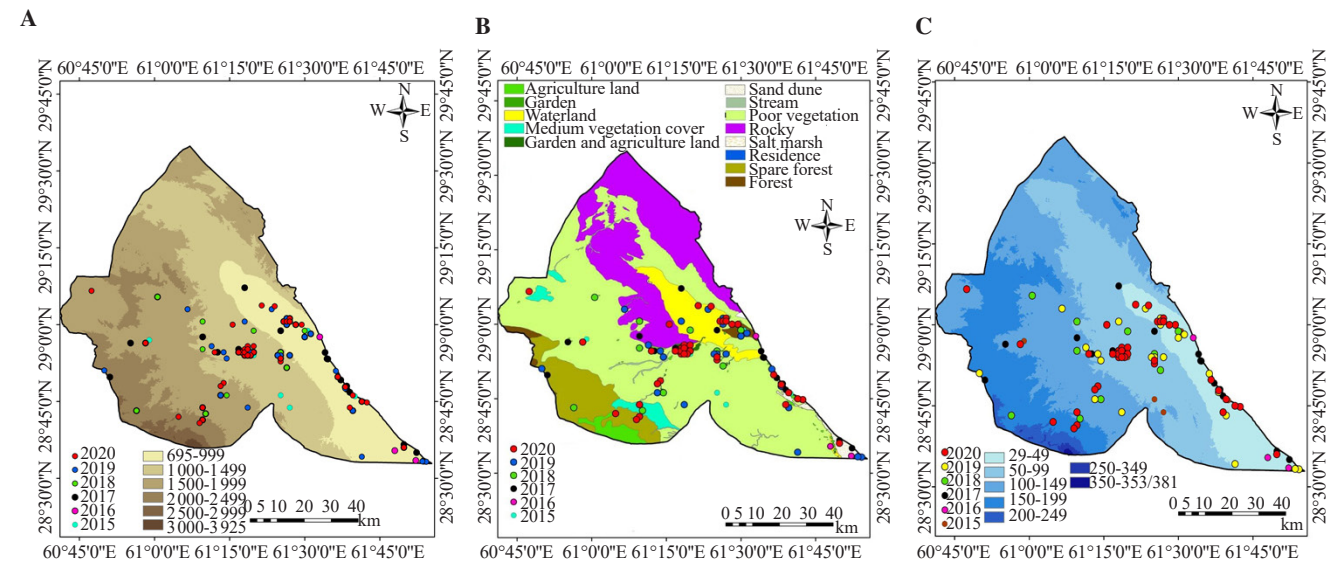**Figure 2.** Distribution of temperature (°C) in Mirjaveh during 2015-2020.

Figure 3. GIS map of the altitude (A), land use (B), and precipitation (C) in Mirjaveh during 2015-2020.

related to the cultural similarity of the residents in these areas, *i.e.*, men were mostly involved in outdoor activities, especially in rural areas.

In this study, the incidence of animal bites was observed in all the age groups. There was a significant difference. The highest rate of animal bites was reported in those aged 5-19 years old. Chen *et al.* found that children aged 1-15 years old were more likely to be injured in Wuhan, China[13]. Matter *et al.* reported that animal bites were more frequent among people under 20 years of age in Switzerland[14]. A study on cities in Kenya from 2011 to 2016 revealed that most of the injured cases were under 15 years of age[15]. Moreover, the results of the study of Rezaeinasab in Kerman during 1994-2003 were similar[11]. This consistency could be because children mostly stay in their place of residence, play outside the building in the neighborhoods, and harass the animals.

The results showed that temperature was correlated with the incidence rate of animal bites. The number of bite cases increased with the rise in temperature and the highest rate was observed in the summer. The animal bite cases mostly occurred in the central part, Ladiz followed by Rig Malek at 30°C and above. There was a correlation between temperature and the incidence of animal bites, and the highest and lowest rates were related to summer and winter, respectively. This finding was inconsistent with the study by Rezaeinasab et al. who found that the incidence of animal bites significantly increased in drought conditions in Kerman during 1994-2003[11]. The results of the present study were also in line with those of the study in northern Iran by Hosseini *et al.*[16]. The epidemiological study of animal bites in Isfahan in 2015 showed that the highest (28.48%) and lowest rates were related to summer and winter, respectively. This consistency could be because spring and summer are the breeding seasons. Moreover, the holidays are in these two seasons, which results in increased traffic. The farmers work more in the spring and summer and children play more outdoors[17]. Inconsistent with the present work, Ghafouri *et al.* reported no significant difference between the seasons in Bojnurd from 2005 to 2016[18].

Naqibi *et al.* found that the incidence rate of animal bites increased from 2008 to 2012 in Mazandaran[19]. Moreover, studies by Hosseini *et al.* in northern Iran[16], Khazaei in Isfahan[20], and Rezaeinasab in Kerman[11] and Karami[17] revealed that the incidence rate of animal bites had an upward trend. This trend could be attributed to increased access to health units, public awareness of the importance of rabies, increased number of animals among humans, especially dogs and cats, not using collars for domestic dogs and herds, lack of fencing around houses, particularly in rural areas, the higher desire of families to keep pets, and the greater number of dogs wandering between the Iran and Pakistan borders.

The results demonstrated that the incidence rate of animal bites varied in different months and seasons, and the highest rate was observed in the summer and spring. In line with the results of our study, Hosseini *et al.* reported that the highest rate occurred in the summer and spring in northern Iran[16]. Khazaei found that the highest rate was related to summer in Isfahan[18]. Moreover, Hashemi and Khodakarim conducted an epidemiological study on animal bite cases in Quchan and found similar results in this regard[21]. This consistency could be attributed to factors such as the increased activity of the residents, children's tendency to play more in open spaces, different behaviors of the affected individuals such as how they dress in warm seasons, the higher number of stray animals in the place of residence, and possibly dogs mating in the spring and late summer. However, the findings of the present work were not in line with those of the study by Ghafouri *et al.* who reported no significant difference between the seasons in Bojnurd from 2005-2016[18].

Due to the large number of non-Iranian residents in Mirjaveh, the nationality of animal bite cases was examined. It was found that 20.9% of the cases were non-Iranian. This inconsistency could be attributed to different living environments and cultures, *i.e.*, the individuals living in Mirjaveh were on the outskirts of the city and mostly had houses without yards, kept different types of animals including dogs, and did not pay attention to environmental health, which could lead to the gathering of stray dogs. Furthermore, Mirjaveh has a larger proportion of non-Iranians relative to its total population due to its shared border with Pakistan.

The results showed that the highest frequency of animal bites was related to students (51.2%) followed by housewives. Consistent with our research, Chrakazi et al. investigated the epidemiology of animal bites in Aq Qala during 2000-2009 and reported that the highest rate belonged to students (20.9%) followed by housewives[22]. Moreover, the findings of our study were in line with those of the meta-analysis by Abedi *et al.*[23]. The reasons for this consistency could be the presence of students in open spaces for playing games, their willingness to help their parents in gardens and agricultural lands, harassment of animals, especially dogs, and other similar factors. Providing instructions to this group and improving their health literacy could be effective.

The incidence of animal bites was higher in agricultural lands, gardens, and suburbs located in the central part, Ladiz followed by Rig Malek, which could be due to the increased traffic in these areas, the presence of children with their parents in farms, gardens, and places with water pump engines, proximity of places where dogs gather to people's places of residence, improper garbage disposal on the outskirts of the city, the local culture, the high number of dogs and other animals wandering in gardens and agricultural lands, and similar factors.

The study showed a significant negative correlation between the incidence of animal bites and the precipitation rate and altitude. While the search results did not provide specific studies that directly

correlate precipitation rate with animal bites, some studies have shown that meteorological factors such as temperature, humidity, and precipitation can influence the incidence of animal bites. For example, a study conducted in Turkey found that high temperature, low precipitation, and humidity were associated with mammalian bites[24]. Another study in Brazil found that the incidence of animal bites was higher during the rainy season[25].

The study found that animal bites are a significant health issue in Mirjaveh, with an upward trend in incidence rate until 2019, which then decreased possibly due to increased public awareness and access to treatment and vaccination. Children, housewives, and students are at a higher risk for animal bites, and it is recommended that preventive training and education be provided to improve health literacy. The study recommends that preventive measures, such as waste disposal and stray animal removal programs, be implemented in accordance with seasonal trends in bite rates. Additionally, interventional and preventive activities should be implemented during months with higher incidence rates, and comprehensive health services should be provided.

Conflict of interest statement

The authors report no conflict of interest.

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Data availability statement

The data supporting the findings of this study are available from the corresponding authors upon request.

Authors' contributions

Study concept and design: HA and MR; analysis and interpretation of data: KY; drafting of the manuscript: MR; critical revision of the manuscript for important intellectual content: MP and HA; statistical analysis: MR.

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