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Original Article

Epidemiology, Clustering and Spatial Distribution of Animal Bites in Algeria

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ABSTRACT

Introduction: Animals can transmit many viral and bacterial diseases through bites and saliva that can be potentially fatal to human. Rabies, one of these diseases, is rife in two-thirds of the world's countries. Algeria is not spared. This study was scoped to provide insight into the demography and epidemiology, spatial distribution and clustering patterns of animal bites in Algeria.

Methods: The global and local Moran's I were used to investigate geographic clustering patterns of animal bites in Algeria. The animal bites data provided by North West Health Region (NWHR) Observatory was analyzed to glean useful information.

Results: Over the past five decades, 1201 human rabies fatalities have been recorded in Algeria with a yearly average of 20 cases and a male predominance. As for 2017, a total of 116403 animal attacks were recorded. Dog bites accounted for 64.1%, followed by cat bites for 30.5%. The rabies vaccine was practiced in 74% of cases and vaccine with rabies immune globulin in 26% cases. The incidence was estimated at 279 per 100000 inhabitants. The incidence of animal bites, dog and cat bites exhibited spatial autocorrelation globally; the Moran index values were 0.41, 0.43 and 0.60 respectively. Significant hot spots were located in Tell, and significant cold spots were located on Sahara and High-Plateaus. The analysis of the 21314 animal attacks reported in NWHR in 2019, showed that young children and men are the most-at-risk. Indeed, 71.3% were male and 58.7% occurred outdoors. Among the 8275 bites that occurred in children under 15 years, 66.8% were boys and 29.3% were children under 5 years. Most of the bites were Category II(45.7%) followed by Category III(38.6%).

Conclusion: The current strategy needs to be reviewed, reformed and strengthened while promoting cross-sectoral work with a collaborative approach of all relevant sectors for a One Health initiative.

Introduction

Animals can transmit many viral and bacterial diseases through bites and saliva that can be potentially fatal to humans. Rabies, an anthropozoonosis, is one of these diseases. The disease is rife in two-thirds of the world's countries and roughly half of the world's

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population lives in endemic areas. Africa and Asia are the two continents with the highest fatalities and where the canine rabies is not under control. The disease presents a weighty threat to veterinary and public health, and it places a heavy burden on health care expenditures in many countries. Although it is a vaccine-preventable viral disease and all the tools needed to stamp out it exist, it remains one of the deadliest zoonotic diseases. It kills nearly 59000 humans per year, 95% of them in Africa and Asia. This figure is far short of a true estimate given that the disease is not widely reported. Cats, dogs, monkeys and Snakes are the animal species most cited in human bites, moreover, rabid dog bites account for the overwhelming majority of human deaths.[1,2]
Rabies, a reportable disease in Algeria, circulates enzootically, with an annual average of 900 cases of human rabies and between 15 and 20 human rabies deaths.[3] There is no in-depth study on animal bites in Algeria. This study was designed to perform an analysis of available data, to picture the clustering and spatial distribution of animal bites in Algeria, to supply insights into the demographic and epidemiological characteristics of animal bites on humans in the country's North West Health Region (NWHR).

Materials and Methods

Study region

Algeria, a North African country, is divided into three geographic regions, namely the Tell (25 provinces, 4% of the territory and 60% of the population), the High-Plateaus (14 provinces, 13% of the territory and 30% of the population), and the Sahara (9 provinces, 83% of the territory and 10% of the population). As of January 1, 2020, the estimated resident population in the country reached 43.9 million.[4] The NWHR, one of the five health regions of the country, covering an area of 73148 km² and an estimated population of 8.9 million inhabitants as 2019 with male to female ratio 1.02, is made up of ten provinces: Oran, Saida, Tiaret, Relizane, Mascara, Mostaganem, Tissemsilt, Tlemcen, Sidi Bel Abbes and Ain Temouchent.[5-6]

Rabies

Rabies, transmitted to human or animal, leads to certain death. The disease is mainly transmitted by rabid dogs and cats.[1] People exposed to rabies benefit from the post-exposure prophylaxis (PEP). The risk assessment for rabies is based on the nature of the exposure, the condition of the animal involved and a careful history. The nature of the exposure is classified into three categories, namely, Category I (direct contact with an animal or licking intact skin), Category II (bites or scratches without bleeding in places other than the head, extremities and genital organs), and Category III (bites or scratches even without bleeding located on the face, head, neck, hands, feet, genital organs. Single or multiple bite or scratch with bleeding, bite by wild animal, exposure to a bat, licking or contamination of mucous membranes with saliva, licking on injured skin). When the exposure to the animal is real, the wound should be washed thoroughly with soap and water and the anti-rabies treatment immediately started, regardless of the condition of the animal involved. Treatment consists of a series of rabies vaccinations and administration of

rabies immune globulin (RIG) if requisite. Currently, only inactivated virus vaccines are in use in the country. These are two types of inactivated viral rabies vaccines: vaccine prepared in cell culture and vaccine prepared on nerve tissue.[3]

Data

Yearly data were drawn from the epidemiological records of the Ministry of Health.[5] The number of human attacks, biting animal species (Dog, Cat, Cow, Donkey, Sheep, Fox, Rat, horse, Monkey, Sheep, Squirrel, Jackal, Wild Boar, other), and PEP for the year 2017 at province level were drawn from records of the health promotion and prevention department, Ministry of Health, Algeria. The North West Health Region Observatory (NWHRO) provided us with additional data regarding the NWHR during 2019 consisting of monthly data by gender, age group, biting animal species, category of injury, and PEP administered.[6] The animal rabies cases and the number of rabies foci were drawn from records of the Animal Health Department, Veterinary Services Branch, Ministry for Agriculture and Rural Development, Algeria.[7]

Spatial autocorrelation analysis

The Moran's I statistic was used to analyze the global spatial autocorrelation and the first order Queen's contiguity rule was used to specify the spatial neighborhood relationship. The higher the Moran's I value, the stronger the autocorrelation. Its statistical significance is determined by the z score and the corresponding p-value. The local Moran's I statistic was used to identify local clusters and local spatial outliers. The identification of the location and types of clusters was made using the local indicators of spatial association. The Moran's I value ranges from -1 to +1, where a positive value indicates positive spatial autocorrelation, that is, similar values of a variable between neighboring spatial locations and a negative value indicates negative spatial autocorrelation, that is, contrasting values of a variable between neighboring spatial locations. The Global Moran's I is calculated using the following formula

$$Global\ Moran's\ I = \frac{n}{\sum_{i\neq j} w_{ij}} \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\left(X_i-\bar{X}\right)\left(X_j-\bar{X}\right)}{\sum_{j=1}^{n}\left(X_i-\bar{X}\right)^2}$$

where n is the number of locations, X_i is the observed value of the variable of interest in location *i*, and $\bar{X}$ is the mean of all values. The spatial weights, w_{ij}, represent the spatial proximity between locations *i* and *j*, with $w_{ii}=0$. Local Moran's I statistic, also known as a LISA (local indicator of spatial association), is calculated using the following formula:

$$I_i = \frac{\left(X_i-\bar{X}\right)}{\sum_{i=1}^{n}\left(X_i-\bar{X}\right)^2/n}\sum_{j=1}^{n} w_{ij}\left(X_j-\bar{X}\right)$$

The z-score of Moran's I are computed as follows:

$$z_I = \frac{I-E[I]}{\sqrt{E\left[I^2\right]-E[I]^2}}$$

where $E[I]=-\frac{1}{n-1}$. The critical z-score and p-value levels, with a 95% confidence, are ±1.96 and 0.05.[8-11]

The appropriate maps introduced by Anselin (1995) using the Local Indicators of Spatial

Autocorrelation (LISA) visually assisted in locating different clusters.[8-11]

Maps were produced using MapInfo Professional 11 and spatial autocorrelation analyses were carried out using GeoDa software (https://geodacenter.github.io/).

Results

Animal Bites and Rabies in Algeria

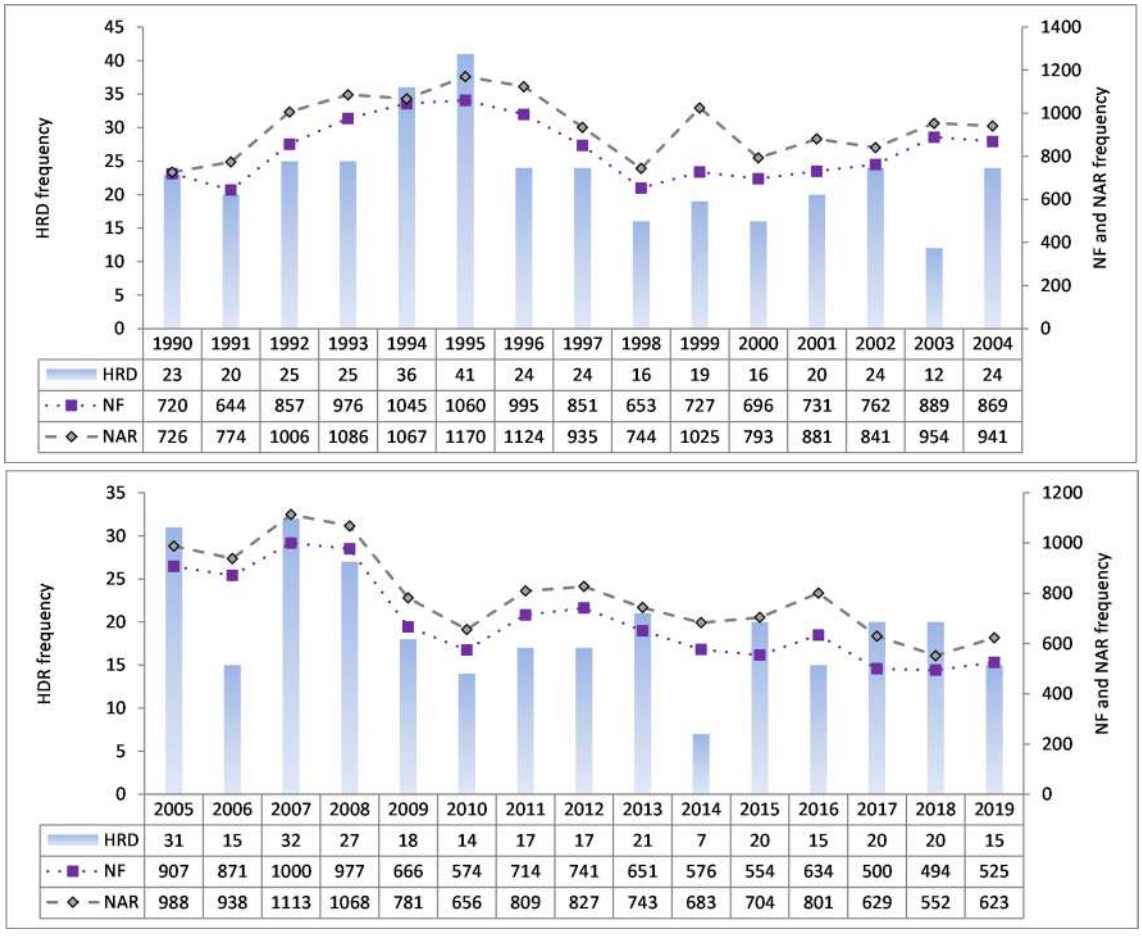
Over the past five decades, 1201 human rabies fatalities have been recorded in Algeria with an average of 240 cases per decade with a male predominance. The yearly human rabies mean fell from 25.3 for the decade 1990-1999 to 21.9 for the decade 2000-2009 and to 16.4 for the decade 2010-2019. If we take into account the evolution of the Algerian population, the number of human cases per year has experienced slight fluctuations for over century-long with the exception of the period 1976-1980 when human cases exploded (371 cases) (Table 1).[12]

Table 1. Evolution of fatal cases of human rabies in Algeria from 1970 to 2022

1970-1975	81
1976-1980	371
1981-1985	63
1986-1990	59
1991-1995	147
1996-2000	99
2001-2005	111
2006-2010	106
2011-2015	82
2016-2020	82
2021-2022	26

As displayed in Figure 1, the animal rabies cases and the number of rabies foci followed a similar trend and are strongly correlated; the Pearson product-moment correlation coefficient is 0.95. An exception is observed in 1999 where the number of animal rabies was significantly higher than the number of rabies foci. Likewise, the number of human fatalities and the number of foci is highly correlated; the Pearson product-moment correlation coefficient is 0.70.

Overall, there were 116403 incidents of animal bites in Algeria in 2017. Of these, 73% were in Tell, 22% in the High-Plateaus, 5% in Sahara. All age groups were affected, and children under the age of 15 accounted for 41% of cases. The frequency of animal bites in humans in Northern provinces was higher as depicted in Figure 2. The overall incidence rate has been estimated to be 279 cases per 100000 people. The lowest incidence rate, 30.3, was reported in Adrar province situated in the south of the country with estimated population density at 1.2 persons per square kilometer, and the highest incidence, 647.5, was recorded in Mostaghanem province situated in the North West coast of the country with estimated population density at 395.3 persons per square kilometer. Half of the country's provinces have an incidence higher than the national mean. As regards, the animal type, dog bites accounted for 64.1% (74575) of reported animal bites to humans followed by cat bites with 30.5% (35537). The remaining bite cases were distributed as 2512 (respectively, 939, 875, 150, 112, 163, 361, 41, 4, 1134) for rat (respectively, cow, donkey, sheep, fox, horse, monkey, squirrel, jackal, wild boar, other). In total 33483 (28,1%) (Respectively, 10593 (8.9%), 54590 (45.8%), 20414 (17.1%)) people received PEP consisting of rabies tissue vaccine (respectively, rabies tissue vaccine and



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
HRD	23	20	25	25	36	41	24	24	16	19	16	20	24	12	24
NF	720	644	857	976	1045	1060	995	851	653	727	696	731	762	889	869
NAR	726	774	1006	1086	1067	1170	1124	935	744	1025	793	881	841	954	941

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
HRD	31	15	32	27	18	14	17	17	21	7	20	15	20	20	15
NF	907	871	1000	977	666	574	714	741	651	576	554	634	500	494	525
NAR	988	938	1113	1068	781	656	809	827	743	683	704	801	629	552	623

Figure 1. Yearly evolution of human rabies death cases (HRD), number of animal rabies foci (NF), and number of animal rabies (NAR) in Algeria during the last three decades.

RIG, rabies cell vaccine, rabies cell vaccine and RIG). Total expenditures for 2017 amounted to 403,889,506 DZD (3 124 669 US$). These costs relate only to the financial expenditure in terms of rabies vaccine and RIG. This represents an additional and heavy burden for the healthcare system.

The 20 declared rabies fatalities were predominantly males (17 males versus 3 females) and the age fluctuated between 2 and 82 years with a mean of 27.4 years. Rabies PEP is provided free of charge in Algeria. Almost all people who have been bitten and visited the emergency service received PEP. At national level in 2017, 74% of victims received rabies vaccine alone and 26% of victims received rabies vaccine combined with RIG. Only 39% of fatalities bites were classified in category III. Only 10 people consulted a health structure immediately after the bite occurred, while the remaining 10 people did not consult a health structure immediately after the bite due to negligence or ignorance of the disease. The overpowering majority of human rabies deaths were caused by rabid dog bites.

Spatial autocorrelation analysis

The incidence rates, the number of dog bites and cat bites exhibit spatial autocorrelation

globally; the respective Moran index values are positive and the corresponding z scores are greater than the critical value 1.96 at a level of significance of 0.05 (Table 2).

The most significant hot spots were located in the north of the country and provinces exhibiting significant cold spots (low low) were located in the Sahara and the high-plateaus (Figure 2). The number of provinces in nonsignificant spots ranged between 30 and 35.

Animal Bites in the North West Health Region of Algeria

A total of 21314 animal attacks were recorded in 2019 in the NWHR. The demographic characteristics of these incidents by province are displayed in Table 3. The incidence of the region was estimated at 237 per 100000 people and varies between provinces according to age group and to gender as depicted in Figure 3B. The highest incidence rate, 356 per 100000 people, was recorded in Tiaret province while the lowest incidence, 146 per 100000 people, was recorded in Tlemcen province. The highest incidence for children under 15 years was recorded in Mostaghanem province and was 726 per 100000 boys, 565.9 per 100000 girls, and 647.1 per 100000 for both sexes. The highest incidence for people above 15 years was recorded in Tiaret province and was 495.4 per 100000 males, 159.5 per 100000 females, and 328.3 per 100000 for people above 15 years. Figure 3A shows the spatial distribution of the incidence of animal bites with the number of animal bites by animal type. The outside to inside dwelling ratio ranged between 0.6 to 4 and the number of incidents outside dwellings was higher than those occurred inside dwellings for 7 provinces as shown in Figure 3C. In three provinces, namely, Mostaganem, Relizane and Tissemsilt, the number of injuries by domesticated dogs and domesticated cats was higher than the number of stray dogs and stray cats.

Most of the victims were males (71.3%), giving male-to-female ratio of 2.5. Of the 8275 (38.8%) bites occurred in children under 15 years, 5531 (66.8%) were boys, 2421 (29.3%)

Table 2. Spatial autocorrelation analysis for 2017

	Incidence	Dogs	Cats	Other
Global spatial autocorrelation				
Moran's I	0,4094	0,4307	0,6021	0,3709
Zscore	4,6678	4,9651	7,1235	4,4795
P	0,001	0,001	0,001	0,001
Number of spatial autocorrelation locations				
Highhigh	6	3	7	4
Lowlow	10	8	10	9
Lowhigh	0	4	1	0
Highlow	1	1	0	0
NS	31	32	30	35

Significance level 0.05. NS: Not significant

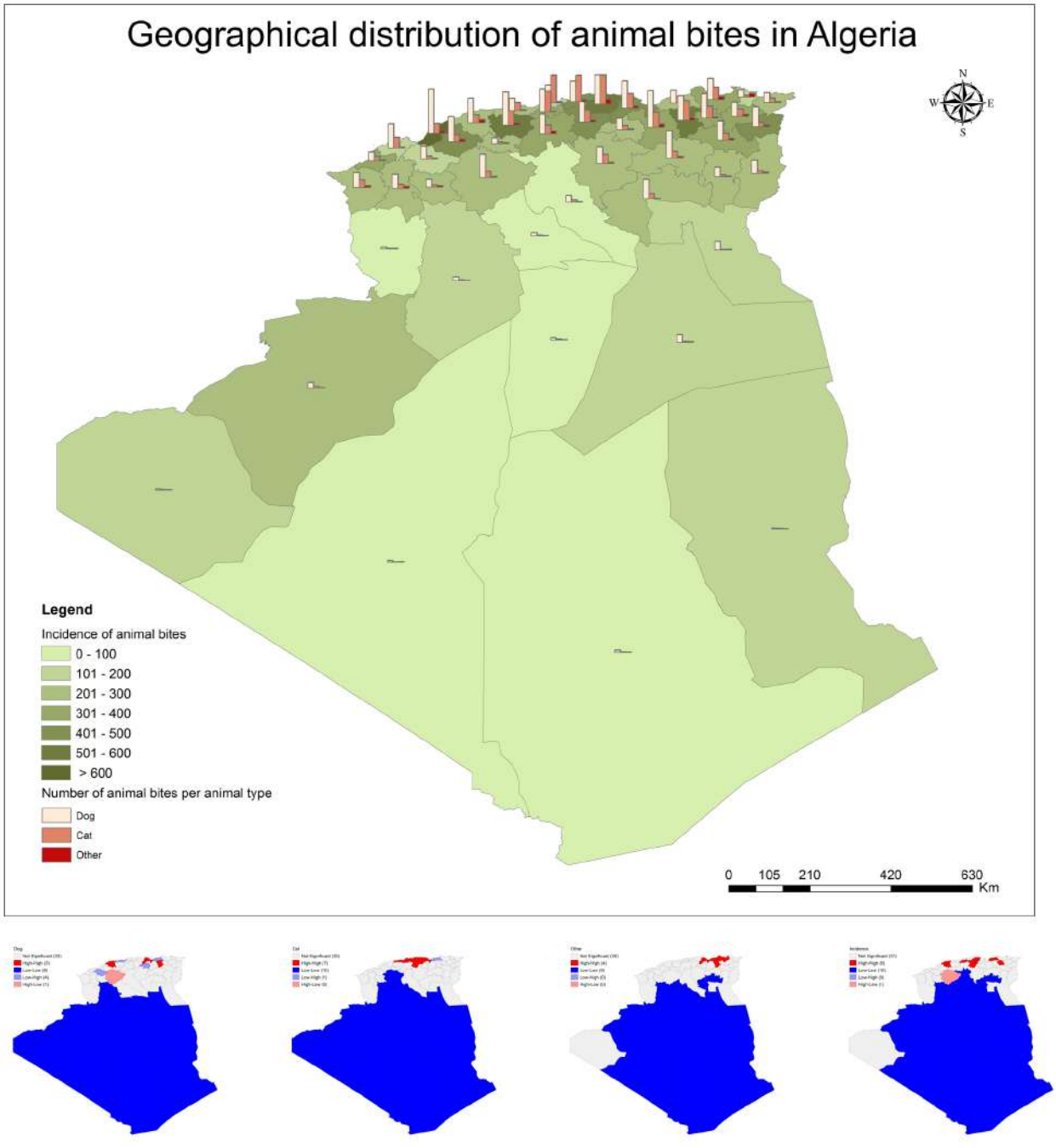


Figure 2. Spatial distribution of human animal bites incidence and the number of animal bites by animal type and Spatial clustering of animal bite incidence across Algeria during 2017. Blue (respectively red, pink,light-blue,gray) corresponds to low low (respectively high high,high low, low high,not significant) clusters.

Table 3. Demographic characteristics of animal bites in North West Region

Province		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
						Frequency						
		1416	1921	2663	3573	2866	1282	1164	3808	863	1656	102
						By age group and by gender						
0-5	M	84(5,9)	209(10,9)	297(11,2)	183(5,1)	289(10,1)	50(3,9)	63(5,4)	275(7,2)	57(6,6)	68(4,1)	11(10,8)
	F	48(3,4)	75(3,9)	204(7,7)	93(2,6)	137(4,8)	28(2,2)	28(2,4)	136(3,6)	31(3,6)	52(3,1)	3(2,9)
6-10	M	135(9,5)	206(10,7)	347(13,0)	255(7,1)	329(11,5)	98(7,6)	96(8,2)	391(10,3)	108(12,5)	128(7,7)	20(19,6)
	F	51(3,6)	100(5,2)	295(11,1)	133(3,7)	184(6,4)	38(3,0)	34(2,9)	168(4,4)	52(6,0)	69(4,2)	11(10,8)
11-14	M	116(8,2)	184(9,6)	294(11,0)	283(7,9)	216(7,5)	146(11,4)	80(6,9)	297(7,8)	72(8,3)	131(7,9)	13(12,7)
	F	35(2,5)	44(2,3)	211(7,9)	118(3,3)	109(3,8)	54(4,2)	27(2,3)	76(2,0)	26(3,0)	65(3,9)	9(8,8)
>14	M	748(52,8)	834(43,4)	716(26,9)	1799(50,3)	1156(40,3)	701(54,7)	669(57,5)	1869(49,1)	380(44,0)	776(46,9)	26(25,5)
	F	199(14,1)	269(14,0)	299(11,2)	709(19,8)	446(15,6)	167(13,0)	167(14,3)	596(15,7)	137(15,9)	367(22,2)	9(8,8)
						By location						
Inside dwellings		499(35.2)	988(51.4)	1445(54,3)	1037(29,0)	1740(60,7)	340(26,5)	487(41,8)	1551(40,7)	352(40,8)	334(20,2)	31(30,4)
Outside dwellings		917(64.8)	933(48.6)	1218(45,7)	2536(71,0)	1126(39,3)	942(73,5)	677(58,2)	2257(59,3)	511(59,2)	1322(79,8)	71(69,6)
						By animal type						
Stray Dog		485(34,3)	744(38,7)	639(24,0)	1684(47,1)	841(29,3)	800(62,4)	588(50,5)	1463(38,4)	283(32,8)	706(42,6)	26(25,5)
Domesticated Dog		370(26,1)	716(37,3)	847(31,8)	623(17,4)	1296(45,2)	203(15,8)	213(18,3)	1270(33,4)	311(36,0)	182(11,0)	29(28,4)
Stray Cat		304(21,5)	209(10,9)	404(15,2)	877(24,5)	230(8,0)	79(6,2)	158(13,6)	458(12,0)	49(5,7)	518(31,3)	16(15,7)
Domesticated Cat		217(15,3)	156(8,1)	536(20,1)	320(9,0)	362(12,6)	119(9,3)	68(5,8)	492(12,9)	108(12,5)	170(10,3)	22(21,6)
Other Domestic		27(1,9)	53(2,8)	159(6,0)	56(1,6)	104(3,6)	21(1,6)	115(9,9)	83(2,2)	109(12,6)	58(3,5)	1(1,0)
Jackal		3(0,2)	2(0,1)	7(0,3)	1(0,0)	10(0,3)	0(0)	0(0)	1(0,0)	1(0,1)	0(0)	2(2,0)
Boar		0(0)	0(0)	0(0)	1(0,0)	2(0,1)	0(0)	0(0)	0(0)	0(0)	1(0,1)	1(1,0)
Other Wild		10(0,7)	41(2,1)	16(0,6)	11(0,3)	21(0,7)	60(4,7)	22(1,9)	41(1,1)	2(0,2)	21(1,3)	4(3,9)
						By category						
Category I		3(0,2)	412(21,4)	3(0,1)	824(23,1)	641(22,4)	0(0)	349(30,0)	651(17,1)	275(31,9)	188(11,4)	1(1,0)
Category II		656(46,3)	1023(53,3)	399(15,0)	1937(54,2)	1805(63,0)	1268(98,9)	320(27,5)	1198(31,5)	343(39,7)	750(45,3)	39(38,2)
Category III		757(53,5)	486(25,3)	2261(84,9)	812(22,7)	420(14,7)	14(1,1)	495(42,5)	1959(51,4)	245(28,4)	718(43,4)	59(57,8)
						Treatment						
RCV		617(43,6)	968(50,7)	1784(66,5)	2675(74,9)	1465(51,3)	1260(98,3)	768(67,1)	1158(36,3)	486(56,5)	654(39,5)	73(76,8)
RCV and RIG		799(56,4)	871(45,6)	898(33,5)	897(25,1)	547(19,1)	14(1,1)	375(32,8)	2029(63,6)	374(43,5)	975(58,9)	22(23,2)
RTV		0(0)	72(3,8)	0(0)	0(0)	745(26,1)	8(0,6)	2(0,2)	4(0,1)	0(0)	5(0,3)	0(0)
RTV and RIG		0(0)	0(0)	0(0)	1(0,0)	101(3,5)	0(0)	0(0)	0(0)	0(0)	22(1,3)	0(0)

P1, Ain Temouchent; P2, Mascara; P3, Mostaganem; P4, Oran; 5, Relizane; P6, Sidi Bel Abbes; P7, Saida; P8, Tiaret; P9, Tissemsilt; P10, Tlemcen; P11, Residing outside NWR.
RTV, Rabies tissue vaccine; RCV, Rabies cell vaccine, RIG, Rabies immune globulin.
The figure in brackets indicates the percentage.

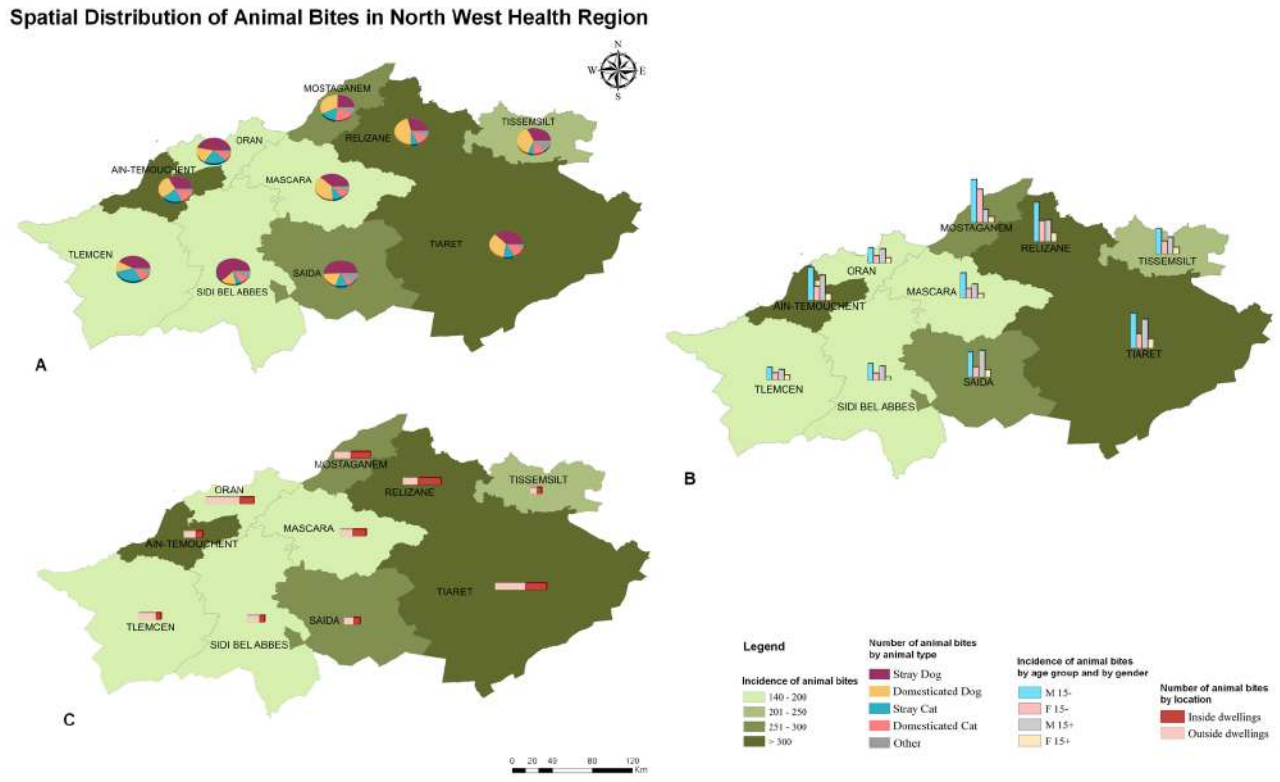


Figure 3. Spatial distribution of the incidence of animal bites per 100 000 inhabitants in the North West Region with Number of animal bites by animal type(A), Incidence of animal bites by age group and by gender(B), Number of animal bites by location(C).

cases were children under 5 years old of whom 1586 (65.5%) boys. 58.7% of attacks occurred outside dwellings. Dog bites accounted for 68.3% of all cases, followed by cat bites at 27.6%. Most of the bites were of category II (45.7%) followed by category III (38.6%); then category I (15.7%). In total, 20669 victims received PEP of whom 57,6% received rabies tissue vaccine, 37,7% rabies tissue vaccine and RIG, 4,0% rabies cell vaccine, and 0,6% rabies cell vaccine and RIG.

There was a slight difference in animal bites occurrence between seasons. Indeed, 28.2% of the bites occurred in summer, followed by spring, with 25.5%, then autumn with 25.1% and winter with 21.2% of cases. The monthly distribution of bites shows a peak of animal bites (2148) in July (Figure 4 A). The peak of stray dog bites (835) and stray cat bites (406) is also observed in July while the peak of domesticated dog (598) is observed in March and the peak of domesticated cat (292) is observed in September as displayed Figure 4B. It is also observed slight fluctuation in the monthly frequency of bites inside dwellings while outside dwelling a rise in the number of bites is observed in June and July (Figure 4B). Six rabies-related human fatalities of which 4 children under 15 years were deplored in 2019 in the NWHR and dogs were the source of all human rabies deaths. The duration between the rabies injury and the patient's death ranged from 22 to 44 days. Two deaths were reported in Oran province: a seven-year-old boy bitten by a stray dog on his face, arm and thigh on June 16, 2019 classified category III, he

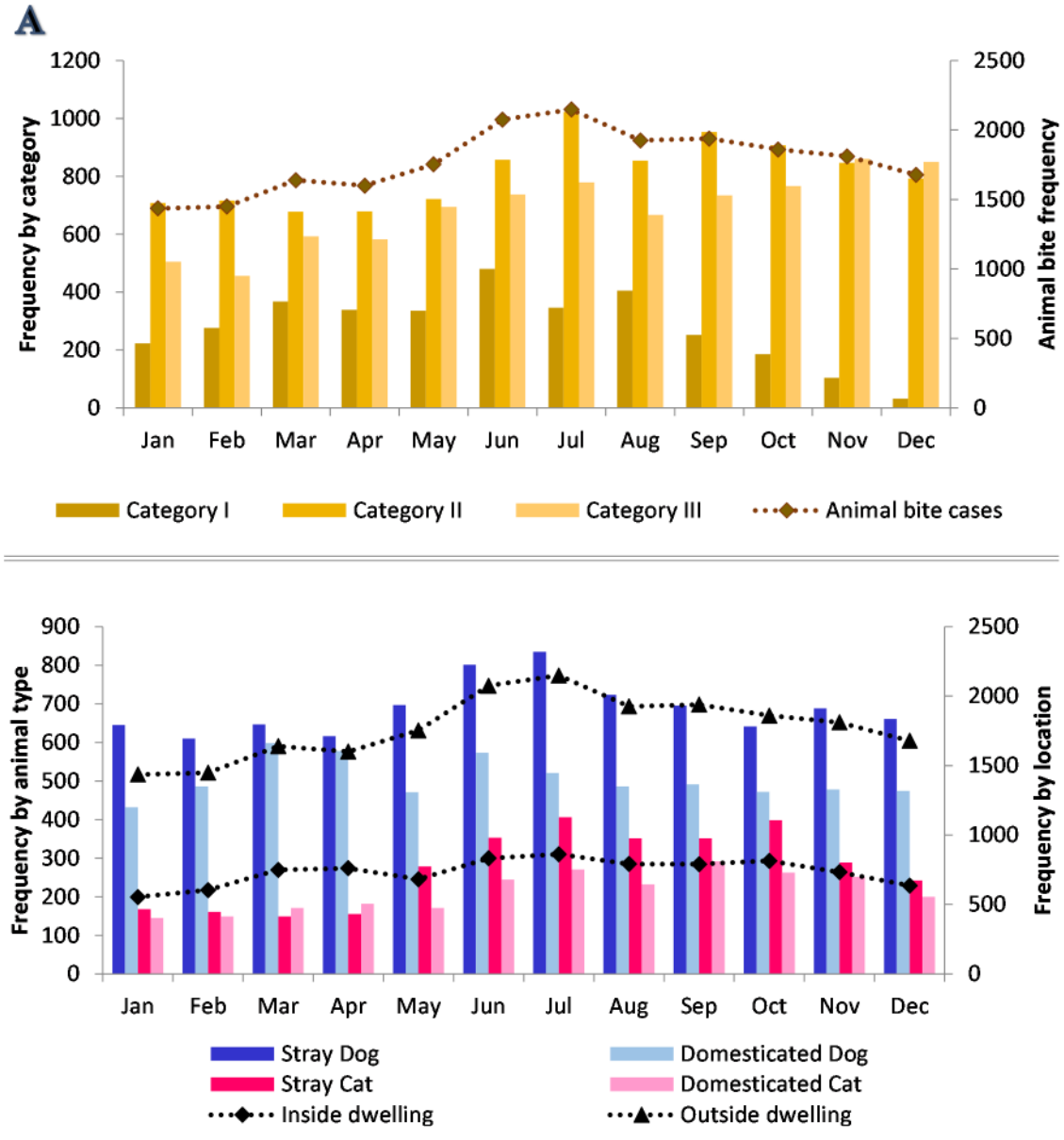


Figure 4. Monthly distribution of animal bites in 2019: (A) by category of injury, (B) by animal type and by location.

received local care and rabies vaccine and RIG just after the incident. The boy passed away on July 10, 2019. The second death case was a man aged 30 years bitten on the right elbow by a stray dog on November 7, 2019 classified category III, he received local care and rabies vaccine and RIG on November 11, 2019. He passed away on December 2019. The third case, a man from Ain Temouchent province, aged 56 years bitten in the face and hands by a dog on November 19, 2019. He was classified category III and received local care and rabies vaccine and RIG just after the incident. He passed away on December 11, 2019. The fourth case was a three-year-old girl from Mostganem province bitten by a stray dog on the face and

head on October 24, 2019. She was classified category III and received local care and rabies vaccine and RIG. The girl passed away on November 21, 2019. The fifth case was a nine-year-old boy from Tiaret province bitten by an unvaccinated domesticated dog on his feet on July 7, 2019. The child was classified category III, and the boy passed away on August 19, 2019. The last case was a thirteen-year-old boy from Tissemsilt province bitten by an unknown dog in the spring and died on July 29, 2019.

Discussion

Animal bites represent major public health and social concerns and are an important cause of morbidity and mortality in many countries.[13] Algeria is affected by this issue. It is estimated that 0.3% of the Algerian population is bitten by animals each year with an overall incidence estimated at 279 per 100000 people. Comparably, studies on human animal bites conducted in 2017 in selected counties in Kenya and in Yazd province in Iran showed that the bite incidence was 289 per 100000 inhabitants and 229.8 per 100000 inhabitants respectively.[14-16] A wide variation in the incidence of animal bites was noticed at province level; this was also observed in Iran and Uganda.[16-17]

Rabies is present in over 150 countries and territories and Algeria is not spared.[13] Classified as a major zoonosis by public authorities, rabies continues to plague in Algeria and unfortunately to claim lives as illustrated in this study. Decade after decade, a smooth decline in the human rabies fatality is observed. Identified as a priority disease in 1984, rabies benefits from a national control program whose results unfortunately fall short of expectations. Although bitten people are treated promptly and mass vaccination of domestic dogs and cats to combat the disease at the source is carried out and euthanasia of stray dogs and cats is practiced yearly; animal rabies continues to be enzootic, with an average 120 000 people bitten each year including an average of 900 rabies cases and between 15 to 20 of the deaths.[3] These human deaths due to rabies are unacceptable as they are partly attributed to negligence and ignorance of the vital risk on the part of the victims.

The epidemiological studies carried out from 1894 to date converge on the role played by the dog as a reservoir in maintaining and spreading the rabies virus in Algeria.[12] Moreover, stray animals, essentially carnivores, represent a significant proportion of biting animals. This is compatible with literature.[18-24]

To the best of our knowledge, no study has been carried out on the spatial clustering of animal bites in Algeria. Through this study, the spatial distribution and spatial clustering patterns of animal bite incidence, dog bites and cat bites, identified the significant hot spots in the north of the country. Variations in the incidence of animal bites between Northern provinces, Highland provinces and Saharan provinces may be explained by the disparity in human population density, climate and geographical conditions in these regions.

Animal bites have been recorded throughout the year with a slight raise in the summer months; various studies have documented similar trends.[15,18-20] Additionally, the difference in animal bites occurrence between seasons was not strongly significant. The high frequencies were observed in summer followed by spring then autumn. This was not in line with results in a study undertaken in

Chili; a significant difference between seasons was reported where the high frequencies were recorded in winter followed by autumn then summer.[21] More than half of animal bites (58.7%) occurred outdoors, contrary to Chile were 57.48% occurred indoors.[21] A male predominance was observed in all age groups; similar findings have been reported in other countries.[22-24] Moreover, there was a difference in bite incidence according to gender and age-group which is in accordance with the results in other regions.[14] Children are far more likely to receive animal bites. The incidence rate for children under 15 years is higher; similar results were found in other countries.[18] Some studies convey that dog bites top the list of animal bites and account for tens of millions of injuries per year. In terms of incidence, cat bites are ranked second to dog bites. Dog and cat bites were the most commonly reported animal bites to humans in Algeria. They account for more or less 94% of bites; which is consistent with most of the studies, however, the percentage of bites related to dogs and cat differs from country to country.[18,20] Moreover, dog bites are a significant source of human rabies deaths as concluded in this study and other studies elsewhere.[1,20]

One of the limitations of this study is the lack of detailed data about human injuries and information on the context in which the incident occurred; it falls far short of what is needed to elaborate effective control strategies. Controlling both stray dogs and cats is another important issue for rabies control, as well as vaccinating domestic animals against rabies. Unfortunately, the number of stray or domesticated dogs and cats is unknown in Algeria. The absence of such data presents another barrier in the containment of this issue. Educational, preventive, and informative programs directed at both adults and children so that they comprehend the information are needed in addition to workable efforts that must be made to prevent dog and cat bites as these animals are the most prevalent and when considered with human bites account for over 94% of the total bites seen. Animal bite reduction can significantly minimize the risk of rabies infection, thereby reducing public health costs for the expensive post-exposure treatment.

Despite all the material and human efforts made by the Algerian state to manage the risk of rabies, carelessness of the risk of transmission of rabies following an animal bite as well as unaware of potentially negative consequences of an animal bite, timely care-seeking behaviors in case of bites and add to that, the difficulty of eradicating the animal disease and lack of information about the carnivore population in the country, hamper the national rabies control program. Furthermore, the limited available epidemiological and demographic data about animal injuries and rabies in the country cannot be sufficiently exploited for developing workable and effective control strategies. Without knowledge of the size of the dog population, through ecological and sociological studies, to control animal rabies which occurs in an enzootic state, all the programs undertaken will remain uncertain.

Conclusion

Algeria invests enormous resources in order to combat this scourge but despite these efforts, rabies continues to plague, shattering between 15 and 20 lives each year. Young children and men were the most-at-risk and only around

a quarter of them consulted a health facility immediately after the bite. Rabid dogs were the cause for the overwhelming of fatalities.
Information, education and communications are very safe ways to prevent the population from rabies before and after exposure to the risk of rabies, in addition development of sustainable strategies against stray dogs. To conclude, the current strategy needs to be reviewed, reformed and strengthened while promoting cross-sectoral work with a collaborative approach of all relevant sectors for a One Health initiative to achieve the target set WHO goal: Rabies-Zero deaths by 2030.

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Conflicts of Interest

The Authors declare no conflicts of interests.

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