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► **To cite this version:**

Philippe Gautret, Sèverine Le Roux, Benoit Faucher, Jean Gaudart, Philippe Brouqui, et al.. Epidemiology of urban dog-related injuries requiring rabies post-exposure prophylaxis in Marseille, France. International Journal of Infectious Diseases, 2013, 10.1016/j.ijid.2012.09.011 . hal-01307685

**HAL Id: hal-01307685**

**<https://amu.hal.science/hal-01307685v1>**

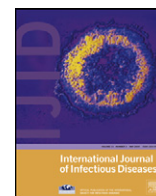
Submitted on 26 Apr 2016

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## Epidemiology of urban dog-related injuries requiring rabies post-exposure prophylaxis in Marseille, France

Philippe Gautret<sup>a,\*</sup>, Séverine Le Roux<sup>a</sup>, Benoît Faucher<sup>a</sup>, Jean Gaudart<sup>b</sup>,  
Philippe Brouqui<sup>a</sup>, Philippe Parola<sup>a</sup>

<sup>a</sup> Institut Hospitalo-Universitaire en Maladies Infectieuses et Tropicales, Hôpital Nord, AP-HM, Chemin des Bourrely, 13915 Marseille, cedex 20, France

<sup>b</sup> Equipe Biostatistiques, LERTIM, Faculté de Médecine, Marseille, France

### ARTICLE INFO

#### Article history:

Received 16 January 2012

Received in revised form 20 April 2012

Accepted 26 September 2012

**Corresponding Editor:** William Cameron,  
Ottawa, Canada

#### Keywords:

Dog bites

Rabies post-exposure prophylaxis

Epidemiology

Risk factors

Spatial distribution

### SUMMARY

**Background:** Dog bites are a serious public health concern. Besides injuries and the adverse psychological impacts, dog bites can be complicated by infections including rabies, which has the highest case-fatality rate of all infectious diseases.

**Methods:** Dog-associated injuries occurring in the city of Marseille, France were investigated in 245 individuals among patients presenting to the rabies treatment center over a 4-year period.

**Results:** Male patients were more likely to report dog bites compared to female patients (66.5% vs. 33.5%; odds ratio 2.25, 95% confidence interval 1.72–2.93). The mean age of injured patients was 32 years (range 1–85 years). Children and young adults under 30 years of age were more than four times more likely to report dog bites compared to others. Most cases occurred outdoors (73.0%) – in public areas (38.0%) – and involved animals of unknown owners in 56.3% of the cases. Only 28.2% of dogs were available for observation. Most patients (63.7%) received complete rabies post-exposure prophylaxis. The distribution of dog bites in the city was not homogeneous and the incidence of bites was significantly higher in some areas. Eleven percent of patients declared having been bitten by dogs whose owner was a street beggar, and a clustered distribution was evidenced for these cases in one area of the city.

**Conclusions:** Programs offering low-cost rabies vaccination and veterinary care to pets belonging to the group of street beggars should be considered. Such programs may be implemented in other large cities in France and Europe where street beggars are frequently seen.

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## 1. Introduction

Dog bites are a serious public health concern. Besides injuries and the adverse psychological impacts, dog bites can be complicated by infections including rabies, which has the highest case-fatality rate of all infectious diseases.<sup>1</sup> The last case of human rabies acquired in mainland France was reported in 1924 and the last case of fox rabies in 1998. However, rabid dogs are repeatedly imported into France by travelers, with the majority originating from Morocco after having been transported through Spain by car.<sup>2–6</sup>

The decision to prescribe rabies vaccine and/or rabies immunoglobulin to patients injured by dogs depends on the origin of the animal. Over-prescription of rabies post-exposure prophylaxis (PEP) has been questioned in France.<sup>7</sup> In Marseille, efforts to minimize over-prescription of the vaccination for

rabies PEP has been conducted, by delaying the initiation of rabies treatment in injuries involving an apparently healthy dog that can be kept under observation.<sup>8</sup> However, significant numbers of rabies PEP vaccinations are still given to injured patients due to the high proportion of dogs that cannot be kept under observation. In this context, interventions aimed at reducing the number of dog bites are critical. The reduction of dog-related injuries by educational interventions has shown some success in children,<sup>9,10</sup> although this has been contradicted.<sup>11</sup> As a first step towards the possible implementation of such a strategy in Marseille, we conducted a preliminary survey to describe the epidemiology of dog-related injuries requiring rabies PEP in the city.

## 2. Materials and methods

From 2007 to 2010, epidemiological data on dog-related injuries and associated rabies PEP treatment were prospectively collected from patients attending the Marseille rabies treatment center (RTC) using standardized forms. At the Marseille RTC,

\* Corresponding author. Tel.: +33 (0)4 91 96 35 35/36; fax: +33 (0)4 91 96 89 38.  
E-mail address: [philippe.gautret@club-internet.fr](mailto:philippe.gautret@club-internet.fr) (P. Gautret).

most patients are screened by telephone call with a specialized physician so that those patients injured by dogs that can be kept under surveillance are screened-out and do not receive rabies PEP. These patients were not included in our survey. Only those who were advised to visit the center when the responsible animal was not available for surveillance were included. Additional patients who spontaneously presented to the center were also included. Only patients who had been injured within the boundaries of the city of Marseille were selected. Demographic and clinical data and rabies prophylaxis details are routinely documented at the RTC. Additional data were obtained retrospectively by telephone, when possible, regarding the detailed circumstances of the dog attack: characteristics of the dog's owner, place of exposure within the city, environment, and reason for the bite. Interviews were all conducted by one person. The city of Marseille is located in the south of France and comprises 16 districts. Human demographic data (total population and distribution according to sex and age range) were extracted from the 2007 official census (<http://www.insee.fr>). At that time, the population totaled 852 396 inhabitants. Climatic data were obtained from the Wunderground database (<http://www.wunderground.com>).

Place of exposure and place of residence were mapped using Quantum GIS 1.6.0 software (Open Source Geospatial Foundation). The spatial distribution of cases according to the season, the day of the week (weekend vs. working days), and the category of owner (street beggars or not) was investigated using SaTScan software. To detect clusters, this software systematically moves a circular scanning window of increasing diameter over the studied region and compares observed numbers inside the window to the numbers that would be expected under the null hypothesis (random distribution of the studied features). The maximum allowed cluster size corresponded to 50% of the study population. The statistical significance for each cluster was obtained through Monte Carlo hypothesis testing, i.e., results of the likelihood function were compared with 999 random replications of the dataset generated under the null hypothesis.

Differences in proportions (categorical variables) were tested by Pearson tests using SPSS (SPSS, Inc.) software package. A *p*-value of <0.05 was considered significant. Odds ratios (ORs) were estimated by logistic regression. All statistical tests were two-sided. Comparisons of percentages and ORs with 95% confidence intervals (95% CI) were carried out using R 2.8.1 environment ([www.r-project.org](http://www.r-project.org)).

### 3. Results

A total of 245 patients injured by dogs inside the city presented to the RTC between 2007 and 2010. The mean annual incidence was 0.71 per 1000 inhabitants, with no significant annual variation.

#### 3.1. Demographics

The male to female sex ratio was 1.98 in the injured population compared to 0.88 in the whole population. Male patients were more than two times more likely to report dog bites compared to female patients (66.5% vs. 33.5%; OR 2.25, 95% CI 1.72–2.93). The mean age of injured patients was 32 years (median 29 years, range 1–85 years). Individuals aged 0–29 years were over-represented among injured individuals (53.5%) compared to the whole population (38.7%), while those aged 30 years and over were under-represented (Table 1); 75.9% of injured patients were over 15 years of age.

**Table 1**

Patients with dog bite injuries presenting to the Marseille rabies treatment center, by age category, compared to the Marseille population

Age (years)	Injured patients	%	Inhabitants	%	OR	95% CI
0–14	59	24.1	154 704	18.2	4.35	1.99–9.52
15–29	72	29.4	175 000	20.5	4.69	2.16–10.20
30–44	46	18.8	173 819	20.4	3.02	1.36–6.69
45–59	31	12.7	158 051	18.5	2.24	0.98–5.08
60–74	29	11.8	111 002	13.0	2.98	1.31–6.80
≥75	7	2.8	79 820	9.4	1	0–0
Unknown	1	0.4				
Total	245	100	852 396	100		

#### 3.2. Circumstances

In 44.9% of the cases, the dog's owner was not identified because the animal was a free-roaming dog, or because the owner refused to provide their identity and address. No case of a dog traveling in from a rabies endemic area was recorded among those dogs whose owner was identified. Of the injured patients, 11.4% mentioned that the dog's owner was a street beggar. Most cases occurred outdoors (73.0%) – in public areas (38.0%) – and 29.8% of respondents thought the dog attacked them intentionally after they had interacted with the animal, out of the dog's territory (Table 2).

#### 3.3. Spatial distribution and temporal and climatic factors

The mean annual incidence varied significantly according to the place of exposure within the city, with 0.19 cases per 1000

**Table 2**

Details of 245 dog bite incidents in Marseille

Details of incidents	n (%)
<i>Identification of the dog's owner</i>	
Identified	107 (43.7)
Un-identified (free-roaming dogs and owners refusing to provide their identity and address)	110 (44.9)
Street beggars (individuals sitting on the sidewalk and asking for money from people passing by)	28 (11.4)
<i>Environment</i>	
Public areas (streets)	93 (38.0)
State financed apartment complex area (outdoors)	28 (11.4)
Victim's or other home	21 (8.6)
Public garden or dog park	7 (2.9)
Nature reserve area	2 (0.8)
Not documented <sup>a</sup>	94 (38.4)
<i>Reason for bite as mentioned by the victim</i>	
Intentional bite following volunteer interaction with a dog out of its territory <sup>b</sup>	73 (29.8)
Attacked by a dog while running	41 (16.7)
Unprovoked attack	29 (11.8)
Involved in a fight between dogs	20 (8.2)
Attacked by a dog while entering the dog's territory <sup>b</sup>	2 (0.8)
Not documented <sup>a</sup>	80 (32.7)
<i>Distance between place of residence and hospital (km)</i>	
≤4	35 (14.3)
5–9	70 (28.6)
10–14	74 (30.2)
≥15	50 (20.4)
Not documented	16 (6.5)
<i>Body site of injury</i>	
Lower limbs	99 (40.4)
Upper limbs	89 (36.3)
Multiple	24 (9.8)
Head and neck	17 (6.9)
Trunk	10 (4.1)
Not documented	6 (2.4)

<sup>a</sup> Data were mostly obtained by telephone interview. We were unable to reach a number of patients and therefore to document the environment and reason for the bite in those cases.

<sup>b</sup> Dog territory=home or garden of the dog owner.

inhabitants in the 9<sup>th</sup> district (southern part of the city) and 2.43 per 1000 inhabitants in the 16<sup>th</sup> district (northeast part of the city) (OR 12.47, 95% CI 4.91–31.64). The majority of those injured in the 16<sup>th</sup> district were residents of that area (Figure 1; Supplementary Material, file 1). Injuries caused by dogs whose owner was a street beggar were significantly more frequently reported from an area centered on the 1<sup>st</sup> district, as shown in Figure 1 (OR 13.5,  $p < 0.0001$ ). The distance from the place of residence to the RTC was less than 14 km in most cases (73.1%) (Table 2). In addition, there was no difference in distribution of cases according to the season, day of the week, school period, wind speed, temperature, or lunar cycle (Supplementary Material, files 2 and 3). There was no significant spatial distribution difference based on season or day of the week when the injury occurred (data not shown).

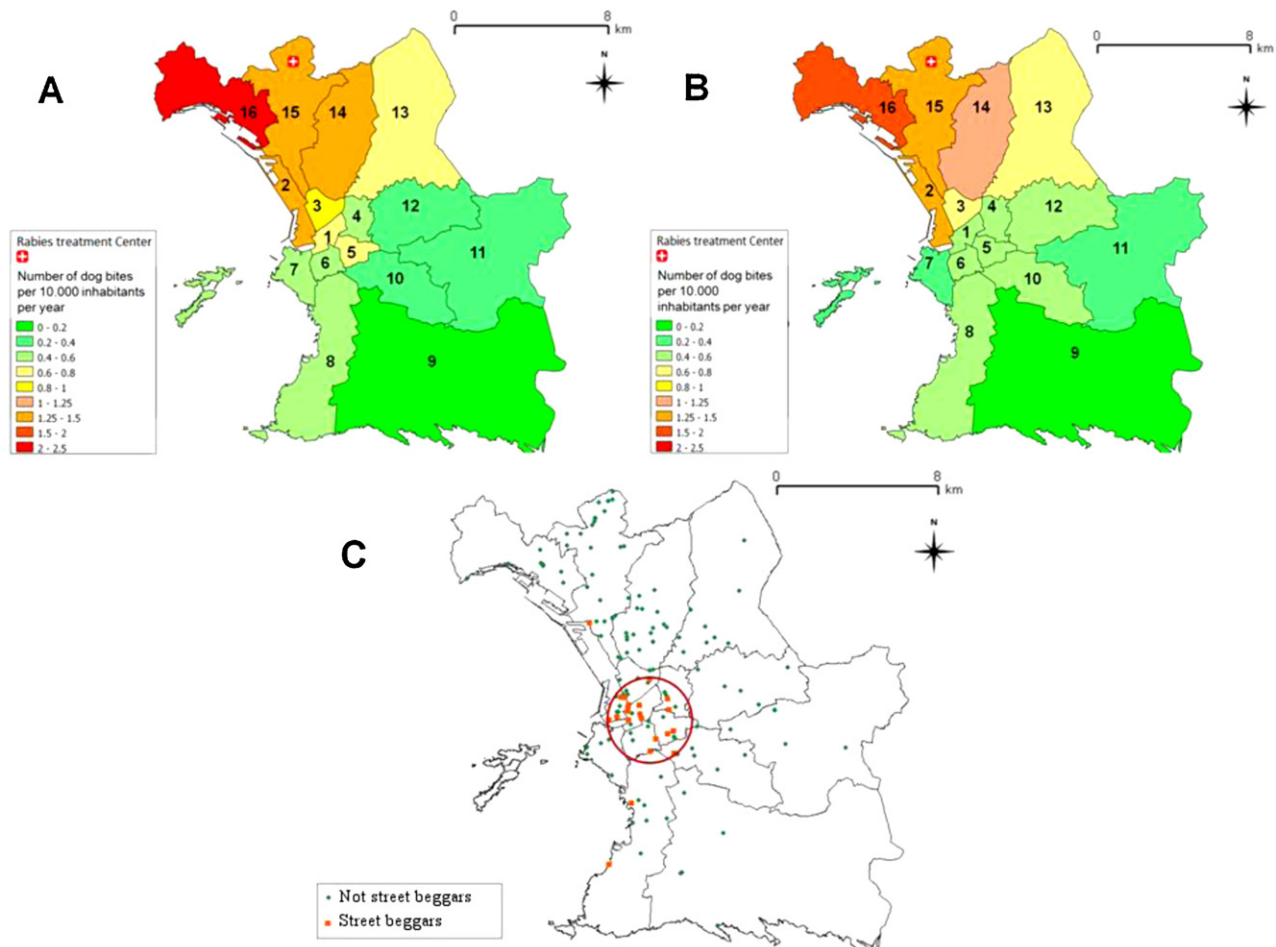
### 3.4. Type of injury and rabies post-exposure prophylaxis

Most injuries (88.3%) were trans-dermal injuries and localized to the lower and upper limbs. Overall, 63.7% of injured patients received complete rabies post-exposure prophylaxis. Of 245 dogs, only 55 (22.4%) were available for surveillance by veterinary personnel and only 14 (5.7%) for surveillance by their owner, allowing the avoidance or interruption of post-exposure vaccination for nearly all of the patients injured by these dogs. By contrast, nearly all patients injured by dogs whose observation was not feasible (71.8%) were vaccinated.

## 4. Discussion

The exact number of dog bites occurring annually in France is unknown. The annual incidence of dog bites seen in the emergency departments in France has been estimated at around 0.03–0.05 per 1000 individuals aged <15 years, accounting for two-thirds of all dog bite injuries seen in the emergency department.<sup>12</sup> In Marseille, around 50% of injured patients are screened-out by telephone call when the animal responsible can be kept under surveillance.<sup>8</sup> Therefore, the actual annual incidence of patients injured by dogs in Marseille that are notified to the RTC is approximately 1.4 per 1000 inhabitants. It is well known that patients seeking care for rabies PEP following animal-related injuries represent a small proportion of the actual number of injured patients.<sup>13</sup> Therefore, the annual incidence in our study very likely underestimates the true incidence of dog bites in the city of Marseille and our results cannot be extrapolated to the entire population of dog bite victims. Nevertheless, it provides useful information to better characterize the circumstances of dog bite incidents that are seen at our center.

Compared to females, male patients had a higher likelihood of being injured by dogs, as already observed by numerous authors.<sup>14</sup> While most studies have indicated that the majority of dog bites occur in children, usually in their own home, and are inflicted by their own pet,<sup>15,16</sup> our survey showed distinct results with most cases occurring not only in children, but also in young adults aged 15–29 years, mostly outside their home and involving animals of



**Figure 1.** Maps showing (A) the location of exposure and (B) the places of residence of injured patients presenting to the Marseille rabies treatment center, and (C) the cluster of bites due to dogs owned by street beggars (C). The numbers indicate the districts of Marseille.

unknown owners in most instances (56.3%). This probably results from a selection bias, as patients injured by their own dogs are usually told by telephone to postpone the rabies PEP while their dog is under observation. This further illustrates that the identification of risk factors for dog-related injuries by epidemiological surveys largely depends on the source of data and that care needs to be taken in comparing the results.<sup>17</sup> Our results suggest, as reported by others,<sup>18</sup> that dog bite prevention strategies teaching people to interact better with dogs are unlikely to be enough to prevent these attacks, as only 29.8% did interact with their aggressor. On those occasions where the human did not interact with the dog that bit them, the focus should be on the owners, who must be made aware that their dog can inflict damage to other people, to feel accountable for the behavior of their pet, and to be willing to take the necessary measures to prevent it causing harm to others. However, in our study, half of the dog owners were unidentified.

The distribution of cases within the city in our survey should be interpreted with caution. The higher prevalence of dog bites requiring rabies PEP in northwest Marseille may be due to a higher density of dogs in that area. The dog population in Marseille is estimated to be around 100 000 animals; however, their distribution in the city is unknown. Alternatively, the higher prevalence of bites in individuals injured and living in the northwest area may result from the location of the RCT in this part of the city. The RCT is the only place where rabies PEP can be obtained in the city and the surrounding area. Of major concern, a clear cluster of dog bite cases linked to dogs whose owner was a street beggar was observed around the 1<sup>st</sup> district of Marseille, in the west-central area of the city. In this case, the localization of the RTC cannot account for the specific distribution of street beggar dog-related injuries. This area is the commercial center of the city with a concentration of shops, restaurants, and bars, and beggars are usually located in this zone because it is easier to beg. The exact numbers of street beggars in Marseille and of their dogs are unknown. The number of street beggars in France is difficult to assess and the evaluations usually considered as most reliable provide numbers of 100 000 to 200 000, representing less than 0.4% of the entire population. The fact that 11.4% of bites involved street beggar dogs in our study strongly suggests that this specific population of dogs may be relatively large in Marseille, or that victims of such dogs perceived them to be high-risk in relation to possible rabies infection. Further investigations should be made to better characterize this group and to identify the origin of the dogs and potential illegal importation from rabies-endemic areas.

We failed to find any temporal or climatic variations in the incidence of dog bites in our survey, which is in contrast to the results of other investigators.<sup>19–21</sup> No relationship between the lunar phase and bite incidence was evidenced in our survey, as previously shown by others.<sup>20,22</sup>

The main findings of our survey are that more than half of the dog bites occurring in the city of Marseille that required rabies PEP involved animals of unknown owners and that more than 11% of bite victims had been bitten by dogs belonging to street beggars. Also, a clustered distribution was evidenced for these latter cases in one area of the city. Based on our results, educational interventions in children would not be very efficient in reducing the number of rabies PEP treatments in Marseille. Interventions targeting street beggar dogs could be of some interest, although such dogs only account for a small part of the bites leading to rabies PEP. French law requires that dogs are kept on the lead in public areas. French regulations also require that dogs imported from a rabies endemic area are vaccinated against rabies and licensed;

however, it is not mandatory to vaccinate and license dogs born in mainland France with the exception of Staffordshire (pit bull) terriers, boerboels, the Japanese tosa, and rottweilers. Street beggars may not be able to afford the rabies vaccine for their pets. Programs offering low-cost rabies vaccination and veterinary care to pets belonging to this group, as well as emphasizing the need for the owners to keep their pets on the leash, should be considered. Such programs may be implemented in other large cities in France and Europe where street beggars are frequently seen.

*Conflict of interest:* None of the authors of this paper has a financial or personal relationship with other people or organizations that could inappropriately influence or bias the content of the paper.

## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.ijid.2012.09.011>.

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