

ORIGINAL ARTICLE

Profile of post-exposure anti-rabies treatments to wild mammals in a health region, Pernambuco, Brazil, 2014-2020

Perfil dos atendimentos antirrábicos pós-exposição a mamíferos silvestres em região de saúde, Pernambuco, Brasil, 2014-2020

Perfil de la atención antirrábica post-exposición a mamíferos silvestres en una región de salud, Pernambuco, Brasil, 2014-2020

Laysa Lindaura Lau Rocha Cordeiro¹ ORCID 0009-0008-2289-542X
Maria Olívia Soares Rodrigues² ORCID 0000-0002-2048-1038
Louisiana Regadas de Macedo Quinino¹ ORCID 0000-0002-7123-8089
Francisco Duarte Farias Bezerra² ORCID 0009-0004-0302-6588
Raylene Medeiros Ferreira Costa² ORCID 0009-0005-1622-7159
Emília Carolle Azevedo de Oliveira¹ ORCID 0000-0002-0957-1542

¹Fundação Oswaldo Cruz, Instituto Aggeu Magalhães, Recife, Pernambuco, Brazil.

²State Health Department of Pernambuco, Recife, Pernambuco, Brazil.

Address: Instituto Aggeu Magalhães – Av. Professor Moraes Rego, s/n – Cidade Universitária – Recife/PE – CEP 50.740-465.

E-mail: emiliacarolle@hotmail.com

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ABSTRACT

Justification and Objectives: since 2016, Brazil has not registered any cases of human rabies transmitted by dogs, with the disease now primarily associated with wild mammals. In Pernambuco, the last reported case occurred in 2017 in Recife. Considering the reporting of anti-rabies treatments as a crucial tool for the epidemiological surveillance of rabies, this study aimed to analyze post-exposure anti-rabies treatments related to wild mammals in the First Health Region of Pernambuco between 2014 and 2020. **Methods:** a descriptive, analytical, and cross-sectional study was conducted on human anti-rabies treatments reported in the Notifiable Diseases Information System. Data were processed using Excel, with the chi-square test assuming $p < 0.05$. A qualitative assessment was performed to identify duplicate records in different health units. **Results:** a total of 799 human anti-rabies treatments were identified, primarily in adults (20-34 years) and mixed-race individuals, with no statistical difference between sexes. Bats were the most involved species. The accidents mainly occurred through bites, on hands and feet, with single and superficial wounds. Most prophylactic recommendations were serum-vaccination. A total of 64 duplicate treatments were recorded in different health units. **Conclusion:** although most post-exposure prophylactic recommendations were appropriate, anti-rabies accidents involving wild mammals are classified as severe. This underscores the importance of strictly adhering to the prophylactic protocol established by the health authority. The identification of duplicate records also highlights the need for improvements in the integration of health systems and the training of professionals to ensure efficiency in case reporting and treatment.

Keywords: *Epidemiology. Rabies. Post-Exposure Prophylaxis. Wild Mammals.*

RESUMO

Justificativa e Objetivos: desde 2016, o Brasil não registra casos de raiva humana transmitida por cães, com a doença agora associada principalmente a mamíferos silvestres. Em Pernambuco, o último caso ocorreu em 2017, em Recife. Considerando a notificação dos atendimentos antirrábicos uma ferramenta crucial para a vigilância epidemiológica da raiva, este estudo teve como objetivo analisar os atendimentos antirrábicos pós-exposição a mamíferos silvestres na Primeira Região de Saúde de Pernambuco entre 2014 e 2020. **Métodos:** estudo descritivo, analítico e transversal dos atendimentos antirrábicos humanos notificados no Sistema de Informação de Agravos de Notificação. Os dados foram processados utilizando o *software Excel*, com o teste qui-quadrado assumindo $p < 0,05$. Uma avaliação qualitativa foi feita para identificar registros duplicados em diferentes unidades de saúde. **Resultados:** foram identificados 799 atendimentos antirrábicos humanos, principalmente em adultos (20-34 anos) e pessoas pardas, sem diferença estatística entre os sexos. O morcego foi a espécie mais envolvida. Os acidentes ocorreram principalmente por mordedura, em mãos e pés, com ferimentos únicos e superficiais. A maioria das indicações profiláticas foi a soro-vacinação. Foram registradas 64 duplicidades de atendimentos em unidades de saúde distintas. **Conclusão:** embora a maioria das indicações profiláticas pós-exposição tenha sido adequada, os acidentes antirrábicos envolvendo mamíferos silvestres são classificados como graves. Isso destaca a importância do cumprimento rigoroso do protocolo profilático estabelecido pela autoridade sanitária. As duplicidades nos registros apontam para a necessidade de melhorias na integração dos sistemas de saúde e na capacitação dos profissionais para garantir a eficiência na notificação e tratamento dos casos.

Descritores: *Epidemiologia. Raiva. Profilaxia Pós-Exposição. Mamíferos Silvestres.*

RESUMEN

Justificación y Objetivos: desde 2016, Brasil no ha registrado casos de rabia humana transmitida por perros, con la enfermedad ahora asociada principalmente a mamíferos silvestres. En Pernambuco, el último caso ocurrió en 2017, en Recife. Considerando la notificación de los atendimientos antirrábicos como una herramienta crucial para la vigilancia epidemiológica de la rabia, este estudio tuvo como objetivo analizar los atendimientos antirrábicos post-exposición a mamíferos silvestres en la Primera Región de Salud de Pernambuco entre 2014 y 2020. **Métodos:** se realizó un estudio descriptivo, analítico y transversal de los atendimientos antirrábicos humanos notificados en el Sistema de Información de Agravios de Notificación. Los datos fueron procesados utilizando el *software Excel*, con la prueba de chi-cuadrado asumiendo $p < 0,05$. Se realizó una evaluación cualitativa para identificar registros duplicados en diferentes unidades de salud. **Resultados:** se identificaron 799 atendimientos antirrábicos humanos, principalmente en adultos (20-34 años) y personas pardas, sin diferencia estadística entre los sexos. El murciélago fue la especie más involucrada. Los accidentes ocurrieron principalmente por mordedura, en manos y pies, con heridas únicas y superficiales. La mayoría de las indicaciones profiláticas fueron suero-vacunación. Se registraron 64 duplicidades de atendimientos en distintas unidades de salud. **Conclusión:** aunque la mayoría de las indicaciones profiláticas post-exposición fueron adecuadas, los accidentes antirrábicos que involucran mamíferos silvestres se clasifican como graves. Esto destaca la importancia del cumplimiento riguroso del protocolo profilático

establecido por la autoridad sanitaria. La identificación de duplicidades en los registros también señala la necesidad de mejoras en la integración de los sistemas de salud y en la capacitación de los profesionales para garantizar la eficiencia en la notificación y tratamiento de los casos.

Palabras Clave: *Epidemiología. Rabia. Profilaxis Post-Exposición. Mamíferos Silvestres.*

INTRODUCTION

Rabies is an anthroponosis of high relevance in public health due to its high lethality, resulting in more than 60,000 annual deaths worldwide.¹ Caused by the virus of the genus *Lyssavirus*, of the family *Rhabdoviridae*, present in the saliva of infected animals, the current transmission has been significantly associated with the hematophagous bat.²⁻⁴ Since 2016, there have been no reports of human rabies transmitted by dogs in Brazil, indicating a change in the epidemiological profile of the disease, with cases being predominantly transmitted by wild mammals or resulting from their antigenic variants, such as the vampire bat variant (AgV3) and variants of *Callithrix jacchus* and wild canids.⁵ Rabies occurs most frequently in northern and northeastern Brazil, mainly affecting children and adolescents in rural areas.⁶

In Pernambuco, between 1990 and 2023, 45 cases of human rabies were reported, with the last fatal case confirmed in the city of Recife, in 2017, transmitted by a cat infected with AgV3.^{7,8} As for anti-rabies care after exposure to wild mammals, approximately 35% of reports occurred in Recife and in the municipalities of the Metropolitan Region of Recife (MRR), between 2011 and 2017,⁹ belonging to the First Health Region of Pernambuco. Most of the care involved accidents with bats and primates.⁹

Although it has a fatality rate of almost 100%, rabies is a vaccine-preventable disease. Human rabies prophylaxis is offered free of charge by the Brazilian Health System, with the recommendation of administering serum and vaccine (or re-exposure) in cases of accidents involving wild mammals.^{10,11} Moreover, human rabies accidents must be immediately reported by healthcare services, even when treatment with immunobiological agents is not recommended. These actions, together with rabies vaccination campaigns for dogs and cats and health education initiatives, contribute to reducing the incidence of the disease and the effectiveness of rabies elimination programs, strengthening health systems, especially surveillance systems.

Considering the above, this study aimed to analyze anti-rabies care after exposure to wild mammals in the First Health Region of Pernambuco between 2014 and 2021.

METHODS

This is a descriptive and inferential study, with a cross-sectional design, of anti-rabies care after exposure to wild mammals reported in the Notifiable Diseases Information System (In Portuguese, *Sistema de Informação de Agravos de Notificação - SINAN*), between 2014 and 2020, in the First Health Region of Pernambuco.

The state of Pernambuco is made up of 184 municipalities and the Fernando de Noronha Archipelago, administratively organized into 12 health regions. The First Health Region is the most populous (4,208,906 inhab.; 3,721.3 km²) and with the greatest supply of healthcare services, being made up of the municipalities of Abreu e Lima, Araçoiaba, Cabo de Santo Agostinho, Camaragibe, Chã Grande, Chã de Alegria, Glory of Goitá, the Archipelago of Fernando de Noronha, Igarassu, Ipojuca, Itamaracá, Itapissuma, Jaboatão dos Guararapes, Moreno, Olinda, Paulista, Pombos, Recife, São Lourenço da Mata and Vitória de Santo Antão.¹²

The data were obtained from the Coordination of Zoonoses and Accidents due to Venomous Animals of the State Health Department of Pernambuco on March 24, 2023. All cases reported in the First Health Region as “human anti-rabies care” were considered. The records were selected based on year of exposure (2014-2020) and attacking animal species, covering chiroptera (bats), primates (monkeys) and foxes, the wild mammals of greatest importance in the epidemiological cycle of rabies in Brazil.¹¹ Duplicates by SINAN registration number and cases reported with animals of other species and outside the period analyzed were excluded.

The selected variables were classified into three categories: sociodemographic profile; epidemiological history; and treatment. The sociodemographic profile included the variables municipality of reporting, sex, age, race/color, education level, and area of residence. In the epidemiological history, type of exposure to the rabies virus, wound site, type of wound, date of exposure, history of anti-rabies treatment, attacking animal species and animal condition for the purposes of treatment conduct were considered. In the treatment category, treatment recommended, animal final condition after the observation period, interruption of treatment, reason for interruption, active search for the health unit of patients who abandoned treatment and additional observations were analyzed.

Descriptive statistical analysis was performed using absolute and relative frequencies, mean, standard deviation (SD) and incidence rate. The total annual incidence rate of cases was calculated as the ratio between the absolute number of registered cases (2014-2020) and the estimated population of the First Health Region, according to the Brazilian Institute of Geography and Statistics of 2010. The incidence rate by animal species was calculated as the ratio between the absolute number of cases per species (2014-2020) and the estimated population for each species, both multiplied by 100,000.

The chi-square test was used to test the association between the variables of interest during the study period, related to sociodemographic characteristics, wound characteristics and animal species, considering a 95% Confidence Interval and a significance level of <0.05 . All database processing, statistical tests, graphs and tables were performed in Microsoft Excel 365.

As part of qualitative analysis, the recommendation of post-exposure rabies prophylaxis with serum and vaccine was classified as “adequate”, following the current health authority recommendations.^{10,11} The re-exposure procedure was not assessed for this classification, as it requires a more detailed investigation that correlates the variables of history of anti-rabies treatment, period of completion (up to 90 days/after 90 days) and number of doses applied. Furthermore, all post-exposure prophylactic measures for wild mammals that were not recommended were classified as “inadequate”. An individual and qualitative analysis was also performed on duplicate records of the same exposure reported in more than one health unit, aiming to identify consistency in the recommendation of post-exposure anti-rabies treatment.

This research was conducted in accordance with the ethical standards defined by Resolutions 466/2012, 510/2016 and 580/2018 of the Ministry of Health, and was approved by the *Instituto Aggeu Magalhães* (IAM) (Fiocruz/PE) Research Ethics Committee, under Opinion 5,873,716 and Certificate of Presentation for Ethical Consideration 65555522.7.0000.5190.

RESULTS

Between 2014 and 2020, the First Health Region reported 799 human anti-rabies treatments after exposure to wild mammals. In total, 17 municipalities recorded anti-rabies treatment after exposure to bats, primates or foxes, mainly in the city of Recife (n=499; 62.5%). Together, the number of cases reported in the cities of Vitória de Santo Antão, Paulista, Jaboatão dos Guararapes and Olinda totaled 24.6%. The average number

of annual cases was approximately 114 (SD = 62), with the highest number of reports recorded in 2017 (n = 209; 5.0/100,000 inhab.), and the lowest in 2020 (n = 14; 0.3/100,000 inhab.) (Figure 1).

The annual average number of accidents involving bats, primates and foxes was 60.7 (SD = 32.5), 46.6 (SD = 27.6) and 6.9 (SD = 3.8), respectively. The incidence rate of care in the population due to accidents with foxes was highest in 2014 (n = 11; 0.3/100,000 inhab.), whereas for bats (n = 114; 2.7/100,000 inhab.) and primates (n = 86; 2.0/100,000 inhab.) the peak occurred in 2017 (Figure 2).

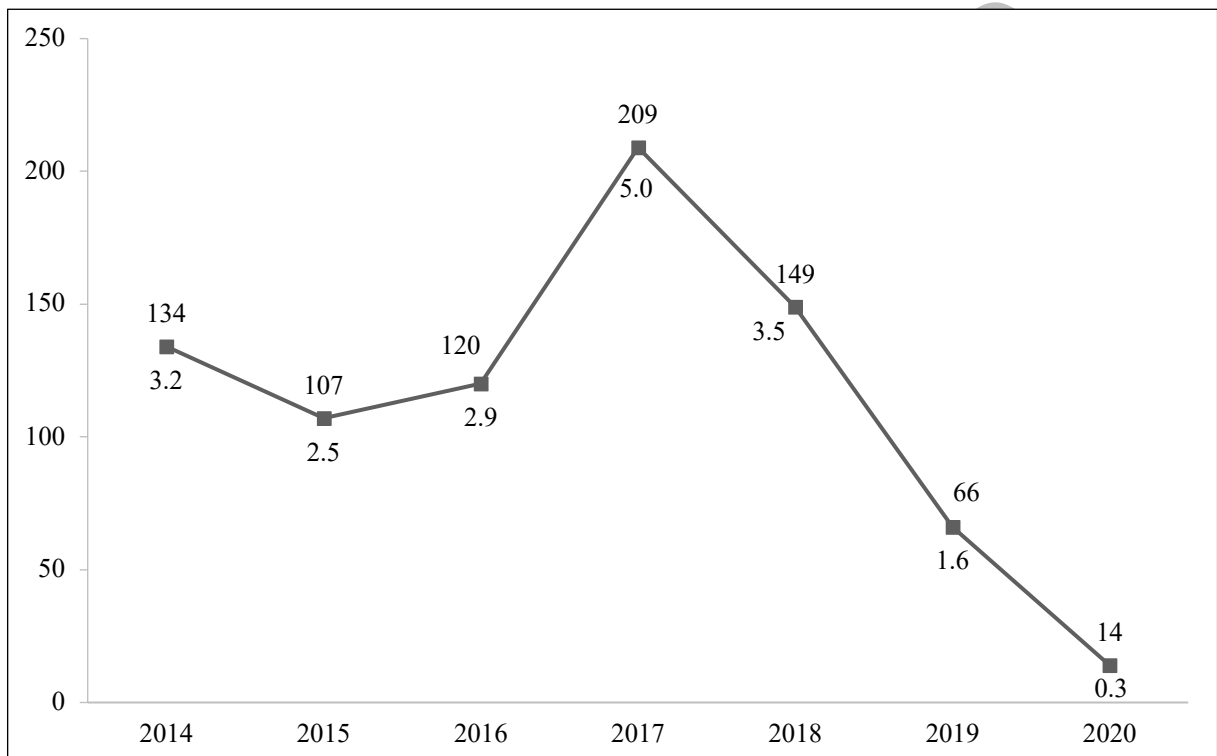


Figure 1. Time series of post-exposure anti-rabies care to wild mammals according to the number and total incidence rate. First Health Region, Pernambuco, 2014 to 2020

Source: SINAN data. Prepared by the authors.

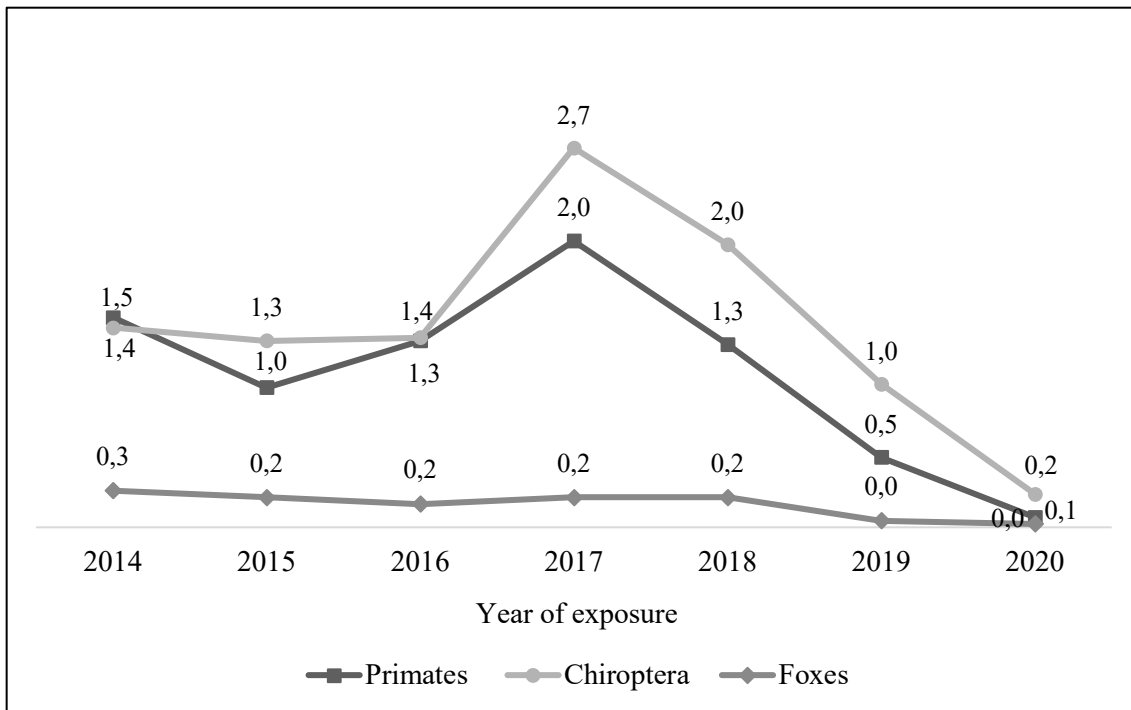


Figure 2. Incidence rate of anti-rabies care after exposure to bats, primates and foxes. First Health Region, Pernambuco, 2014 to 2020
Source: SINAN data. Prepared by the authors.

The distribution by sex was homogeneous, with 51.1% of cases involving men and 48.9% involving women. The most affected age group was 20 to 34 years (24.8%), with the majority of people being mixed-race (36.4%). Records with the race/color and education fields not filled in or marked as unknown were quite representative, totaling, respectively, 43.6% and 57.7%. The majority of individuals lived in urban areas (87.4%) (Table 1).

In relation to sex and race/color, mixed-race people were the most affected, specifically females ($\chi^2 = 15.2$; $p = 0.004$). The association between sex and age group ($\chi^2 = 12.1$; $p = 0.208$) and sex and education ($\chi^2 = 9.4$; $p = 0.307$) was not significant.

Table 1. Sociodemographic profile of anti-rabies care after exposure to wild mammals. First Health Region, Pernambuco, 2014 to 2020

SOCIODEMOGRAPHIC PROFILE				
	Female	Male	Total	p^4
	n (%)	n (%)	n (%)	
Age group				0.208
< 1 year	8 (2)	11 (2.7)	19 (2.4)	
1 to 4 years	15 (3.8)	17 (4.2)	32 (4)	
5 to 9 years	28 (7.2)	30 (7.4)	58 (7.3)	
10 to 14 years	18 (4.6)	27 (6.6)	45 (5.6)	
15 to 19 years	28 (7.2)	33 (8.1)	61 (7.6)	
20 to 34 years	90 (23)	108 (26.5)	198 (24.8)	
35 to 49 years	84 (21.5)	97 (23.8)	181 (22.7)	

50 to 64 years	84 (21.5)	58 (14.2)	142 (17.8)
65 to 79 years	27 (6.9)	23 (5.6)	50 (6.3)
80 and older	9 (2.3)	4 (1)	13 (1.6)
Race/color	0.004		
White	63 (16.1)	68 (16.7)	131 (16.4)
Black	6 (1.5)	19 (4.7)	25 (3.1)
Yellow	0 (0)	1 (0.2)	1 (0.1)
Mixed-race	148 (37.9)	143 (35)	291 (36.4)
Indigenous	1 (0.3)	2 (0.5)	3 (0.4)
Ignored or blank	173 (44.2)	175 (42.9)	348 (43.6)
Education	0.307		
Illiterate	0 (0)	2 (0.5)	2 (0.3)
Incomplete 1 st to 4 th grade of elementary school ¹	15 (3.8)	23 (5.6)	38 (4.8)
Complete 4 th grade of elementary school ¹	4 (1)	6 (1.5)	10 (1.3)
Incomplete 5 th to 8 th grade of elementary school ²	13 (3.3)	20 (4.9)	33 (4.1)
Complete elementary school ²	12 (3.1)	7 (1.7)	19 (2.4)
Incomplete high school ³	9 (2.3)	7 (1.7)	16 (2)
Complete high school ³	41 (10.5)	44 (10.8)	85 (10.6)
Incomplete higher education	10 (2.6)	7 (1.7)	17 (2.1)
Complete higher education	24 (6.1)	22 (5.4)	46 (5.8)
Ignored or blank	229 (58.6)	232 (56.9)	461 (57.7)
Not applicable	34 (8.7)	38 (9.3)	72 (9)
Area of residence	0.436		
Urban	349 (89.3)	349 (85.5)	698 (87.4)
Rural	17 (4.3)	22 (5.4)	39 (4.9)
Ignored or blank	25 (6.4)	37 (9.1)	62 (7.8)

Note: ¹Former primary or 1st grade; ²Former high school or 1st grade; ³Former high school or 2nd grade; ⁴The “ignored”, “not applicable” and blank fields were not considered in the chi-square test.

Source: SINAN data. Prepared by the authors.

Accidents occurred mainly due to biting (79%), with a higher frequency on hands and feet (47.8%). Single wounds were the most frequently reported (63.7%), as were superficial wounds (59.6%). In general, the recommendation of serum and vaccine was observed in 81.1% of cases, and the conduct was classified as adequate. Re-exposure conduct was observed in 1.3% of cases (n=10); of these, only eight records contained information on history of post-exposure anti-rabies treatment (Table 2).

The type of exposure ($\chi^2 = 20.6$; $p = 0.008$), wound site ($\chi^2 = 43.9$; $p = 0.000$), wound ($\chi^2 = 22.7$; $p = 0.000$) and type of wound ($\chi^2 = 15.5$; $p = 0.004$) were statistically significant between species, as was treatment recommended ($\chi^2 = 53.2$; $p = 0.000$) (Table 2). Although biting was predominant in accidents involving the three species, scratching was also significant, followed by indirect contact, for bats, and licking, for primates and foxes. Hands and feet had the highest frequency of wounds, followed by upper limbs and head/neck in both bat and primate accidents, whereas lower limbs were the second most frequently reported site in fox accidents. Wound-free exposures were observed for both bats and primates.

More than half of animals were declared dead or missing (54.4%) when the “animal condition” field was filled in. Similarly, regarding animal final condition, clinical diagnosis was negative in most cases (66.7%). Among the few cases that underwent laboratory diagnosis (3% of the total), 0.5% tested positive for rabies (Table 2).

Table 2. Anti-rabies care after exposure to wild mammals according to epidemiological history and treatment. First Health Region, Pernambuco, 2014 to 2020

ATTACKING ANIMAL SPECIES					
	Primate n (%)	Chiroptera (%)	Fox n (%)	Total n (%)	P
Type of exposure					0.008
Indirect contact	6 (1.8)	29 (6.8)	0 (0)	35 (4.3)	
Scratching	32 (9.6)	53 (12.5)	5 (9.8)	90 (11.1)	
Licking	9 (2.7)	10 (2.4)	1 (2)	20 (2.5)	
Biting	278 (83.5)	316 (74.4)	45 (88.2)	639 (79)	
Other	8 (2.4)	17 (4)	0 (0)	25 (3.1)	
Site					0.000
Mucosa	5 (1.5)	17 (3.9)	0 (0)	22 (2.6)	
Head/neck	59 (17.4)	64 (14.6)	1 (1.8)	124 (14.9)	
Hands/feet	183 (53.8)	193 (44.2)	22 (40)	398 (47.8)	
Trunk	13 (3.8)	26 (5.9)	5 (9.1)	44 (5.3)	
Upper limbs	57 (16.8)	78 (17.8)	11 (20)	146 (17.5)	
Lower limbs	23 (6.8)	59 (13.5)	16 (29.1)	98 (11.8)	
Wound					0.000
Single	197 (64.6)	257 (64.1)	26 (54.2)	480 (63.7)	
Multiple	103 (33.8)	112 (27.9)	22 (45.8)	237 (31.4)	
No wound	5 (1.6)	32 (8)	0 (0)	37 (4.9)	
Type of wound					0.004
Deep	129 (43.3)	120 (33.2)	23 (46.9)	272 (38.4)	
Superficial	160 (53.7)	238 (65.9)	24 (49)	422 (59.6)	
Lacerating	9 (3)	3 (0.8)	2 (4.1)	14 (2)	
Animal condition (treatment conduct)					0.000
Dead/missing	128 (44.1)	235 (63)	19 (48.7)	382 (54.4)	
Rabid	2 (0.7)	11 (2.9)	0 (0)	13 (1.9)	
Healthy	75 (25.9)	20 (5.4)	10 (25.6)	105 (15)	
Suspicious	85 (29.3)	107 (28.7)	10 (25.6)	202 (28.8)	
Treatment recommended					0.000
Pre-exposure	14 (4.4)	2 (0.5)	2 (4.3)	18 (2.3)	
No treatment required	2 (0.6)	8 (1.9)	0 (0)	10 (1.3)	
Animal observation	2 (0.6)	3 (0.7)	0 (0)	5 (0.6)	
Observation + vaccine	31 (9.7)	10 (2.4)	6 (12.8)	47 (6)	
Vaccine	21 (6.6)	28 (6.7)	9 (19.1)	58 (7.4)	
Serum + vaccine	248 (77.7)	358 (85.9)	29 (61.7)	635 (81.1)	
Re-exposure scheme	1 (0.3)	8 (1.9)	1 (2.1)	10 (1.3)	
Animal final condition					0.545
Rabies negative (clin.)	72 (67.3)	53 (63.1)	11 (84.6)	136 (66.7)	
Rabies negative (lab.)	2 (1.9)	3 (3.6)	0 (0)	5 (2.5)	
Rabies positive (clin.)	0 (0)	2 (2.4)	0 (0)	2 (1)	

Rabies positive (lab.)	0 (0)	1 (1.2)	0 (0)	1 (0.5)
Dead/euthanized/no diagnosis	33 (30.8)	25 (29.8)	2 (15.4)	60 (29.4)
Interruption of treatment	0.965			
Yes	28 (14.2)	30 (14)	4 (16)	62 (14.2)
No	169 (85.8)	184 (86)	21 (84)	374 (85.8)
Reason for interruption	0.603			
Recommendation of health unit	11 (39.3)	9 (30)	1 (25)	21 (33.9)
Abandonment	16 (57.1)	17 (56.7)	3 (75)	36 (58.1)
Transfer	1 (3.6)	4 (13.3)	0 (0)	5 (8.1)
Active search	0.435			
Yes	8 (61.5)	10 (66.7)	3 (100)	21 (67.7)
No	5 (38.5)	5 (33.3)	0 (0)	10 (32.3)

Source: SINAN data. Prepared by the authors.

By qualitatively analyzing duplicate records, it was possible to identify that 64 cases of the same accident were reported in more than one health unit. The recommendation for treatment with serum and vaccine prevailed in the three care units. However, conducts classified as inadequate, such as observation and vaccine (1st unit - 1.6%) and only vaccine (1st unit - 7.8%; 2nd unit - 1.6%), were also recommended (Table 3).

Table 3. Duplicate reports in different health units. First Health Region, Pernambuco, 2014 to 2020

	1st Health Unit n (%)	2nd Health Unit n (%)	3rd Health Unit n (%)
Treatment recommended			
Observation + vaccine	1 (1.6)	0 (0)	0 (0)
Vaccine	5 (7.8)	1 (1.6)	0 (0)
Serum + vaccine	56 (87.5)	63 (98.4)	6 (100)
Not filled in	2 (3.1)	0 (0)	0

Source: SINAN data. Prepared by the authors.

DISCUSSION

During the period analyzed, 799 human anti-rabies treatments were reported after exposure to wild mammals, predominantly in the city of Recife. In the sociodemographic profile, mixed-race people were the most affected, with a higher prevalence among women, young people and adults with a high school education, and residents of urban areas. Among the three species studied, exposure to bats was the most reported. Anti-rabies care was mainly due to bites, affecting hands and feet, with single and superficial lesions. The anti-rabies prophylaxis recommended was appropriate for the type of exposure in most cases, although some inadequate recommendations were also identified.

The year 2017 recorded the highest number of reports, similar to that observed in an analysis of rabies accidents involving wild mammals for the state of Pernambuco.⁹ That year, the city of Recife reported the last human rabies death in the state, with the source of infection being a stray cat infected by the vampire bat variant, in a phenomenon known as “spillover”.^{7,8,13} Underreporting may explain the sharp drop in case registrations in the final years of the period analyzed. This may be related to several factors, including the lack of adequate training of healthcare professionals to identify and report cases, changes in surveillance policies, and the possible reduction in demand for care due to the population’s lack of knowledge about the importance of post-exposure treatment. Furthermore, the COVID-19 pandemic may have impacted healthcare services’ ability to effectively report cases in recent years, diverting resources and attention to controlling the new health emergency.

Other positive factors that may explain the findings include improvements in prevention measures, such as vaccination campaigns and rabies control in domestic and wild animals as well as increased public awareness and better training of healthcare professionals. On the other hand, negative factors such as reduced active surveillance, lack of resources and demographic changes may also have contributed to the variations in case records.

The race/color and education fields were substantially ignored or not filled in in this study, reflecting the incompleteness of the database. These criteria are fundamental to delineating the epidemiological profile of the population, allowing the identification of vulnerable groups and inequalities in access to information and healthcare services. The lack of such data may result in less knowledge about the disease and the need for post-exposure rabies care to wild mammals, in addition to highlighting access barriers from the perspective of racial inequities.^{14,15}

In this study, accidents involving bats were the most representative, with an average of 1.4 accidents per 100,000 inhabitants in the First Health Region. When analyzing the incidence rate of attacks by bites from animals that transmit rabies in Brazil (2008-2016), Benavides *et al.*¹⁶ found results that ranged from 0.6 to 2.3 bites per 100,000 inhabitants in accidents with wild mammals, values lower than those observed in dog and cat bites. The authors, however, emphasize the importance of careful interpretation of these findings, since both underreporting and the geographic occurrence of attacks, such as outbreaks in rural areas and indigenous communities,^{2,17} may influence the results, making them elevated in some locations.¹⁶

Biting was the main type of exposure found, being commonly reported in the literature.^{6,18-20} Hands and feet were the most frequently attacked areas, probably because they were used in an attempt to defend themselves against attacks/accidents or because they were extremities, supporting other authors.^{18,19,21,22} Recently, a man died after being infected with the rabies virus in the state of Ceará. The symptoms occurred concomitantly with the COVID-19 infection, two months after being bitten on the right wrist by a marmoset. The patient did not receive post-exposure rabies prophylaxis, and the diagnosis was confirmed post-mortem by direct immunofluorescence.²³

Single and superficial wounds were the most reported for the three species, in disagreement with an analysis carried out on post-exposure anti-rabies care for wild mammals in the state of Pernambuco (2011-2017), where deep wounds were the most reported.⁹

Post-exposure rabies prophylaxis with serum and vaccine was the most recommended by healthcare professionals, in accordance with the protocol established by the Ministry of Health for accidents with bats or any other species of wild mammal.^{10,11} For primates, observation and vaccination were the second most common treatment recommendations, while for bats and foxes, only vaccination was recommended. In addition to being incoherent and inconsistent, the recommendation to observe the animal (whether a dog or cat) or to dispense treatment in cases involving bats and primates represents a weakness in the service offered to public health, considering the lethality of the disease. Several factors may be associated with inadequate recommendations for anti-rabies prophylaxis after exposure to wild mammals, such as the epidemiological transition of the disease in recent years, professionals' lack of knowledge of current immunological protocol, lack of training on the subject, high turnover of professionals in healthcare services and even low provision of health education for the population.^{24,25}

Abandonment was the main reason given for interrupting treatment, and it is important to consider the possibility that the patient completed the prophylactic regimen in a different health unit from the one where the patient was first treated, resulting in duplicate records in non-integrated healthcare services. Interruption of treatment on the recommendation of the health unit was observed in a considerable number of reports, with the protocol being inappropriate for the type of accident analyzed (wild mammals).

In total, it was possible to identify 64 duplicate records for the same exposure in up to three different health units. Analyzing the "observations" field, it was identified that some patients were referred for human anti-rabies serum (not available in the first

consultation) and for subsequent doses, generating duplicates due to the lack of communication and integration between the reporting units. The recommendation of serum and vaccine also prevailed in the different consultations.

The analysis of post-exposure rabies care for wild mammals in the First Health Region of Pernambuco is particularly relevant, as this is the most populous region of the state and has the largest supply of healthcare services. Between 2011 and 2017, Pernambuco reported 6,363 human rabies care involving wild mammals,⁹ with most reports occurring in the MRR (35.1%) and *agreste* (23.7%).

The municipalities of the MRR are part of the First Health Region, which frequently meets the demand of other regions, due to its robust health infrastructure.¹² Therefore, the results of this study provide valuable insights for epidemiological surveillance, planning public health actions and improving responses to rabies accidents, not only in the First Health Region, but potentially throughout the state of Pernambuco and similar regions.

This study used secondary data, which may present limitations regarding data underreporting, incompleteness and inconsistency, which may trigger information biases. Correctly filling out investigation forms is essential to guide the rabies prophylaxis protocol, analyze the epidemiological profile of accidents and develop strategic actions for the prevention and control of the disease based on evidence. To minimize the limitations of this study, duplicates and incomplete and inconsistent records were identified, with methodological rigor in the statistical analyses.

Therefore, it is important to highlight the need for health teams to receive regular updates on the epidemiology of the disease, prevention methods and immunization protocols, as well as on the correct completion of the reporting form, which is considered extremely important for monitoring diseases and health problems. Finally, it is also recommended that qualitative studies be developed to assess professionals' and managers' perception regarding reporting, care flows and prophylaxis, in addition to the implementation of health education actions that promote awareness among the population about the risks associated with disease transmission, especially in the wild cycle.

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Authors' contributions:

Laysa Lindaura Lau Rocha Cordeiro contributed to project administration, literature search, formal analysis, conceptualization, methodology, data curation, statistics, writing (first draft, review, and editing), investigation, resources, software, supervision, validation, conclusions. **Maria Olívia Soares Rodrigues** and **Louisiana Regadas de Macedo Quinino** contributed to writing (review and editing), interpretation of results, conclusions, validation, and visualization. **Francisco Duarte Farias Bezerra** contributed to project administration, methodology, interpretation of results, and review. **Raylene Medeiros Ferreira Costa** contributed to data curation, software, interpretation of results, and review. **Emília Carolle Azevedo de Oliveira** contributed to project administration, literature search, formal analysis, writing (review and editing), investigation, methodology, resources, supervision, validation, and conclusions.

All authors have approved the final version of the manuscript and are responsible for all aspects of it, including ensuring its accuracy and integrity.