Infectious disease

An epidemiological study of dog bites and utilization of anti-rabies vaccine in Al-Anbar governorate

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Keywords

Dog bites • Rabies • Post-exposure prophylaxis • Vaccination adherence • Iraq • Stray dog

Summary

Background. *Dog bites are an important public health problem throughout the world because of the risk of rabies transmission. This study aimed to describe the epidemiological profile of reported dog bite cases in Al-Anbar Governorate and to assess the utilization of anti-rabies vaccination.*
Methods. *We conducted a retrospective surveillance-based study in Al-Anbar Governorate, Iraq, using registered records of dog bite cases reported between 1January 2020 and 31 December 2025. Dog bite records were included in the main analysis. Descriptive statistics, chi-square tests, and binary logistic regression were used to assess factors associated with documented completion of rabies PEP.*
Results. *Among 6,927 registered animal bite records, 5,655 (81.7%) were dog bites. The mean age of patients was 20.6±15.5 years, and 4,434 (78.4%) were male. The highest proportion of cases occurred among individuals aged 10–14 years (22.1%). Stray dogs accounted for 4,603 (66.5%) of all animal bite records. Among dog bite victims, 4,837 (85.5%) initiated PEP, but only 1,377 (24.4%) had documented completion of all four vaccine doses. In multivariable analysis, multiple bites were associated with higher odds of PEP completion, while face and head bites, penetrating surface scratches, and RIG administration were associated with lower odds of documented completion.*
Conclusion. *Dog bites remain a major public health problem in Al-Anbar Governorate, with low documented completion of rabies PEP. Strengthening surveillance, improving follow-up, ensuring vaccine and RIG availability, and implementing One Health rabies prevention strategies are needed.*

Introduction

Dog bites are an important public health problem worldwide, causing considerable morbidity for physical injuries and the risk of infectious complications, including zoonoses [1]. Based on the severity of contact, the World Health Organization (WHO) classifies animal bites into three categories (I-III) and recommends the immediate post-exposure prophylaxis (PEP) for the prevention of rabies infection in exposed individuals [2]. Rabies remains the most severe consequence of dog bites, being almost always fatal after the onset of clinical symptoms, although it is entirely preventable by proper vaccination in time [3]. Dogs are the main reservoir and source of human rabies transmission worldwide [4].
Rabies is still present in many parts of the world, particularly in some parts of the Middle East where canine rabies is still enzootic [5]. Rabies has been recognized in Iraq for many years, but effective control remains a challenge because of weakened surveillance systems, low vaccination coverage of dogs, lack of routine laboratory confirmation, and reliance on ineffective population control measures such as culling, which disrupt long-term rabies control [6].
Dog bites are of public health importance, but epidemiological data on dog bites in Iraq are scarce due to the lack of systematic monitoring in the Iraqi provinces. This lack of surveillance data limits the ability to effectively evaluate the effectiveness of preventive measures and assess regional differences in exposure patterns [7]. Therefore, a strengthened surveillance system is an important epidemiological indicator to estimate the ongoing risk of transmission of rabies virus and to assess the need for post-exposure prophylaxis (PEP) [8].
The World Health Organization, in collaboration with the Global Alliance for Rabies Control, has set a target at the global level to eliminate dog-mediated human rabies by 2030 through a coordinated One Health approach involving human health care, animal vaccination programs, and methods for managing dog populations. This can be achieved only by improving surveillance systems and using vaccines optimally [9].
Al-Anbar Governorate is one of the largest in Iraq. There are no specific epidemiological studies on dog bites and the use of anti-rabies vaccination in exposed individuals. The aim of the study was to assess the utilization of anti-rabies vaccination among dog bite victims and to describe the epidemiological profile of reported dog bite cases in Al-Anbar Governorate. Specifically, the study described demographic characteristics, circumstances of exposure, and time trends and measured the proportion of people who initiated and completed the recommended PEP regimen.

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Methods

Study design and setting

A retrospective surveillance-based study was conducted in Al Anbar Governorate, Iraq, using registered dog bite cases reported between 1 January 2020 and 31 December 2025. This study was reported in accordance with the STROBE guidelines for observational studies, and the completed STROBE checklist is provided as supplementary material (Tab. S1).

Data source and study population

Data were obtained from the Al-Anbar Health Directorate's records, specifically from the Public Health Department, Communicable Diseases Division, and Zoonotic Diseases Unit, which uses a standardized surveillance form to collect primary information from hospitals and primary health care institutions across Al-Anbar Governorate.

All registered animal bite cases from 1 January 2020 to 31 December 2025 were reviewed. No sample size calculation was performed because all eligible surveillance records available during the study period were included. Dog bite cases were included in the main analysis to determine the epidemiology of dog bites and the use of anti-rabies vaccination. Cases involving other animals were included only to describe the overall distribution of animal exposures.

Some cases were excluded from specific statistical analyses because critical information required for these analyses was missing or inconsistent. The surveillance records for 2025 included all registered cases reported between 1 January and 31 December 2025; therefore, annual data for 2025 were complete.

Operational definition and variables

Throughout the study period, an animal bite was defined as any documented bite recorded in the official registers for individuals of all ages. The biting animal was classified based on registry records as owned dogs, stray dogs, or other animals [10].

The study variables included age, sex, residence, exposure site (head/face, upper limb, lower limb, trunk, or multiple sites), type of biting animal, and injury severity.

Clinical records categorized the severity of exposure into superficial scratches or abrasions, superficial bite wounds, and deep bite wounds. In addition, the interval between the date of the bite and the initiation of anti-rabies vaccination was recorded.

Post-exposure prophylaxis (PEP) variables included the administration of the rabies vaccine; the vaccination schedule used (Zagreb regimen: two doses on day 0, followed by single doses on days 7 and 21); the total number of vaccination doses administered in accordance with the schedule; and recorded administration of rabies immunoglobulin (RIG).

In this study, completion of anti-rabies vaccination (ARV) was defined as cases that received all four vaccine doses according to the prescribed schedule, whereas incomplete ARV was defined as receiving fewer than the full four-dose regimen [11]. Completion status was assessed using all registered dog bite records. Cases were classified as completed when documentation showed receipt of all four doses of the Zagreb regimen. Records lacking documentation of four doses were classified as incomplete.

Missing information

Missing information was present in several variables. Vaccination status was unknown in 773 cases (13.7%), RIG status in 695 cases (12.3%), and occupation in 1660 cases (29.4%). In addition, 980 records were excluded from the analysis of the interval between exposure and initiation of PEP because of missing or inconsistent dates. Analyses were conducted using available data only, and no imputation procedures were performed. No registered records were available for 2021 because surveillance reports for that year were missing from the archived database. Potential information bias was assessed by describing the extent of missing data and by excluding records with unknown or missing values from the multivariable regression analysis.

Statistical Data Analysis

Collected data were coded, entered, presented, and analyzed using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA). The data were presented by using descriptive statistics such as frequencies, percentages, means and standard deviation.

The chi-square test was used to assess the association between categorical variables and completion of post exposure prophylaxis. Statistical significance was considered at $p \leq 0.05$ [12]. Binary logistic regression analysis was performed to identify independent predictors of documented completion of rabies post-exposure prophylaxis. PEP completion was coded as completed versus not completed. Variables considered clinically relevant, including age group, sex, type of dog, anatomical site of bite, bite description, number of bites, and RIG status, were included in the model. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were reported. Records with missing or unknown values in any model variable were excluded from this analysis.

Results

A total of 6,927 animal bite cases were registered in Al Anbar governorate between 2020 and 2025, which included 5,655 (81.7%) cases of dog bites. The selection of animal bite records included in the study is presented in Figure 1.

Demographic characteristics

Among 5,655 dog bite cases, the mean age of the patient was 20.6±15.5; the most affected age group was 10-14 (22.1%), followed by 5-9 years (17.5%), and the lowest proportion was observed in the 55-59 years group (1.5%). Males constituted the majority of dog bite cases

Tab. I. Demographic characteristics.

Variable	Category	n	Percentage %
Age group (years)	<5 years	405	7.2%
	5-9	988	17.5%
	10-14	1,250	22.1%
	15-19	698	12.3%
	20-24	497	8.8%
	25-29	413	7.3%
	30-34	325	5.7%
	35-39	265	4.7%
	40-44	231	4.1%
	45-49	176	3.1%
	50-54	163	2.9%
	55-59	82	1.5%
	≥60 years	162	2.8%
Mean±SD	20.6±15.5	-	-
Sex	Male	4,434	78.4%
	Female	1,221	21.6%
Occupation	Student	1,843	32.6%
	Unknown	1,660	29.4%
	Unemployed	1,569	27.7%
	Housewife	277	4.9%
	Employee	138	2.4%
	Military	133	2.3%
	Retired	20	0.4%
	Health worker	6	0.1%
	Farmer	9	0.2%
	Total	5,655	100%

Tab. II. Spatial and temporal distribution.

Variable	Category	n	Percentage %
District	Al Fallujah	2,287	40.5%
	Al Ramadi	1,032	18.2%
	Al Qaim	860	15.2%
	Heet	290	5.1%
	Al Amiriyah	313	5.5%
	Al Karma	284	5.0%
	Haditha	138	2.4%
	Anah	99	1.8%
	Rawah	58	1.1%
	Al Khalidiyah	116	2.1%
	Al Rutbah	98	1.7%
	Al Baghdadi	61	1.1%
	Al Habbaniyah	19	0.3
Year	2020	243	4.3%
	2022	674	11.9%
	2023	1,275	22.5%
	2024	1,383	24.5%
	2025	2,080	36.8%
Season	Autumn	1,504	26.6%
	Summer	1,488	26.3%
	Spring	1,358	24.0%
	Winter	1,305	23.1%
	Total	5,655	100%

(78.4%), while females accounted for 21.6% (Tab. I). Students represent the largest occupational group (32.6%), followed by cases where their occupation was unknown (29.4%), and health workers were the lowest proportion (0.1%).

Spatial and temporal distribution

Table II demonstrates the highest proportion of dog bite cases was reported in Al Fallujah district (40.5%) followed by Al Ramadi (18.2%) and the lowest proportion was observed in Al Habbaniyah (0.3%).

The annual distribution of the cases showed a marked increase of the bites over time, with the highest number of bites recorded in 2025 (36.8%) and the lowest in 2020 (4.3%). In the year 2021, there were no registrations, according to records. The annual distribution of dog bite cases is shown in Figure 2.

Seasonally, the highest proportion was observed in autumn (26.6%), followed by summer (26.3%), and the lowest in winter (23.1%). The monthly distribution of dog bite cases is shown in Figure 3.

Characteristics of bites

Table III shows the distribution of all registered animal bite records according to the type of biting animal. Dog bites represented the majority of records, accounting for 5,655 cases (81.7%), and these dog bite records were used for the main analysis of epidemiological characteristics and rabies PEP utilization.

Table IV shows that the anatomical site of the bite was the lower limbs in more than half of the cases (54.3%), followed by the upper limbs (33.1%) and the genitals in the lowest percentage (0.3%).

The description of bites according to records shows that more than half of the cases, 54.3%, suffered from superficial scratches, followed by penetrating surface scratches, 18.4%, and penetrating wounds, 14%, while the lowest percentage, 13.3%, were superficial wounds.

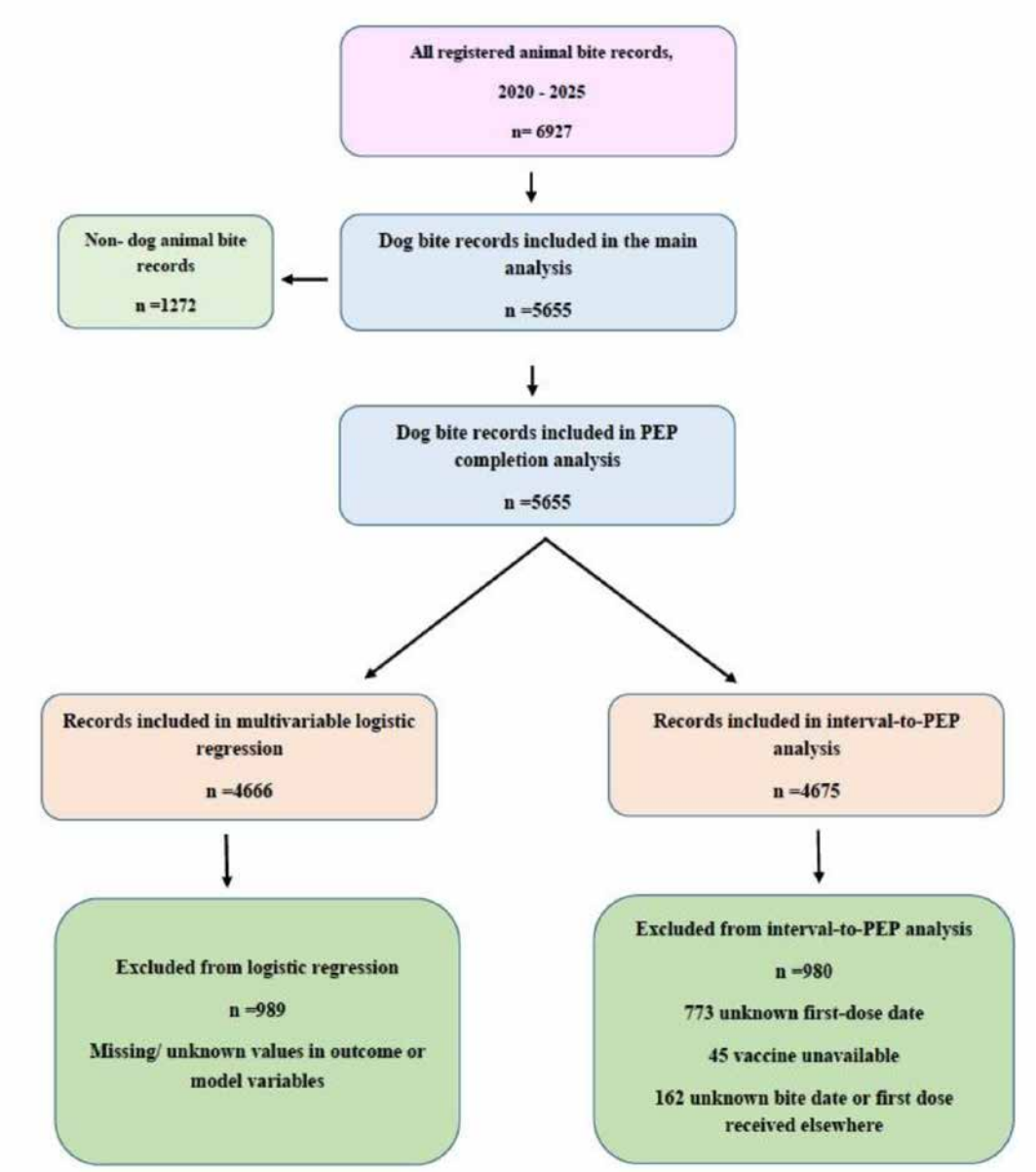
Out of 5,655 cases, the most common bite category found was category II (84.2%), and category III was represented by 15.8%. single bites accounted for 77.6% of all bites or wounds, while multiple bites accounted for 22.4%, which represented the lowest percentage.

Post-exposure prophylaxis

Among 5,655 dog bite cases, 4,837 (85.5%) initiated the first dose of PEP, 13.7% had unknown vaccination status, and 0.8% did not receive the vaccine because it was unavailable. More than half of the cases, 55.8%, received rabies immunoglobulin, followed by cases that did not receive RIG (31.9%) and the lowest percentage (12.3%) in cases where their RIG status was unknown.

Among all 5,655 registered dog bite cases, 1,377 (24.4%) were documented as having completed all four doses of the rabies vaccination schedule, while 75.6% did not.

Fig. 1. Flow diagram of animal bite records and dog bite cases included in the study.



Interval between dog bite exposure and starting PEP

Among 4,675 dog bite cases, the majority of cases, 88.5%, began receiving the vaccine on the same day of exposure, followed by 4.6% initiated PEP after one day, whereas 1.0% initiated PEP after 4-7 days. We excluded 980 cases as follows: 773 cases had an unknown first dose date; 45 cases were not vaccinated because the vaccine was unavailable; and 162 cases were excluded due to either an unknown date of the bite or receiving the first dose at another site, as documented in the records.

Factors associated with completion of post-exposure prophylaxis

A statistically significant association was observed between the completion of vaccination and the type of biting animal, the description of bites, and the number of bites; however, no significant association was found with sex or the anatomical site of the bite.

Multivariable logistic regression analysis

In the multivariable logistic regression model, 4,666 dog bite records with complete data were included. Multiple bites were independently associated with higher odds of documented PEP completion compared with singular bites. Bites involving the face and head and penetrating surface scratches were associated with lower odds of completion. RIG administration was also associated with lower odds of documented PEP completion.

Characteristics of rabies-related death during the study period

Three rabies-related deaths were identified during the study period. All three cases were male and involved bites

Fig. 2. Annual distribution of dog bite cases among the study sample (n=5,655).

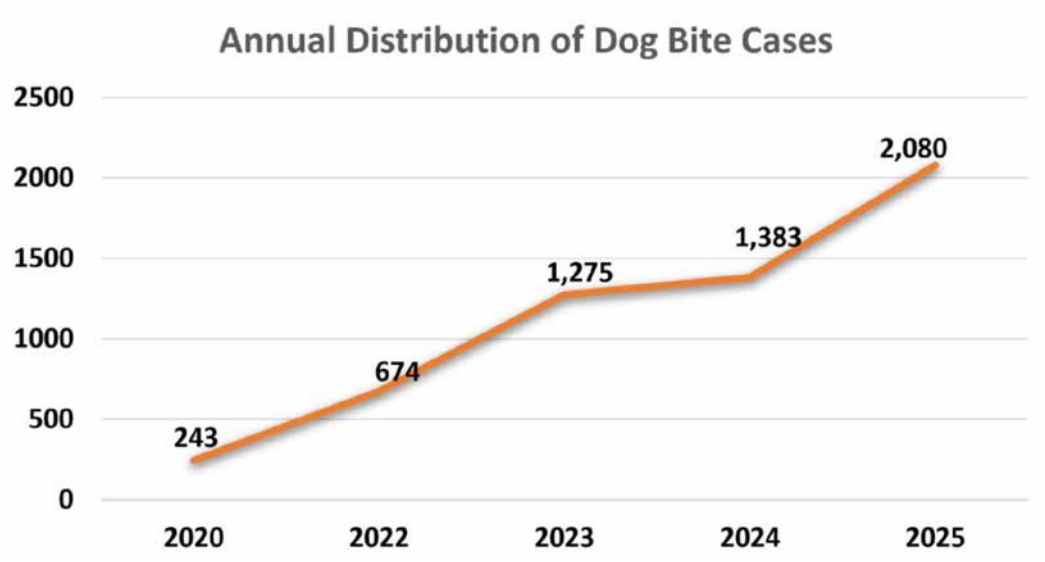
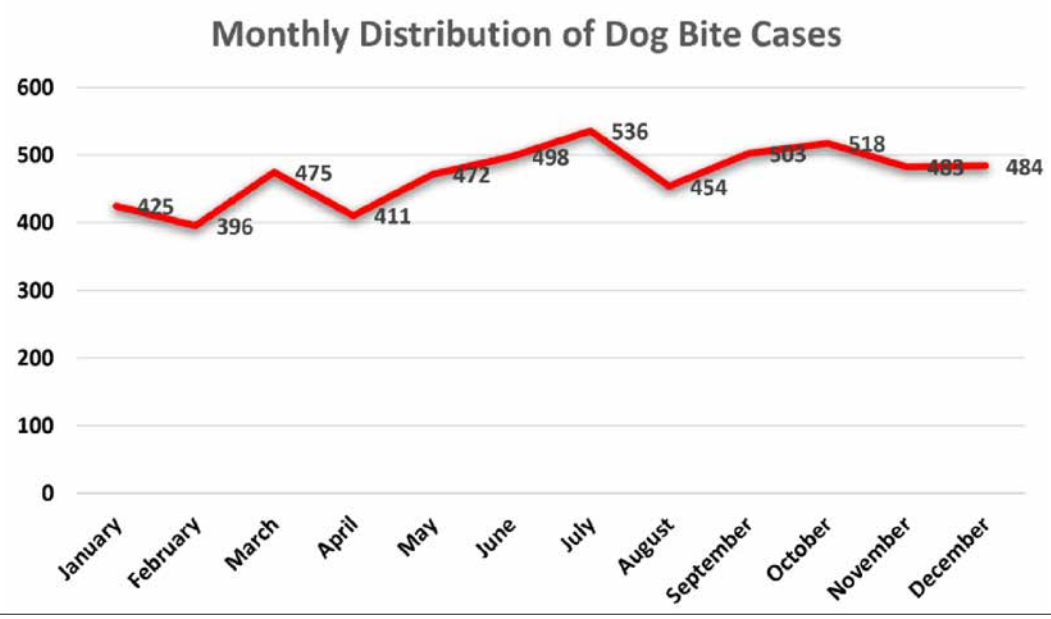


Fig. 3. Monthly distribution of dog bite cases, showing the highest number in July and the lowest number in February.



to the face or head region; two patients did not receive post-exposure prophylaxis, while one patient initiated but did not complete the full vaccination schedule. The diagnosis was based on clinical presentation compatible with rabies and a documented history of dog-bite exposure. Laboratory confirmation was unavailable in the reviewed surveillance records, and information regarding laboratory testing was not documented; therefore, confirmation status could not be verified retrospectively.

Discussion

To the best of our knowledge, this is the first study to describe the epidemiological profile of dog bite cases and rabies post-exposure prophylaxis (PEP) practices in the Al-Anbar governorate, western Iraq. The findings provide baseline data that may support the development of local prevention strategies and allow comparison with other regions and international studies.

Age is an important determinant of dog bite injuries, as nearly half of the victims (46.8%) in this study were under 15 years old, and this observation is consistent with previous studies [13-16]. This may be because children are particularly vulnerable to dog bites due to their spontaneous affection for animals, smaller stature, and lack of awareness about safe interactions.

Males accounted for the majority of dog bite victims. In

Tab. III. Distribution of registered animal bite records by type of biting animal during the study period (n=6,927).

Animal Type	n	Percentage%
Stray dog	4,603	66.5%
Owned dog	1,052	15.2%
Cat	763	11.0%
Other	344	5.0%
Unknown	148	2.1%
Wolf	10	0.1%
Fox	7	0.1%
Total	6,927	100%

This table includes all registered animal bite records. Dog bite records (n=5,655) were included in the main analysis of dog bite epidemiology and rabies PEP utilization. Records involving non-dog animals were presented only to describe the overall distribution of animal exposures.

Tab. IV. Characteristics of bites.

Variable	Category	n	Percentage %
Bite site	Lower limbs	3,070	54.3%
	Upper limbs	1,872	33.1%
	Trunk	250	4.4%
	Multisite	326	5.8%
	Face and head	119	2.1%
	Genitals	18	0.3%
Bite description	Superficial scratches	3,072	54.3%
	Penetrating surface scratches	1,041	18.4%
	Superficial wounds	752	13.3%
	Penetrating wounds	790	14%
WHO exposure category	Category II	4,762	84.2%
	Category III	893	15.8%
Number of bites	Singular	4,387	77.6%
	Multiple	1,268	22.4%
	Total	5,655	100%

Tab. V. Post exposure prophylaxis status.

Variable	Category	n	Percentage %
PEP status	Initiated PEP	4,837	85.5%
	No vaccine (Not available)	45	0.8%
	Unknown vaccination status	773	13.7%
RIG status	Yes	3,156	55.8%
	No	1,804	31.9%
	Unknown	695	12.3%
Dose status	Not completed	4,278	75.6%
	Completed all four doses	1,377	24.4%
	Total	5,655	100%

Tab. VI. Interval between dog bite exposure and starting PEP.

Interval between dog bite exposure and starting PEP	n	Percentage %
On the same day of exposure	4,141	88.5%
After 1 day	216	4.6%
After 2-3 days	119	2.5%
After 4-7 days	45	1%
More than 7 days	154	3.4%
Total	4,675	100%

the current study, dog bites were almost three times more common among males than females, this finding agrees with previous studies [17, 18]. Males may spend more time outdoors, increasing their likelihood of exposure to dogs. However, other research suggests that dogs are more likely to bite women. These differences may reflect socio-cultural and behavioral variations between males and females [19]. Interpretation of occupational patterns should be made cautiously, as occupation was unknown for nearly one-third of records. Students represented the largest occupational group among bite victims, and this finding is consistent with previous research, demonstrating that students engage in more interactive behavior with animals, leading to a higher likelihood of dog bites [20-22]. Students may be more frequently exposed to dogs because of increased outdoor activities and unsafe interactions with animals. The present study is consistent with the literature, as more than half of dog bites occurred in urban areas [23, 24]. This could be related to the distribution and density of the human population in relation to the number of dog bite cases.

The present study showed a positive trend in the number of dog exposures from 2020 to 2025, with no available records in 2021, similar temporal increases have been reported in other studies [25]. Several factors may explain this pattern, including improvements in surveillance and reporting systems, increased healthcare utilization, changes in dog population dynamics, or increased human–dog interactions. However, because the present study was based on surveillance records and was not designed to investigate the causes of temporal changes, no causal explanation can be established. The majority of bites occurred in the autumn and summer. This seasonal pattern may be associated with increased outdoor human activity during warmer months, resulting in more frequent human–dog interactions. Seasonal behavioral changes in dogs, including reproductive activity and aggression, may also contribute to this finding [17, 26]. In the present study, dog attacks occurred in over eighty percent of cases, and more than half (54.3%) affected the lower limbs. Similar results have been reported in previous studies [21, 27]. This pattern may also reflect the local context in Iraq, where dogs are allowed to roam freely, and there is no vaccination program in place. Dog culling campaigns may provide only temporary control and are often ineffective as a long-term strategy. Inadequate dog population control and the free roaming of both stray and owned dogs may increase the risk of dog-related incidents and contribute to public health concerns [6].

The majority of dog bite victims were classified as category II according to the WHO classification. More

Tab. VII. Factors associated with completion of post exposure prophylaxis.

Variable	Category	Completed n (%)	Not completed n (%)	*p-value*
Sex) n=5655)	Male	1,064 (24)	3,370 (76)	0.8231
	Female	313 (25.6)	908 (74.4)	
Site bite(n 5655)	Face and head	27 (22.7)	92 (77.3)	0.083
	Genitals	7 (35)	13 (65)	
	Lower limbs	785 (25.6)	2,285 (74.4)	
	Multisite	81 (24.8)	245 (75.2)	
	Trunk	64 (25.6)	186 (74.4)	
	Upper limbs	414 (22.1)	1,458 (77.9)	
Bite description (n=5655)	Penetrating surface scratch	197 (18.9)	844 (81.1)	0.001*
	Penetrating wound	195 (24.7)	595 (75.3)	
	Superficial scratch	733 (23.9)	2,339 (76.1)	
	Superficial wound	252 (33.5)	500 (66.5)	
Number 0f bites (n=5655)	Multiple	363 (28.6)	905 (71.4)	0.001*
	Singular	1,014 (23.1)	3,373 (76.9)	
Animal type (n=6779)	Cat	160 (21)	603 (79)	0.001*
	Other+	40 (11.1)	321 (88.9)	
	Owned dog	303 (28.8)	749 (71.2)	
	Stray dog	1,074 (23.3)	3,529 (76.7)	

* Significant difference between percentages using Pearson Chi-square test (χ^2-test) at 0.05 level. + Other animals included foxes, wolves and other animals' species. For animal type analysis, records with unknown animal type were excluded; therefore, the denominator was 6,779.

than half of the cases (54.3%) involved superficial scratches and single wounds. These findings are consistent with other studies [12, 18] although inconsistent results have also been reported [19, 28].

Although most dog bite victims received the first dose on the day of exposure, we found that only 24.4% of cases completed all four doses of rabies vaccination, while 75.6% did not. Similar findings have been reported in previous studies, indicating that negligence, lack of awareness, logistical challenges and vaccine unavailability are all factors that may contribute to poor adherence to the vaccination schedule [29, 30]. More than half of the cases received rabies immunoglobulin, and previous studies have reported that this may reflect differences in health care access, awareness, and adherence to WHO recommendations regarding category III exposures [31].

No significant association was observed between gender or bite site and vaccine completion. However, type of animal, bite description, and number of bites were significantly associated with vaccine completion status. Similar findings have been documented in previous studies [30, 32, 33].

In the multivariable logistic regression analysis, multiple bites, anatomical site of injury, bite description, and RIG administration were associated with documented completion of rabies PEP. Victims with multiple bites had higher odds of completing the vaccination schedule, which may be explained by greater perceived severity of exposure and better recognition of the need to complete PEP after more extensive injuries. Previous studies have reported that clinical and exposure-related factors can influence adherence to rabies vaccination schedules [30, 32, 33]. Unexpectedly, bites involving the face and head were associated with lower odds of documented PEP completion. This should not be interpreted as indicating lower clinical importance, as head and face bites are high-risk exposures because of their proximity to the central nervous system; in the present study, all three rabies-related deaths involved bites to the face or head region. This finding may reflect the small number of such injuries, referral of severe cases to other facilities, death before completion of vaccination, or incomplete follow-up documentation. The association between RIG administration and lower odds of PEP completion should not be interpreted causally, as RIG is generally indicated for more severe exposures and routine surveillance records may include documentation or classification errors [2, 31]. Three deaths associated with dog bites were recorded during the study period; all cases were clinically diagnosed without laboratory confirmation. Two patients did not receive PEP and sought medical care only after clinical symptoms appeared; the third patient failed to complete the vaccination schedule because of vaccine unavailability.

The present study had some limitations. First, the retrospective use of surveillance records resulted in incomplete documentation and missing data, particularly for the year 2021. In addition, missing information for some variables, including occupation, vaccination status, and RIG administration, may have introduced information bias and affected the accuracy of certain estimates. Therefore, findings related to these variables should be interpreted with caution. Second, laboratory confirmation of rabies-related deaths was unavailable in the surveillance records reviewed for this study.

Tab. VIII. Multivariable logistic regression analysis of predictors of rabies PEP completion among dog bite victims.

Variable	Category	AOR	95% CI	*p-value*
Age group (years)	<5 years	Reference	----	----
	5-9	0.851	0.626-1.158	0.305
	10-14	0.755	0.558-1.021	0.068
	15-19	0.786	0.566-1.093	0.152
	20-24	0.908	0.641-1.286	0.586
	25-29	0.793	0.547-1.151	0.223
	30-34	0.867	0.584-1.287	0.480
	35-39	0.743	0.492-1.123	0.159
	40-44	0.870	0.562-1.346	0.531
	45-49	0.549	0.326-0.923	0.024*
	50-54	0.767	0.470-1.253	0.290
	55-59	0.894	0.470-1.698	0.731
	≥60 years	1.301	0.805-2.103	0.283
Sex	Female	Reference	----	----
	Male	0.853	0.719-1.011	0.067
Dog type	Stray dog	Reference	----	----
	Owned dog	0.995	0.823-1.203	0.961
Bite site	Lower limbs	Reference	-----	-----
	Face and head	0.468	0.271-0.807	0.006*
	Genitals	0.913	0.287-2.907	0.877
	Multisite	0.880	0.584-1.325	0.540
	Trunk	0.883	0.632-1.232	0.463
	Upper limbs	0.889	0.761-1.038	0.137
Bite description	Superficial scratch	Reference	-----	-----
	Penetrating surface scratch	0.630	0.518-0.788	<0.001*
	Penetrating wound	0.867	0.687-1.095	0.231
	Superficial wound	1.249	1.016-1.535	0.035*
Number of bites	Singular	Reference	-----	-----
	Multiple	1.316	1.089-1.590	0.004*
RIG status	No	Reference	----	----
	Yes	0.777	0.661-0.914	0.002*

AOR: adjusted odds ratio; CI: confidence interval; RIG: rabies immunoglobulin; PEP: post-exposure prophylaxis. The model included 4,666 dog bite records with complete data. Records with missing or unknown values in any model variable were excluded. *Statistically significant at $p \leq 0.05$.

Although findings may not be fully generalizable to all Iraqi governorates because of regional differences in dog populations and healthcare access, the results provide important evidence for rabies prevention strategies in western Iraq.

Conclusion

Dog bites remain an important public health problem in Al-Anbar Governorate, particularly because of the low documented completion rate of rabies PEP despite a high rate of vaccine initiation. The findings highlight the need to improve adherence to the full PEP schedule, ensure continuous availability of rabies vaccine and RIG, strengthen surveillance and documentation systems, and expand public education on rabies prevention. Integrated One Health interventions, including mass dog vaccination and humane management of stray dog populations, are essential to reduce the risk of rabies transmission in Al-Anbar Governorate and Iraq.

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Tab. IX. Characteristics of rabies-related death during study period.

Variable	Case 1	Case 2	Case 3
Year	2023	2024	2025
Cases	1	1	1
Age	8 years	45 years	8 years
Sex	Male	Male	Male
Biting animal	Stray dog	Stray dog	Owned dog
Anatomical site bite	Face	Face	Face and head
Date of bite	Not documented	16/12/2023	5/4/2025
Symptoms onset date	Not documented	5/1/2024	20/5/2025
Interval from bite to symptoms	Approximately 1.5 months, according to the report	20 days	45 days
PEP	Not taken	Not completed	Not taken
Reported clinical manifestations	Dyspnea, hydrophobia, followed by loss of consciousness and death	Dyspnea, hydrophobia, followed by loss of consciousness and death	Dyspnea, hydrophobia, followed by loss of consciousness and death
Basis of diagnosis	Clinical presentation compatible with rabies and history of dog-bite exposure	Clinical presentation compatible with rabies and history of dog-bite exposure	Clinical presentation compatible with rabies and history of dog-bite exposure
Laboratory confirmation	Not available	Not available	Not available
Reason laboratory confirmation was unavailable	Not documented in surveillance records	Not documented in surveillance records	Not documented in surveillance records

Ethical Approval

The study was approved by the Medical Ethics Committee of Middle Technical University, reference number MEC (180). All ethical considerations including patients' confidentiality and privacy of all recorded information were strictly followed before data collection.

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This research received no external funding.

Conflict of interest statement

The authors declare no conflict of interest.

Author contributions

NSJ: conceived and designed the study, collected the data, performed the statistical analysis, interpreted the results, and drafted the manuscript. AHR: supervised the study design, contributed to data interpretation, critically revised the manuscript, and provided scientific guidance throughout the research process. RSS: contributed to the study supervision, reviewed the manuscript, and provided critical intellectual input. All authors read and approved the final manuscript.

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Supplementary material

Tab. S1. STROBE checklist.

Item No.	STROBE item	Recommendation	Reported in manuscript / location	Status
1	Title and abstract	Indicate the study design with a commonly used term in the title or abstract; provide an informative and balanced summary	Abstract: Methods identifies a retrospective surveillance-based study; Abstract summarizes background, methods, results, and conclusion	Reported
2	Background/rationale	Explain the scientific background and rationale for the investigation	Introduction: public health importance of dog bites/rabies, need for surveillance data in Iraq and Al-Anbar	Reported
3	Objectives	State specific objectives, including any prespecified hypotheses	End of Introduction: describes aim to assess anti-rabies vaccination utilization and epidemiological profile; specific objectives listed	Reported
4	Study design	Present key elements of study design early in the paper	Methods, Study design and setting: retrospective surveillance-based study	Reported
5	Setting	Describe setting, locations, and relevant dates including periods of data collection	Methods, Study design and setting/ Data source: Al-Anbar Governorate, Iraq; records from 1 January 2020 to 31 December 2025	Reported
6	Participants	Give eligibility criteria and sources/ methods of selection of participants	Methods, Data source and study population: all registered animal bite cases reviewed; dog bite cases included in main analysis; other animal exposures described only	Reported
7	Variables	Clearly define outcomes, exposures, predictors, potential confounders, and effect modifiers	Methods, Operational definition and variables: animal type, bite site, injury severity, PEP variables, RIG, and PEP completion definition	Reported
8	Data sources/ measurement	For each variable of interest, give sources of data and details of methods of assessment	Methods, Data source and Operational definition: standardized surveillance forms from hospitals and PHC institutions; registry-based classification	Reported
9	Bias	Describe efforts to address potential sources of bias	Methods, Missing information: extent of missing data described; available-case analyses; complete-case approach for multivariable regression; Discussion limitations mention information bias	Reported
10	Study size	Explain how the study size was arrived at	Methods, Data source and study population: no sample size calculation because all eligible surveillance records during the period were included	Reported
11	Quantitative variables	Explain how quantitative variables were handled in the analyses	Methods/Results: age reported as mean±SD and categorized into age groups; time interval to PEP analyzed in categories	Reported
12a	Statistical methods	Describe all statistical methods, including those used to control for confounding	Methods, Statistical Data Analysis: descriptive statistics, chi-square tests, binary logistic regression, AORs and 95% CIs	Reported
12b	Statistical methods: subgroups/interactions	Describe methods used to examine subgroups and interactions	No formal interaction analyses were reported; subgroup/category analyses were performed using categorical predictors	Not applicable / not performed
12c	Missing data	Explain how missing data were addressed	Methods, Missing information: unknown vaccination, RIG, occupation, missing/ inconsistent dates; no imputation; complete-case regression	Reported
12d	Statistical methods: study design	If applicable, describe analytical methods taking account of sampling strategy	Not applicable; study included all eligible registered surveillance records rather than a sample survey	Not applicable

12e	Sensitivity analyses	Describe any sensitivity analyses	No sensitivity analysis was reported. Denominators and exclusions were clarified for analyses	Not performed
13a	Participants	Report numbers of individuals at each stage of study	Results and Figure 1: 6,927 animal bite records; 5,655 dog bite records; 4,666 included in regression; 4,675 included in interval-to-PEP analysis	Reported
13b	Participants: non-participation	Give reasons for non-participation at each stage	Methods/Results and Figure 1: non-dog bites excluded from main analysis; records excluded from interval analysis and regression due to missing/unknown data	Reported
13c	Flow diagram	Consider use of a flow diagram	Figure 1: Flow diagram of animal bite records and dog bite cases included in the study	Reported
14a	Descriptive data	Give characteristics of study participants and information on exposures and potential confounders	Results Tables 1–5: demographic characteristics, spatial/temporal distribution, animal type, bite characteristics, PEP status	Reported
14b	Missing data in descriptive data	Indicate number of participants with missing data for each variable of interest	Methods Missing information and Tables 3/5/7: unknown animal type, vaccination status, RIG status, occupation, excluded date records	Reported
14c	Follow-up time	Summarize follow-up time where applicable	Not applicable as this is a retrospective registry-based surveillance study without person-time follow-up	Not applicable
15	Outcome data	Report numbers of outcome events or summary measures	Results Table 5: PEP initiation and completion; Table 9: three rabies-related deaths	Reported
16a	Main results	Give unadjusted and, if applicable, confounder-adjusted estimates and precision	Results Tables 7 and 8: chi-square associations and multivariable logistic regression with AORs, 95% CIs, and p-values	Reported
16b	Main results: category boundaries	Report category boundaries when continuous variables were categorized	Tables 1, 6, and 8: age groups and interval-to-PEP categories reported	Reported
16c	Main results: relative/absolute risk	Consider translating relative risk into absolute risk for a meaningful time period	Not applicable; logistic regression reported odds ratios for documented PEP completion	Not applicable
17	Other analyses	Report other analyses done	Results: chi-square tests, multivariable logistic regression, and descriptive presentation of rabies-related deaths	Reported
18	Key results	Summarize key results with reference to study objectives	Discussion: summarizes epidemiology, PEP initiation/completion, logistic regression findings, and rabies-related deaths	Reported
19	Limitations	Discuss limitations, taking into account sources of potential bias or imprecision	Discussion limitations: incomplete surveillance documentation, missing data, no 2021 records, possible information bias, lack of laboratory confirmation, generalizability	Reported
20	Interpretation	Give a cautious overall interpretation considering objectives, limitations, multiplicity, and other evidence	Discussion: compares findings with previous studies and avoids unsupported causal interpretation for temporal increases and regression findings	Reported
21	Generalizability	Discuss generalizability of the study results	Discussion: findings may not be fully generalizable to all Iraqi governorates due to regional differences, but useful for western Iraq	Reported
22	Funding	Give source of funding and role of funders	Funding statement: research received no external funding	Reported