

Original Article

One Health Bulletin

Trends in reported animal bites and rabies-related mortality in Nepal (2014–2024): A descriptive analysis of national surveillance data

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ABSTRACT

Objective: To assess national trends and the burden of animal bites in Nepal from 2014 to 2024, and estimate their impact using national surveillance data.

Methods: We analyzed national Annual Health Reports from 2014 to 2024. Descriptive statistics, Spearman's correlations, and trend analyses were performed. Negative binomial regression modeled deaths due to overdispersion in count data.

Results: An annual mean of 59 715 dog bites and 5 706 other animal bites were reported, with a mean of 275 848 anti-rabies vaccine (ARV) vials consumed and a mean of 17 deaths annually. Reported dog bite counts increased steadily over the study period, with an average annual rise of approximately 12 600 cases. Mortality varied across years and did not show a direct proportional relationship with dog bite volume. Spearman's correlation indicated only a partial correlation between reported bites and ARV consumption, suggesting a disconnect between exposure incidence and vaccine utilization.

Conclusions: Dog bites account for the majority of cases, but other species may drive mortality. Strengthened One Health surveillance, equitable ARV distribution, and regional collaboration are required to meet rabies elimination goals.

KEYWORDS: Animal bites, Rabies, Nepal, One Health, Zoonoses, Surveillance

1. Introduction

Despite being completely preventable with prompt post-exposure prophylaxis (PEP) and ongoing animal vaccination programs, rabies is still one of the most deadly zoonotic diseases, with a case-fatality rate that approaches 100% once symptoms manifest[1,2]. An estimated 59 000 people die from rabies each year worldwide, with Asia bearing the brunt of the disease[3–5]. Up to 99% of rabies cases in humans are caused by dogs, highlighting the vital need for dog vaccinations and bite prevention measures[6,7]. Dog bites account for more than 90% of reported animal bite cases in Nepal, where rabies is endemic[6,8]. Tens of thousands of bite incidents occur each year, according to national surveillance data, but underreporting is still a problem because of surveillance gaps and low health-seeking behaviors[1,9]. Even though Nepal is committed to the "Zero by 30" global plan, which aims to eradicate dog mediated human rabies deaths by 2030, persistent rabies mortality and varying bite incidence show that prevention and control remain difficult[9,10]. The necessity of bolstering surveillance, immunization, and public awareness is highlighted by recent outbreaks, such as the 2024 surge in Nepal's Far Western Region with a 92.3% positivity rate

Significance

Animal bites and rabies remain major public health issues in Nepal; however, national long-term evidence has been lacking. This paper presents the first ten-year analysis of national surveillance data (2014-2024), revealing a sharp rise in bite incidence and continued deaths from rabies. By identifying gaps in vaccine use, surveillance, and prevention, the findings encourage targeted initiatives to achieve the WHO's "Zero by 2030" rabies elimination goal.

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in suspected samples and at least one human death[1,9,11].Local epidemiological studies consistently demonstrate that victims frequently neglect to seek prompt medical attention, that many biting animals remain unvaccinated, and children and young males are disproportionately affected[5,12,13]. These results are consistent with broader trends in South Asia[14], where high exposure risks are sustained by growing numbers of free-ranging dogs, porous borders, and inadequate One Health integration[3,5,15]. Comparative studies conducted throughout Asia show that the prevalence of rabies is still 23% in tested animals and 52% in tested humans, with foxes and other wildlife reservoirs playing a major role in the disease' s spread[16–20]. These findings highlight the significance of integrated surveillance systems that record the dynamics of both domestic and wildlife rabies[1,3]. In addition to dogs, other animals that increase the risk of bite-related injuries and zoonotic diseases like rabies and bacterial infections like *Bartonella* and *Leptospira* include cats, monkeys, bats, and rodents[1,13,21]. The various ecological contexts of rabies transmission are highlighted by the fact that dog bites predominate in Nepal[2,22], monkey bites are becoming more common in South Asia[3,23], and bat-mediated rabies is still the primary cause of rabies deaths in the United States[20].

The decade-long burden of animal bites and rabies mortality in Nepal has not been measured by a thorough national assessment, despite the availability of annual reports. By examining national surveillance data from 2014 to 2024, this study fills that gap by offering a descriptive summary of bite patterns and rabies-related fatalities. This work adds to the expanding One Health evidence base by placing Nepal's experience in the larger Asian and global context. It also identifies ongoing rabies control challenges and identifies priority areas for intervention, including mass dog vaccination, better access to PEP, public education, and integrated surveillance across human and animal health sectors.

2. Methods

2.1 Ethical statement

This study utilized publicly available, aggregated secondary data from Nepal's Annual Health Reports (2014–2024). No individual-level or identifiable data were used; therefore, ethical approval was not required under the National Ethical Guidelines for Health Research in Nepal (NHRC, 2022).The study was conducted in compliance with ethical standards for secondary data use and research integrity.

2.2 Data source and preparation

Data on animal bite incidents in Nepal were sourced from Annual Health reports, spanning fiscal years 2014 to 2024, including variables for dog bites, other animal bites, combined animal bites, anti-rabies vaccine (ARV) vials consumed, and deaths. The dataset was pre-processed using R software (version 4.4.3). All analyses were performed on the complete dataset of 11 annual observations.

2.3 Statistical analysis and visualization

Descriptive statistics, including means, standard deviations (SD), medians, minima, and maxima, were computed for dog bites, other animal bites, combined bites, ARV vials, and deaths using the dplyr package. Spearman's rank correlation was employed to assess associations among these variables, given the non-normal distribution and small sample size, with pairwise complete observations. Given the small number of annual observations, formal time-series diagnostics (including autocorrelation testing and residual normality assessment) were not emphasized To evaluate

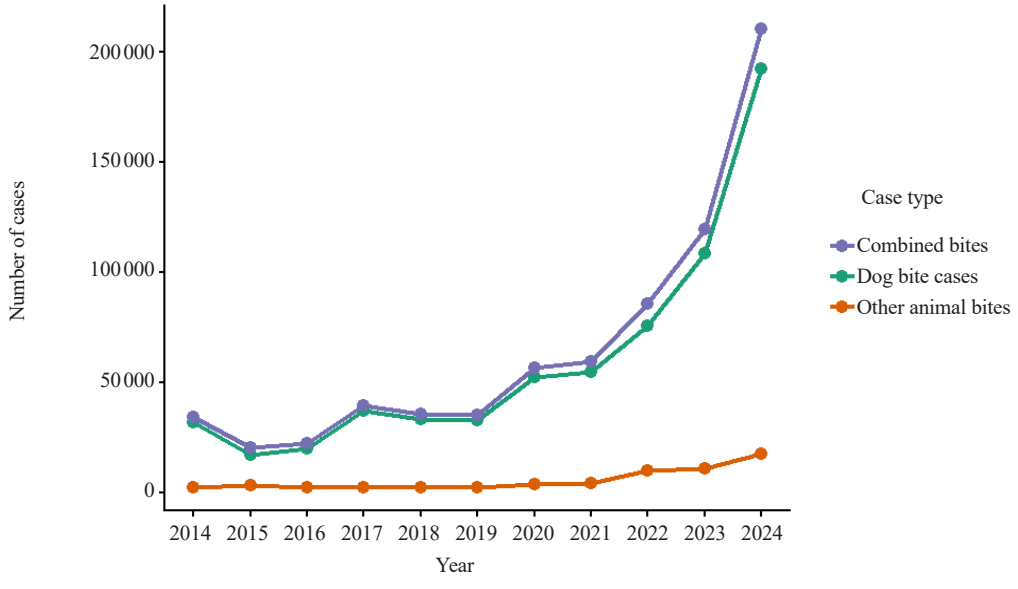


Figure 1. Dogs and other animals bite cases from 2014 to 2024 in Nepal.

temporal patterns, regression analyses were used to summarize observed trends rather than to support causal or predictive inference; consequently, formal time-series diagnostics for autocorrelation and residual normality were not emphasized.

The dispersion parameter (>1) indicated extra-Poisson variability (dispersion = 2.27); therefore, a negative binomial regression model was applied using the MASS package (glm.nb), with model fit evaluated *via* the Akaike Information Criterion and residual deviance.

Temporal trends in animal bite cases, ARV vials consumed, and deaths were illustrated using line and point plots. Fiscal years were treated as categorical for case comparisons and numeric for trend analyses. To account for differences in scale, variables were standardized using z-scores, enabling comparison within a single y-axis without the need for dual-axis plots.

3. Results

3.1. Descriptive epidemiology of animal bites

Over the decade (2014–2024), animal bite incidents in Nepal rose markedly, indicating an expanding public health burden. Dog bites accounted for an annual mean of 59 715 cases (range: 42 318-81 905), representing approximately 91% of all reported animal bites. Non-dog animal bites averaged 5 706 cases per year (range: 3 214-7 988). Combined bites averaged 65 421 annually, with a mean of 275 848 ARV vials consumed. Mortality averaged 16.9 cases per year, reflecting low but variable fatality rates.

3.2. Correlation analysis

Spearman's rank correlation analysis was used to explore descriptive associations among annual counts of dog bites, non-dog animal bites, ARV vials consumed, and deaths. Correlations involving total animal bite counts were interpreted descriptively only, as total bites are mathematically derived from dog and non-dog bite data. ARV consumption showed weak to moderate positive correlations with both dog bites and non-dog bites, suggesting a partial correspondence between reported bite incidence and vaccine utilization. Death counts demonstrated weak correlations with bite variables, indicating that annual mortality was not directly proportional to reported bite frequency.

3.3. Trends in animal bite incidence

Reported dog bite cases increased from 42 318 in 2014 to 81 905 in 2024. The average annual increase across the study period was approximately 12 600 cases (Figure 1). A linear regression model was used to summarize the temporal pattern in reported dog bite counts, showing an increasing pattern over the study period (slope = 12 621 cases per year; adjusted R^2 = 0.63). This slope reflects the average annual change observed rather than a predictive or inferential estimate. Rabies-related deaths averaged 16.9 per year (range: 9-27). The highest number of deaths was reported in 2018 (n = 27), while the lowest occurred in 2021 (n = 9).

3.4. Predictors of mortality from animal bites

Annual ARV vial consumption increased from 198 450 in 2014 to 322 610 in 2024, with a mean annual consumption of 275 848 vials. The proportional increase in ARV use was smaller than the increase observed in reported bite cases. In the negative binomial regression analysis, annual death counts varied across fiscal years. Variation in mortality did not show a consistent proportional relationship with

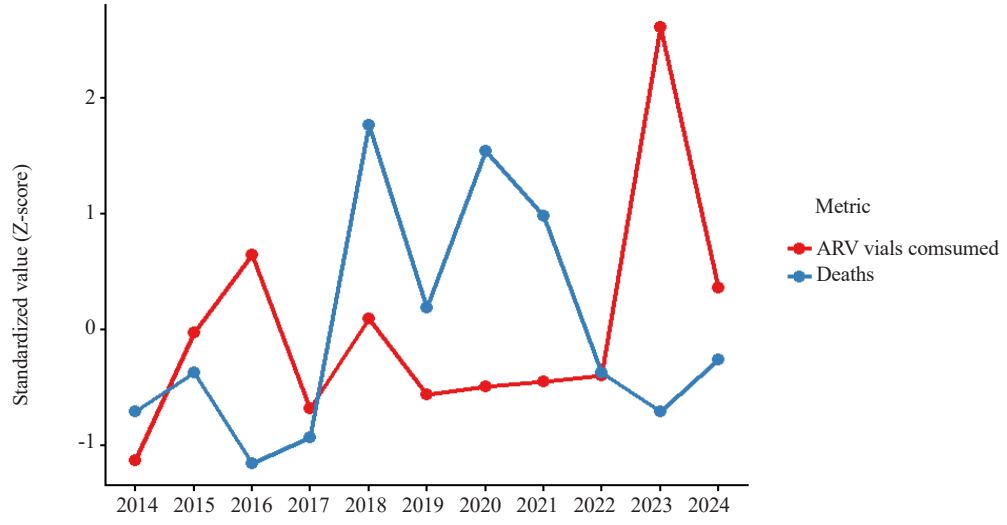


Figure 2. Deaths due to animal bites from 2014 to 2024 in Nepal.

dog bite counts, while non-dog animal bites showed greater year-to-year variability (Figure 2). These results summarize temporal patterns in mortality rather than inferential associations.

4. Discussion

This study provides a decade-long descriptive and analytical overview of animal bite epidemiology in Nepal, highlighting rising incidence, patterns of vaccine utilization, and determinants of mortality. Overall, the findings indicate a growing public health burden from animal bites, driven largely by dog bites, alongside relatively low but persistent rabies-related mortality[9,22]. The marked rise in animal bite incidents between 2014 and 2024, particularly dog bites, suggests an expanding risk of rabies exposure in Nepal. The high annual average of dog bites compared to non-dog animal bites is consistent with Nepal's large free-roaming dog population, rapid urbanization, inadequate waste management, and limited enforcement of dog population control programs[1,8,12]. Similar trends have been reported in other low- and middle-income countries (LMICs), where urban growth and human–animal interactions increase bite risk[3,7].

Comparable patterns are observed in neighboring countries. In India[4,13,14,16], dog bites account for more than 90% of reported animal bites, with a steady increase over recent decades. Studies from Bangladesh [24] and Sri Lanka[17,25] also report dogs as the predominant source of bites, although Sri Lanka has achieved lower incidence and mortality through sustained mass dog vaccination and strong surveillance systems. In contrast, Nepal's rising trend suggests gaps in coordinated dog vaccination, sterilization programs, and community awareness[2,11,22].The weak to moderate positive correlations between animal bite incidence and ARV vial consumption suggest that vaccine use broadly reflects reported exposure but not in a strictly proportional manner. This partial correspondence may be explained by several factors. First, ARV consumption depends not only on the number of bites but also on bite severity, category of exposure, adherence to PEP schedules, and availability of vaccines at health facilities. Second, underreporting of animal bites—especially in rural and remote areas—may distort the apparent relationship between true incidence and vaccine use.

Similar inconsistencies have been documented in studies from India[4,5,16] and Pakistan[26,27], where ARV utilization does not always scale linearly with bite incidence due to stock-outs, health-seeking behavior, and differences in clinical practice. In contrast, countries with robust rabies control programs, such as Thailand[28,29], demonstrate closer alignment between reported bites and vaccine use, reflecting stronger surveillance and standardized PEP delivery.

The significant upward trend in dog bite incidence, as indicated by linear regression analysis, underscores a sustained increase over the study period. The observed slope represents an average annual increase rather than a predictive estimate, but it nonetheless signals a concerning trajectory. This finding aligns with previous reports from Nepal that document increasing outpatient visits for dog bites over time[8,11].

However, this trend contrasts with experiences in Sri Lanka [17,25] and parts of China[30], where aggressive dog vaccination campaigns and animal birth control programs have led to stabilization or decline in dog bite incidence. The divergence suggests that Nepal has yet to achieve sufficient coverage or continuity in such interventions[9]. Despite the high and increasing number of animal bites, mortality remained relatively low and showed weak correlations with bite incidence. This finding supports existing evidence that timely PEP is highly effective in preventing rabies deaths, even in high-exposure settings. The lack of association between dog bite counts and deaths suggests that most dog bite victims who access care receive effective prophylaxis.

The borderline association between non-dog animal bites and mortality may reflect delayed health-seeking behavior, lower risk perception, or atypical exposure pathways (*e.g.*, wildlife or livestock bites), which may be more common in rural areas[15,31,32]. Similar observations have been reported in studies from India[5,14,16] and Bangladesh[24,33], where bites from non-dog animals, though less frequent, can contribute disproportionately to rabies deaths due to delayed or inadequate treatment.The significant association between fiscal year and mortality indicates temporal variability, possibly influenced by changes in surveillance quality, reporting practices, vaccine availability, or external disruptions such as the COVID-19 pandemic[5,7,12,14]. Other studies have noted temporary increases in rabies deaths during periods of healthcare disruption, supporting this interpretation[3,34]. Evidence from neighboring countries demonstrates that integrated One Health approaches—combining mass dog vaccination, dog population management, public awareness, and strengthened surveillance—are essential for reducing both bite incidence and rabies deaths[3,9,34,35]. Nepal's[8,9] epidemiological pattern more closely resembles that of India[14] and Bangladesh[24] than Sri Lanka[17], emphasizing the need for long-term, coordinated rabies elimination strategies.

This study's strength lies in its national-level, decade-long analysis, providing a comprehensive overview of trends and associations. However, the findings should be interpreted in light of limitations, including reliance on secondary surveillance data, potential underreporting of bites and deaths, and lack of individual-level clinical information. Correlation analyses were descriptive

and do not imply causality, particularly for mathematically derived variables such as total bites.

A key limitation of this study is the relatively small number of annual observations (n=11), which may have reduced the statistical power of the regression analyses and limited the precision of the estimated trends. trend analyses were based on a limited number of annual observations, which restricts the reliability of residual diagnostics and increases the possibility of spurious statistical significance. Accordingly, reported p-values should be interpreted cautiously, and observed trends are best viewed as indicative patterns within national surveillance data rather than definitive time-series effects. Furthermore, the reliance on secondary data from national health reports introduces potential underreporting and misclassification, especially in remote areas. Cases managed outside formal health systems are also likely excluded, leading to an underestimation of the true burden. Nonetheless, the decade-long dataset provides valuable insights into national trends and offers important evidence for guiding public health interventions.

5. Conclusions

Dog bites account for the vast majority of animal bite cases in Nepal, and their incidence has risen markedly over the past decade. Although mortality remains relatively low, the persistence of rabies-related deaths underscores critical gaps in prevention and timely treatment. Addressing this challenge will require coordinated public health strategies, including mass dog vaccination, equitable access to post-exposure prophylaxis, and strengthened surveillance systems. Sustained national and regional commitment aligned with the WHO “Zero by 2030” goal is essential to eliminate rabies and reduce the overall burden of animal bites in Nepal.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

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Data availability statement

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

Authors’ contributions

All authors were responsible for the conception and design of the study as well as the writing of the manuscript. Gautam J was in charge of conceptualization, formal analysis, visualization, investigation, methodology, software, and original draft writing. Bharati N undertook formal analysis, visualization, investigation, methodology, software, and original draft writing. Niroula D was responsible for methodology, formal analysis, and review & editing. KC A participated in review and editing. Bhandari S handled methodology and review and editing.

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