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Research Article

A Historical Study of Rabies Outbreaks in East Nusa Tenggara Province in 2022-2024

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Abstract. Rabies is a fatal zoonotic disease and remains a public health problem in Indonesia, particularly in the Province of East Nusa Tenggara (NTT). This study aims to historically examine the Extraordinary Events (KLB) of rabies in NTT during the 2022–2024 period, including epidemiological patterns, case trends, distribution, and risk factors influencing the spread of the disease. The method used is a literature study with data sources from scientific journals, official reports, and related publications obtained through Google Scholar and PubMed databases. The study results indicate that rabies in NTT has been developing since 1997 and has become endemic in several regions, with a significant increase in cases in 2023 that met the KLB criteria. The trend of rabies-transmitting animal bites (GHPR) shows an increase from 12,721 cases in 2022 to 30,317 cases in 2024. The highest case distribution is found in the child age group, particularly 5–9 years old. As well as areas with a high dog population density. Major risk factors include low dog vaccination coverage, high animal mobility, low public knowledge, and limited access to health services. Control efforts through a One Health approach have been carried out, but they have not been optimal in breaking the chain of transmission.

Keywords: East Nusa Tenggara; Epidemiology; Outbreak; Rabies; Zoonosis.

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1. Introduction

Rabies is an infectious and zoonotic disease caused by the Lyssavirus, a neurotropic, single-stranded RNA virus with a negative-sense genome (WHO, 2013). Most rabies cases are transmitted through bites. Non-bite transmission may occur through contamination of open wounds, scratches, abrasions, or mucous membranes with saliva from infected animals (Jackson, 2000). The term rabies is derived from the Latin word *rabere*, meaning "to lose one's sanity" or "madness." Rabies is a fatal zoonotic viral disease first identified in the 1880s by Louis Pasteur. It is caused by a negative-sense RNA virus belonging to the genus *Lyssavirus* and the family *Rhabdoviridae*, which attacks the mammalian nervous system and can lead to permanent neurological damage, although the disease is preventable through vaccination (Bili, 2014). Despite advances in prevention and control measures, rabies remains a significant public health concern, particularly in Indonesia (Yudining *et al.*, 2024). The burden of rabies in several developing countries remains substantial, with the disease causing approximately 55,000 deaths annually, particularly among children in Africa and Asia (Davlin et al., 2014).

Globally, dog-mediated rabies is estimated to cause approximately 59,000 human deaths each year (Jane Ling et al., 2023). According to data from the World Health Organization, the highest proportion of rabies-related deaths was reported in Africa,

accounting for 56% of global mortality, while 44% occurred in Asia. In Asia, an estimated 35,172 deaths were attributed to dog-mediated rabies, representing approximately 59.6% of total global rabies mortality. India ranks first in terms of rabies-related deaths, contributing 59.9% of cases in Asia and 35% of cases worldwide. In Central Asia, approximately 1,875 deaths due to dog-mediated rabies were estimated, whereas 229 rabies-related deaths were reported in the Middle East (Irma, 2026).

Rabies remains a critical public health issue in Indonesia, with a very high risk of mortality if not promptly managed. According to data from the Ministry of Health of the Republic of Indonesia, a total of 104,229 cases of bites from animals suspected of being infected with rabies were reported in 2022, representing a substantial increase compared with the previous year (Kementerian Kesehatan RI, 2023). Several provinces, including Bali, East Nusa Tenggara, and South Sulawesi, continue to report relatively high numbers of rabies cases, highlighting the need for comprehensive and serious intervention from both regional and central governments (V. A. B. Mau et al., 2024).

Based on data from the Ministry of Health of the Republic of Indonesia, the Government of South Central Timor Regency declared a rabies outbreak status on May 30, 2023. This decision was prompted by the death of one individual among 46 reported rabies infection cases (Foeh et al., 2024). In East Nusa Tenggara, 14 regencies and one municipality have been declared rabies outbreak areas, including Flores Regency, Timor Regency, Sikka Regency, Ende Regency, Nagekeo Regency, Ngada Regency, East Manggarai Regency, Manggarai Regency, West Manggarai Regency, South Central Timor Regency, Kupang Regency, North Central Timor Regency, Malaka Regency, Belu Regency, and Kupang. The number of Rabies-Transmitting Animal Bite (RTAB) cases reached 20,705 as of March 2024, compared with 20,930 cases reported in 2023, while 12,721 cases were recorded in 2021 and 10,867 cases in 2022. During the 2021–2022 period, RTAB cases were reported in only nine regencies (Dinas Kesehatan Provinsi NTT, 2024).

This study aims to provide a comprehensive analysis of the rabies outbreak in East Nusa Tenggara by examining the epidemiological characteristics of the outbreak, the distribution patterns of reported cases, and the population groups most vulnerable to rabies transmission within the region.

Preliminaries or Related Work or Literature Review

An extraordinary event (KLB) is a condition where there is an increase in the incidence of disease or death in a region within a certain period, which can lead to a potential epidemic if not addressed promptly. An KLB is an important indicator in the public health early warning system because it reflects a disruption in the balance between the disease agent, the host, and the environment. In the context of zoonoses, an KLB is often influenced by the interaction between humans and animals as disease reservoirs, as occurs in rabies.

Rabies is a viral infection that attacks the central nervous system and is always fatal until clinical symptoms appear. Historically, rabies has been known for thousands of years and is one of the oldest zoonotic diseases. To this day, rabies remains a global public health problem, particularly in developing countries with limited resources. Rabies is endemic in several regions, particularly in Indonesia. East Nusa Tenggara (NTT) Province is among those at high risk of rabies outbreaks. The dynamics of rabies spread in NTT are heavily influenced by the high dog population, which is generally still free-ranging. Furthermore, the archipelagic geography makes monitoring animal traffic more difficult, thus increasing the spread of disease between regions.

Rabies outbreaks in East Nusa Tenggara (NTT) have occurred repeatedly and exhibit a distinctive epidemiological pattern: high rates of bites from rabies-transmitting animals (GHPR) followed by human deaths. Contributing factors include low dog vaccination coverage, delayed post-bite treatment in humans, and limited access to healthcare facilities. Furthermore, sociocultural factors, which place dogs in close proximity to pets and as guardians, also increase the risk of exposure.

3. Materials and Method

The method used in writing this article is a literature review. This study was conducted by collecting data from various sources, such as journals and related articles obtained from several databases, including Google Scholar and PubMed, using the keyword "Rabies Outbreak in East Nusa Tenggara." The selected articles were case reports from journals published within the last two years, namely from 2023 to 2024

4. Results and Discussion

History of Rabies Outbreak in East Nusa Tenggara

The development of rabies in East Nusa Tenggara (NTT) reflects the epidemiological dynamics of zoonotic diseases influenced by the interaction between the host, agent, and environment. The first rabies case in East Nusa Tenggara (NTT) was recorded in 1997, marked by a dog bite incident in Sarotari Village, Larantuka District, the capital of East Flores Regency (F. Mau & Desato, 2011). This incident occurred due to the illegal importation of dogs from Buton Island in Southeast Sulawesi, known as a rabies endemic area. Thus, within three years of the first bite case, rabies had spread to all regencies on Flores Island.

Between 2000 and 2022, rabies developed into an endemic disease in East Nusa Tenggara (NTT), particularly on the islands of Flores and Lemabata, with a continuous transmission pattern and relatively stable incidence rates. However, in 2023, there was a significant increase in cases, categorizing rabies as an extraordinary event (KLB), with cases emerging in new areas on Timor Island. This development pattern indicates that the chain of rabies transmission has not been completely broken, allowing the virus to persist in its primary reservoir, namely dogs.

Epidemiologically, rabies cases in East Nusa Tenggara (NTT) are significantly influenced by suboptimal control during the pre-pathogenesis phase, the stage before the disease develops in humans. High dog populations, vaccination coverage that has not yet reached the minimum elimination threshold (≥70%), and inter-regional animal mobility are key factors maintaining the presence of infection reservoirs. This condition aligns with the basic epidemiological principle that zoonotic diseases will persist and develop if their sources of transmission are not effectively controlled, despite interventions in humans. This is evident in the Flores and Lembata regions, which have remained endemic for rabies for over twenty years.

Entering the pathogenesis phase of the disease's natural history, the high number of rabies-transmitting animal bites (RABs) indicates the still-high frequency of contact between humans and dogs (the reservoir). Since the rabies outbreak was declared in 2023, there have been 20,705 RABs, which then jumped to 30,046 RABs in 2024. This situation is worsened by low public awareness of the need to seek immediate first aid after being bitten and delays in administering the anti-rabies vaccine (RAV). This situation increases the likelihood of the infection progressing to the clinical stage, which in rabies is almost always fatal if not treated promptly and appropriately.

In the post-pathogenesis phase, the high mortality rate, with a case fatality rate (CFR) approaching 100%, indicates that rabies remains a highly fatal disease if left untreated before clinical symptoms appear. The continued annual reports of deaths in East Nusa Tenggara (NTT) indicate weaknesses in the health system, particularly in surveillance, response speed, and equitable distribution of health services. This challenge is particularly pronounced in island and remote areas where access to health facilities and the availability of vaccines and anti-rabies serum are limited.

Trends in Rabies Outbreak Cases in East Nusa Tenggara

The trend of rabies cases in East Nusa Tenggara (NTT) shows a fluctuating pattern (rising and falling), but tends to increase over the long term. This condition is related to the natural history of the disease, which has not been interrupted since rabies was first introduced in 1997. From an epidemiological perspective, after its rapid spread throughout the islands of Flores and Lembata in the early 2000s, rabies cases have not experienced a significant decline, but have persisted as an endemic disease with periodic spikes in cases. This situation indicates a recurring pattern of endemicity (always present) and epidemics (spikes in cases) influenced by the population dynamics of dogs as the primary reservoir animal.

From 2000 to 2010, rabies cases in East Nusa Tenggara showed a relatively stable but still high pattern, marked by the continued occurrence of bites from rabies-transmitting animals (GPHR) every year, reflecting the continued active transmission of the virus in the community and the unbroken cycle of transmission in dogs. This condition occurred because dog vaccination was still limited and not widely organized, so herd immunity had not yet developed. Entering 2010-2016, there was a very significant increase in cases, marked by thousands of bites and hundreds of deaths. This situation indicates that dog vaccination coverage has not been met.

Furthermore, from 2017 to 2022, case trends showed high fluctuations, particularly in endemic areas like Flores and Lembata. Although a mass rabies eradication program began in 2014 with a target vaccination coverage of 85% or more (Bili, 2014), its effectiveness has not been optimal due to uneven distribution in remote areas. As a result, the GHPR rate remains high each year, and the chain of transmission continues.

Following the declaration of a rabies outbreak in 2023, marked by widespread rabies cases in the previously rabies-free South Central Timor Regency, the outbreak continued into North Central Timor and Malaka in 2025. Between 2023 and 2025, there was a sharp spike in cases, totaling tens of thousands of bites and hundreds of deaths in East Nusa Tenggara (NTT). This situation demonstrates that transmission is not only persisting in existing areas but is also spreading to new, previously disease-free areas.

Distribution of Rabies Outbreaks in East Nusa Tenggara

Person

The distribution of rabies cases in NTT Province for the 2022–2024 period shows an increase in the number of cases across all age groups, with varying caseloads between groups. Cumulatively, the highest number of cases occurred in the 5–9 age group with 16,014 cases, followed by the 20–45 age group with 12,641 cases, and the under-5 age group with 10,932 cases. The 10–14 age group recorded a total of 8,903 cases, while the 46–64 and over-64 age groups recorded 7,949 and 3,055 cases, respectively. The lowest number of cases was found in the 15–19 age group with 4,252 cases. Based on the annual distribution, all age groups showed a trend of increasing cases from 2022 to 2024. In the 5–9 age group, the number of cases increased from 3,367 cases in 2022 to 5,246 cases in 2023 and 7,401 cases in 2024. A similar increase was also seen in the 20–45 age group, namely from 2,257 cases in 2022 to 4,017 cases in 2023 and 6,367 cases in 2024 (NTT Provincial Health Office 2024, Ambanaga 2025).

This pattern indicates that children, particularly those aged 5–9, contributed the most cases compared to other age groups during the observation period. The incidence of rabies-transmitting animal bites (RABs) is related to children's habit of frequently playing with pets without considering the risk of bites (Ndoen et al., 2024).

Place

The distribution of rabies deaths in NTT Province for the 2022–2024 period shows spatial variation between districts, with an increasing pattern in some areas. South Central Timor Regency recorded the highest number of deaths, with 13 cases in 2024, after no cases in 2022 and 2023. Sikka Regency also showed a relatively high and stable number of cases, with 6 cases in 2023 and 2024, respectively. Several districts showed a fluctuating pattern. Ende Regency recorded 5 cases in 2022, decreasing to 4 cases in 2023, and then increasing again to 5 cases in 2024. East Manggarai Regency showed a gradual increase from 2 cases in 2022 and 2023 to 3 cases in 2024. Ngada Regency experienced a decrease from 1 case in 2022 and 2023 to no cases in 2024. In other regions, the number of cases was relatively low but still showed an increase in 2024. Kupang Regency increased from no cases in 2022 and 2023 to 5 cases in 2024. North Central Timor Regency increased from 0 cases in 2022 to 3 cases in 2023 and 7 cases in 2024. Malaka Regency increased from 0 cases in 2022 to 1 case in 2023 and 5 cases in 2024, while Belu Regency increased from no cases in 2022 and 2023 to 3 cases in 2024 (NTT Provincial Health Office) 2024, Ambanaga 2025).

Time

The temporal distribution of rabies cases in NTT Province for the 2022–2024 period shows a gradual increase in the number of cases each year. The total number of cases in 2022 was recorded at 12,721, then increased in 2023 to 20,708 cases, and again in 2024 to 30,317 cases (NTT Provincial Health Office 2024, Ambanaga 2025). The increase in the number of cases occurring in these two time intervals shows a consistent upward pattern without any decrease during the observation period. This pattern indicates that rabies incidence is still ongoing and has not shown a downward trend until the end of 2024.

Epidemiological Frequency Measures

Case Fatality Rate

Rabies is an acute infectious disease of the central nervous system caused by the rabies virus and transmitted through bites or exposure to infected tissues from reservoir animals such as dogs, cats, and monkeys, as well as through other routes including aerogenic

transmission, organ transplantation, or contact with injured skin or mucosal surfaces. Once clinical symptoms appear, the disease is almost invariably fatal, with a case fatality rate (CFR) approaching 100%, and no known natural immunity has been identified in humans (Kemenkes, 2011).

Based on rabies case data, a total of 12,721 cases were recorded in 2022, increasing to 20,708 cases in 2023 and 30,317 cases in 2024 (Dinas Kesehatan Provinsi NTT 2024, Ambanaga 2025).

$$\textbf{CFR} = \frac{number\ of\ deaths}{number\ of\ cases} \times 100\%$$

2022: $\textbf{CFR} = \frac{9}{12.721} \times 100\% = 0{,}07\%$

2023: $\textbf{CFR} = \frac{25}{20.708} \times 100\% = 0{,}12\%$

2024: $\textbf{CFR} = \frac{45}{30.317} \times 100\% = 0{,}15\%$

Based on the criteria for a rabies outbreak, an area is classified as experiencing an outbreak when the number of deaths increases by twofold or more compared with the previous period. (Kemenkes, 2011).

Although the Case Fatality Rate (CFR) of rabies in East Nusa Tenggara during the 2022–2024 period was relatively low (<1%), this condition does not indicate that rabies is a disease with low severity. Rabies remains a highly fatal disease once clinical symptoms have developed.

Based on the available data, the number of rabies-related deaths in East Nusa Tenggara increased from 9 cases in 2022 to 25 cases in 2023, representing an approximately 2.78-fold increase. This condition indicates that the outbreak criteria for rabies were met during that period. In contrast, the increase from 2023 to 2024, from 25 cases to 45 cases (a 1.8-fold increase), did not meet the twofold increase criterion, although it still reflected an upward trend. Therefore, the indication of a rabies outbreak is more appropriately associated with the increase observed between 2022 and 2023 rather than the overall observation period.

Mortality

Based on population data, East Nusa Tenggara experienced population growth during the 2022–2024 period. The population was recorded at 5,466,285 individuals in 2022, increasing to 5,569,068 individuals in 2023 and further rising to 5,656,039 individuals in 2024. (BPS, 2025)

$$\textbf{Mortalitas} = \frac{number\ of\ deaths}{total\ population} \times 100.000$$

2022 $= \frac{9}{5.466.285} \times 100.000 = 0{,}16$ per 100.000 penduduk

2023 $= \frac{25}{5.569.068} \times 100.000 = 0{,}45$ per 100.000 penduduk

2024 $= \frac{45}{5.656.039} \times 100.000 = 0{,}80$ per 100.000 penduduk

The rabies mortality rate in East Nusa Tenggara demonstrated an increasing trend during the 2022–2024 period. The mortality rate rose from approximately 0.16 per 100,000 population in 2022 to 0.45 per 100,000 population in 2023 and further increased to 0.80 per 100,000 population in 2024. This upward trend indicates an increasing burden of rabies-related mortality within the overall population.

Risk Factors and Determinants

Risk factors associated with the rabies outbreak in East Nusa Tenggara are closely related to individual factors, community behaviors, and the population dynamics of rabies-transmitting animals (RTAs). Based on previous studies, in Nonohonis Urban Village, contributing factors include low levels of knowledge, age, animal husbandry practices, intensity of contact with rabies-transmitting animals (RTAs), as well as the health and vaccination status of animals. Limited public knowledge has been identified as a major contributing factor, as individuals with insufficient understanding of rabies are less likely to undertake appropriate preventive measures or provide proper initial management following an animal bite. In addition, individuals aged under 15 years are considered more vulnerable due to their greater tendency to interact with animals without adequate awareness of the associated risks (Constantia & Sogen, 2024).

Animal husbandry practices also constitute an important risk factor for rabies transmission, particularly the common practice of allowing dogs to roam freely without

supervision, thereby increasing the likelihood of contact with infected animals. Direct interactions between humans and animals, such as playing with or feeding animals, may also trigger bites as a result of aggressive animal responses. Furthermore, the lack of routine animal health examinations and low vaccination coverage contribute to inadequate immunity among domestic animals against the rabies virus, increasing their potential to become sources of transmission. Studies conducted in Ngada Regency have demonstrated that the increasing incidence of animal bite cases is significantly associated with the density of the dog population within a given area, where regions with larger dog populations tend to exhibit a higher incidence of bite-related events (F. Mau & Desato, 2011).

Environmental and seasonal factors also contribute to an increased risk of rabies transmission, with animal bite cases tending to rise during specific periods, particularly in April, June, July, and November, while the highest incidence is commonly observed in July. This pattern is associated with the biological behavior of dogs, especially during the mating season, which generally occurs before and during the rainy season (approximately November–December), when dogs exhibit increased activity and aggressiveness. In contrast, during the dry season, limited availability of food and water may drive stray dogs to move into residential areas, thereby increasing interactions with humans and domestic animals.

The determinants of the rabies outbreak in East Nusa Tenggara were initially linked to the introduction of stray dogs from Sulawesi into the Flores region. This finding indicates that interregional animal movement without adequate supervision constitutes a major determinant in the spread of rabies. The geographical characteristics of NTT as an archipelagic region with numerous maritime transportation routes further increase the risk of disease transmission through uncontrolled animal movement; therefore, strengthened surveillance and implementation of quarantine measures are essential components of rabies control efforts. In addition, social and cultural factors also play an important role, as dogs in several areas of NTT possess significant social and economic value, serving as household guards, components of traditional customs such as bride wealth, and symbols associated with local beliefs. These conditions contribute to community resistance toward dog elimination programs, thereby complicating efforts to control the dog population.

Control Measures and Field Challenges

Rabies control in East Nusa Tenggara has been implemented through a One Health approach involving human health, animal health, and the environmental sectors (Kale et al., 2025). Various strategies have been implemented, such as mass vaccination of dogs to achieve herd immunity, post-exposure prophylaxis (PEP) for bitten individuals, and public education on rabies prevention and early treatment. Efforts have also been made to strengthen the surveillance system and integrated case reporting, involve traditional and community leaders in control programs, and implement village-based regulations regarding dog ownership and control. This approach is supported by increased human resource capacity and cross-sectoral collaboration at the regional and international levels.

However, the effectiveness of these efforts can be seen from the trend of rabies cases in recent years. Data from the NTT Rabies Surveillance Task Force shows that cases of bites from rabies-transmitting animals (GHPR) increased from 20,705 in 2023 to 30,046 in 2024, indicating that rabies control was not optimal during that period. Entering 2025, there was a decrease in the number of cases compared to the previous year. As of May 2025, there were 2,149 GHPR cases recorded with 10 deaths, while as of August 2025, there were 16,939 bite cases recorded with 20 deaths. This decrease in cases is also supported by reports that there was a 24.5% decrease in HPR cases in the period August-September 2025 following the implementation of policies restricting animal movement and increasing vaccination. This indicates that the interventions carried out are starting to have a positive impact in suppressing the spread of rabies.

However, the overall trend of rabies cases in NTT has not shown a consistent and stable decline. The surge in cases in 2024 and the continued discovery of cases and deaths in 2025 indicate that efforts have not been fully effective in breaking the chain of rabies transmission. This ineffectiveness is due to various challenges in the field, such as low dog vaccination coverage that has not yet reached the herd immunity target, limited vaccinators, and difficult-to-reach geographic conditions. Furthermore, sociocultural factors such as the habit of keeping dogs that are released freely and high animal mobility also contribute to

accelerating the spread of rabies. Meanwhile, within the health system, limited access to PEP services, a suboptimal surveillance system, and weak cross-sectoral coordination further exacerbate the situation.

Therefore, it is necessary to strengthen a more comprehensive, sustainable, and community-based control strategy to achieve effective rabies elimination in NTT.

5. Conclusion

The rabies outbreak in East Nusa Tenggara (NTT) Province is a complex public health problem influenced by the interaction of various epidemiological factors. Historically, rabies has developed since 1997 and has become endemic in several areas, with a significant increase in cases in 2023 that meet the criteria for an outbreak. Case trends show an increase from 2022 to 2024, including the number of bites from rabies-infecting animals and the death rate. The distribution of cases indicates that children (5-9 years) are the most vulnerable group, while geographically cases are widespread, with an increase in previously rabies-free areas. Key risk factors include low dog vaccination coverage, high animal populations and mobility, public behavior regarding animal care, and limited access to healthcare and vaccines. Although various control efforts have been implemented through the One Health approach, the results achieved have not been optimal in breaking the chain of rabies transmission. Therefore, strengthening more comprehensive, sustainable, and community-based control strategies is needed, particularly through increasing dog vaccination coverage, public education, monitoring animal movement, and improving access to healthcare services.

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