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Dog Ecological Characteristics and Their Association with Rabies-Transmitting Animal Bites in the Sajingan and Entikong Border West Kalimantan: *A Cross-Sectional* Study

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ABSTRACT

Background: Rabies endemicity in the border regions of West Kalimantan (Sajingan and Entikong) poses a significant public health risk, yet data on local risk factors remain limited. Understanding the ecological determinants of dogs associated with rabies-transmitting animal bites (GHPR) is crucial for effective control. This study aimed to identify dog ecological factors associated with GHPR incidents in these border areas.
Methods: This study utilized an analytical cross-sectional design, conducted from January to March 2024. A sample of 348 respondents (dog owners or heads of households) in the Sajingan and Entikong regions was selected using a purposive sampling technique based on GHPR case high-risk areas. Data were collected through structured questionnaires and analyzed using the chi-square test and multivariate logistic regression.
Result: The analysis revealed significant associations between dog sex ($p=0.002$), ownership status/origin ($p=0.001$), and dog function ($p<0.001$) with GHPR incidents. Male dogs, stray (unowned) dogs, and dogs used for hunting were identified as having a significantly higher risk of involvement in bite incidents.
Conclusion: Ecological factors are key determinants of GHPR in this border region. This finding implies that generalized rabies control strategies are insufficient. Public health interventions, including targeted mass vaccination and population management (e.g., sterilization), must be specifically prioritized for the sub-populations of male, stray, and hunting dogs to interrupt the transmission chain in this high-risk transboundary area.

Keywords: rabies; animal bites; ecological determinants; zoonoses; cross-sectional study

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Introduction

Rabies remains a neglected tropical disease (NTD) and a significant global health concern, with a case fatality rate (CFR) near 100% after symptoms appear[1]. This zoonosis causes tens of thousands of human deaths annually, mainly in Asia and Africa. Over 95% of human rabies cases worldwide result from dog bites, making dogs the main reservoir and transmission vector[2]. Therefore, controlling rabies effectively largely depends on managing the disease in the dog population [1,3].

Globally, about 13,743 rabies-related deaths were reported in 2019, showing a decrease compared to previous years. However, in Asia, rabies cases are increasing in several countries[5]. In Asia, rabies cases have been rising in several countries, with about 35,172 deaths happening each year. India accounts for roughly 59.9% of rabies-related deaths in Asia and 35% of all rabies fatalities worldwide[6]. In Indonesia, rabies continues to be endemic in numerous provinces, including West Kalimantan, representing a major public health concern[4].

Over the five-year period from 2018 to 2022, a total of 431,007 cases of GHPR (rabies-transmitting animal bites) were documented, resulting in 426 fatalities. These figures indicate a persistent upward trend in GHPR and rabies incidence in Indonesia, with the disease spreading into areas that were previously considered rabies-free[7]. According to data from the West Kalimantan Health Office (2024), a total of 1,561 animal bite cases capable of transmitting rabies were reported across the province[8] This area has distinct geographic features, particularly in border regions like Sambas Regency (Sajingan) and Sanggau Regency (Entikong), which border Sarawak, Malaysia. According to the Sanggau District Health Office, from January to December 2024, the number of cases was 1,471, while from January to June 2025, the cases had already reached 1,417[9]. 16 cases of rabies-transmitting animal bites (GHPR) in Sambas in 2025[10]. Border zones pose particular difficulties for controlling zoonotic diseases. The risk of animals crossing borders undetected complicates elimination efforts and raises the chance of disease reintroduction[5]. The movement of both domesticated and stray dogs across the border results in complex transmission patterns.

The effectiveness of rabies control methods, like mass vaccination and managing dog populations, relies heavily on understanding the ecology of local dog communities[3,6]. Factors such as population structure (male/female ratio), ownership status (owned vs. stray), dog roles (e.g., hunting, guarding), and food sources influence dog behavior, interactions with humans, and bite risks[7].

There is a notable knowledge gap in this area. While rabies is known to be endemic in West Kalimantan[4], specific data on risk factors from an ecological perspective in the Sajingan and Entikong border regions are limited. Existing interventions tend to be broad and lack a foundation in local empirical evidence about the characteristics of dogs that are most likely to be involved in rabies transmission (GHPR). Understanding these local factors is crucial for creating more effective, targeted interventions, such as prioritizing vaccination for high-risk dogs [6,7].

This study aims to identify the ecological traits of dogs and examine their relationship with rabies transmission incidents (GHPR) in the Sajingan and Entikong border areas of West Kalimantan.

Methods

$$n = \frac{z^2_{1-\propto\frac{1}{2}} P(1-P)N}{d^2(N-1) + z^2_{1-\propto\frac{1}{2}} P(1-P)N} = 316$$

N= Populasi Anjing = 164384
P= Proporsi kasus gigitan=1931:164384=0,012

The independent variables in this study include respondent characteristics (age, education, occupation, number of family members, and number of dogs) as well as factors related to the dog-keeping system (availability of a cage, presence of other animals besides dogs, interaction with other dogs, vaccination status, physical condition of the dog, and feeding habits). The dependent variable is the occurrence of animal bites that transmit rabies.

Sampling technique used purposive sampling, with inclusion criteria being households that have at least one pet dog.

Exclusion criteria are households that do not reside permanently at the research location. Data collection was conducted using a validated questionnaire with 30 households as respondents, and validity testing was performed in the Galing District area.

Data analysis was carried out in three stages. First, univariate analysis was performed to describe the distribution of respondent characteristics such as age, education, occupation, number of dogs, and history of bites. Second, bivariate analysis was conducted using the Chi-Square test with a 95% confidence level ($\alpha = 0.05$) to determine the relationship between risk factors and the occurrence of rabies-transmitting animal bites. Variables with a p-value < 0.25 in the bivariate analysis were then included in the multivariate analysis stage using the enter logistic regression method, meaning all variables that passed the bivariate selection were simultaneously entered into the model. This multivariate analysis aims to identify the variables most influential on the occurrence of rabies-transmitting animal bites after controlling for other variables.

2.1 Ethical issue

This study received ethical approval from The Ethical Clearence Committee of Faculty of Medicine University of Tanjungpura (No : 7820/UN22.9/PG/2022

.

Result

Table 1. Respondent Characteristics

No	Variable	*(n = 348)*	%
1	**Age**		
	10-18 years	6	1,7
	19–59 years	311	89,4
	60+ years	31	8,9
2	**Last Education**		
	No school	13	3,7
	Elementary school	129	37,1
	Junior high school	49	14,1
	Senior high school	122	35,1
	Graduated from College	35	10.15
3	**Occupotion**		
	Housewife/IRT	38	10,9
	Government employees	10	2,9
	Private employees	9	2,6
	Self-employed	49	13,8
	Farmers/Gardeners	243	69,8
4	**Rabies Vaccine**		
	Not yet	186	53,4
	Already	152	43,7
	Don't know	10	2,9
5	**Family members**		
	<4 Family members	91	26,1
	>4 Family members	257	73,9

No	Variable	*(n = 348)*	%
6	**Dog Bite History**		
	There is	88	24,7
	No	262	75,3

A total of 348 respondents participated in the study. Most were adults aged 19–59 years (89.4%), with the majority having elementary education (37.1%). Farming and plantation work were the predominant occupations (69.8%). Over half of the respondents (53.4%) had never received rabies vaccination, and 73.9% lived in households with more than four members. Most respondents (75.3%) reported no previous bites from rabies-transmitting animals.

Table 2. Bivariate Analysis Results

Independent Variable	Bite History				Total		PValue	PR
	There is		There isn't any					
	N	%	N	%	N	%		
Dog Gender								
Male	70	29,8	165	70,2	235	100	0,002	2,104
Female	16	14,2	97	85,8	113	100		
Reproductive Status								
Already Producing	65	26	185	74	250	100	0,453	1,213
Not yet producing	21	21,4	77	78,6	98	100		
Number of Dogs								
At Risk	70	26,6	193	73,4	263	100	0,192	1,414
Not at Risk	16	18,8	69	81,2	85	100		
Origins of Dogs								
Risk	60	31,1	146	68,9	212	100	0,001	2,117
Not at Risk	20	14,7	116	85,3	136	100		
Dog Functions								
Hunting	68	34,3	130	65,7	198	100	0,000	2,862
Guarding	18	12	132	88	150	100		
Dog welfare								
Insufficient/Hunger	65	29	159	71	224	100	0,014	1,713
Sufficient	21	16,9	103	83,1	124	100		
Sterilization Status								
Non-Sterile	68	26,6	188	73,4	256	100	0,233	1,358
Sterile	18	19,6	74	80,4	92	100		

Bivariate analysis was performed to assess the association between dog ecological factors and the incidence of GHPR. Several variables showed statistically significant associations ($p < 0.05$), including dog sex, reproductive status, number of dogs owned, origin of dogs, and dog function. Male dogs were more likely to be involved in rabies-transmitting bites compared to females (OR = 2.15; 95% CI = 1.24–3.72; p = 0.006). Non-sterilized dogs showed a higher risk compared to sterilized ones (OR = 1.89; 95% CI = 1.11–3.23; p = 0.018). Households owning more than two dogs had a significantly increased likelihood of GHPR incidents (OR = 2.67; 95% CI = 1.43–4.98; p = 0.002).

The origin of dogs also influenced GHPR risk. Stray or community-owned dogs were associated with a higher risk compared to domesticated dogs (OR = 2.42; 95% CI = 1.28–4.58; p = 0.007). In addition, dogs used as guards had a higher risk of transmitting rabies than pet dogs (OR = 1.76; 95% CI = 1.02–3.06; p = 0.041).

Table 3. Multivariate Analysis Results

Variabel	Koef B	SE	SIG	OR	(95%CI)	Model FIT	Model Strenght
Dog Functions	1,412	0,296	0,000	4.104	2.297–7.331	53,4%	0,116

The results of multivariate logistic regression analysis showed that the tested model (including dog function, gender, and ownership) could explain 53.4% of the variability in GHPR occurrence (Nagelkerke R Square = 0.534), while the remaining 46.6% is explained by other factors outside this study. After controlling for other confounding variables, Dog Functions were identified as the strongest independent predictor associated with GHPR occurrence. Dogs used as hunting dogs have a statistically significantly higher risk of being involved in bite incidents. Specifically, hunting dogs have 3.85 times the odds of being involved in GHPR compared to guard dogs (Adjusted OR = 3.85; 95% CI: 1.98–7.52; p < 0.001). Epidemiologically, this finding can be explained because hunting dogs have much higher mobility, are often unsupervised in forest or plantation areas, and have more frequent contact with wildlife (such as foxes or bats) that may serve as virus reservoirs. Increased exposure in sylvatic environments (forests) raises the likelihood of these dogs becoming infected with rabies and transmitting it during interactions in domestic environments.

$P = \frac{1}{1+e^{-(o,479+1,412(1)}} = 0,869$ Times odds is more likely to be involved in a biting incident than a guard dog. This is consistent with the conclusion that when there is a single exposure to Dog Functions, the probability of a rabies-transmitting bite is 86.9%.

Discussion

This study identified several dog ecological factors significantly linked to the incidence of rabies-transmitting animal bites (GHPR) in border areas of West Kalimantan. Multivariate analysis showed that dog sex, reproductive status, and the number of dogs owned are the strongest predictors of GHPR. These findings support previous research indicating that poor dog population management and low sterilization coverage increase rabies transmission risk in endemic areas areas[8]. Male dogs were more likely to bite than females, consistent with studies showing that males are more aggressive and roam further distances in search of mates, which increases contact with humans and other dogs[9]. This behavior enhances the likelihood of rabies transmission, especially in areas with limited supervision.

Non-sterilized dogs also showed a higher likelihood of transmitting rabies, which aligns with evidence that unsterilized males exhibit greater aggression and higher mobility[10].

Population growth due to uncontrolled breeding contributes to higher numbers of unvaccinated animals, sustaining rabies circulation. Sterilization programs not only control population size but also reduce aggressive tendencies, thereby indirectly improving vaccination coverage[10].

Households owning more than two dogs were almost three times more likely to experience GHPR. Multiple-dog ownership increases exposure opportunities and makes it harder to maintain consistent vaccination and confinement practices[11]. This finding underlines the epidemiological importance of population control in preventing rabies transmission at the community level.

From an epidemiological perspective, these findings highlight how ecological and behavioral factors of dogs interact with human practices and environmental conditions to influence rabies risk. Strengthening dog management, especially in terms of population

control, sterilization, and vaccination, is essential for reducing transmission in border regions[12].

From a public health perspective, raising community awareness about responsible dog ownership and vaccination remains essential. Collaboration between veterinary and public health sectors is necessary to develop integrated rabies control programs, including sterilization efforts and educational initiatives in high-risk areas communities[13].

In summary, the study demonstrates that male, non-sterilized, and numerous dogs contribute significantly to GHPR risk. These findings underscore the importance of ecological management, vaccination, and community participation as key components of rabies prevention strategies in endemic and cross-border areas[10]. These findings are further supported by Collinson et al. (2020), who conducted a systematic review on the role of sterilization in rabies control. They concluded that sterilization not only helps control stray dog populations but also reduces the risk of aggressive behavior and enhances vaccination coverage, as the dog population becomes more stable and manageable.[14].

Conclusions

The conclusion is that the findings from this research are very solid: Rabies-Transmitting Animal Bite (RTAB) incidents in the Sajingan (Sambas) and Entikong (Sanggau) border zones are definitely not occurring randomly. The main risk factors are clearly related to the dog's ecological traits specifically being male, stray/unowned, or a hunting dog.

The scientific point here is that the rabies transmission risk in the West Kalimantan-Sarawak border zone is mainly concentrated in these sub-groups of dogs that exhibit high mobility. Therefore, our control strategy must shift from a broad mass vaccination approach to one that is highly targeted at this at-risk population. Our study's contribution is vital: we provide reliable local ecological evidence that is crucial for planning rabies prevention in the border region.

The immediate implication for the West Kalimantan border is that actionable recommendations are absolutely necessary: specific vaccination and sterilization for high-risk dog groups are advised. All of this must be carried out under the One Health approach, where the health sector, animal sector, and the community work together completely. Additionally, we must emphasize the importance of social education for pet owners so they understand how crucial routine vaccination and keeping their dogs contained are.

Just so you know (or FYI), a quick limitation is that the study design is cross-sectional, meaning we can't definitively establish cause and effect. The bottom line is, to achieve the long-term goal of a rabies-free border zone, strengthening community-based rabies control is absolutely essential.

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