

Factors Associated with Risk Exposure to Human Rabies among Mammal Bite Cases in Mukah Division, Sarawak, East Malaysia

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ABSTRACT

INTRODUCTION: Rabies is a neglected disease. Before the epidemic of rabies in Sarawak in July 2017, surveillance of mammal bites was not well implemented throughout the state. Our objective was to determine the prevalence of mammal bites in the Mukah Division and the factors that are associated with the risk of exposure to human rabies.

MATERIALS AND METHODS: This is a cross-sectional study that used data from reported cases of mammal bites in Mukah Division, Sarawak, from 2018–2019. A universal sampling method was used, and 457 cases of mammal bites were included in the analysis. Data was analysed using single logistic regression and multiple logistic regression.

RESULTS: The prevalence of mammal bites in Mukah Division was 0.35% with a cumulative incidence of 354 per 100 000 population. Age group 0-14 years old (AOR 6.49, 95%CI 1.26-33.53), free-roaming pet (AOR 2.93, 95% 1.36-6.28) and stray mammals (AOR 10.88, 95% CI 5.05-23.48) were found to be significantly associated with risk exposure to human rabies in Mukah Division in the final model. **CONCLUSION:** Health awareness and education should be emphasized to the community and medical personnel on the identified risk factors so that rabies infection can be prevented.

Keywords

Rabies, factors, risk exposure, mammal, bites

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INTRODUCTION

Worldwide, it is estimated about 59 000 deaths annually due to rabies and Asia region alone contributes to 35 000 deaths yearly. India reported the highest number of fatalities among Asian countries, with 59% of death.¹ Malaysia and other developed countries have been declared free from rabies,² however in July 2017, Sarawak, located in East Malaysia, recorded the first-ever human rabies cases since 1998. Since then, Sarawak recorded 30 human rabies cases, with 28 dead and two survivors.³

Rabies is a neglected disease, and before the epidemic of rabies in Sarawak, surveillance of mammal bites were not well implemented throughout the state. Thus, cases of mammal bites and human rabies cases are under-reported. Therefore, factors associated with mammal bites in Sarawak have not been thoroughly studied due to the lack of well-implemented surveillance of mammal bites. These mammal bites carry a risk of exposure to human rabies.

Since 2017, Sarawak Disaster Management Committee has led various agencies in the state to curb rabies in Sarawak. Among control measures implemented to fight rabies included the i) introduction of immune belt area, which stretched from Telok Melano of Semantan District (Kuching Division) to Lubok Antu (Sri Aman Division), ii) licensing of dogs, iii) public awareness and disease education, iv) free mass vaccination of dogs, and v) removal of stray dogs. Thus, this study has two objectives which are: i) to determine the prevalence of mammal bites in the Mukah Division, 2) to determine the factors of mammal bites that are associated with risk exposure to human rabies.

MATERIAL AND METHODS

This study is a cross-sectional study conducted at Mukah Division. All districts in Mukah Division were included in the study, namely, Mukah, Dalat, Matu, Daro, and Tanjung

Manis District. A universal sampling method was used and this study included all reported cases of mammal bites received by the Mukah Health Divisional Office from 2018 until 2019.

Case Definition of Rabies Exposure

- i. Definite risk of rabies was defined as cases exposed to stray mammal or no known owner, or mammal has at least one symptom of rabies, and the mammals involved cannot be observed for 14 days after the bite incident
- ii. Possible risk of rabies was defined as mammals that can be observed for 14 days without any definite risk features.

Data Collection

All cases of mammal bites in Mukah Division were collected from 2018 to 2019 were used for data analysis. From the notified cases, sociodemographic data of cases, locality of the incident, characteristic of a bite including i) number of bites, ii) bitten body part, iii) category of wound, iv) type of animal, v) category of animal, vi) cases PEP status, viii) date of incident occurred, and ix) date of seeking treatment were extracted and analysed. Identifiers of the subject include name and identification number, were removed from secondary data for anonymity by Mukah Health Division.

Statistical Analysis

The independent variables in this study are i) District in Mukah Division, ii) gender, iii) age, iv) race, v) place of incident of bite, vi) category of mammal, vii) type of animal, viii) part of body bitten, ix) number of bites, and x) grade of wound. The outcome of the study was risk exposure to rabies and divided into i) definite risk and ii) possible risk of rabies. The data was analysed using IBM SPSS version 26. A simple and multiple logistic regression test were used to determine the association factors of risk exposure to human rabies. Data presented in terms of

odds ratio, 95% confidence intervals and degree of freedom. Significant factors were taken at $p < 0.05$. Only factors found significant in simple logistic regression were analysed by multiple logistic regression. Factors found significant in multiple logistic regression were included in our final model and equation. Interaction between significant factors was checked. We used the area under the curve of the receiver operating characteristic (AUROC) to assess discrimination. Ethical approval for this study was obtained from the Medical Research and Ethics Committee (MREC), Ministry of Health Malaysia (NMRR-21-368-58367). This study also acquired ethical approval from UiTM Ethics (Ethical approval from UiTM (REC/05/2021(EX/75))).

RESULTS

Prevalence and Cumulative Incidence

A total of 457 reported cases of mammal bite were included in the analysis. The prevalence of mammal bites from 2018-2019 was 0.35%, while the cumulative incident of mammal bite was 354 per 100 000 per population. Table 1, summarizes the demographic of patient of a bitten case in Mukah Division. Females contributed to 51.2% of cases compare to male. The median age of patients were 32 years old, with children and young adults recorded more than half of the bite (23.6% in age group 0-14 and 28.4% in age group 15-29).

Melanau, the largest ethnic group in Mukah, contributed to 50.5% of cases, and most bite cases occurred in Mukah District (66.3%). Other mammal bites (cat, $n=245$, monkey, $n=9$) represent 53% of cases in the Mukah Division. Most bite cases involved domestic pets, which account for more than 70% of cases (44.2% cases involved fully indoor pets and 29.3% cases involving free-roaming pets), and thus most bite incidents occurred at home. The upper extremities (hand, forearm, and arm) are the commonest site of the bite. Most of the bite is single and categorized as grade 3 wound.

Table 1: Demographic of reported bitten cases in Mukah division

Variable	Sample Size (n=457)	Risk Status (%)	
		Possible	Definite
Gender			
Male	223	176 (78.9)	47 (21.1)
Female	234	200 (85.5)	34 (14.5)
Race			
Melanau	231	192 (83.1)	39 (16.9)
Iban	117	97 (82.9)	20 (17.1)
Chinese	64	55 (85.9)	9 (14.1)
Malay	19	13 (68.4)	6 (31.6)
Other Bumiputra	26	19 (73.1)	7 (26.9)
Division			
Mukah	303	248 (81.8)	55 (18.2)
Dalat	94	80 (85.1)	14 (14.9)
Matu	16	13 (81.3)	3 (18.8)
Daro	31	23 (74.2)	8 (25.8)
Tg Manis	13	12 (92.3)	1 (7.7)
Age (years)	32.92 (\pm 21.89) *		
0 – 14	108	71 (65.7)	37 (34.3)
15 – 29	130	107 (82.3)	23 (17.7)
30 – 44	77	70 (90.9)	7 (9.1)
45 – 59	71	64 (90.1)	7 (9.9)
60 – 74	51	46 (90.2)	5 (9.8)
75 – 89	20	18 (90.0)	2 (10)
Type Of Animal			
Dog	203	156 (76.8)	47 (23.2)
Other mammals	254	220 (86.6)	34 (14.4)
Categories of Animal			
Pet	202	190 (94.1)	12 (5.9)
Free roaming pet	134	107 (79.9)	27 (20.1)
Stray	121	79 (65.3)	42 (34.7)
Body part of Bitten			
Upper Extremities	268	226 (84.3)	42 (15.7)
Lower Extremities	164	134 (81.7)	30 (18.3)
Other	25	16 (64)	9 (36)
Number of Bites			
Single	385	322 (83.6)	63 (16.4)
Multiple	72	54 (75.0)	18 (25.0)
Grade of Wound			
One	26	24 (92.3)	2(7.7)
Two	161	143 (88.8)	18 (11.2)
Three	270	209 (77.4)	61 (22.6)
Place of Incident			
House	311	260 (83.6)	51 (16.4)
Long house	57	45 (78.9)	12 (21.1)
Educational Institution	38	26 (68.4)	12 (31.6)
Public places	25	22 (88.0)	3 (12.0)
Workplace	26	23 (88.5)	3 (11.5)

*mean

Factors Associated with Risk Exposure to Rabies in Mukah Division

Simple logistic regression was done; age, place of incident occurred, category of animals, part of the body bitten, and grade of wound found to be statistically significant as shown in Table 2. Multiple logistic regression was done for the final model. Table 3. We found that stray mammals poised the greatest risk for rabies exposure compared to pets (OR 10.88, 95% CI 5.05–23.48,

$p < 0.001$). Free-roaming pets also posed about 3 times higher odds for rabies exposure than a pet (OR 2.93, 95% CI 1.36–6.28, $p = 0.006$). In terms of wound grade, both wound grades 1 and 2 had less likely odds for rabies exposure than wound grades 3. Children 14 years old and below had higher risk of exposure to rabies compare to older age with 6.49 higher risk of rabies exposure (95% CI 1.26–33.53, $p = 0.025$). In our model, the area under the curve (AUC) is 80.7% (95% CI 75.8–85.7). Thus, the model discriminates 80.7% of the predicted of having definite risk correctly in the final model.

Table 2: Factors associates with risk exposure of rabies in Mukah division

Variable	Crude OR (95% CI)	Wald(df)	p-value
Division			
Matu	1		
Mukah	0.96 (0.27,3.49)	0.004 (1)	0.952
Dalat	0.76 (0.19, 3.01)	0.155 (1)	0.694
Daro	1.51 (0.34, 6.70)	0.291(1)	0.590
Tg Manis	0.361 (0.03, 3.96)	0.695 (1)	0.405
Gender			
Male	1.57 (0.97, 2.55)	3.323 (1)	0.068
Female	1		
Age			
0-14	4.70 (1.03, 21.32)	4.003 (1)	0.045*
15-29	1.94 (0.42, 8.92)	0.716 (1)	0.398
30-44	0.90 (0.17, 4.71)	0.016 (1)	0.901
45-59	0.98 (0.19, 5.16)	0.000 (1)	0.985
60-74	0.98 (0.17, 5.51)	0.001 (1)	0.980
75-89	1		
Race			
Chinese	1		
Iban	0.81 (0.37, 1.77)	0.292 (1)	0.589
Malay	1.02(0.56, 1.83)	0.002 (1)	0.960
Melanau	2.27 (0.71,4.61)	1.566 (1)	0.117
Other Bumiputra	1.81 (0.81, 6.34)	2.455 (1)	0.211
Place of Incident			
House	1		
Longhouse	1.36 (0.67, 2.75)	0.731 (1)	0.393
Public	0.70 (0.20, 2.41)	0.329 (1)	0.566
Educational Institution	2.35 (1.12, 4.97)	5.041 (1)	0.025*
Workplace	0.67 (0.19, 2.30)	0.416 (1)	0.519
Category of Mammal			
Pet	1		
Free roaming pet	3.99 (1.95,8.21)	14.214 (1)	<0.001**
Stray	8.42 (4.21, 16.84)	36.288 (1)	<0.001**
Type of Animal			
Dog	1.95 (1.20, 3.17)	7.229 (1)	0.007*
Other Mammals	1		
Part of Body Bitten			
Lower Extremities	1		
Upper Extremities	0.83 (0.50, 1.40)	0.502 (1)	0.478
Other	2.51 (1.01, 6.23)	3.959 (1)	0.047*
Number of Bite			
Single	1		
Multiple	0.59 (0.32, 1.07)	3.051 (1)	0.081
Grade of Wound			
1	0.29 (0.07, 1.24)	2.791 (1)	0.095
2	0.43 (0.25, 0.76)	8.448 (1)	0.004*
3	1		

*Significant at <0.05, ** significant at <0.001

Table 3: Final model of factors associated with risk exposure to rabies in Mukah division

Variable	B	S.E	Adjusted OR (95% CI)	Wald(df)	p-value
Category of Mammal					
Free Roaming	1.074	0.389	2.93 (1.36, 6.28)	7.600 (1)	0.006*
Pet					
Stray	2.387	0.392	10.88 (5.05, 23.48)	37.045 (1)	<0.001**
Grade of Wound					
1	-2.364	0.817	0.09 (0.02, 0.47)	8.370 (1)	0.004*
2	-1.092	0.335	0.34 (0.17, 0.65)	10.656 (1)	0.001*
Age					
0-14	1.870	0.838	6.49 (1.26, 33.53)	4.985 (1)	0.026*
15-29	0.820	0.844	2.27 (0.43, 11.88)	0.942 (1)	0.332
30-44	-0.029	0.905	0.97 (0.17, 5.73)	0.001 (1)	0.975
45-59	0.056	0.904	1.06 (0.18, 6.22)	0.004 (1)	0.951
60-74	-0.001	0.955	0.99 (0.15, 6.49)	0.000 (1)	0.999
Constant	-3.450	0.868	0.032	15.797(1)	<0.001

*Significant at <0.05, ** significant at <0.001

DISCUSSION

Prevalence and Incidence of Mammal Bite in Mukah Division

The prevalence of mammal bites in the Mukah Division was 0.35%. The prevalence of mammal bites worldwide varies among countries. However, our finding is consistent with a study done in the United States that reported the prevalence of bite was 0.25% in 2009. However, the prevalence decreased to 0.19% in 2014.⁴ On the other hand, other countries such as United Kingdom (UK) recorded a higher prevalence of bites cases, 2.5%⁵ likely due to better reporting systems and notification. Our estimation of prevalence could also be underestimated since some cases likely remain unreported. In Belgium, through a phone survey, they noticed that 50% of cases of bite remained unreported to either medical authority or local authority.⁶

We also calculated the cumulative incidence of mammal bite in the Mukah division and found that the incidence is 354 per 100 000 or 3.5 per 1000 population. The reported cumulative incidence is consistent with studies conducted in developing countries, and endemic areas of rabies such as Iran 423 per 100 000 per population and Kenya reported at 289 per 100 000 per population.^{7,8} However, reported cases of bites in Mukah Division are higher than neighbouring division, Sibui, where they recorded a cumulative incidence of 1.7 per 1000.⁹

Factors Associated with Risk Exposure to Rabies in Mukah Division

Age, grade of wound, and category of mammal significantly associate with risk exposure to rabies in Mukah. In terms of age, children below 14 years old posed 6 times risk for definite rabies exposure compared to older adults. This finding is consistent with the World Health Organization (WHO), which stated that children aged 15 years below have a 40% risk of being bitten by suspected rabid mammal.¹⁰ Children also tend to be bitten over the head, neck and face region.¹¹ This scenario is due to children's shorter physical appearance, and thus, these sites are easily reached by suspected rabid mammals. As these sites are near the brain, children will have a shorter incubation period and pose a higher risk for rabies transmission than adults. Proximity behaviour of children to moving objects and misinterpretation of dog's distress signalling gesture could also expose children to high-risk bites.^{12,13} Dogs or cats have often been portrayed as men's best friends, and interactions such as kissing and hugging are encouraged widely on television and social media.

These will encourage children to have closer interaction with these mammals. Without realizing distress, signalling gestures of these mammals could potentially lead to the aggressive behaviour of the mammal and posed exposure for high-risk bite to children. We also found out that free-roaming pets and stray mammals posed a greater risk for definite rabies than pets. Pets in this study is defined as fully caged or indoor mammals. Strays have 10 times risk compared to pet while free-roaming pet has 3 times risk compared to pet. The study conducted by Ngugi et al. in Kenya also found similar findings where free-roaming pets posed a greater risk for rabies transmission (OR 1.7, 95% CI 1.5-1.9).⁸ Stray mammals pose a higher risk for rabies as a most strays are unvaccinated and thus have higher probabilities of transmitting rabies virus to humans.

However, free-roaming pets also pose a significant threat to humans. Interaction between free-roaming pets with wild mammals can lead them to be infected with rabies. As these free-roaming pets live closer to its owner and family

thus, have greater chance transmitting the virus to human. In the situation in Sarawak, from July 2017 until October 2019, it was reported that 5 out of 21 cases of human rabies were caused by a newly adopted dog.¹⁴ Furthermore, from 2020 until July 2021, Sibu Division recorded 7 human rabies cases, and 6 of the cases were caused by free-roaming pets.¹⁵⁻¹⁷ Thus, this finding is consistent with the current scenario, and health education regarding the danger of free-roaming pets should be emphasized in Mukah Division to avoid human rabies cases in the future. Category of the wound also significantly associated with the risk of human rabies. Both grade wounds 1 and 2 were less likely for human rabies exposure than wound grade 3. The rabies virus cannot be transmitted to humans through intact skin.

A greater wound grade will provide more contact of exposure to saliva containing rabies virus from rabid mammals, and breached skin layer will facilitate the transmission of the virus to muscle where the virus will replicate. Rabies virus then travelled to the brain at 5-100mm/day through the central nervous system and cause rabies infection to the victim. There are few limitations to this study. As this study only analysed secondary data, variables are limited. Factors such as knowledge, attitude, and practices were not included in the analysis and recommended for further studies. Lastly, the findings are confined to Mukah locality.

RECOMMENDATIONS

The school will be a perfect place to educate our future generation and protect them from high-risk bites. Our study also recommended that understanding dog's behaviour and distress signalling be included and emphasized more in our health education campaign, especially among the children. We also encouraged our health campaign information and material to be translated to multiple native languages in Sarawak to reflect the need for its diverse ethnicity. Rising cases of human rabies caused by free-roaming pets are alarming and need to be tackled seriously. The owner should be accountable for any injury caused by their roaming pet, which can be achieved through law enforcements. The current fine

imposed is low and should be increased. In Sarawak, Veterinary Public Health Ordinance 1999, section 37 states that any dog found within a rabies-infected area, which is not under effective control, the owner shall be liable to a fine not exceeding RM5000 (USD 1100) or imprisonment not exceeding 3 months, or both. Meanwhile, in West Malaysia, Animal Act 1953 (Act 647), section 39, the owner shall be liable to a fine of RM250 (USD 55) for a similar offenses. In the event their pet causes any injury to other people, Minor Offence Act 1955 (revised 1987), section 6 states that for any roaming dogs that just chase after individuals, the owner will be fined not exceeding RM100 (USD 22). However, if their dogs chase after and cause any injury to individuals, a fine not exceeding RM50 (USD 11) will be imposed, and the owner will be required to compensate the victim with an amount not exceeding Rm100 (USD 22).

The owner can also be penalized under Penal Code Act 574, section 289, with imprisonment up to 6 months or a fine of maximum RM2000 (USD 440), or both. Both of these law applied to West Malaysia. The punishment imposed on owner negligence are extremely low compared to the threat free-roaming pets pose to the community. Therefore, we encouraged these laws to be revised with more reasonable fines to instil responsibilities to pet owners. Rabies is a fatal disease, but it is preventable with prompt wound management and post-exposure prophylaxis treatment (PEP). Evidence of factors associated with risk exposure of human rabies help to ensure PEP treatment will be prioritized to patient with definite risk of human rabies. Through this, it will improve cost-effectiveness of the treatment and prevent human rabies.

CONCLUSION

Mukah mammal bite prevalence is 0.35%, with a cumulative incidence of 354 per 100 000 population. We also found out that factors such as children below 14 years old, bite from the stray and free-roaming pet, and wound category 3 posed a significant risk for human rabies transmission.

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CONFLICT OF INTEREST

The authors have declared that no competing interest

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