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Abstract

Objectives Feline ownership is popular and represents the largest segment of the pet population in Malaysia. Most feline owners own, on average, 2–3 cats, with some having >10 cats per household. Feline immunodeficiency virus (FIV) and feline leukaemia virus (FeLV) are two clinically important viral infections in cats. Documenting the prevalence of these diseases in the feline population is important for both veterinarians and the public.

Methods This was a retrospective study, using data collected from the domestic cat population seen at a 24 h private veterinary hospital in Malaysia, to determine the prevalence of FIV and FeLV in an urban area and risk factors associated with these infections. Between 2010 and 2016, 2230 blood samples were collected and tested for FIV antibodies and FeLV antigen using commercially available ELISA test kits.

Results In total, 10.0% (n = 224; 95% confidence interval [CI] 8.80–11.26) were seropositive for FIV; 12.0% (n = 267; 95% CI 10.62–13.32) were seropositive for FeLV; and 2.6% (n = 58; 95% CI 2.01–3.17) were seropositive for both.

Conclusions and relevance The prevalence of FIV is lower and FeLV higher than previously documented for this region. Because of the immunosuppressive potential of both viruses, client education and use of appropriate control strategies such as routine screening, vaccination and eradication should be considered.

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Introduction

Infection with feline immunodeficiency virus (FIV) and/or feline leukaemia virus (FeLV) are important and common diseases in the family Felidae (both domestic and feral cats). FIV is a lentivirus, whereas FeLV is a gamma-retrovirus.¹ FIV is transmitted mainly through bites.² FeLV can be transmitted by close and prolonged social contact between healthy and carrier cats. Thus, the spread of FeLV might be supported by mutual grooming and sharing food or water bowls, in addition to spreading via bites.^{3,4} Other less common methods of transmission include tears, transplacental transmission, milk,⁵ plasma, urine, faeces and iatrogenically via blood transfusion.^{4,6,7}

Many global seroprevalence studies have been reported for FIV and FeLV, including Malaysia.^{4–8} In previous studies, age, sex, neutering status, outdoor access and multi-cat households have been recognised as risk factors associated with FIV and FeLV infections.^{2,8,9} Both

FIV and FeLV provide useful models of human T-cell leukaemia virus and human immunodeficiency virus-1.^{10,11}

The purpose of this study was to determine the seroprevalences of FIV and FeLV from a large data collection concerning the feline population in urban Malaysia. We speculated that both FIV and FeLV have a lower prevalence in Europe, the USA and Australia as a result of early implementation of protective screening and

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vaccination, which was not undertaken in Asia. We felt the present study to be important as the previous prevalence study of Malaysian cats indicated a higher prevalence than in Europe and the USA, and a lower prevalence than China.⁸ However, the previous study represented a small sample size from a semi-urban area, which we believe may not provide a fair representation of disease prevalence in Malaysia.⁸

Materials and methods

Study area

Malaysia, located in South East Asia, has a total landmass of 330,803 km² (127,720 miles²) separated by the South China Sea into two similarly sized regions, namely peninsular Malaysia and East Malaysia (Malaysian Borneo). The country extends from a latitude of 1°20'N to 6°40'N and from a longitude of 99°35'E to 104°20'E. The local climate is equatorial and characterised by the annual southwest (April–October) and north-east (October–February) monsoons. Humidity is usually high, and the average annual rainfall is 250 cm (98 inches). The Animal Medical Centre (AMC) is a 24 h hospital with a patient distribution throughout peninsular Malaysia and has a core clientele in Kuala Lumpur and the neighbouring suburbs.

Samples

Retrovirus screening is recommended for all cats visiting the AMC for the first time. Between 2010 and 2016, blood was collected in EDTA tubes from 2230 domesticated cats and submitted to the AMC IDEXX laboratory, Malaysia, for FIV and FeLV screening using an ELISA test kit (SNAP FIV/FeLV Combo Test; IDEXX Laboratories) following the manufacturer's recommendations. According to the manufacturer, FIV kits have a sensitivity of 93.5% and a specificity of 100%, whereas the sensitivity and specificity of FeLV kits are 98.6% and 98.2%, respectively. Viral screening (after obtaining owner consent) is a routine procedure for all cats that present to the AMC for the first time owing to the high incidence of infected cases. In this retrospective study, we grouped the sample population based only on age, sex, breed, date of sampling and location, as those data were available and accessible.

Risk factors

Possible risk and protective factors associated with FIV and/or FeLV infection were evaluated using data obtained from the hospital database. Age was categorised as juvenile (<1 year) and adult (≥1 year). Other factors, such as sex, breed (crossbreed vs purebreds), date sampled and location (Selangor and Kuala Lumpur vs other districts), were recorded.

Data analysis

Data were tabulated into Microsoft Excel and analysed using SPSS version 23 (IBM). Prevalence was determined

as number of cats with a positive serological test divided by the total number of cats evaluated. Calculation of confidence interval (CI) was considered at the 95% level for prevalence rate. Univariate and multivariate logistic regression analyses and χ^2 tests were used for the identification of risk factors/predictors associated or not with positive results for FIV and FeLV. The Hosmer–Lemeshow goodness-of-fit test was used to assess the goodness of fit through multivariate logistical regression. Significant associations were considered at $P < 0.05$.

Results

Population and prevalence

The sample size in this study was 2230 cats from Malaysia. Data were collected between 2010 and 2016 (Table 1). Over the study period, 224 and 267 cats tested positive for FIV and FeLV, respectively.

The total percentages of seropositive cats were 10.0% ($n = 224$; 95% CI 8.80–11.26) for FIV and 12.0% ($n = 267$; 95% CI 10.62–13.32) for FeLV. A total of 2.6% ($n = 58$; 95% CI 2.01–3.17) of cats tested were positive for both viruses.

Multivariate logistic regression analysis of risk factors

The prevalence of seropositive cats for both FIV and FeLV was greater in adult cats (FIV: $n = 181/224$ [80.8%; OR 2.983, 95% CI 2.102–4.233]; FeLV: $n = 192/267$ [71.9%; OR 1.774, 95% CI 1.331–2.365]) than in juvenile cats (FIV: $n = 43/224$ [19.2%]; FeLV: $n = 75/267$ [28.1%]). Male cats represented a higher seropositive status (FIV 174/224, 77.6%; 2.678, 1.921–3.733; FeLV 168/267, 62.9%; 1.144, 0.872–1.502) vs female cats (FIV: $n = 50/224$ [22.3%]; FeLV: $n = 99/267$ [37.1%]). The neutered status of cats was excluded as there were missing data in some cases. Mixed-breed cats had a higher seroprevalence (FIV: $n = 148/224$ [66.1%]; FeLV: $n = 214/267$ [80.1%]) than purebred cats (FIV: $n = 76/224$ [33.9%]; FeLV: 53/267 [19.8%]). Seropositive cases were located mainly in the state of Selangor and in the city of Kuala Lumpur (FIV: $n = 220/224$ [98.2%; OR 1.090, 95% CI 0.911–1.303]; FeLV: $n = 259/267$ [97.0%; OR 1.040, 95% CI 0.916–1.181]) vs other states and districts (FIV: $n = 4/224$ [1.8%]; FeLV: $n = 75/267$ [28.1%]). Risk factors identified in this study for both FIV and FeLV were male and adult cats. The Hosmer–Lemeshow test showed that the model fit the data (FIV: $\chi^2 = 32.709$, $df = 8$, $P = 0.00$; FeLV: $\chi^2 = 9.148$, $df = 7$, $P = 0.242$).

Discussion

This study documented a higher seroprevalence and a wider distribution of FIV and FeLV in Malaysia. The study period was between 2010 and January 2016, with the largest number of samples obtained in 2015. This was attributed to a better administrative process that facilitated full patient signalment and client data collection.

Table 1 Descriptive characteristics of the feline immunodeficiency virus (FIV) and feline leukaemia virus (FeLV) seropositive cat populations

	Total (n)	FIV positive		FeLV positive	
		n (%)	OR (95% CI)	n (%)	OR (95% CI)
Samples	2230	224 (10.0)*		267 (12.0%)*	
Location/state					
WP	2155	220 (10.2)	1.090 (0.911–1.303)	259 (12.0)	1.040 (0.916–1.181)
Other	75	4 (5.3)		8 (10.6)	
Age					
Juvenile	937	43 (4.6)		75 (8.0)	
Adult	1293	181 (14.0)*	2.983 (2.102–4.233)*	192 (14.8)*	1.774 (1.331–2.365)*
Sex					
Male	1266	174(13.7)*	2.678 (1.921–3.733)*	168 (13.3)*	1.144 (0.872–1.502)*
Female	964	50 (5.2)		99 (10.3)	
Date of sampling					
2010	2	0 (0.0)		0 (0.0)	
2011	2	0 (0.0)		0 (0.0)	
2012	45	5 (11.1)		11 (24.4)	
2013	318	38 (11.9)		32 (10.1)	
2014	702	82 (11.7)		98 (14.0)	
2015	1149	99 (8.6)		124 (10.8)	
2016	2	0 (0.0)		2 (100.0)	
Breed					
Native	1637	148 (9.0)	1.003 (0.986–1.020)	214 (13.1)	0.990 (0.976–1.005)
Pedigree	593	76 (12.8)		53 (8.9)	
FIV and FeLV coinfection	58 (2.6)	58 (25.8)	2.527 (1.791–3.564)	58 (21.7)	0.390 (0.277–0.549)

*Statistically significant difference $P \leq 0.05$

OR = odds ratio; CI = confidence interval; WP = Federal Territory

Before 2014, complete patient and client data were not recorded in the hospital database. We are aware that there has not been a study to statistically identify the breeds or total population of cats in Malaysia. At the AMC 60% of the total feline population presented for consultation are mixed domestic shorthairs and 40% are purebred cats. It has been noted that the purebred cats in Malaysia are more likely to be kept indoors in smaller groups and more likely to be vaccinated for FeLV, which may explain the low prevalence rate of FIV and FeLV in purebred cats compared to mixed-breed cats. Anecdotally, we have noted a high seroprevalence of FIV and FeLV within the Malaysian cat population. For this reason, routine viral screening was recommended for cats brought in for a first visit clinical examination and vaccination, irrespective of the health status.

In this study, FIV seroprevalence was lower than previous studies in Malaysia, China, Turkey and Australia,^{1,8,12,13} and greater than studies in Germany, the USA, Canada, the UK and Australia.^{4,14–18} FeLV seroprevalence was higher than found in studies from China, Austria and Turkey,^{12,13,19} and within the same range found in a previous Malaysian study.⁸ The observed differences between the current study and those mentioned above can be attributed to density of sample population,

geographical region and control measures. We believe a recent study published by the University of Putra Malaysia does not reflect a true representation of the viral prevalence in Malaysia as the study population was small and the hospital location was in a semi-urban area 50 km from Kuala Lumpur.⁸

This study showed that the seroprevalence of FeLV was higher than that of FIV. A possible explanation for this may be the broad transmission mechanisms of FeLV,^{4,6} whereas FIV is mainly transmitted through bites.³ Of the studied viruses, vaccination for FeLV is the only one available in Malaysia and routinely used for cats tested as FeLV-negative. Recommendations for vaccination are given to owners with multi-cat households.

The study indicated that 2.6% of the study population was positive for both FIV and FeLV infection. Although there are conflicting opinions concerning the epidemiological relationship between FIV and FeLV, the present study did not show any statistical association between them. Hosie et al reported that that FIV and FeLV occur independently,¹⁶ whereas Moraillon and Gleich et al reported significant associations between the two viruses.^{14,20} Given the current debate surrounding immunodeficiency viruses, co-infection with FIV and FeLV leads to higher morbidity and mortality when compared

with single infection by either of the virus. Studies have shown that FIV and FeLV are responsible for significant morbidity and mortality in the cat population.⁷ Both viruses affect the immune system, resulting in varying degrees of immunosuppression.

There is evidence of a significant association between sex and age on the one hand and FIV and FeLV on the other. In this study, male cats tended to have a greater probability of being positive for FIV and FeLV: 2.7 times for FIV and 1.2 times for FeLV. This finding correlates with the data from a previous Malaysian study, as well as other global studies,^{8,9,14,21} but not with the study by Bandecchi et al.²²

In this study, adult cats were at a greater risk of being positive for either FIV or FeLV. Adult cats were 2.98 times more likely to test positive for FIV antibody and 1.77 times for FeLV p27 antigen, which is similar to a study from Belgium,⁹ but different to the result of Bande et al.¹ According to previous studies,^{8,22-24} the examined cat population (feral, owned or shelter cats), medical behavioural characteristics might be the reason behind these variations.

In Malaysia, time of year, location and breed were not significantly associated with the prevalence of FIV or FeLV infection.

Conclusions

This study suggests that FIV and FeLV infections are relatively common in Malaysia and that male adult cats are at a greater risk of infection. These results should be helpful in clinical diagnosis and designing further plans to combat these diseases in Malaysia.

Author Note Kits used for screening of both FIV and FeLV was the SNAP FIV/FeLV Combo Test (IDEXX Laboratories).

Conflict of interest The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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