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# Occurrence of feline immunodeficiency virus and feline leukaemia virus in Maputo city and province, Mozambique: a pilot study

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## Abstract

**Objectives** Feline immunodeficiency virus (FIV) and feline leukaemia virus (FeLV) are immunosuppressive viruses in cats that increase their susceptibility to zoonotic pathogens. This study aimed to determine the occurrence of one or both viruses, the risk factors associated with infection, and to develop further recommendations.

**Methods** This was a cross-sectional study conducted at the Veterinary Faculty of Eduardo Mondlane University, Mozambique, between March and December 2017, in 145 cats. From each of 145 cats, we took 1.5 ml of blood by jugular puncture for detection of antibodies to FIV and FeLV antigens in whole blood using a commercial test kit, DFV Test FeLV/FIV.

**Results** We found an overall prevalence of 11.0% and 14.5% for FIV antibodies and FeLV antigens, respectively, with four (2.8%) cats coinfecting by both pathogens. Male cats were more likely to be infected with FIV (odds ratio [OR] 1.1, 95% confidence interval [CI] 0.3–4.0) compared with female cats. Clinically ill cats were more likely to have a positive result for FeLV antigen infection (OR 18.8, 95% CI 5.2–68.3). Moreover, cats living in suburban areas have a greater chance of a positive result for FeLV infection (OR 3.7, 95% CI 1.4–9.6) compared with cats living in urban areas.

**Conclusions and relevance** FIV and FeLV occur in cats from Maputo and possibly all over the country. Further studies should be conducted in Mozambique and other African countries to define the burden of both pathogens in cats, coinfection with other zoonotic pathogens and the possible role played by the cats on the transmission of zoonotic and opportunistic diseases to humans.

**Keywords:** Feline immunodeficiency virus; feline leukaemia virus; retrovirus; Maputo city; Maputo province; Mozambique

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## Introduction

Feline leukaemia virus (FeLV) and feline immunodeficiency virus (FIV) are immunosuppressive retroviruses that can infect both domestic and wild animals,<sup>1–3</sup> and are the most common and important viral causes of infectious disease in cats worldwide.<sup>4,5</sup> Furthermore, cats are reservoirs of zoonotic and opportunistic microorganisms such as *Toxoplasma gondii*, *Microsporium canis*, *Mycobacterium tuberculosis*, *Cryptococcus neoformans* and *Mycoplasma haemofelis*, and infection with FIV and FeLV increases their risk of infection with those pathogens,<sup>3,5–8</sup> which, in turn, can be transmitted to humans. These pathogens are the main causative agents of morbidity and mortality in people with AIDS.<sup>9,10</sup>

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In cats, FIV infection usually arises from direct inoculation of the virus into the body via bites,<sup>2,5</sup> while FeLV infection is also associated with fighting or is spread during coitus, birth, nursing, or sharing of dishes and body fluids such as milk, plasma and urine, and via blood transfusions.<sup>2,5,11</sup> The risk factors for acquiring these viruses vary, according to the literature. Some studies found that male sex, adulthood and exposure to the outdoors were the main risk factors,<sup>2,5</sup> while other studies also considered non-neutered conditions and feline population density as relevant factors.<sup>2,5</sup>

Reports of the prevalence of FIV and FeLV worldwide are numerous, but information is lacking for most parts of Latin America and Africa.<sup>3</sup> A study performed in Addis Ababa to determine the prevalence of antibodies (Ab) to *T gondii*, *Bartonella quintana*, FIV and FeLV in cats did not find any cat infected with FIV or FeLV.<sup>12</sup> Another study carried out in South Africa in 56 cats reported a seropositivity of 14% and 32% for FIV antibodies (FIV-Ab) and FeLV antigens (FeLV-Ag), respectively, while coinfection with both viruses occurred in 9% of animals.<sup>13</sup> There are also a few studies from Botswana, Uganda and Tanzania, mainly in lions, where the prevalence of FIV was reported to be 71%, while no Ag were detected for FeLV.<sup>14–16</sup> Importantly, no studies have been published regarding the prevalence of FIV or FeLV in Mozambique; although at Eduardo Mondlane University (UEM) Veterinary Faculty Clinic in Maputo, Mozambique, some cats show clinical signs consistent with a clinical diagnosis of infection with one or both viruses.

There are approximately 36.9 million people living globally with HIV, and, of those, 19.6 million (53.1%) live in Southeast Africa.<sup>17</sup> FIV and FeLV, as for other human pandemics, including HIV, originated from zoonotic infections<sup>18</sup> through contact between humans and other animals. Because of the possibility that immunocompromised cats could transfer infections to humans infected with HIV, we conducted the present study to determine the occurrence of FIV and FeLV in domestic cats from Maputo city and Maputo province, and to evaluate risk factors associated with seropositivity in cats. From these data, we hoped to develop recommendations for further studies aiming to define the prevalence of these viruses in cats, coinfection with some zoonotic pathogens and the possible role played by cats in the transmission of these zoonotic and opportunistic diseases to humans, especially in AIDS patients.

## Materials and methods

### Study area

This study took place in Maputo city and Maputo province, Mozambique, in Southeast Africa. Mozambique is among the top 10 countries with the highest prevalence of HIV infection, with a general prevalence of 11%. In Maputo city and Maputo province the prevalence of HIV is 16.9% and 22.9%, respectively.<sup>17,19</sup>

We conducted a pilot, exploratory, cross-sectional study from March to December 2017 in 145 domestic cats from urban and suburban Maputo city and Maputo province, from the following sites: Veterinary Clinic at the Veterinary Faculty of UEM (24); Val Clinic (30); Maputo city and Maputo province neighbours (67); and the Mozambique Animal Protection Society (24).

### Risk factors

Demographic and clinical data such as age, sex, household origin (urban or suburban), the presence of disease clinical signs, outdoor access and the presence of other cats in the household were collected in a questionnaire specifically designed for the purpose of the study. A clinical examination assessed the presence of fever, lymphadenopathy, a loss of body mass and pale mucous membranes.

### Blood collection and processing

From each cat, we collected 1.5 ml of blood by jugular puncture using 21 G disposable hypodermic needles and placed the blood in a tube with EDTA as the anticoagulant. Each tube was properly identified after sample collection and taken immediately to the microbiology laboratory at UEM Veterinary Faculty where it was kept at 4°C until further processing.

The samples were processed using a commercial kit test, DFV Test FeLV/FIV (DIVASA-FARMAVIC) with a double immunochromatographic device to detect both FeLV p27 Ag and Ab against FIV in a single assay, according to the manufacturer's instructions.

### Data analysis

Demographic and clinical data were entered into a Microsoft Excel spreadsheet and analysed using STATA software version 15.0. For data analysis, we stratified the cats according to their age as young (>6 weeks to 1 year), adult (>1–10 years) or geriatric (>10 years). Those with clinical signs of disease were classified as clinically ill.

The frequencies of Ag and Ab were determined based on the number of cats with a positive chromatographic Ag or Ab test, divided by the total number of cats evaluated. Differences in the proportion of FIV-Ab- and FeLV-Ag-positive cats were tested using a  $\chi^2$  test (for variables with more than five observations in all cells) or Fisher's exact test (for variables with fewer than five observations in at least one cell). Univariate logistic regression modelling was employed, and odds ratios (ORs) were used to evaluate risk factors associated with the outcomes of interest. A *P* value <0.05 was considered to be statistically significant.

## Results

Results of bivariate analyses of potential risk factors for FIV and FeLV and coinfection with both pathogens in seropositive cat populations are presented in Table 1.

**Table 1** Results of bivariate analyses of potential risk factors for feline immunodeficiency virus (FIV) and feline leukaemia virus (FeLV) and coinfection with both pathogens in seropositive cat populations

Variable	Positive, n (%)	FIV+ test results			FeLV+ test results			FIV and FeLV+ test results		
		Positive, n (%)	OR (95% CI)	P value	Positive, n (%)	OR (95% CI)	P value	Positive, n (%)	OR (95% CI)	P value
Total	–	16 (11.0)	–	–	21 (14.5)	–	–	4 (2.8)	–	–
Age										
Young	59 (40.7)	7 (11.9)	Ref	–	9 (15.3)	Ref	–	4 (6.8)	Ref	–
Adult	79 (54.5)	7 (8.9)	0.7 (0.2–2.2)	0.564	11 (13.9)	0.9 (0.3–2.3)	0.826	0 (0.0)	–	–
Geriatric	7 (4.8)	2 (28.6)	3.0 (0.5–18.3)	0.241	1 (14.3)	0.9 (0.1–8.6)	0.946	0 (0.0)	–	–
Sex										
Female	62 (42.8)	0 (0.0)	Ref	–	6 (9.7)	Ref	–	0 (0.0)	Ref	–
Male	83 (57.2)	16 (19.3)	1.1 (0.3–4.0)	0.04*	15 (18.1)	1.5 (0.5–4.6)	0.450	4 (4.8)	3.1 (0.3–28.8)	0.312
Household origin										
Urban	94 (64.8)	12 (12.8)	Ref	–	8 (8.5)	Ref	–	3 (3.2)	Ref	–
Suburban	51 (35.2)	4 (7.8)	0.6 (0.2–1.9)	0.371	13 (25.5)	3.7 (1.4–9.6)	0.008*	1 (2.0)	0.6 (0.1–6.0)	0.669
Health status										
Sick	48 (33.1)	7 (14.6)	1.7 (0.6–4.8)	0.341	18 (37.5)	18.8 (5.2–68.3)	0.000*	3 (6.3)	6.4 (0.6–63.2)	0.112
Healthy	97 (66.9)	9 (9.3)	Ref	–	3 (3.1)	Ref	–	1 (1.0)	Ref	–
Outdoor access										
No	7 (4.8)	1 (14.3)	Ref	–	1 (14.3)	Ref	–	1 (14.3)	Ref	–
Yes	138 (95.2)	15 (10.9)	0.7 (0.1–6.5)	0.779	20 (14.5)	1.0 (0.1–8.9)	0.988	3 (2.2)	0.1 (0.0–1.5)	0.101
Singly housed										
No	119 (82.1)	13 (10.9)	Ref	–	16 (13.5)	Ref	–	3 (2.5)	Ref	–
Yes	26 (17.9)	3 (11.5)	1.1 (0.3–4.0)	0.928	5 (19.2)	1.5 (0.5–4.6)	0.450	1 (3.8)	1.5 (0.2–15.5)	0.711

\*Statistically significant difference

OR = odds ratio; CI = confidence interval; Ref = reference category

Of the 145 cats studied, 83 (57.2%) were male, 79 (54.4%) were adults, 94 (64.8%) lived in urban areas, 138 (95.2%) had outdoor access, 48 (33.1%) were clinically ill and 26 (17.9%) were the only cat in the household. We found an overall prevalence of 11.0% for FIV-Ab positivity and 14.5% for FeLV-Ag positivity, with four (2.8%) cats coinfecting by both pathogens.

The results in Table 1 showed a statistically significant association between FIV infection and sex ( $P < 0.05$ ), and between FeLV infection and the presence of clinical illness and household origin ( $P < 0.05$ ). Moreover, Table 1 shows that male cats were more likely to be infected with FIV (OR 1.1, 95% confidence interval [CI] 0.3–4.0) compared with female cats. Cats living in suburban areas had a greater chance of being positive for FeLV infection (OR 3.7, 95% CI 1.4–9.6) compared with cats living in urban areas. Clinically ill cats were more likely to have a positive result for FeLV-Ag (OR 18.8, 95% CI 5.2–68.3). Factors such as age, outdoor access and singly housed status were not found to be significantly associated with FIV-Ab or FeLV-Ag seropositive status ( $P > 0.05$ ).

## Discussion

This was a pilot and exploratory study, aimed at generating baseline information about the occurrence of FIV, FeLV or both pathogens in cats from Maputo city and Maputo province, Mozambique. We also sought to uncover risk factors associated with infection and thereby develop recommendations for further studies aiming to define the prevalence of these viruses in cats and their possible role in the transmission of opportunistic diseases to humans, especially AIDS patients.

We found a high prevalence of both pathogens, 11% for FIV and 14.5% for FeLV. These findings should be viewed in the context of similar studies conducted in Canada, the United Arab Emirates, Malaysia, Tunisia and South Africa, where seroprevalence varied greatly from 2.5–37.5% for FIV and from 2.3–35.0% for FeLV.<sup>3,5,13,20,21</sup>

Regarding sex, male cats were more likely to be infected with FIV compared with female cats, as well as to suffer from coinfection with the two pathogens. In keeping with findings from other studies, this may reflect the fact that male cats are more often involved in fighting, due to territorial or sexual aggression when given outdoor access, which, in turn, can result in bite wounds and transmission of the virus.<sup>3,5</sup> In addition, it was also noted previously that castrated cats tend to be less aggressive and therefore less involved in fighting.<sup>2,20</sup> People in Maputo, and Mozambique in general, do not typically castrate their cats for various reasons, such as limited finances and the lack of any tradition to take their pets to a veterinary clinic. This could also contribute to the transmission of both viruses.

Clinically ill cats were more likely to be infected by FeLV than apparently healthy cats, as well as to have a higher frequency of coinfection by both pathogens; these effects were statistically significant. Studies in Canada, the UK, Malaysia and Iran also found similar results, which might reflect the immunosuppressive nature of the viruses, favouring the acquisition of other diseases.<sup>5,20,22–24</sup>

Household origin (living in a suburban area) was a statistically significant risk for infection with FeLV. This finding is similar to those in studies conducted in places such as Canada, North America, Asia, Latin America and Iran, in which living in a suburban area was an important risk factor for seropositivity with FeLV.<sup>3,20,25</sup> Furthermore, suburban cats are most likely to be exposed to the bites of *Ctenocephalides felis*, a cat flea that can also transmit FeLV.<sup>4</sup>

We failed to find a statistically significant effect of age on the prevalence of infection with either FIV or FeLV. Of note, in this study coinfection with both pathogens (2.8%) was only present in young cats. This finding not only supports the proposal that infection is acquired at an early age, but also suggests that cats infected with both viruses have a reduced life expectancy and die even before reaching adulthood, as suggested by others.<sup>2</sup>

However, there were some limitations to our study that should be acknowledged. First, as this was an exploratory study, we worked with a limited sample of cats that were recruited for convenience and, consequently, the results obtained cannot necessarily be extrapolated to all of Maputo city or province, much less to the country or the region as a whole. Second, these infections have not been confirmed by confirmatory tests, owing to financial limitations. Third, most of the cats used in our study were unconfined, with free access to the outdoors, or were even strays. The former situation is very common in Maputo and throughout the country, where cat owners often live in houses with poorly demarcated yards, precluding our ability to adequately evaluate the effect of this risk factor (as also noted in Iran).<sup>25</sup>

The presence of these feline retroviruses in Maputo city, and possibly throughout the country and Southeast Africa, deserves special attention, as both FIV and FeLV are immunosuppressive viruses for cats, increasing their susceptibility to zoonotic and opportunistic microorganisms such as *T gondii*, *M canis*, *M tuberculosis*, *C neoformans* and *M haemofelis*,<sup>3,5–7</sup> which are all important causes of morbidity and mortality in AIDS patients.<sup>9,10</sup>

We conclude, therefore, that further studies of this topic are needed in Mozambique and Southeast Africa as they are among the regions most affected by AIDS.<sup>17,19</sup> Such studies should document the occurrence and prevalence of infection by both viruses in cats and other domestic animals, as well as the frequency of coinfection with

zoonotic and opportunistic pathogens. This will allow agricultural/veterinary and health authorities to design appropriate measures for the diagnosis, management and control of health in both cats and humans.

## Conclusions

FIV and FeLV circulate in Maputo, Mozambique, and its neighbouring countries, and thus we can expect these viruses to be endemic in Mozambique and throughout the Southeast Africa region, given the wide range of domestic and wild animals that they infect.

Further studies aimed at determining the occurrence and prevalence of FIV and FeLV infection in cats and their role in the transmission of zoonotic and opportunistic diseases, especially to AIDS patients, are much needed in Mozambique and Southeast Africa, as they are the major causes of morbidity and mortality in AIDS patients.

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**Ethical approval** The study was approved by the Scientific Committee of the Veterinary Faculty at Eduardo Mondlane University. The authors declare that no experiments were performed on humans or animals for this study. The blood samples obtained were consistent with routine veterinary medical care.

**Informed consent** Informed consent to perform this research was obtained from the cat's owners after explaining to them the aims of the study and methodology to be applied. We declare that the contents of this manuscript have not been previously published or under consideration anywhere else for publication.

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