Acta vet. scand. 1992, *33,* 9-14.

A Survey of FIV Antibodies and FeLV Antigens in Free-roaming Cats in the Capital Area of Finland

By *A. Sukura, T. Salminen* and *L.-A. Lindberg*

Department of Anatomy, College of Veterinary Medicine, and Helsinki Society for the Protection of Animals, Helsinki, Finland.

Sukura, A., T. Salminen and L.-A. Lindberg: A survey of FIV antibodies and FeLV antigens in free-roaming cats in the capital area of Finland. Acta vet. scand. 1992, 33, 9-14.– Feline immunodeficiency virus (FIV) was first isolated and identified in 1986. Since then it has been shown to have a worldwide distribution, and the infection generally appears to have reached a state of endemicity. This is the 1st study of FIV-prevalence in Finland. Serum samples of 196 free-roaming cats were tested for antibodies to FIV and FeLV antigens (Feline leukemia virus). With a combined enzyme-linked immunosorbent assay (ELISA), 13 of the cats (6.6%) turned out to be positive for FIV and 2 for FeLV (1.0%). Adult male cats in the capital area of Finland had a FIV prevalence of 24%, a relative proportion 4.7 times higher than that for females.

FAIDS; feline-aids; immunosuppression; retroviridae; lentivirus; feline immunodeficiency virus; epidemiology; feline leukemia virus.

Introduction

Feline immunodeficiency virus (FIV) was isolated in 1986 in Northern California from a cattery where cats had been suffering from an immunodeficiency-like syndrome for 4 years (*Pedersen et al.* 1987). FIV belongs to the retroviridae family and to the same subfamily—lentivirinae—as the Human Immunodeficiency Virus (HIV). Thus far the virus has shown to be feline-specific. Among medical research workers, very much interest has, however, been directed to the possibility that FIV could offer a good animal model for HIV-infection (*Connaughton* 1989). Retrospective studies of the serum-bank material has shown that this lentivirus has existed at least since 1975 in cat populations (*Gruffydd-Jones et al.* 1988). Worldwide geographical distribution of the infection indicates that in its pattern of occurrence in cat populations, FIV is more endemic than epidemic (*Bennett et al.* 1989, *Ishida et al.* 1989, *Pedersen et al.* 1989, *Yamamaoto et al.* 1989). The virus is not very contagious and requires for transmission close contact between cats (*Pedersen* 1987, *Yamamoto* 1988b). It can be isolated from cerebrospinal fluid, serum, and plasma of infected animals. The virus is also present in blood and saliva: therefore it is efficiently spread by bites. (*Yamamoto et al.* 1988b, *Yamamaoto et al.* 1989).

Due to the means of transmission it is understandable that in epidemiological studies, free roaming has been found to be one risk factor for the infection. Moreover, males seem to be more likely to be infected than females (*Grindem et al.* 1989, *Ishida et al.* 1989). The peak prevalence of the disease is in cats 5 to 6 years of age and older (*Pedersen et al.* 1989).

In order to estimate the prevalence of FIV infection in Finland, a serologic survey was performed on free-roaming cats in the capital area of Finland.

Material and methods

Cats

The cats in this study were obtained via the Helsinki Society for the Protection of Animals (HSPCA). The Society takes care of free–roaming cats and tries to find their owners or to place healthy and adaptive cats in suitable homes. In the period between March and October 1990, serum samples were obtained from all the cats (196) in the custody of the Society. These cats were originally free roaming; some of them were feral, and some had a transient history as pet animals. The cats received by the HSPCA were mostly from the capital area of Finland (the cities of Helsinki, Vantaa and Espoo), but 27% of the tested cats were from outside the capital area.

Animals were collected either at the cattery of the Society or in catteries run by members of the Society. The determination of sex, place of capture and the age category were considered to be of satisfactory validity and reliability. Complete data, however, were not available for all the cats. The age of an adult cat was impossible to estimate exactly by inspection; therefore, the age was estimated in 2 categories: juveniles < 1 year, and adults > 1 year old.

Two queens which turned out to be FIV-positive had borne litters in the main cattery immediately after custody. The resultant 6 kittens, 2 females in 1 litter and 4 males in the other, were tested at the age of 2 months. The kittens were excluded from statistical analyses.

All the samples were taken by the veterinarian who attends the main cattery or by private clinics which do the neutering of the animals before they are placed in new homes. Serum was separated from the blood samples before they were mailed to the laboratory.

Serum assay

Serum assays were carried out in a private veterinary laboratory (VetLab, Tampere, Finland) which used the commercially available combined FIV and FeLV ELISA kit (Cite Combo®). This laboratory runs the test once a week and stores the received samples frozen until the study. According to the manufacturer, either total blood samples or serum samples are suitable for the test. Unfortunately, because some of the samples were hemolyzed, the performance of the kit required evaluation by use of a few artificially hemolyzed samples. The results were not affected.

Statistical methods

Data collected on age, place of capture and sex were analyzed with respect to the FIV-ELISA results, by applying uncorrected Chi-Square analysis if the test requirements were filled, otherwise the 2-tailed Fisher exact test was used.

Results

Of 196 free-roaming cats, 13 had FIV-antibodies (prevalence, 6.6%) and 2 had FeLV-antigens (prevalence, 1.0%). Both FeLV-positive cats were adult intact males captured in the capital area: they were FIV-negative. Of the 6 kittens born in the main cattery from the 2 FIV-positive queens, 2 had FIV-antibodies when tested at the age of 2 months. These both belonged to the same litter, and all 4 kittens in the other were negative.

Place of capture

The data was compiled for 161 cats (82% of the free-roaming cats). Of the 13 FIV-positive cats, 12 were captured from the capital area and 1 from outside the capital area: prevalences were 10.1% and 2.3%. When the frequencies in the capital area were compa-

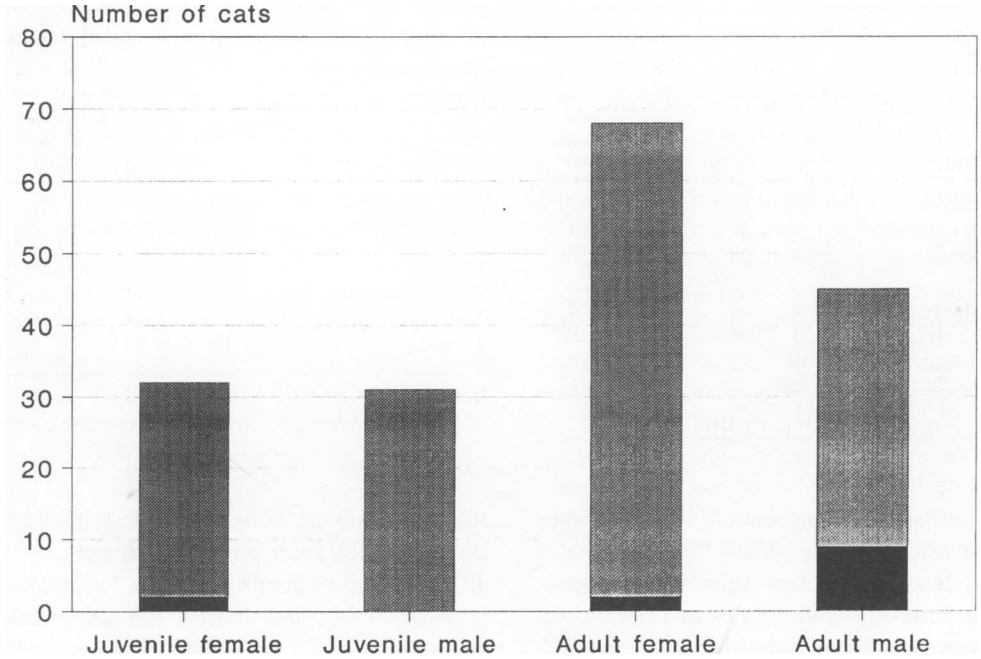

Figure 1. Result of FIV-ELISA test in different age-groups and by sex, juvenile (< 1 year) and adult (> 1 year). Age approximated by inspection. FIV-seropositive cats = ■ and FIV-seronegative cats = ▒.

red with those in the noncapital area the difference was not statistically significant (2-tailed Fisher exact test, p=0.19).

Age

Data were available from 176 cats (90% of the freeroaming animals). Of the 13 FIV-positive cats, 11 were adults, and 2 juveniles. The prevalences were 9.7% and 3.2% (Figure 1). By the 2-tailed Fisher exact test, the prevalences of juveniles and adults did not differ significantly (p=0.14).

Sex

Sex was registered for 192 of the free-roaming cats (98%). Of the 13 positive cats, 4 were female, 6 intact males, and 3 neutered males. Males thus showed a prevalence of 10.8% and females of 3.6% (Table 1), a difference which was statistically significant (uncorrected x^2=3.8, p=0.050). When the neutered males were compared to the intact the difference was not statistically significant (2-tailed Fisher exact test, p=0.17). However, when the data were stratified by age, the effect of the neutering had no statistically significant effect among adult males, but the difference between the sexes was even more obvious, males showing a prevalence of 20% and females of 2.9% (2-tailed Fisher exact test p=0.0065).

Among adults, all the 11 positive animals were from the capital area (prevalence 14%). The difference from the non-capital area was

Table 1. Number and prevalence (%) of cats grouped by FIV antibody status versus sex.

Sex status	FIV status +	-	Total	Prevalence of FIV
Intact male	6	63	69	8.7
Neutered male	3	11	14	21.4
Total males	9	74	83	10.8
Intact female	4	91	95	4.2
Neutered female	0	14	14	0
Total females	4	105	109	3.7
Total	13	179	192	6.8

Table 2. Number and prevalence (%) of adult grouped by FIV antibody status versus area and sex.

Source	FIV status +	-	Total	Prevalence of FIV
Capital area:				
Male	9	28	37	24.3
Female	2	37	39	5.1
Non capital area:				
Male	0	4	4	0
Female	0	18	18	0
Total	11	87	98	11.2

not statistically significant, (2-tailed Fisher exact test, p=0.066). When the adult males from the capital area were tested against adult females, the difference was statistically significant (uncorrected x^2=5.65 p=0.017 Table 2).

Discussion

In epidemiological studies the result is affected by the nature of the sample from the study population. FIV-surveys have mainly been carried out on the clients of veterinary clinics, either on healthy or on clinically sick animals (*Friend et al.* 1990, *Grindem et al.* 1989, *Hopper et al.* 1989, *Knowles et al.* 1989, *Lutz et al.* 1990).

It is believed that cat fight is an important risk factor for FIV infection; consequently free-roaming cats may be expected to be at especially high risk of acquiring this infection (*Yamamoto et al.* 1989). We deliberately chose to study the specific free-roaming population. Information on prevalence among high-risk animals in Finland would provide basic data especially for animals welfare activities, for efforts at preventing the spread of FIV infection. The commercially available combined FIV and FeLV test kit allowed us to obtain data on FeLV-prevalence as well.

In our material the prevalence of FeLV-antigens was 1.0%, and that for FIV-antibodies 6.6%. *Knowles et al.* (1989), studying FIV and FeLV prevalence in British and North American household cats, discovered that the prevalence of FeLV in cats with chronic stomatitis to be very low in both countries (7%), but still much higher than in our material. *Grindem et al.* (1989) studied randomly selected serum bank material, original from the clinicians. They found FeLV infection to be more common than FIV infection in their material (8% vs. 3.6% among clinically healthy animals and 35% vs 15% in clinically ill animals). A majority of authors have not found any linkage between FIV and FeLV infections (*Ishida et al.* 1989, *Knowles et al.* 1989, *Pedersen et al.* 1989, *Witt et al.* 1989, *Yamamoto et al.* 1989).

A survey in Canada and USA showed outdoor pet cats to be at a higher risk of having FIV antibodies than were indoor cats (8% versus 33%; *Yamamoto et al.* 1989). Outdoor unowned cats in Canada and USA had the highest prevalence, 25%. Free-roaming cats

were at a 3 times higher risk than confined cats (*Yamamoto et al.* 1989). Bennett et al. (1989) found prevalence in pet cats to be 16%, and in feral cats, 27%. In a survey in Denmark, outdoor pet cats showed a 4.7% prvalence, while feral cats showed a 10.5% prevalence (*Kristensen et al.* 1989). *Lutz et al.* (1988) have summarized epidemiological surveys in Europe and found that prevalence in clinical material varies from 3% to 22% in diseased cats.

Witt et al. (1989) supposed that sexually intact males have more fights and therefore have a higher frequency of exposure to a bite-transmitted disease. In our material prevalences did not differ in neutered and intact males. A similar finding, that the neutering had no effect on FIV-prevalence, was reported in a survey in Japan (*Ishida et al.* 1989).

One of the 2 FIV-positive queens which produced kittens immediately after capture had a seropositive litter, the other, a negative. Transmission in utero or via colostrum has not been demonstrated (*Yamamoto et al.* 1988a, *Pedersen et al.* 1989). Because we were not able to do virus isolation, the possibility of the maternal antibodies is open. Another possibility is that infection of the kittens might have taken place in the process of nursing.

Although the difference is not statistically significant, FIV seropositivity was more prevalent in the capital area than outside. Cat density might be higher in a city area, which allows more cat fights, thus explaining a higher FIV prevalence.

In summary, FIV-seropositivity was rather common in the free-roaming cat population (6.6%) in Finland, being higher in the capital area of Finland (10.2%). Adult male cats had a statistically higher prevalence (20%) than females, and males in the capital area had the highest prevalence (24%). The proportion of seropositive adult males was 4.7 times higher than for females. In animal welfare work where captured cats are placed in new homes, testing should be focused on adult male cats, if it is impossible to test all cats. As a rule of thumb, untested homeless cats should not be placed in a household having other cats.

Acknowledgements

The authors wish to thank the Helsinki Society for the Protection of Animals for their cooperation during the study. This study was supported by the Emil Aaltonen Foundation and the College of Veterinary Medicine.

References

Bennett M, McCracken C, Lutz H, Gaskell CJ, Gaskeel RM, Brown A, Knowles JO: Prevalence of antibodies to feline immunodeficiency virus in some cat populations. Vet. Rec. 1989, *124,* 397-398.

Connaughton D: What you need to know about the feline immunodeficiency virus. J. Amer. vet. med. Ass. 1989, *194,* 169-173.

Friend S, Birch CJ, Lording PM, Marshall JA, Studdert MJ: Feline immunodeficiency virus. Prevalence, disease associations and isolation. Aust. vet. J. 1990, *67,* 237-243.

Grindem CB, Corbett WT, Ammerman BE, Tomkins MT: Seroepidemiologic survey of feline immunodeficiency virus infection in cats of Wake County, North Carolina. J. Amer. vet. med. Ass. 1989, *194,* 226-228.

Gruffydd-Jones TJ, Hopper CD, Harbour DA, Lutz H: Serological evidence of feline immunodeficiency virus infection in UK cats from 1975-76. Vet. Rec. 1988, *123,* 569-570.

Hopper CD, Sparkes AH, Gruffydd-Jones TJ, Crispin SM, Muir P, Harbour DA, Stokes CR: Clinical and laboratory findings in cats infected with feline immunodeficiency virus. Vet. Rec. 1989, *125,* 341-346.

Ishida T, Washizu T, Toriyabe K, Motoyoshi S, Tomoda I,Pedersen NC: Feline immunodeficiency virus infection in cats of Japan. J. Amer. vet. med. Assoc. 1989, *194,* 221-225.

Knowles JO, Gaskell RM, Gaskell CJ, Harvey CE, Lutz H: Prevalence of feline calicivirus, feline leukaemia virus and antibodies to FIV in cats

with chronic stomatitis. Vet. Rec. 1989, *124,* 336-338.

Kristensen TS, Petersen SF, Hoff-Jorgensen R: Feline AIDS (FAIDS) og Feline Immunodificiency Virus (FIV). (Feline AIDS (FAIDS) and Feline Immunodificiency Virus (FIV)). Dansk Vet. Tidsskr. 1989, *72,* 447-452.

Lutz H, Arnold P, Hübscher U, Egberink H, Pedersen N, Horzinek MC: Specificity assessment of feline T-lymphotropic Lentivirus serology. J. vet. Med. B. 1988, *35,* 773-778

Lutz H, Lehmann R, Winkler G, Kottwitz B, Dittmer A, Wolfensberger C, Arnold P: Das feline Immunschwächevirus in der Schweiz: Klinik und epidemiologie im vergleich mit dem Leukämie- und dem Coronavirus. (Feline immunodeficiency virus in Switzerland: Clinical and epidemiological aspects in comparison with FeLV- and corona virus infections). Arch. Tierheilk. 1990, *132,* 217-225.

Pedersen NC, Ho EW, Brown ML, Yamamoto JK: Isolation of a T-Lymphotropic virus from domestic cats with an immunodeficiency-like syndrome. Science. 1987, *235,* 790-793.

Pedersen NC, Yamamoto JK, Ishida T, Hansen H: Feline immunodeficiency virus infection. Vet. Imm. and Imm.path. 1989, *21,* 111-129.

Witt CJ, Moench TR, Gittelsohn AM, Bishop BD, Childs JE: Epidemiologic observations on feline immunodeficiency virus and Toxoplasma gondii coinfection in cats in Baltimore, MD. J. Amer. vet. med. Ass. 1989, *194,* 229-233.

Yamamoto JK, Pedersen NC, Ho EW, Okuda T, Theilen GH: Feline immunodeficiency syndrome. A comparison between feline T-lymphotropic and feline leukemia virus. Leukemia 1988a, *2,* 204s-215s.

Yamamoto JK, Sparger E, Ho EW, Andersen PR, o'Conner TP, Mandell CP, Lowenstine L, Munn R, Pedersen NC: Pathogenesis of experimentally induced feline immunodeficiency virus infection in cats. J. vet. Res. 1988b, *49,* 1246-1258.

Yamamoto JK, Hansen H, Ho EW, Morishita TY, Okuda T, Sawa TR, Nakamura RM, Pedersen NC: Epidemiologic and clinical aspects of feline immunodeficiency virus infection in cats from the continental United States and Canada and possible mode of trasmission. J. Amer. vet. med. Ass. 1989, *194,* 213-220.

Sammanfattning

FIV antikroppar och FeLV antigener hos fritt strövande kattor i huvudstadsregionen i Finland.

Kattor erhållna från Djurskyddföreningen i Helsingfors blev serumtestade (196 st) mellan februari och november. Kattorna hade rört sig fritt ute. Tretton kattor hade FIV-antikroppar (6.6%) och 2 FeLV-antigener (1.0%). Prevalensen (24%) hos fullvuxna hankattor inom huvudstadsområdet var 4.7 gånger större än hos honkattor.

(Received December 15, 1990; accepted April 19, 1991).

Reprints may be requested from: A. Sukura, Department of Anatomy, College of Veterinary Medicine, P.O. Box 6, SF-00581 Helsinki 58, Finland.