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Risk factors for idiopathic cystitis in Norwegian cats: a matched case-control study

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Abstract

Objectives The aim of the study was to compare a group of cats with feline idiopathic cystitis (FIC) with a group of control cats without present or previous signs of lower urinary tract disease in order to identify factors in characteristics, personality, behaviour, environment and daily life that would make them more susceptible to the disease.

Methods The study was a matched case-control study comparing results from telephone interviews based on a standardised questionnaire. The questions were organised into six subject groups: the characteristics of the cat; the cat's environment; the presence of other pets in the household; the cat's feeding and drinking regime; management of the cat's litter box; and the cat's opportunity to perform natural behaviour.

Results The results from the present study showed that a cat diagnosed with FIC was more likely to be overweight and to be of a nervous disposition than the control cats. In addition, several differences between cases and controls were detected at a univariable level of analysis, related to outdoor access and the cats' perceived safety and comfort in their home environments. While not significant after multivariable analysis, these variables may still be of importance owing to potential interrelations.

Conclusions and relevance Several significant differences between cats with FIC and control cats were revealed, and the results support the hypothesis of environmental stress as being a potential factor in the development of FIC.

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Introduction

Feline lower urinary tract disease (FLUTD) is common in the domestic cat, affecting approximately 1.5% of cats treated in primary veterinary practices.[1–4] Possible causes are reported to be infections, urolithiasis, urethral plugs, neoplasia and anatomical defects, or iatrogenic causes.[5–9] However, when thorough diagnostic investigation does not reveal a specific cause, the patients are classified as having feline idiopathic cystitis (FIC).[5,10]

Several studies have reported FIC as the most frequent cause of FLUTD, accounting for 54–69% of cases.[6,10–13] As reviewed by Kruger et al,[10] many theories have been evaluated with regard to the aetiopathogenesis of FIC, such as various infections, vesicourachal diverticulum, behavioural problems, dysfunctions and abnormalities in the urothelium, or neurogenic inflammation. However, a consistent cause remains to be revealed and there are, therefore, no specific diagnostic markers or consistently effective methods of therapy available.[8,10,12,13] FIC has much in common with interstitial cystitis in humans, including the clinical signs, a tendency towards recurrence, comorbid conditions and a relationship with stress.[10,13,14] It is suggested that these disorders may represent syndromes resulting from a variety of separate underlying, but potentially interrelated mechanisms, rather than one disease with a single uniform pathogenesis.[10]

The association between FIC and environmental, psychological, physiological and pathological stressors, together with the identification of multiple abnormalities of the nervous and endocrine systems in affected cats, has

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led to the hypothesis that psychoneuroendocrine factors may be involved in the pathogenesis of the disease.[3,12,15–18] Suggested stressors include conflicts with other cats within or outside the household, changes in diet, environment or weather, owner stress and greater changes such as moving house or the addition of new animals or persons to the household.[11,12,18] The role of stress in the induction and/or maintenance of FIC is supported by studies reporting that affected cats seem to react differently to stress than control cats.[17–22] Further support is gained from studies reporting positive effects of environmental and behavioural modifications in these patients.[3,23] Additionally, in a recent review, Buffington presented the possibility of FIC being a part of a larger systemic disorder, with related disease processes and stress responses extending outside the urinary system – the Pandora syndrome.[24]

The aim of the present study was to compare a group of cats with FIC with a group of control cats without present or previous signs of lower urinary tract disease in order to identify factors in characteristics, personality, behaviour, environment and daily life that would make them more susceptible to the disease.

Materials and methods

The study was a matched case-control study, using telephone interviews based on a standardised questionnaire, comparing cats diagnosed with FIC and control cats that had never shown signs of FLUTD.

Study population

The study population consisted of client-owned cats from Oslo and the surrounding areas presented to the Department of Companion Animal Clinical Sciences at the Norwegian School of Veterinary Science (NVH).

The cases were recruited from a group of 104 cats diagnosed with FIC, as described in a previously published study of FLUTD performed at NVH in the period 2003–2007.[25,26] A total of 70 cases were included; 34 of the owners could, for various reasons, not be reached at the time of the present study.

Inclusion criteria for the FIC group in the previous study were clinical signs of FLUTD (periuria, haematuria, dysuria, pollakiuria or stranguria) and a final diagnosis consistent with FIC made by excluding other causes of FLUTD by physical examination, blood and urine analysis, and radiological examination.[25,26] Exclusion criteria included any treatment that could interfere with the diagnostics (medication altering blood pressure, urine production and/or composition, hormones or medication with an antimicrobial effect) and concurrent diseases likely to be of influence on the urinary findings, such as chronic kidney disease, diabetes mellitus or hyperthyroidism. Only cats aged 7 months or older were included, and no restrictions were made with regard to sex, reproductive status or breed.

The controls consisted of 95 cats randomly selected from the patient database at NVH. A search was made for each case and the first available match not previously enrolled in the control group was chosen. The controls were individually matched in pairs with the cats in the case group by age, sex and reproductive status. Exclusion criteria for the controls were present or previous clinical signs of FLUTD (ie, periuria, haematuria, dysuria, pollakiuria or stranguria). The control group was established in 2009 and the present study performed directly thereafter.

Questionnaire

A standardised questionnaire was designed in order to evaluate aspects of the cats' characteristics and daily life as potential factors in the development of FIC. In order to identify unintelligible questions and sources of misinterpretation, the questionnaire was tested in a pilot study that included six owners of healthy cats. Appropriate changes to the questionnaire were made based on the responses.

The final questionnaire consisted of 40 closed questions, which included checklists, two-choice or multiple choice questions. The questions were grouped into six parts according to subject: the characteristics of the cat; the cat's environment; the presence of other pets in the household; the cat's feeding and drinking regime; the management of the cat's litter box; and the cat's opportunity to perform natural behaviour. Definitions were provided for some of the terms used in the questionnaire; these were presented to the owners during the interview (see supplementary material).

Telephone interview

The telephone numbers of the cat owners were obtained from the patient database at NVH. In cases of missing, outdated or incomplete contact information, internet-based search engines (www.telefonkatalogen.no and www.1881.no) were used to retrieve the correct information. If an owner could not be reached by telephone, a letter was sent, encouraging the owner to participate in the study.

The interviews were performed in January and February 2009 by three of the authors. A script was made, and each interview began with an introduction explaining the purpose and importance of the study. The owners of the cats with FIC were asked to answer the questions based on the circumstances present at the time their cat was diagnosed with idiopathic cystitis. The interviewers were trained and, in order to increase the internal validity of the results, initially performed the interviews in pairs.

In addition to the body condition scores reported by the owners, the actual body weight of each cat was obtained from the patient database at NVH (ie, body

weight at the time of diagnosis for the FIC cats and at time of inclusion for the control cats).

For the FIC cats, a substantial amount of information was also available for confirmation in the questionnaires used in the larger study of FLUTD from 2003–2006, such as description of body condition, type of food, whether the cat was defined as nervous, outdoor access, and so on.

Permission to perform the study was granted from the research and ethics committee at the NVH, as well as from the individual owners.

Statistical analysis

The results are presented as frequencies of occurrence, expressed in percentages for categorical variables and mean (standard error [SE]) for continuous variables. The relationship between the potential explanatory variables and the outcome was initially tested using a tabular χ^2 analysis for categorical analyses and the Kruskal–Wallis for continuous variables. These statistical analyses were performed in JMP 10 (SAS Institute). Finally, variables with a P value <0.20 from the univariable analyses were used as candidate variables for multivariable analyses in a matched logistic regression platform in Stata/ MP13 for Windows (StataCorp). The logistic model was established using a backward selection procedure with a likelihood ratio test of 0.05 as the inclusion criteria. Model testing was performed using standard procedures, including graphical examination of the model predictions compared with outcome. Variables found to be of statistical significance in the multivariable model were tested for pairwise interactions.

Results

Study population

The inclusion of 70 cases and 95 control cats gave 1.4 controls per case. Of the cases, 56 (80%) were domestic shorthair (DSH) and 14 (20%) were pure breed cats. Corresponding values for the control group were 77 (81%) and 24 (25%), respectively ($P = 0.08$). Mean age was 5.7 years (SE 0.42) for the cases and 5.8 years (SE 0.36) for the controls. Forty-seven (67%) of the cats with FIC were neutered males, three (4%) were intact males, 16 (23%) were spayed females and four (6%) were intact females. Corresponding values for the controls were 60 (63%), six (6%), 23 (24%) and six (6%), respectively.

Characteristics

An overview of the univariable analyses of the cats' characteristics is given in Table 1. More than half of the owners of the cats with FIC reported their cats to be slightly overweight (30%) or obese (21%), while the corresponding numbers for the controls were 28% and 4%, respectively. This resulted in a significant difference ($P = 0.004$). Mean body weight was 5.3 kg (SE 0.15) for the cats with FIC and 4.5 kg (SE 0.15) for the controls, a significant difference ($P = 0.0002$) that is in keeping with the body condition reports from the owners.

There were significant differences in the behavioural traits reported among the cats with FIC and the controls. Forty-four percent of the cats with FIC were described as nervous compared with 25% of the controls ($P = 0.011$). The cats with FIC were also more commonly reported as fearful (36%) compared with the controls (24%); with a P value of 0.109, this variable also qualified for inclusion

Table 1 Univariable analysis comparing cats with feline idiopathic cystitis (FIC) with control cats. Part 1: the cats' characteristics

Variable	Alternatives	FIC (n = 70)	Controls (n = 95)	*P* value
Use of the cat	Companion	70 (100)	92 (97)	0.263
	Companion and breeding or show	0	3 (3)	
Rehoming (from shelter or between private homes)	Yes	25 (36)	27 (28)	0.320
	No	45 (64)	68 (72)	
Body condition	Thin	6 (9)	9 (9)	0.004
	Normal	28 (40)	55 (58)	
	Slightly overweight	21 (30)	27 (28)	
	Obese	15 (21)	4 (4)	
Nervous behaviour	Yes	31 (44)	24 (25)	0.011
	No	39 (56)	71 (75)	
Fearful behaviour	Yes	25 (36)	23 (24)	0.109
	No	45 (64)	72 (76)	
Aggressive behaviour	Yes	6 (9)	11 (12)	0.527
	No	64 (91)	84 (88)	

Data are presented as n (%)

in the multivariable analysis. P values >0.20 were found with regard to aggressive behaviour, previous rehoming and the use of the cats as companions or also as breeding or show animals. Consequently, these variables were not included in the multivariable analysis.

In the multivariable analysis, obesity and a nervous predisposition among the FIC cats were both found to be significant results, with P values of 0.004 and 0.011, respectively (Table 2).

The cats' environment

Of the variables regarding the cats' environment, only outdoor access qualified for inclusion in the multivariable analysis (Table 3). The FIC cats were significantly more likely to live strictly indoors (53%), compared with controls (35%) ($P = 0.020$). However, despite being an obvious candidate variable at the univariable level, this variable was not found significant in the multivariable model.

Other pets in the household

None of the differences detected between cats with FIC and controls when evaluating variables related to other pets in the household qualified for inclusion in the multivariable analysis (Table 4).

Table 2 Results from a multivariable regression model of risk factors for feline idiopathic cystitis (FIC) in a case-control study of 70 cats with FIC and 95 control cats

Variable	OR	*P* value	95 CI
Body condition		0.004*	
Thin	1.00	–	–
Normal	0.86	0.819	0.24–3.05
Slightly overweight	1.57	0.537	0.38–6.50
Obese	7.03	0.033	1.17–42.39
Nervous behaviour		0.011*	
Yes	1.00	–	–
No	0.33	0.007	0.14–0.74
Frequent change of diet		0.033*	
Yes	1.00	–	–
No	2.41	0.025	1.12–5.18

*P value from the likelihood ratio test of the variable
OR = odds ratio; CI = confidence interval

The cats' eating and drinking regime

The univariable analyses of variables evaluated with regard to eating and drinking are listed in Table 5. The cats with FIC were significantly more likely to be meal-fed (36%) compared with the controls, where the majority

Table 3 Univariable analysis comparing cats with feline idiopathic cystitis (FIC) with control cats. Part 2: the cats' environment

Variable	Alternatives	FIC (n = 70)	Controls (n = 90)	*P* value
Outdoor access	Yes	33 (47)	62 (65)	0.020
	No	37 (53)	33 (35)	
Type of area	Countryside	2 (3)	2 (2)	0.985
	Small village	13 (19)	19 (20)	
	Suburb	21 (30)	29 (31)	
	City	34 (49)	45 (47)	
Type of housing	Detached/terraced	22 (31)	41 (43)	0.286
	Apartment ground floor	14 (20)	14 (15)	
	Apartment 1st floor/higher	34 (49)	40 (42)	
Neighbouring cats	Yes	32 (46)	40 (42)	0.668
	No	1 (1)	19 (20)	
	Not answered	37 (53)	36 (38)	
Fighting with neighbouring cats	Yes	20 (29)	23 (24)	0.612
	No	12 (17)	–	
	Not applicable	38 (54)	72 (76)	
Often injured fighting	Yes	11 (16)	16 (17)	0.271
	No	9 (13)	24 (25)	
	Not applicable	50 (71)	55 (58)	
Cat flap/pet door	Yes	4 (6)	7 (7)	0.672
	No	66 (94)	88 (93)	
Chooses sleeping place	Yes	67 (96)	91 (96)	0.981
	No	3 (4)	4 (4)	
Core area	Yes	70 (100)	95 (100)	–
	No	0	0	

Data are presented as n (%)

Table 4 Univariable analysis comparing cats with feline idiopathic cystitis (FIC) with control cats. Part 3: other animals in the household

Variable	Alternatives	FIC (n = 70)	Controls (n = 95)	*P* value
Other animals in the household	Yes	33 (48)	40 (42)	0.467
	No	37 (53)	55 (58)	
Dogs in the household	Yes	8/33 (24)	12/40 (30)	0.582
	No	25/33 (76)	28/40 (70)	
Other cats in the household	Yes (1 additional cat)	25/33 (76)	29/40 (73)	0.288
	Yes (⩾2)	5/33 (15)	3/40 (8)	
	No	3/33 (9)	8/40 (20)	
Stable cat population in household	Yes	29/30 (97)	29/32 (91)	0.322
	No	1/30 (3)	3/32 (9)	
Cats eating together	Yes	26/30 (87)	30/32 (94)	0.343
	No	4/30 (13)	2/32 (6)	
Cats sleeping together	Yes	22/30 (73)	24/32 (75)	0.819
	No	8/30 (27)	8/32 (25)	

Data are presented as n (%)

Table 5 Univariable analysis comparing cats with feline idiopathic cystitis (FIC) with control cats. Part 4: the cats' feeding and drinking regime

Variable	Alternatives	FIC (n = 70)	Controls (n = 95)	*P* value
Type of food	Commercial dry food	47 (67)	76 (80)	0.002
	Commercial canned food	11 (16)	3 (3)	
	Homemade diet	0	5 (5)	
	Combinations	12 (17)	11 (12)	
Often change of diet	Yes	24 (34)	45 (48)	0.080
	No	46 (66)	49 (52)	
Specialised diet after neutering	Yes	14 (22)	9 (11)	0.063
	No	49 (78)	74 (89)	
Feeding schedule	Ad libitum	45 (64)	77 (81)	0.016
	Meal fed	25 (36)	18 (19)	
Comfort/safety when eating/drinking	Yes	62 (89)	91 (96)	0.079
	No	8 (11)	4 (4)	
Separate location for food/water and litter box	Yes	59 (84)	79 (83)	0.846
	No	11 (16)	16 (17)	
Fresh food and water	Yes	62 (89)	81 (85)	0.534
	No	8 (11)	14 (15)	
Regular cleaning of bowls	Yes	45 (64)	55 (58)	0.406
	No	25 (36)	40 (42)	

Data are presented as n (%)

were fed ad libitum (81%) ($P = 0.016$). There was also a significant difference between the two groups with regard to type of food presented to the cats. The control cats were predominantly fed a commercial dry diet, while the number of FIC cats fed commercial canned food or combinations of types of food was higher ($P = 0.002$). In addition, the *P* values related to frequent changes in diet among the controls ($P = 0.080$), more frequent use of specialised commercial diet after neutering in cats with FIC ($P = 0.063$) and a tendency towards cats with FIC having their food and water bowl in a less safe and comfortable location ($P = 0.079$) were considered eligible for multivariable analysis. The remaining factors did not qualify for further analysis (keeping the food and water fresh, the frequency of cleaning the food and water bowl with a detergent, and whether the food and water bowls were kept in a separate location from the litter box).

Only the association between frequent changes in diet and controls was found to be significant in the multivariable analysis ($P = 0.033$) (Table 2).

Table 6 Univariable analysis comparing cats with feline idiopathic cystitis (FIC) with control cats. Part 5: management of the cats' litter box

Variable	Alternatives	FIC (n = 70)	Controls (n = 95)	*P* value
Number of litter boxes	Same as number of cats	44 (63)	57 (60)	0.087
	More than number of cats	1 (1)	4 (4)	
	Less than number of cats	22 (31)	21 (22)	
	No litter box	3 (4)	13 (14)	
Comfort/safety when using box	Yes	60/67 (90)	80/82 (98)	0.038
	No	7/67 (10)	2/82 (2)	
Type of litter substrate	Cat sand	57/67 (85)	66/82 (80)	0.669
	Litter pearls	8/67 (12)	14/82 (17)	
	Litter pellets	2/67 (3)	2/82 (2)	
Size of litter box	Longer than the cat	64/67 (96)	79/82 (96)	0.801
	Shorter than the cat	3/67 (4)	3/82 (4)	
Scooping out of the litter box	Daily	33/67 (49)	48/82 (59)	0.244
	Every other day	11/67 (16)	16/82 (20)	
	Less frequently	23/67 (34)	18/82 (22)	
Cleaning the litter box	Weekly	29/67 (43)	30/82 (37)	0.736
	Every other week	11/67 (16)	19/82 (23)	
	Monthly	15/67 (22)	18/82 (22)	
	Less frequently	12/67 (18)	15/82 (18)	

Data are presented as n (%)

Table 7 Univariable analysis comparing cats with feline idiopathic cystitis (FIC) with control cats. Part 6: the cats' opportunity to perform natural behaviour

Variable	Alternatives	FIC (n = 70)	Controls (n = 95)	*P* value
Scratching area provided	Yes	64 (91)	90 (95)	0.403
	No	6 (9)	5 (5)	
Climbing post/elevated vantage point	Yes	60 (86)	89 (94)	0.089
	No	10 (14)	6 (6)	
Degree of playful activity	Low	2 (3)	4 (4)	0.868
	Average	23 (33)	29 (31)	
	High	45 (64)	62 (65)	

Data are presented as n (%)

Litter box management

In the univariable analyses, compared with controls, a significantly higher number of cats with FIC had their litter box in a location that did not offer a quiet, safe and comfortable environment for the cat (10%) (2%) ($P = 0.038$). In addition, the control cats were less likely to have a litter box in their homes ($P = 0.087$). However, these variables were not found in the multivariable analysis to be significant.

The remaining differences found between the cats with FIC and controls with regard to size of litter boxes, the type of substrate used in the boxes, frequency of scooping out of the litter box or cleaning the litter box itself were not found to be eligible for inclusion in the multivariable analysis (Table 6).

Opportunity to perform natural behaviour

Among the variables evaluated with regard to opportunity to perform natural behaviour, only the indication of cats with FIC being less likely to have access to an elevated vantage point (14%) compared with controls (6%) ($P = 0.089$) qualified for further analysis (Table 7). However, the variable was not found to be significant in the multivariable analysis.

Discussion

The present comparison of cats with FIC with control cats revealed several differences. On a univariable level of analysis, a cat diagnosed with FIC was significantly more likely to be overweight, of a nervous disposition and restricted to a life indoors. Compared with the control cats, a larger proportion of cats with FIC was meal fed and had their litter box in a location less likely to provide safety and comfort. Also, the tendencies of cats with FIC to be more likely to be described as fearful, have less frequent changes in diet, to be less likely to

have an elevated vantage point in their home, and to be less likely to have food and water bowls in a location providing safety and comfort were found eligible for inclusion in the multivariable model. However, after multivariable analysis, only the tendencies among cats with FIC towards being overweight, having a nervous disposition and having less frequent changes of diet were found to be significant, with *P* values of 0.004, 0.011 and 0.033, respectively.

There are potential interrelations between several of the variables found to be eligible for inclusion in the multivariable analysis, which, to some extent, may explain the end results. Obesity has previously been reported in relation to FIC and FLUTD in general,[6,11,27–29] and has, as a factor in itself, been shown to predispose for and exacerbate other diseases.[30] The main contributing factors to obesity are inactivity and increased food consumption. Inactivity and subsequent weight gain have been described as both a sign and result of stress, and a result of neutering.[31–34] Fettman et al considered the increase in body weight after neutering primarily to be a result of increased food consumption rather than inactivity.[35] However, other authors consider changes in activity level to be of importance. Roaming may persist in male cats neutered after puberty; thus, the impact on activity level may depend on the timing of the castration.[36] In a small survey conducted among veterinary practitioners, the effects of neutering on behaviour and level of activity were found to be more pronounced in male cats than in females, a result which may explain, in part, the overrepresentation of neutered males among the cats with FIC in the project database.[37]

While being fed ad libitum could potentially contribute to obesity, especially in cats with low activity levels, meal feeding, however, may be a source of stress to cats, forcing them to eat together with other cats and at a schedule differing from their natural eating pattern.[29,32,36] It should be kept in mind that the casual connection could be the other way around; the tendency towards obesity among cats with FIC could have led to higher proportion of cats in this group being fed restricted portions of food. The lower frequency of changes of diet among the cats with FIC and the higher proportion fed specialised diets may have a similar explanation; the owners may have had special types of diets recommended by their veterinarian owing to the need for weight loss or other medical conditions.

The difference between cases and controls with regard to outdoor access may also be seen in relation to stress and obesity.[12,29,32,38] Besides the obvious effect on activity level, the opportunity to leave the house at will has been shown to reduce stress and reduced chances of developing cystitis.[32,38]

In the present study, the owners of the cats with FIC were more likely to describe their cats as nervous and, to a certain extent, as fearful. This is in accordance with other studies and also relates to the stress association detected in humans with interstitial cystitis.[9,11,12,29,32,39] Further, it strengthens the hypotheses of a psychoneuroendocrine pathogenesis and the implication that FIC may be more likely to occur in susceptible cats in combination with external stressors.[12,29]

The relationship between some of the additional significant findings and stress is also apparent, such as the differences detected between cases and controls with regard to levels of perceived safety and comfort related to the location of food and water bowls and litter box. Also, the lack of an elevated vantage point in the homes of some of the cats with FIC may function as a stressor, especially in combination with restrictions on outdoor access.

The cats with FIC included in the present study were predominantly DSH, and no significant difference was detected with regard to breed between cases and controls. While some earlier studies reported a possible predisposition to FIC in pure-breed cats, a similar tendency towards an increased prevalence in DSH cats was described in a recently published study of FIC.[11,12,28] In the present study, the majority of the cats with FIC were neutered males (63%), reflecting the total database of FLUTD cats from which the FIC cats were selected, where 67% of the cats were neutered males. This is in accordance with previous studies of FIC and FLUTD in general and does not reflect a skewed distribution of male and female feline patients in general in the study area.[4,11–13,21,27] The sex distribution in the clinic's patient mass is quite even, although the proportion of neutered/spayed cats is greater than the number of intact cats. Urethral plugs of various composition have been suggested as an important cause or contributing factor in the development of FIC.[12,40] The cats may not necessarily be diagnosed as obstructed at presentation, as plugs may dissolve or be removed in the process of catheterisation.[7,12] However, the present study included obstructed, as well as unobstructed, cats; thus, the increased risk of being obstructed related to the anatomy of the male feline urinary system does not explain the large proportion of neutered males.[11,27]

In the aforementioned survey among veterinary practitioners on the effects of neutering, the author noted a greater impact of gonadectomy in male cats than females. In addition, the author reported that the more profound changes observed in male cats resulted in reduced sex differences; there were few and minimal differences between neutered male cats and neutered female cats.[37] These findings are, to some extent, supported by studies comparing groups of neutered and intact feral cats, and also neutered cats in private homes.[41–43] Time of castration was again reported to be of importance, as it is hypothesised that in some cats reaching sexual maturity before castration, social rank and behaviour become fixed at the time of neutering.[43] Previously, an increased chance of urethral obstruction was proposed as a potential adverse effect of

prepubertal castration due to underdeveloped urethral diameter.[44] This is no longer considered a risk, and, in fact, a reduced chance of developing clinical signs of FLUTD was associated with early castration in an unpublished student project at the NVH. This is in agreement with a larger study of cats adopted from shelters, where cats neutered at a traditional age (>24 weeks) were found to be of greater risk of developing lower urinary tract disease than cats neutered at a prepubertal age (<24 weeks).[45] More research is needed to determine the effect of neutering, and especially the age at neutering, on the male cats' susceptibility to stress and subsequent development of FIC, or the even more complex stress-related disease syndrome recently presented by Buffington.[24]

Evaluation of the multivariable model was found to be satisfactory. With the current design of 70 cases and 95 controls, the power at 5% significance in a non-matched study would be 69% to detect an odds ratio of 3.0 for a variable at 10% occurrence in controls, 86.0 for a 20% occurrence and 91.0 for a 30% occurrence. As our study did not reveal a large effect of matching, this would be representative for our study. A factor at 15% occurrence would represent a power of approximately 80% with this design.

The cats with FIC in the present study were all primary accession cases, in contrast to most previously published studies, which are commonly based on referred cases.[7,37] This may contribute to increased external validity, reflecting the situation in general first-opinion practice. The patient load admitted to the non-referral, small animal policlinic at the NVH is considered to reflect the general patient population in the area.[46] A possible limitation of the present study, however, is the element of recall bias with regard to the cats with FIC, as the owners were asked to recall the circumstances present at the time their cats were diagnosed with idiopathic cystitis. Recall bias is more likely to affect non-consistent variables such as 'change of food' than more constant variables such as the personality of the cat. The magnitude of recall bias was, however, found to be minimal when comparing the data from the present study with the information available for confirmation in the database established from the study performed in the period 2003–2006, as previously described. Another potential limitation is that some of the variables examined were, to some extent, owner defined. While definitions were made for most variables, definite description of, for instance, a safe and comfortable location for food and water bowls or the litter box was considered difficult with regard to covering all possibilities. Obtaining the information through a telephone interview may have amended some of the potential shortcomings related to lack of definitions, as the interviewers were able to clarify and discuss these with the cat owners.

Retrospectively, questions pertaining to moving house or introducing new persons to the household should also have been included in the questionnaire, as some of the respondents volunteered information of this nature during the interviews. Episodes of FIC were reported, for instance, in connection with the owners having a baby or leaving the cat with an unfamiliar caretaker when travelling.

Conclusions

The results from the present study showed that a cat diagnosed with FIC was more likely to be overweight and of a nervous disposition than the control cats. In addition, several differences between cases and controls were detected at a univariable level of analysis, related to outdoor access and the cats' perceived safety and comfort in their home environments. While not significant after multivariable analysis, owing to potential interrelations, these variables may still be of importance.

Supplementary material Questionnaire and definition of terms used in the questionnaire.

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