

Papers

Use of a web-based questionnaire to explore cat owners' attitudes towards vaccination in cats

G. Habacher, T. Gruffydd-Jones, J. Murray

This study aimed to develop a better understanding of factors involved in cat owners' decisions related to vaccination and to explore their views and knowledge of vaccination. Data were collected using a web-based 'Cat Health Questionnaire'. A total of 3204 respondents participated in the survey, each answering questions with only one cat in mind. Forty-one questionnaires were not included; of the remaining 3163 cats, 69 per cent were reported to have been vaccinated in the last 12 months. Vaccination as a kitten was the strongest predictor of up-to-date vaccination status, followed by the intention to take the cat to a cattery or cat show in the next year. The owners' perception of the importance of stress on the cat, the age of the cat or the cost of vaccination was associated with the cat's current vaccination status. Owners who perceived the severity of infectious diseases or veterinary advice as very important were more likely to vaccinate their cats than owners who perceived these factors as less important. The owners' perceptions of the risk and their previous experiences of side effects in a cat were not associated with a decreased likelihood of vaccination.

VACCINATION has become an integral part of pet healthcare (Wise and others 2003, Lue and others 2008), and has been of great benefit in controlling infectious diseases. The protection offered by vaccination has dramatically reduced feline mortality and morbidity caused by associated infectious diseases (Scott and Geissinger 1999, Mouzin and others 2004). The establishment of widespread vaccination programmes has led to a pronounced decline in the frequency of some feline infectious diseases: feline panleucopenia is now perceived to be very uncommon (Greene and Addie 2006) and, more recently, the prevalence of feline leukaemia virus in many cat populations appears to have decreased notably (Levy and Crawford 2005). Nevertheless, a significant proportion of owners fail to recognise the advantages that vaccination can offer, and there is a perception among veterinarians that cat owners are increasingly concerned about the safety of vaccination.

There is controversy within the veterinary profession regarding the frequency of vaccination and what should be included in vaccines, and several organisations have recommended changes to vaccination guidelines (AAFP 2006, ABCD 2006-2008, Day and others 2007).

In human medicine, parents' concerns about the safety of vaccinations are important in determining the likelihood of vaccination of children (Allred and others 2005). It has been suggested that pet owners have similar concerns about both the safety of vaccination and potential overvaccination (Day 2006). To the authors' knowledge, no studies have been conducted to investigate cat owners' knowledge of

vaccination and factors that might influence their attitudes towards vaccination.

The aim of this study was to develop a better understanding of the factors involved in cat owners' decisions related to vaccination and to explore their views and knowledge of vaccination.

Materials and methods

Data collection

A cross-sectional study of an anonymous convenience sample was conducted during April and May 2008. A link to an online 'Cat Health Questionnaire' was publicised on relevant websites and in e-mailed newsletters covering a variety of cat-related topics that had been identified from an internet search using the search term 'cat'. The providers of these websites had given consent to participate. Websites related to cat health or vaccination issues were avoided to minimise the risk of introducing selection bias.

The participating websites and newsletters invited cat owners, aged 16 years and over, with internet access, who had sole or joint responsibility for a cat in their household and were not working in the veterinary profession, to complete the online 'Cat Health Questionnaire'. Owners with more than one cat were asked to provide information relating to the cat whose name was first when listed in alphabetical order.

The questionnaire included sections on: sociodemographic information about the respondents; vaccination history of cat(s); knowledge of cat diseases and vaccination; experience of vaccination side effects in cats; factors influencing vaccination; and the respondents' opinions of novel vaccination techniques/strategies. Respondents were asked to rate various factors that might influence their decision to have their cat vaccinated, using a five-point scale (5 Very important to 1 Not important at all). Respondents could omit questions, which resulted in some incomplete data sets; however, to maximise the questionnaire completion rates, the questions were ordered in terms of difficulty, with easier questions appearing earlier in the questionnaire. The introductory message and the full questionnaire are available on the University of Bristol website (www.survey.bris.ac.uk/smvsa/felinesurvey).

Initial testing was conducted using a paper version of the questionnaire, which enabled the authors to obtain feedback on the clar-

Veterinary Record (2010) 167, 122-127 doi: 10.1136/vr.b4857

G. Habacher, DrMedVet, MRCVS,
T. Gruffydd-Jones, BVetMed,
DipECVIM-ca, PhD, MRCVS,
J. Murray, BScEcon, MSc, PhD,
Feline Centre, Division of Companion
Animal Studies, Department of
Veterinary Clinical Sciences, University
of Bristol, Langford House, Langford,
North Somerset BS40 5DU

E-mail for correspondence:
gabi.habacher@bristol.ac.uk

Provenance: not commissioned;
externally peer reviewed

ity and any ambiguity of the questions. The questionnaire was then refined before a pilot study was conducted online on 150 anonymous cat owners recruited via participating websites to test the ease of use of the questionnaire, and the clarity and relevance of the questions. The pilot revealed that no modifications were required, and the pilot data were incorporated into the main study. The survey was open from April 19 to May 31, 2008, and took approximately 10 minutes to complete.

The study population was then categorised into cases and controls using the criteria outlined below.

Case definition

Cases were defined as owners who reported that their cats had been vaccinated in the preceding 12 months. These will be referred to as 'currently vaccinated' for the purposes of this study.

Control definition

Controls were owners who reported that their cats had not been vaccinated in the preceding 12 months. These will be referred to as 'currently unvaccinated' for the purposes of this study.

Power of the study

The study was designed to have at least 80 per cent power to detect an odds ratio of 2.0 or more, on the basis of a sample of 900 cats (with a ratio of 4:1 vaccinated:unvaccinated) and a 0.05 probability of a type I error (95 per cent confidence), assuming that 10 per cent of controls were exposed to the variables under consideration (Epi Info 6; US Centers for Disease Control and Prevention).

Data analysis

A descriptive summary of the responses of the cases and controls to some of the questions within the questionnaire was produced. This included estimated cost, previous experience of vaccine-related side effects, acceptance of novel approaches to vaccination (for example, multiple injections, different vaccination sites), and knowledge of infectious diseases and vaccination. Data sets from respondents under the age of 16 years and owners of cats under nine weeks of age were excluded from the statistical analysis (as vaccination data sheet recommendations state that first vaccinations should be given only to cats aged nine weeks or older).

Univariable logistic regression was used to test the variables for association with current vaccination status. Variables with a value of $P < 0.2$ were considered for inclusion in a multivariable model, which was constructed using the technique of backward elimination. Variables were retained in the model if they were shown to improve the fit of the model significantly by assessing the change of deviance. If variable categories (for example, 'very important' and 'rather important') were considered similar in nature, then different categories were combined to assess whether this led to an improvement to the fit of the model, which was also assessed by the change in deviance. The final multivariable model was based on 1553 respondents (1036 cases and 517 controls) who provided information on all variables included in the model. The effect of plausible two-way interactions between variables was checked for. Variables with $P \leq 0.05$ were considered to be statistically significant. A Hosmer-Lemeshow test was carried out to assess the goodness of fit of the final multivariable model. The statistical package SPSS version 14.0 (SPSS) was used for the analysis.

Results

Survey response

A total of 3204 respondents participated in the survey, but not all provided data for all the questions. The data sets of 41 respondents were excluded, 37 because the respondent was under 16 years of age and four because the cat was under nine weeks of age; the 3163 remaining data sets were used for analysis. Ninety-seven per cent (3068 of 3163) of survey respondents finished the sections on cat information and vaccination, with 93 per cent (2941 of 3163) completing the final section on sociodemographic factors. The size of the denominator population could not be calculated as the online nature of the questionnaire meant that there was unrestricted access.

TABLE 1: Description of respondents participating in a web-based questionnaire investigating cat owners' attitudes towards vaccination conducted in April and May 2008, including univariable odds ratios (OR) and P values for association with the cat's current vaccination status*

	Number (%) of cases	Number (%) of controls	OR	P
Sex				
Male	298 (14.1)	109 (12.7)	1.0	
Female	1819 (85.9)	750 (87.3)	0.9	0.318
Location of home				
Urban	702 (33.3)	285 (33.3)	1.0	
Semi-urban	870 (41.3)	346 (40.4)	1.0	
Rural	536 (25.4)	226 (26.4)	1.0	0.840
Highest level of education in household				
No qualification	35 (1.7)	17 (2.0)	1.0	
GCSE/O levels	343 (16.5)	166 (20.0)	1.0	
A levels	314 (15.1)	158 (19.0)	0.9	
HND/degree	622 (30.0)	224 (26.9)	0.3	
Postgraduate/ professional qualification	761 (36.7)	267 (32.1)	0.3	0.004
Annual household income				
<£10,000	89 (5.0)	67 (9.4)	1.0	
£10,000 to <£14,999	105 (5.9)	74 (10.4)	1.0	
£15,000 to <£19,999	170 (9.5)	88 (12.4)	1.5	
£20,000 to <£24,999	156 (8.7)	76 (10.7)	1.6	
£25,000 to <£29,999	199 (11.2)	96 (13.5)	1.6	
£30,000 to <£39,999	302 (15.2)	108 (15.2)	2.1	
£40,000 to <£49,999	284 (11.1)	79 (11.1)	2.7	
≥£50,000	479 (17.2)	122 (17.2)	3.0	<0.001
Number of children in household				
0	1735 (84.5)	675 (80.9)	1.0	
1-3	312 (15.2)	154 (18.5)	0.8	
≥4	7 (0.3)	5 (0.6)	0.6	0.056
Respondent's age (years)				
16-24	66 (3.3)	12 (1.5)	1.0	
25-34	409 (20.6)	130 (16.0)	0.6	
35-44	536 (27.0)	217 (26.6)	0.5	
45-54	537 (27.0)	241 (29.6)	0.4	
55-64	347 (17.5)	184 (22.6)	0.3	
≥65	94 (4.7)	31 (3.8)	0.6	<0.001

* Total numbers of respondents for each parameter vary because not all respondents answered all of the questions

Sample characteristics

A summary of the sample of respondents who participated in the study is provided in Table 1.

Description of cats

The descriptive characteristics of the cats are summarised in Table 2.

The majority of the cat owners (2193 of 3081, 71 per cent) had acquired their cat when it was under one year of age, most commonly from a rescue centre/charity (1076 of 3074, 35 per cent) or through personal connections such as friends, neighbours, relatives or colleagues (786 of 3074, 26 per cent). A total of 425 (14 per cent) of the 3074 cats were obtained from a breeder. Only 13 (0.4 per cent) respondents described themselves as a cat breeder.

Respondents were asked to identify factors that might deter them from booking a routine veterinary appointment for the cat. The majority of owners (1511 of 2681, 56 per cent) stated that none of the listed factors would be a potential cause for inconvenience. Of the reasons that were listed as a potential cause for inconvenience, the most common were 'finding and catching the cat' (469 of 1170, 40 per cent), 'opening hours' (330 of 1170, 28 per cent), 'distance and transport' (298 of 1170, 26 per cent) and 'time involved' (268 of 1170, 23 per cent).

Vaccine content and side effects

Cat owners with vaccinated cats were asked to specify the infectious diseases that they believed their cat had been vaccinated against. 'Cat flu' (1178 responses) and feline leukaemia (943) were the most commonly reported diseases.

When prompted with a list of feline infectious diseases, 1906 of 3124 (61 per cent) believed that vaccinations were definitely available

TABLE 2: Description of cats owned by respondents participating in a web-based questionnaire investigating cat owners' attitudes towards vaccination conducted in April and May 2008, including univariable odds ratios (OR) and P values for association with the cat's current vaccination status*

	Number (%) of cases	Number (%) of controls	OR	P
Number of cats owned by respondent				
1	693 (32.7)	300 (34.6)	1.0	
2	740 (35.0)	267 (30.8)	1.2	
3	277 (13.1)	121 (14.0)	1.0	
≥4	407 (19.2)	179 (20.7)	1.0	0.189
Age of cat				
9 weeks to <1 year	151 (7.2)	32 (3.7)	1.0	
1 year to <5 years	673 (32.2)	253 (30.0)	0.6	
5 years to <10 years	567 (27.1)	255 (29.8)	0.5	
≥10 years	702 (33.5)	316 (36.9)	0.5	0.001
Pedigree cat				
Yes	404 (19.6)	97 (11.6)	1.0	
No	1654 (80.4)	741 (88.4)	1.9	<0.001
Indoor/outdoor access				
Indoor only	458 (21.7)	170 (19.6)	1.0	
Outdoor only	9 (0.4)	3 (0.4)	1.1	
Indoors and outdoors	1643 (77.9)	693 (80.0)	0.9	0.425
Visited a cattery in the past 12 months				
Yes	455 (21.4)	47 (5.4)	1.0	
No	1673 (78.6)	824 (94.6)	4.8	<0.001
Visited a cat show in the past 12 months				
Yes	73 (3.4)	12 (1.4)	1.0	
No	2055 (96.6)	859 (98.6)	2.5	0.03
Been abroad in the past 12 months				
Yes	4 (0.7)	2 (0.2)	1.0	
No	2114 (99.3)	869 (99.8)	2.9	0.163
Visiting a cattery in the next 12 months				
Yes	520 (27.3)	25 (3.0)	1.0	
No	1382 (72.7)	804 (97.0)	12.1	<0.001
Visiting a cat show in the next 12 months				
Yes	91 (4.7)	8 (0.9)	1.0	
No	1851 (95.3)	841 (99.1)	5.2	<0.001
Going abroad in the next 12 months				
Yes	38 (2.0)	2 (0.2)	1.0	
No	1876 (98.0)	846 (99.8)	8.6	0.003
Current medication for any health problem				
Yes	376 (17.8)	167 (19.3)	1.0	
No	1735 (82.2)	698 (80.7)	0.9	0.338
Vaccinated as a kitten				
Yes	1645 (98.1)	568 (75.2)	1	
No	32 (1.9)	187 (24.8)	16.9	<0.001
Last vaccination or booster				
Within past 12 months	2128 (100)	0 (0)		
>1 year ago or never	0 (0)	871 (100)		

* Total numbers of respondents for each parameter vary because not all respondents answered all of the questions

against feline leukaemia, 1916 of 3045 (63 per cent) against 'cat flu', 1521 of 3041 (50 per cent) against feline parvovirus and 824 of 3065 (27 per cent) against feline immunodeficiency virus (FIV). However, only 343 of 3018 (11 per cent) and 119 of 2989 (4 per cent) of cat owners believed that there was a vaccination that provided protection against *Chlamydia felis* and *Bordetella bronchiseptica*, respectively.

Twenty-three per cent of the cat owners (706 of 3071 respondents) reported having noticed side effects from vaccination in a cat currently or previously owned by them. The most commonly reported problem was lethargy (476 responses, 67 per cent), followed by inappetence (328, 47 per cent), injection site reactions (202, 29 per cent), gastrointestinal signs (178, 25 per cent), fever (121, 17 per cent) and lameness (83, 12 per cent). Other side effects were specified as flu-like signs (25, 4 per cent), allergic reactions (21, 3 per cent) and death (19, 3 per cent).

Opinion of novel approaches to vaccination

Cat owners were questioned about their opinions of new approaches to vaccination sites and vaccination programmes. Almost one-third of cat owners (764 of 2634, 29 per cent) would not accept the use of more than one injection despite veterinary recommendations.

TABLE 3: List of all other significant variables from the univariable regression analysis that were considered for inclusion in the multivariable regression model for risk factors for vaccination status of cats

Variable	P
Importance of cost	<0.001
Importance of side effects	<0.001
Importance of stress for the cat	<0.001
Importance of requirement for a vaccination	<0.001
Importance of veterinary advice	<0.001
Importance of susceptibility to feline infectious diseases	<0.001
Importance of efficacy of vaccination	<0.001
Importance of severity of feline infectious diseases	<0.001
Importance of time involved	<0.001
Importance of lifestyle of the cat	<0.001
Importance of age of the cat	<0.001
Origin of cat	0.04
Postcode	0.001
Owner with a vaccinated cat that has/had an infectious disease	0.193
Owner with an unvaccinated cat that has/had an infectious disease	0.03
Owners that saw side effects to a vaccination in this or a previously owned cat	<0.001

Novel injection sites in the hindlimbs and in the tail were considered acceptable by 1641 (62 per cent) and 1087 (41 per cent) of 2646 respondents, respectively. However, 972 (37 per cent) of the respondents would not be prepared to accept injection in either the hindlimb or the tail.

Univariable regression

Univariable logistic regression was used to test for associations with reported vaccination within the preceding 12 months. In accordance with the case definition, 2128 cases and 871 controls were identified.

Multivariable regression

Thirty variables with $P < 0.2$, as listed in Tables 1, 2 and 3, were considered for inclusion in the multivariable model. The final multivariable logistic regression model is summarised in Table 4. No significant interactions were found between the variables in the model. The Hosmer-Lemeshow test showed the multivariable model to be a good fit ($P > 0.05$).

Discussion

There were two main reasons why a web-based approach was chosen in this study: the online method enabled the collection of data for unvaccinated cats and for cats that were not registered with a veterinary practice. In addition, the web-based approach is a relatively cost-effective and time-efficient technique for obtaining data from across the UK, and therefore enabled the authors to achieve a large sample size.

In the past, the web-based approach has been criticised as being non-representative, as it requires respondents to be computer literate and to have access to a computer. Recent data indicate that 65 per cent of UK households had internet access at home in 2008 (National Statistics 2008). Therefore, the web is a powerful resource, and the internet is increasingly exploited for conducting health surveys electronically (Suchard and others 1998, Fischbacher and others 2000). Studies that require large sample sizes tend to lend themselves particularly well to a web-based format (Eysenbach and Wyatt 2002).

The survey was referred to as 'Cat Health Questionnaire' to avoid bias from preconceptions on attitudes to vaccination. For the same reason, publicising the questionnaire on websites related to cat health or vaccination issues was avoided to minimise the risk of introducing selection bias. However, the link used could not be rooted, and it was therefore impossible to determine whether affiliation with specific websites influenced the responses and no data validity check could be carried out. Response rates were not calculated because of the unknown number of people who accessed the website but decided against participation in the survey.

Ordering questions in levels of difficulty from easy to hard to minimise dropout, and placing the section on sociodemographic details at

TABLE 4: Multivariable regression analysis of a web-based questionnaire conducted in 2008 about cat owners' attitudes towards vaccination of cats

Variable	Cases (%) (n=1036)	Controls (%) (n=517)	Adjusted OR (95% CI)	P
Age of respondent				
16 to 24 years	35 (3.4)	7 (1.4)	1	
25 years or older	1001 (96.6)	510 (98.6)	0.24 (0.09-0.64)	0.040
Postcode location				
London, south-west England, Midlands	301 (29.1)	118 (22.8)	1	
All other UK areas	735 (71.0)	399 (77.2)	0.65 (0.47-0.90)	0.009
Age of cat at present				
9 weeks to <1 year	74 (7.1)	16 (3.1)	1	
1 year or older	962 (92.9)	501 (96.9)	0.45 (0.21-0.95)	0.037
Kitten vaccination				
No	18 (1.7)	134 (25.9)	1	
Yes	1018 (98.3)	383 (74.1)	20.54 (10.83-38.94)	<0.001
Visiting cattery next year				
No	816 (78.8)	507 (98.1)	1	
Yes	220 (21.2)	10 (1.9)	14.35 (6.81-30.21)	<0.001
Visiting cat show next year				
No	991 (95.7)	514 (99.4)	1	
Yes	45 (4.3)	3 (0.6)	11.88 (2.99-47.25)	<0.001
Have/had an unvaccinated cat with disease				
No	938 (90.5)	476 (92.1)	1	
Yes	98 (9.5)	41 (7.9)	2.02 (1.18-3.48)	0.011
Importance of stress				
Not important to rather important	842 (81.3)	334 (64.6)	1	
Very important	194 (18.7)	183 (35.4)	0.43 (0.31-0.59)	<0.001
Importance of age of cat				
Not important to rather unimportant	424 (40.9)	127 (24.6)	1	
Neutral to very important	612 (59.1)	390 (75.5)	0.54 (0.39-0.74)	<0.001
Importance of severity of diseases				
Not important to rather important	319 (30.8)	368 (71.2)	1	
Very important	717 (69.2)	149 (28.8)	4.27 (3.16-5.78)	<0.001
Importance of cost of vaccination (continuous variable)			0.70 (0.63-0.77)	<0.001
Importance of veterinary advice (continuous variable)			1.48 (1.30-1.68)	<0.001

CI Confidence interval, OR Odds ratio

the end, yielded a high completion rate (97 per cent for the sections on cat information and vaccination, and 93 per cent for the final section on sociodemographic factors), similar to findings from previous research (Ekman and others 2007).

Owners with a strong interest in cats may have been more motivated to participate in the survey, potentially introducing a bias. However, a strong cat interest may not necessarily lead to vaccination. For example, in 2007 a survey of factors that pet owners in the UK considered to constitute 'responsible pet ownership' showed that 92 per cent of owners considered that feeding, exercising and giving their pets attention were important, whereas only 48 per cent regarded regular vaccination as important (NOAH, personal communication).

Different sampling methods have varying biases, but evidence suggests that bias associated with using the web as a tool to collect information is no greater than that introduced by the traditional methods of postal or telephone questionnaires (Ekman and others 2006, Braunsberger and others 2007). The validity and reliability of data obtained online also appear to be comparable to those gained by traditional methods (Buchanan and Smith 1999, Nathanson and Reinert 1999).

This study was conducted as a cross-sectional study, and a total of 3163 questionnaires met the inclusion criteria. The majority of the questionnaire respondents were female (2685 of 3122, 86 per cent). The predominance of women among cat owners has also been reported in studies by Lue and others (2008) and by Murray and others (2010). Murray and others (2010) indicated that more women

than men (69 per cent v 31 per cent) provided information about owned cat(s). The reason for the predominance of women among the respondents to the questionnaire is not known; however, it could be due to a higher number of female cat owners than male cat owners, or because women are reportedly more interested in health-related topics (Fox and Rainie 2002). Women also tend to carry the primary responsibility for healthcare, including vaccination, of family pets (Wise and others 2003).

Sixty-four per cent of the respondents (n=1943) reported the highest level of qualifications in the household to be 'HND/degree' or 'professional/postgraduate qualification'. This is considerably higher than the 31 per cent reported in the 2001 national census (National Statistics 2007); although differences in question composition may account for some of this differences, recent research has shown that households including someone qualified to degree level are more likely to own cats than other households (Murray and others 2010).

Sixty-nine per cent of cats (2128 of 3103) were reported to be currently vaccinated. The final multivariable model consisted of 1036 cases and 517 controls, resulting in a 2:1 ratio of vaccinated:unvaccinated cats. Similarly, in a recent telephone survey that randomly selected respondents from the electoral roll, Murray and others (2009) found that 58 per cent of cats were reported as having been vaccinated in the past year. The self-selective nature of the online questionnaire may have attracted a higher proportion of owners who vaccinate their cats regularly. This may have led to a slightly higher rate of vaccination in this sampling group, which may be and be higher than the true prevalence of cats that are vaccinated in the UK.

Both the present study and Murray and others (2009) found a majority of cats to have indoor and outdoor access (79 per cent of cats in the present survey v 87 per cent of cats in Murray and others [2009]); however, the results from the online questionnaire showed that a significantly larger proportion of cats were kept solely indoors (21 per cent v 9 per cent) and that a significantly smaller proportion of cats were kept solely outdoors (0.4 per cent v 4 per cent). This may suggest that cat owners responding to the online questionnaire felt more protective about their cats, and may also explain the surprisingly high number of cats (543 of 2976, 18 per cent) that were reported to receive medication for a health problem. Diseases that were most commonly reported by the cats' owners were hypertension, chronic renal disease, diabetes mellitus, hyperthyroidism, lower urinary tract disease and asthma. Cats that visited their veterinary practice for regular check-ups for a long-standing chronic problem were no more likely to be currently vaccinated than 'healthy' cats, but this may be because vaccination is often regarded as being contraindicated in cats with health problems. It also appeared that the strong owner commitment demonstrated by administering treatment for their cat's health problem was not reflected in an increased likelihood of up-to-date vaccination.

Seventeen per cent (501 of 2896) of the cats were pedigree. This proportion was significantly higher than the proportion of pedigree cats reported by Murray and others (2009) (9 per cent); no association with increased likelihood of vaccination could be determined.

Respondents demonstrated variable knowledge about vaccination to protect cats against infectious diseases. The prevalence of some of the diseases, their profiles (disease severity and the level of concern the owners had about the diseases) and the owners' personal experiences of them may influence the familiarity of the names of the diseases. Seven per cent of the respondents did not name any infectious diseases against which they thought their cat had to be vaccinated, but stated that they followed veterinary recommendation. The majority of respondents believed that feline leukaemia (63 per cent) and 'cat flu' (62 per cent) were 'definitely included' in vaccination. Cat owners are likely to be more familiar with these diseases, as cat flu is very common (Bannasch and Foley 2005) and feline leukaemia very serious. Although vaccination against *C. felis* is widely available in the UK, very few cat owners (4 per cent) believed their cat was vaccinated against this pathogen, and only 21 per cent of respondents thought that it was 'definitely' or 'probably' included as a component of commercially available vaccines. It is not clear whether this reflects limited

knowledge or whether the uptake of this vaccine is very low, or a combination of both factors. On the other hand, 44 per cent of cat owners believed that FIV and 24 per cent that feline infectious peritonitis (FIP) were definitely or probably included in existing vaccines, despite the fact that these vaccinations are not used in the UK. FIP and FIV are both high-profile infectious diseases and were included in the questionnaire to test respondents' knowledge of which diseases can be vaccinated against.

The respondents expressed little concern regarding the safety of vaccination, despite anecdotal perceptions of a strong anti-vaccination view in the press and on the internet. Cat owners reported side effects in 23 per cent of any cats that they had owned. This was surprisingly high, but only a minority of these owners (220 of 706, 31 per cent) reported that this had deterred them from subsequent vaccination of their cat, perhaps because the reported side effects were regarded as mild and transient. These findings suggest that any perception held by veterinary surgeons that cat owners have significant concerns about vaccination may be largely influenced by a few individuals who express strong views, but that most respondents do not have significant concerns.

In the final multivariable model, 12 variables retained significance as risk factors affecting reported vaccination status (Table 4).

Among all socioeconomic factors investigated, only the age and geographical location of the cat owners were of significance in the final multivariable model, with cat owners living in London, the Midlands and south-west England significantly more likely to report vaccination of their cat. London and south-west England are generally considered as affluent areas of the UK; however, it is surprising that this association was not found for other affluent areas such as south-east England. Cat owners aged 16 to 24 years were significantly more likely to report vaccination than owners in other age groups. The reason for this finding is unknown; however, it may be that this reflects fairly recent exposure to their own vaccination.

It was speculated that there was a 'honeymoon' period with a high probability of vaccination associated with the acquisition of a kitten. This was shown by the significantly higher proportion of cats under one year of age that were reported to be vaccinated, in comparison with cats over one year of age. Similarly, cat owners who tended to attribute more importance to the cat's age as a factor when deciding about vaccination were more likely to report current vaccination. This may be due to cat owners' perception that immunity following vaccination may be long-lived or that older cats may be less susceptible to infectious diseases. However, cats that had received primary vaccination as a kitten were 20 times more likely to be reported to be currently vaccinated, irrespective of their current age. This figure remained highly significant ($P < 0.001$) even when cats under one year of age were excluded, indicating that primary vaccination was also highly associated with subsequent vaccination in cats that were aged one year or more at the time of the questionnaire.

The multivariable model showed that a cat owner's view of the severity of infectious diseases was an important factor in their decision whether to vaccinate their cat, with cat owners who considered the severity as 'very important' being four times more likely to report vaccination in the previous 12 months than owners who considered the severity to be less important. Unsurprisingly, respondents who owned or had owned an unvaccinated cat that had suffered from an infectious disease were also significantly more likely to report their current cat as being vaccinated. Similarly, there is evidence that parents are more likely to have their children vaccinated against infectious disease if they perceive the illness associated with the disease to be severe or if they perceive their child to be at high risk of the disease (Sturm and others 2005). However, no relationship between the owner's perception of the cat's susceptibility to infectious disease and the likelihood of vaccination was found.

Veterinary advice was significantly ($P < 0.001$) associated with cats reported to have been vaccinated within the past 12 months. The greater the importance cat owners attributed to veterinary advice, the higher the likelihood of their cat's vaccination being up to date. This is consistent with the findings of studies that investigated parents'

healthcare decisions and vaccination of their children, which identified that the healthcare providers' recommendations were closely associated with the likelihood of choosing to vaccinate (Mays and others 2004, Smith and others 2007).

Twenty-seven per cent of the cat owners (754 of 2785) stated that stress to the cat during a visit to the vet was a very important factor when deciding whether to vaccinate, with cat owners considering this factor to be 'very important' being significantly less likely to vaccinate than cat owners perceiving stress to be less important. This suggests that initiatives aimed at making practices 'cat friendly' (for example, the Feline Advisory Bureau's Cat Friendly Practice scheme [www.fabcats.org/catfriendlypractice]) may encourage some cat owners to present their cats for vaccination.

The cost of vaccination was also associated with the odds of vaccination: the more important cost was perceived to be, the less likely the cat was reported to be vaccinated. However, there was no significant difference between the household income of owners of vaccinated and unvaccinated cats. In addition, the estimated cost of vaccination did not appear to influence the likelihood that the cat was vaccinated.

The web-based approach used in this study proved to be a useful and efficient method to gather data from a large sample. To the authors' knowledge, this is the first reported large-scale study that aimed to explore attitudes and opinions towards vaccination and identify obstacles to vaccination in UK cats. It provides important insights into cat owners' knowledge and behaviour, and factors that influence their decision to have their cat vaccinated. Vaccination was generally recognised as important and few concerns about safety were expressed. This information might be helpful to increase awareness of cat owners' perceptions by veterinarians and allow them to address owners' concerns and communicate with them more effectively.

Acknowledgements

The authors thank the participating website providers for advertising the questionnaire and all the cat owners who provided data for the study. Nick Crabb's help with the questionnaire and website is greatly appreciated. They also thank Cats Protection for funding JM's post and Fort Dodge for funding GH's position.

References

- AAFP (2006) The 2006 American Association of Feline Practitioners Feline Vaccine Advisory Panel Report. www.catvets.com/uploads/PDF/2006_Vaccination_Guidelines_JAVMA_Plus.pdf. Accessed June 10, 2009
- ABCD (2006-2008) The European Advisory Board on Cat Diseases guidelines. www.abcd-vets.org/guidelines/index.asp. Accessed June 10, 2009
- ALLRED, N. J., SHAW, K. M., SANTIBANEZ, T. A., RICKERT, D. L. & SANTOLI, J. M. (2005) Parental vaccine safety concerns – results from the National Immunization Survey, 2001-2002. *American Journal of Preventive Medicine* **28**, 221-224
- BANNASCH, M. J. & FOLEY, J. E. (2005) Epidemiologic evaluation of multiple respiratory pathogens in cats in animal shelters. *Journal of Feline Medicine and Surgery* **7**, 109-119
- BRAUNSBERGER, K., WYBENGA, H. & GATES, R. (2007) A comparison of reliability between telephone and web-based surveys. *Journal of Business Research* **60**, 758-764
- BUCHANAN, T. & SMITH, J. L. (1999) Using the internet for psychological research: personality testing on the world wide web. *British Journal of Psychology* **90**, 125-144
- DAY, M. J. (2006) Vaccine side effects – fact and fiction. *Veterinary Microbiology* **117**, 51-58
- DAY, M. J., HORZINEK, M. C. & SCHULTZ, R. D. (2007) Guidelines for the vaccination of dogs and cats. Compiled by the Vaccination Guideline Group (VGG) of the World Small Animal Veterinary Association (WSAVA). *Journal of Small Animal Practice* **48**, 528-541
- EKMAN, A., DICKMAN, P. W., KLINT, A., WEIDERPASS, E. & LITTON, J. E. (2006) Feasibility of using web-based questionnaires in large population-based epidemiological studies. *European Journal of Epidemiology* **21**, 103-111
- EKMAN, A., KLINT, A., DICKMAN, P. W., ADAMI, H. O. & LITTON, J. E. (2007) Optimizing the design of web-based questionnaires – experience from a population-based study among 50,000 women. *European Journal of Epidemiology* **22**, 293-300
- EYSENBACH, G. & WYATT, J. (2002) Using the internet for surveys and health research. *Journal of Medical Internet Research* **4**, E13
- FISCHBACHER, C., CHAPPEL, D., EDWARDS, R. & SUMMERTON, N. (2000) Health surveys via the internet: quick and dirty or rapid and robust? *Journal of the Royal Society of Medicine* **93**, 356-359
- FOX, S. & RAINIE, L. (2002) E-patients and the online health care revolution. *Physician Executive* **28**, 14-17

- GREENE, C. E. & ADDIE, D. (2006) Feline parvoviral infections. In *Infectious Diseases of the Dog and Cat*. 3rd edn. Ed C. E. Greene. Saunders Elsevier. pp 78-86
- LEVY, J. K. & CRAWFORD, C. (2005) Prevalence of FeLV and FIV in North America. 23rd Annual Forum of the American College of Veterinary Internal Medicine. Baltimore, June 1 to 4, 2005. *Journal of Veterinary Internal Medicine* **19**, 436
- LUE, T. W., PANTENBURG, D. P. & CRAWFORD, P. M. (2008) Impact of the owner-pet and client-veterinarian bond on the care that pets receive. *Journal of the American Veterinary Medical Association* **232**, 531-540
- MAYS, R. M., STURM, L. A. & ZIMET, G. D. (2004) Parental perspectives on vaccinating children against sexually transmitted infections. *Social Science and Medicine* **58**, 1405-1413
- MOUZIN, D. E., LORENZEN, M. J., HAWORTH, J. D. & KING, V. L. (2004) Duration of serologic response to three viral antigens in cats. *Journal of the American Veterinary Medical Association* **224**, 61-66
- MURRAY, J. K., BROWNE, W. J., ROBERTS, M. A., WHITMARSH, A. & GRUFFYDD-JONES, T. J. (2010) Number and ownership profiles of cats and dogs in the UK. *Veterinary Record* **166**, 163-168
- MURRAY, J. K., ROBERTS, M. A., WHITMARSH, A. & GRUFFYDD-JONES, T. J. (2009) Survey of the characteristics of cats owned by households in the UK and factors affecting their neuter status. *Veterinary Record* **164**, 137-141.
- NATHANSON, A. T. & REINERT, S. E. (1999) Windsurfing injuries: results of a paper- and internet-based survey. *Wilderness and Environmental Medicine* **10**, 218-225
- NATIONAL STATISTICS (2007) The level of highest qualification held by adults. www.dcsf.gov.uk/rsgateway/DB/SFR/s000798/DIUSFR05-2008.pdf. Accessed October 5, 2009
- NATIONAL STATISTICS (2008) Internet access 2008. www.statistics.gov.uk/pdfdir/iah0808.pdf. Accessed May 10, 2009
- SCOTT, F. W. & GEISSINGER, C. M. (1999) Long-term immunity in cats vaccinated with an inactivated trivalent vaccine. *American Journal of Veterinary Research* **60**, 652-658
- SMITH, A., YARWOOD, J. & SALISBURY, D. M. (2007) Tracking mothers' attitudes to MMR immunisation 1996-2006. *Vaccine* **25**, 3996-4002
- STURM, L. A., MAYS, R. M. & ZIMET, G. D. (2005) Parental beliefs and decision making about child and adolescent immunization: from polio to sexually transmitted diseases. *Journal of Developmental and Behavioral Pediatrics* **26**, 441-452
- SUCHARD, M. A., HADFIELD, R., ELLIOTT, T. & KENNEDY, S. (1998) Beyond providing information: the internet as a research tool in reproductive medicine. *Human Reproduction* **13**, 6-7
- WISE, J. K., HEATHCOTT, B. L. & SHEPERD, A. J. (2003) Results of the 2002 AVMA survey of the US pet-owning households regarding use of veterinary services and expenditures. *Journal of the American Veterinary Medical Association* **222**, 1524-1525