



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Demographics and husbandry of pet cats living in Sydney, Australia: results of cross-sectional survey of pet ownership

Jenny-Ann LM Toribio ^{BVSc, PhD^{1,a}}, Jacqueline M Norris ^{BVSc, MVS, PhD, MASM, GradCertHigherEd^{1,a}}, Joanna D White ^{BVSc, MACVSc¹}, Nanveet K Dhand ^{BVSc&AH, MVSc, PhD, MACVSc¹}, Samuel A Hamilton ^{BSc(Vet), BVSc, MACVSc¹}, Richard Malik ^{DVSc, DipVetAn, MVetClinStud, PhD, FACVSc, FASM^{1,2*,a}}

¹Faculty of Veterinary Science, The University of Sydney, NSW 2006, Australia

²Centre for Veterinary Education, Conference Centre, Building B22, The University of Sydney, 2006, Australia

Our aim was to collect baseline data on the age, gender, breed, reproductive status and husbandry (housing, diet, vaccination, veterinary attention) of pet cats living in Sydney. Accordingly, a cross-sectional survey of 2768 households was conducted using a postal questionnaire. The 2006 Sydney residential phone book was used as the sampling frame. Non-responders were re-mailed the questionnaire on two further occasions, 2 and 4 weeks after the first posting. Completed questionnaires were received from 884 households. No pets were kept by 387 (43.8%) respondents. Dogs and cats were owned by 295 (33.4%) and 198 (22.5%) of households, respectively, with 7.8% of households having both cat(s) and dog(s). Fish and birds were the next most popular pets. Of the 198 cat-owning households, 54.0% kept only cat(s), while 46.5% kept cats with other pets. The distribution of cat ownership across Sydney was non-uniform. Each cat-owning household kept 1.3 cats on average, with the majority keeping one (75.8% households) or two (18.7%). For the 260 cats, the mean age was 7.1 years, the median 6 years, with a range of 3 months to 22 years. There were significantly more female (143; 55%) than male cats (117; 45%). Only seven cats (2.7%) were sexually entire, and these were all ≤ 6 years. Crossbred cats outnumbered pedigree cats by a ratio of 3.3:1. The Burmese was the most common breed, followed by the Persian. The median age of pedigree cats (5.5 years) was significantly lower than for domestic crossbred cats (7.0 years). Most cats were housed both indoors and outdoors (72.6%), with 19.7% being restricted to indoors and/or 'pet park enclosures'. Pedigree cats were significantly more likely than crossbreds to be housed indoors. Most owners fed their cats a combination of commercial dry and canned food (38.1%), although fresh meat was popular also and either fed alone (1.6%) or in combination with dry food (14.4%), tinned food (1.6%) or canned and dry food (25.8%). A diet consisting of dry food alone was fed to cats in 13.4% of households. Ninety percent of cats had been vaccinated at least once, while 72.2% received a vaccination in the last 3 years. Older cats were less likely to have been vaccinated recently than younger cats. Only 5.8% of cats had never visited a veterinarian. For the 243 cats that had received veterinary attention, the average number of years since the last visit was 1.5.

Date accepted: 14 June 2008

© 2008 ESFM and AAFP. Published by Elsevier Ltd. All rights reserved.

When studying the epidemiology of any naturally occurring disease in pet cats, it is vital to have accurate knowledge concerning the population from which affected cats are drawn.

*Corresponding author. E-mail: R.Malik@vetc.usyd.edu.au

^aThese authors contributed equally to this work.

There are certain questions that we invariably wish to answer, viz: Are male cats more likely to develop the given disease? Are pedigree cats under-represented in the affected cohort? Are older cats more likely to be affected? To properly address these questions, it is mandatory to possess quantitative data on the demographics of the reference (or general)

population of cats from the same geographical region in which the study was undertaken, and ideally for the same time period. Without this knowledge, accurate comparisons between affected and reference populations are not possible and important disease associations cannot be determined.

Thus, to make sense of any clinical investigation into the epidemiology of diseases affecting owned cats, we need to have a well characterised population of 'control' cats from which the diseased cohort is drawn. The same is equally true for human populations, and this is one of the reasons a census is conducted by the Australian Bureau of Statistics at regular intervals (<http://www.abs.gov.au/>). The key demographic factors germane to feline disease associations are age, gender, reproductive status (neutered versus entire) and breed. Other key husbandry factors that may impact on disease prevalence are lifestyle (indoor versus outdoor; sedentary versus active; single versus multi-cat household), diet and access to regular veterinary attention (for preventative health measures, eg, vaccination, parasite control, dental attention).

Very little information has been published in the scientific literature in relation to the owned cat population in Australia,¹⁻³ and only limited data are available concerning cats in countries overseas.⁴⁻⁹ Information can be obtained concerning the breakdown of pedigree cats registered by cat fancy organisations. This type of data, however, is limited in extent and sheds no light on the much larger population of domestic crossbred cats kept as pets and pedigree cats that are not registered.

Australian cat owners have been regularly surveyed by organisations such as the Petcare Information and Advisory Service, largely to provide information for marketing of commercial cat food and related products. Although limited information from these surveys concerning cat population dynamics has appeared,³ further relevant details have been withheld. The development of a simple but accurate model of the Australian feline pet population by the late Chris Baldock and colleagues has been of fundamental importance. Using this model, Baldock et al³ reported a decline in the proportion of Australian cat-owning households from 31% in 1994 to 26% in 1999. The number of cats per household remained relatively constant (at 1.5) over the same time period. The estimated total number of owned cats declined from 3.2 million in 1988 to 2.6 million in 1999, with 2.1 million predicted in 2005. This decrease in cat numbers was said to be a consequence of high rates of neutering (prior to reproduction) and a decline in the number of households taking up cat ownership. This was reflected by a small number of young cats in 'age pyramids' of the feline population, corresponding to a net decrease in the replacement rate of cats into the population, relative to the net rate of loss due to all causes. It was further predicted that this trend would continue, with a compound annual decrease of more than 1.9%.

Interestingly, it has been said that the greatest decline in cat numbers has been evident in the Sydney metropolitan area.² The paucity of data on the owned cat population of Sydney has forced investigators to use reference populations based on the overall cohort of cats attending either a single veterinary hospital/clinic, or a group of practices, over a set time period. Although better than nothing, this type of data is flawed. Firstly, many cats attending clinics are unwell and, therefore, not reflective of the reference population (comprised largely of healthy cats). Secondly, inclusion of disproportionately large numbers of young animals presented for vaccination and desexing introduces a potential source of bias. Thirdly, the veracity of the data recorded and captured by computerised software systems may be unreliable because of transcriptional and recording errors. Fourthly, an unknown proportion of owners do not present their cat(s) for regular veterinary attention, and this may be a reflection of socioeconomic factors such as household wealth which may indirectly impact on feline health. Finally, many studies have come from university veterinary clinics, and consequently are further biased by inclusion of many referred cases which may be even less representative of the wider cat population than cases seen at first opinion practices.

Our primary focus was to obtain, for the first time, accurate information pertaining to owned cats in the Sydney region. This intent was specifically to complement previous and ongoing investigations into renal disease;¹⁰ infectious diseases caused by feline coronavirus,^{11,12} feline leukaemia virus,¹³ feline immunodeficiency virus (FIV),¹⁴⁻¹⁶ *Cryptococcus* species,¹⁷ *Nocardia* species¹⁸ and *Mycobacterium* species;¹⁹ as well as lymphosarcoma²⁰ and other cancers. In all of these studies, inferences concerning potential associations between disease, and age and/or gender, were based on reference populations of hospital patients, which were likely not representative of healthy normal cats. Conducting the survey also provided an opportunity to collect other general data relevant to pet ownership and feline husbandry practices in particular.

Thus, the study reports results of a cross-sectional survey of households using a postal questionnaire to collect data on the age, gender, breed, reproductive status and husbandry (housing, diet, vaccination, veterinary attention) of the pet cat population in the Sydney metropolitan area.

Materials and methods

Selection of households

The reference (or general) population was pet cats in the Sydney metropolitan area. The unit of interest was the individual cat. Using standard formulae, we calculated a target sample size of 385 cats was required to measure gender proportions with 95% level of confidence and 5% acceptable error. In order to enroll a random sample of the general pet cat

population, we needed to contact a random sample of cat owners in Sydney. Based on the assumptions that in 2006 (i) 20% of households in Sydney owned cats, (ii) the average number of cats per cat-owning household was 1.4, and (iii) a response rate of 50% was achievable, a required sample size of 2750 households was calculated.

The 2006 Sydney residential telephone book (1893 pages; comprising about 90% of all households)³ was the sampling frame used in a systematic sampling method to select 2768 households for inclusion. The assistance of 101 undergraduates in the third year of the BVSc programme at the University of Sydney was enlisted. Each student was provided with one pre-selected page of the phone book. Phone book page selection was undertaken by the first author using a sampling interval of 19 with page selection based on a random number between one and 19 for the first, followed then by every 19th page.

Each student selected 28 households by (i) counting the number of households on the allocated page, (ii) calculating the sampling interval (i), (iii) identifying the first household based on a random number (x) between one and i and counting from the top left of the page down the first column to x th household, and (iv) then continuing to count down consecutive columns to select every i th household. Students then wrote the name and address of each selected household against a unique code on a record sheet and on an envelope.

Questionnaire and mailing

The two-page questionnaire covering seven topics (pet ownership; cat ownership; for cat-owning households – cat demographics, indoor/outdoor management, diet, vaccination status and veterinary visits) was designed for presentation as a folded A5 booklet with instructions for completion at the top of the first page. It was written in English and comprised of short closed, semi-closed and open questions. An introductory letter, prepared on University letterhead, was also included to explain the purpose of the study, requesting participation, and stating that responses were confidential. The questionnaire and introductory letter were piloted with six people of varying age, employment and pet ownership status. Some questions were subsequently modified to improve clarity. Estimated completion time was 2 min for non-pet owners, 4–5 min for pet owners and 10–15 min for multi-cat owners (depending on the number of cats owned). A copy of the questionnaire and introductory letter are provided as [Supplementary data](#).

With the assistance of third year veterinary students, the questionnaire, introductory letter and an addressed postage paid return envelope (labelled with the unique household code) were posted in a hand-addressed envelope to each selected household in September 2006. Students were required to look up the relevant postcode. Participation was encouraged by providing the incentive of entry into a prize draw for three \$100 grocery/petrol

vouchers upon receipt of the questionnaire by a specified date. Identical mailings were posted to non-responders 2 and 4 weeks after the first posting, following a modified version of the total design method protocol for postal questionnaire administration (two follow-up mailings at 3 and 7 weeks with a reminder postcard at 1 week).²¹ For the second mail out, students assisted with preparation, but not addressing of envelopes.

Within a few days of the first mail out over 400 envelopes had been returned by the postal service with 'insufficient address' details stamped on the envelope. Inspection of the returned envelopes suggested that some students did not competently address envelopes, failing to provide either the initial with the surname, the state (NSW) and/or the postcode; these minor deficiencies were corrected and the mail was re-posted immediately. Other envelopes were returned due to the absence of unit number in the phone book listing for some people living in large apartment blocks. By prompt searching of the Australian Electoral Commission computerised database, full address details were obtained and the mailing reposted to 178 of these households.

The procedure described for conduct of this study, including student participation, was approved by the Human Ethics Committee of the University of Sydney (Reference number 9256).

Data management and analysis

Data from the returned questionnaires were entered in a purpose-built relational database in Microsoft Access. Tables from this database were imported into SAS statistical software (release 9.1, 2002–03, SAS Institute, Cary, NC, USA) and descriptive analyses undertaken (frequencies for categorical data; mean, median and range for continuous data). Differences between groups were assessed using χ^2 tests for categorical variables of interest and Kruskal–Wallis tests for non-normal continuous variables of interest. To evaluate the spatial distribution of responses and cat ownership, address data were exported to MapInfo (MapInfo Professional 8.0, MapInfo Corporation, USA) and used to map households by local government area (LGA). The response rate per LGA was tested for homogeneity using the χ^2 test. For the spatial analysis of response rates and cat ownership, LGA with less than five responders were excluded.

To investigate the influence of age, gender and breed on owner management, we constructed separate generalised linear mixed models for five outcome variables – (1) indoor/outdoor management, (2) vaccinated ≤ 3 years ago, (3) vaccinated < 1 year ago, (4) never visited a veterinarian and (5) visited veterinarian > 1 year ago. Each model initially included age, gender and breed as fixed effects, and household as a random effect (to adjust for expected similarity in management among cats belonging to the same household), and then using a backward approach, only fixed effect variables significant at $P < 0.05$ were retained. A similar

approach to model construction was implemented for the two continuous outcome variables – (1) years since last vaccination and (2) years since last veterinary visit – after categorisation based on medians due to non-normal distribution.

Results

Questionnaire details and response rate

The questionnaire was posted to 2768 Sydney households based on the name and address listed in the Sydney residential phone book. A total of 478 (17.3%) were marked 'return to sender' for several reasons – insufficient address details (305), the person with listed surname no longer lived at the address (107), the envelope was refused or unclaimed at the address (10) and returned with no comment (56). All other questionnaires were assumed to have been correctly addressed thus received by the household. Thirty-nine LGAs had five or more received questionnaires.

A completed questionnaire was returned by 884 households located in 43 LGAs of Sydney resulting in a response rate of 31.9% for all households sent a questionnaire and 38.6% for households that received the questionnaire. Response rates of households receiving the questionnaire per LGA varied between 15.8% and 83.3%. This variation, when tested was shown to be relatively homogenous ($P = 0.11$), although there was a trend for a lower response rate from LGAs in western and south western Sydney. The spatial variation in response rate is presented in Fig 1.

Pet ownership

No pets were kept by 387 (43.8%) of the respondent households. Considering all respondent households,

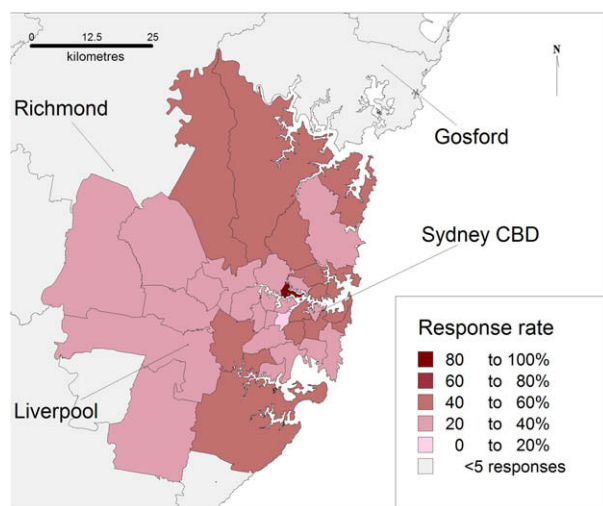


Fig 1. Spatial variation in the response rate according to LGA.

Table 1. Pets kept by 497 pet-owning households in Sydney during September 2006

Type of pet	Number	Percentage
Dog	295	59.4
Cat	198	39.8
Fish	116	23.3
Bird (including ducks)	77	15.5
Rabbit/guinea pig	27	5.4
Snake/lizard	5	1.0
Horse	4	0.8
Sheep/goat	3	0.6
Ferret	1	0.2
Other*	8	1.6

*Other pets included hermit crabs, worms, axolotls, yabbies and possums.

rather than pet-owning households, 33.4% owned dogs and 22.5% owned cats. Among the 497 (56.3%) pet-owning households, the most common pets were dogs (owned by 59.4% of households), cats (39.8%) and fish (23.3%) (Table 1). Two or more different types of pet(s) were kept by 172 (34.6%) households with the most common pet combinations being dog and cat (13.9% of households), followed by dog and fish (11.5%), dog and birds (8.9%), and cat and fish (6.0%).

Cat-owning households

Cats were kept by 198 households with 107 (54.0%) keeping only cats and 92 (46.5%) keeping cats along with other types of pets – most commonly dogs (69 households), fish (30) and birds (17).

Five or more responses were received from 39 of the total 43 LGAs. The percent of cat-owning households

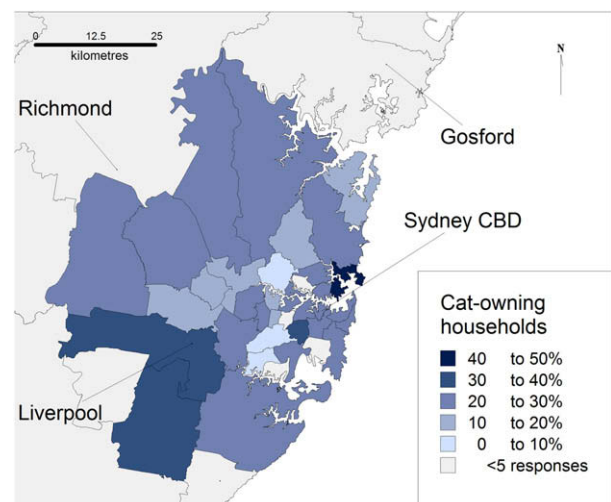


Fig 2. Percent of cat-owning households in the Sydney region according to LGA. The darker the shade, the greater proportion of cat-owning households.

Table 2. Types of food fed to cats owned by 194 households in Sydney during 2006*

Type of food	Number of households	Percentage
Dry food only†	26	13.4
Tinned food only‡	10	5.1
Meat only§	3	1.6
Dry food and tinned food	74	38.1
Dry food and meat	28	14.4
Tinned food and meat	3	1.6
Dry food, tinned food and meat	50	25.8

*Data missing for four households.

†Of these, 15 households fed premium dry cat food only, eight fed supermarket-purchased dry cat food only and three fed a combination of both.

‡Of these, one household fed meat-flavoured tinned food only, four fed fish-flavoured tinned food only and five fed a combination of both.

§All these households fed 'pet meat' (generally kangaroo) purchased from a pet shop or supermarket.

per LGA varied from 0 to 44% (Fig 2). Two LGAs to the north of the Sydney Central Business District (CBD) (Mosman and Manly), two in outer western Sydney (Campbelltown and Liverpool) and one in the inner west (Marrickville) were identified with high proportions of cat ownership (ie, $\geq 30\%$). Moderate levels (ie, 10–20%) were noted in regions to the immediate east, south and north of the Sydney CBD and in LGAs in the north-west fringe. On average each cat-owning household kept 1.3 cats (range 1–5), with the vast majority keeping one (75.8%) or two (18.7%) cats.

Close to 80% of households fed their cat(s) a diet consisting of more than one constituent, with 38.1% feeding a combination of extruded dry food and tinned food and 25.8% feeding dry food, tinned food and fresh meat (Table 2). In 36 households (18%) the cat(s) diet also included a food source other than pet food such as fresh fish or prawns, canned fish, chicken, beef steak or mince, cooked rice or vegetables, and 'left-overs'. Dry food was a component of the diet given to 233 cats (89.6%) (data were missing for four cats from four households). Owners reported inclusion of 'premium dry food' in the diet of 100 (38.5%) study cats; this was influenced by breed (with crossbred cats less likely to receive premium dry food than pedigree cats) but not age or gender (see Table 5).

Owned cats

The 198 cat-owning households kept a total of 260 cats with a mean age of 7.1 years (median 6.0, range 0.25–22) and an uneven gender split of 117 (45.0%) males and 143 (55.0%) females (Table 3). The distribution of ages and gender is provided as an 'age gender pyramid' (Fig 3), to facilitate comparisons with a previous Australia-wide survey.³ Only seven cats were sexually entire (five males, two females) and these were all ≤ 6 years old. The proportion of females was higher than males in four age categories over 10 years; this difference was statistically significant when cats ≤ 10 years and > 10 years were compared (χ^2 ; $P = 0.02$).

Among the 260 cats, there were 196 domestic cross-breeds (76.6%) and 60 purebreds (23.4%) (missing values for four cats; Table 4). Of the domestic cross-bred group, 89.8% were short hairs, the remainder long hairs. Short-haired purebreds made up the majority of pedigree cats (76.7%). The Burmese (15) was the most common short-haired pedigree breed, while among the long-haired pedigree breeds the Persian

Table 3. Age and gender of 260 cats kept by 198 households in Sydney during 2006

Age (years)	Male			Female		
	Neutered	Entire	% Total for each age group	Neutered	Entire	% Total for each age group
≤ 2	20	1	48.8	22	0	51.2
3–4	21	2	46.0	26	1	54.0
5–6	22	1	54.8	18	1	45.2
7–8	18	1	47.5	21	0	52.5
9–10	12	0	46.2	14	0	53.8
11–12	6	0	31.6	13	0	68.4*
13–14	9	0	47.4	10	0	52.6*
15–16	2	0	14.3	12	0	85.7*
17–18	1	0	20.0	4	0	80.0*
≥ 19	1	0	50.0	1	0	50.0
Total	112	5	45.0	141	2	55.0

*Proportion of female cats was significantly higher than for male cats.

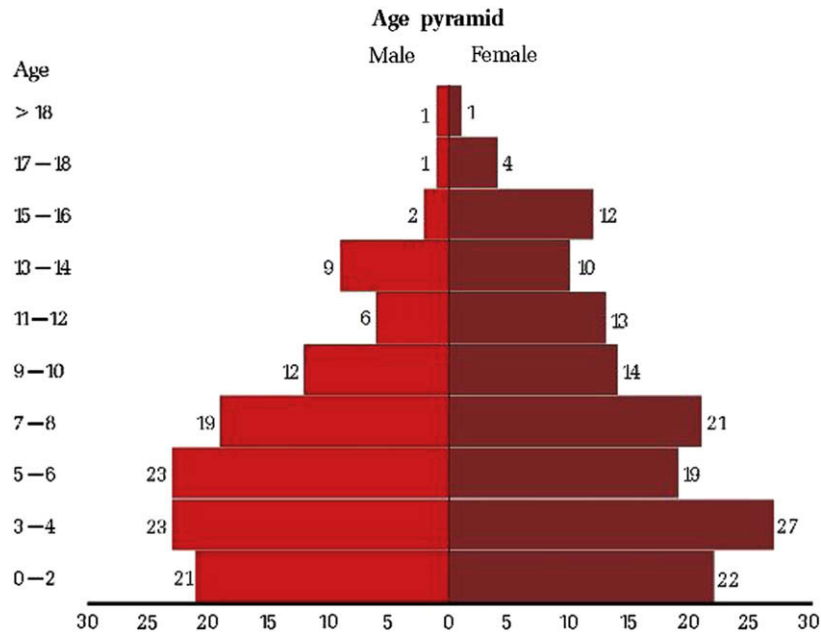


Fig 3. Age pyramid for 260 cats kept by 198 households in Sydney during 2006.

(seven) and Ragdoll (five) were most common. The median age of pedigree cats (5.5; mean 5.9, range 0.3–16) was significantly lower than for domestic cats (7.0; mean 7.5, range 0.6–22; $P = 0.04$).

Indoor/outdoor management

Only 51 (19.7%) cats were kept exclusively indoors or in 'modular cat parks' (<http://www.catnip.com.au/>) or similar secure enclosures. In contrast, 188 (72.6%) cats were allowed to spend some time indoors and outdoors each day, while only 20 (7.7%) spent most of the time outdoors (data missing for one cat). Owner

management of time spent outdoors was not influenced by age or gender, but was significantly influenced by breed, with crossbreds nearly four times more likely to spend time outdoors than pedigree cats (Table 5).

Vaccination status

Of 259 cats for which vaccination status was reported, a total of 233 (90.0%) cats had been vaccinated at least once and 187 (72.2%) within the last 3 years (Fig 4). Age was found to significantly influence vaccination within the last 3 years (younger cats more likely vaccinated), but not gender, nor breed (Table 5). Recent vaccination (within the last year) was significantly influenced by age ($P = 0.0005$). For breed, although non-significant ($P = 0.09$), there was a trend towards pedigree cats having a higher likelihood of vaccination during the last year than crossbred cats (adjusted odds ratio (OR) 2.1, 95%CI 0.9–5.1).

Veterinary visits

Only 15 (5.8%) cats were reported to have never visited a veterinarian. As only seven cats were sexually entire according to their owners, eight cats presumably had been acquired after they had been desexed, which is quite conceivable as most shelters in Australia only sell neutered kittens and cats.

For 243 cats that had attended a clinic, the mean number of years since last visit was 1.5 (median < 1.0 year, range 0–22; Fig 5). Reported reasons for this most recent consultation available for 238 cats are presented in Table 6. Whether or not a cat had visited

Table 4. Breed category of 256 cats kept by 198 households in Sydney during 2006*

Breed	Number	Percentage
Domestic shorthair	176	68.7
Domestic longhair	20	7.8
Pedigree shorthair†	46	18.0
Pedigree longhair‡	14	5.5

*Data missing for four cats.

†Pedigree short-haired breeds included Burmese (15), British shorthair (six), Tonkinese (four), Birman (four), Siamese (three), Australian Mist (three), Russian Blue (two), Burmilla (two), Bengal (one), Cornish Rex (one), Devon Rex (one), Korat (one), Sphynx (one) plus two pedigree-cross cats.

‡Pedigree longhair breeds included Persian (seven), Ragdoll (five) and Norwegian Forest (one) plus two pedigree-cross cats.

Table 5. Final generalised linear mixed models for four aspects of owner management of cats kept by households in Sydney during 2006

Model/parameters	<i>B</i>	Adjusted OR	OR LCL	OR UCL	<i>P</i>
<i>Model for indoor/outdoor management*</i>					
Household random effect	1.26				
Constant	0.57				
Breed					0.002
Domestic	1.32	3.75	1.69	8.33	
Pedigree		1			
<i>Model for premium dry food†</i>					
Household random effect	1.61				
Constant	0.07				
Breed					0.05
Domestic	-0.77	0.46	0.22	0.99	
Pedigree		1			
<i>Model for vaccinated ≤3 years ago‡</i>					
Household random effect	1.77				
Constant	2.44				
Age	-0.16	0.85	0.79	0.92	0.0002
<i>Model for visited veterinarian >1 year ago§</i>					
Household random effect	0.57				
Constant	-0.78				
Age	0.10	1.11	1.04	1.18	0.003

LCL = lower confidence interval, UCL = upper confidence interval.

*Final model for indoor/outdoor management included 255 cats. The outcome was coded as 1 = indoor and outdoor or outdoors only and 0 = indoors only.

†Final model for inclusion of premium dry food in the diet included 256 cats. The outcome was coded as 1 = premium dry food and 0 = other type of dry food.

‡Final model for vaccination ≤3 years included 259 cats.

§Final model for last visited a veterinarian >1 year ago included 243 cats.

a clinician was not influenced by the cat's age, breed or gender. For cats that had visited a veterinarian, the likelihood that the last visit was >1 year ago was not influenced by breed or gender, but did increase with age (Table 5).

Discussion

Study design

A modification of the total design method for questionnaire design and implementation was applied to this study in order to maximise the response rate. Although the response rate achieved was less than anticipated (resulting in the recruitment of less cat-owning households), we consider it to be within acceptable limits given the sampling frame used. Other recent surveys of animal owners using a similar approach but using targeted sampling frames (eg, client lists of equine veterinary practices; owner list of a dog kennel club) achieved response rates of 50.1–65.7% with return to sender losses of 7.2–21.8%.^{22–24} The low return to sender loss of 7.2% achieved by Hotchkiss

et al²⁴ is likely due to mailing software used to verify horse owner addresses supplied by veterinary clinics prior to first posting. This study, in contrast, despite considerable effort taken with questionnaire design and administration, achieved a lower response rate due to use of a non-targeted sampling frame and the lower priority questionnaire return for ordinary households compared to horse or pedigree dog-owning households. However, given the study objective, use of a non-targeted sampling frame in this study was essential to ensure representation of all types of pet cat-owning households, and for future work, the response rate achieved clearly demonstrated that a general survey will obtain fewer responses than a targeted survey.

Considering that 2768 households were initially contacted, the difficulty and cost of obtaining a substantial dataset by using a well designed cross-sectional survey is easily appreciated. We estimate that the cost of conducting this survey was in excess of \$A10,000 (to cover postage of three mail outs, stationary, inducements and database management), not counting the labour provided gratis by students, Centre for Veterinary Education (CVE) staff and co-authors.

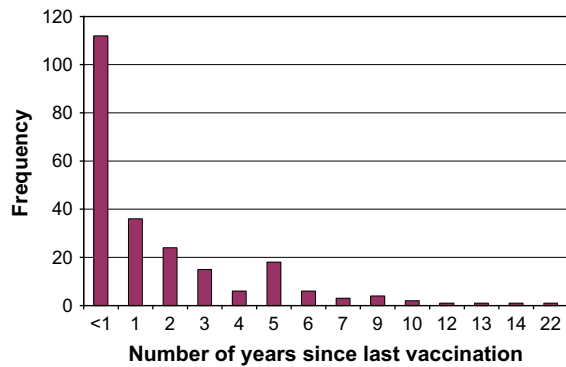


Fig 4. Distribution of cats according to number of years since last vaccination as reported by owners of 230 cats in Sydney during 2006.

Similar to other researchers seeking to obtain information on pet demographics and management, we encountered issues that introduced bias. Use of the telephone directory as the sampling frame for random recruitment of households introduced selection bias. By definition, people without a land line were not included and this may have excluded households of especially low socioeconomic standing. Likewise, households using a mobile phone exclusively or using broad band internet telephony would not have been sampled, possibly underestimating certain demographic groups. In addition, we are aware that some envelopes returned due to insufficient address details belonged to households living in large apartment complexes that could not be delivered due to lack of the apartment number. With the benefit of hindsight, we may have been better served by using randomly selected entries from the electoral rolls, as data on the specific residential address and the exact postcode were more complete than in the phone book. However, choosing the electoral roll as the sampling frame would also have introduced selection bias due to under-

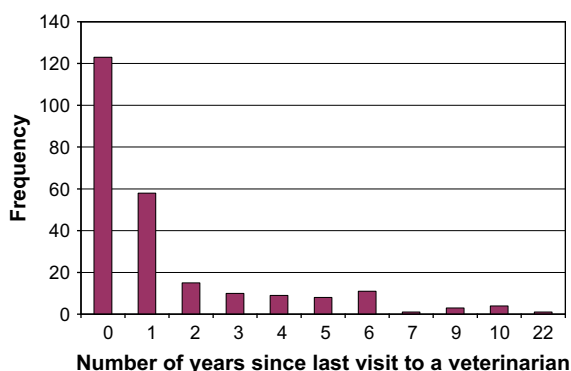


Fig 5. Distribution of cats according to number of years since last visit to a veterinarian as reported by the owners of 243 cats in Sydney during 2006.

Table 6. Reason for last visit to a veterinarian by 238 cats in Sydney

Reason for visit	Number	Percentage
Vaccinations	115	48.3
Other*	21	8.8
Abscess/fight	18	7.6
Injury	16	6.7
Neuter	15	6.3
Teeth	15	6.3
Not well†	13	5.5
Urinary tract problem	7	2.9
Tumour/cancer	6	2.5
Skin problem‡	8	3.4
Board/groom§	4	1.7

*Owner reported one of the following: birth defect, blood donor, eye problem, ongoing treatment, paralysis tick, spider bite, tail amputation, throat problem, ear problem, vaccination reaction.

†Owner reported one or more of the following: fever, lethargy, not eating, diarrhoea, vomiting.

‡Owner reports indicated skin allergy, dermatitis, mites or fleas.

§Owner reported cat was boarded, groomed, nail-clipped or microchipped.

representation of certain demographic groups and to loss of households due to outdated address information (unless conducted in close proximity to an election).

Other potential forms of bias worth considering in this type of study are selection bias arising from differences in responders and non-responders, and measurement bias resulting from type of information sought and presentation of the questionnaire. Pet owner non-response could be a surrogate indicator for management practices that relate to both outcome and risk factors. Level of potential response bias, ie, bias arising from responders tending to be more diligent pet owners, is inherently difficult to estimate due to the limited information available about non-responders. Plotting the distribution of non-responders according to LGA identified a wide variation in response rate (16–83%), although this could not be clearly correlated with socioeconomic geographic variables.

Impressively, all returned questionnaires were usable (as achieved by Hotchkiss et al²⁴ but not Cole et al²² or Reisner et al²³) and there was little missing data. It is, therefore, evident that the questionnaire used was well structured and contained clear, unambiguous questions which helped to avoid introduction of measurement bias due to differences in respondents' question interpretation. Questions on vaccination status and veterinary visits, however, relied on owner memory (particularly if not recent events) which may have led to some misclassification of outcome due to recall bias.

Pet ownership

Approximately 44% of households did not contain any pets. Interestingly, 45% of households in Perth likewise did not have any pets in a telephone survey conducted 17 years ago.²⁵ It may be in the interest of veterinarians, pet food manufacturers or animal welfare groups to define the social and demographic features of this group, so it can be more effectively targeted for the proactive acquisition of appropriate pets.

It was not surprising that dogs and cats were the most popular pets, living in approximately 33% and 23% of households, respectively, with 8% of households owning both cat(s) and dog(s). A survey of pet ownership in Perth²⁵ found quite similar findings, with 34.1% of households owning a dog, 28.6% owning a cat, with both dog(s) and cat(s) being owned by 5.6% of households. Our data are in general agreement with the predicted decline in the percentage of cat-owning households reported for Australia as a whole (from 31% to 26% over the period 1994–1999).³ It is not possible to say whether the further decline in cat ownership in Sydney (to 23% in 2006) is a real phenomenon reflecting the trend demonstrated previously, or attributable to a difference between cats in the Sydney region compared to cats recruited from around the whole country. The former seems more likely, given that industry data continues to indicate the Australian cat population is in decline, with estimates in the popular press suggesting the current owned cat population to be 2.1 million. The continuing decrease in the number of pet cats in Australia contrasts with the increasing popularity of the cat as a companion animal in North America and the UK, where it has superseded the dog in most recent surveys.²⁶ Indeed, in the USA, the compound annual increase in the cat population is said to be somewhere between 1.2 and 1.9%,^{6,26} while the figure in the UK is 1.9% (Magnosi 1999; cited by Ref. 3). The lack of duplication of this trend in Australia, despite lifestyle changes which make cat ownership arguably more rational than dog ownership (as cats have greater independence; less requirement for exercise; less food, boarding and veterinary expenses, etc.), re-emphasises issues raised previously by Baldock et al.³

A number of strategies can be suggested to help reverse this trend. Firstly, promoting responsible cat ownership with restriction of cats largely to indoors would reduce publicity associated with the alleged negative impact of pet cats on wildlife. Secondly, placing greater emphasis on proactive cat ownership (eg, through veterinary or industry subsidised cat adoption schemes) may result in increased take-up of cats into households. Finally, embracing breeding and showing of domestic crossbred cats and promotion of their sale through appropriate outlets would specifically assist in the decline of the outbred domestic cat population. This might circumvent problems associated with a higher proportion of pedigree cats, such as a larger number of genetically programmed disease conditions.

The large number of households that kept fish is noteworthy, and should be considered by small animal clinicians and veterinary educationalists when constructing curricula and continuing education programs, considering that this species is more commonly kept than birds, rabbits, ferrets or 'pocket pets'.

Cat-owning households

Data on cat ownership could be gleaned from 198 households. Considering that 2768 households were initially contacted, the difficulty in obtaining large number of data points using rigorously designed cross-sectional surveys is emphasised. In studies by Baldock and collaborators,³ between 6000 and 12000 phone interviews were typically conducted each year by AC Nielsen Research using a computerised interviewing system; the number of 'successful' interviews was, however, not revealed.

Whilst cats were exclusive pets in 54% of the cat-owning households, they were kept together with other pets – mainly dogs, fish and birds – in the remaining instances. This counters the belief that cat owners dislike dogs and indicates that interspecies disease transmission should be considered by veterinarians providing advice on diseases which can be transmitted from cat to dog (and vice versa). For example, with fleas and the dermatophyte *Microsporum canis*, for which one species can act as the asymptomatic reservoir for the other, co-ownership needs to be considered in treatment and prevention strategies.

The geographic distribution of cat-owning households throughout the Sydney region did not appear uniform, and the reasons for heterogeneity are currently uncertain. The five LGAs with the highest proportion of cat-owning households (Mosman, Manly, Marrickville, Liverpool and Cambelltown) are very diverse in terms of socioeconomic status and density of housing, making it difficult to develop plausible hypotheses regarding factors affecting household cat ownership. To gain a better understanding of the demographics of cat-owning households it would be necessary to include questions relating to factors of interest (eg, ethnicity, religion, cultural beliefs, household income and dwelling type) in future questionnaires. Gleaning such information may provide useful insights relevant to the promotion of active cat ownership.

Single versus multi-cat households

The majority of cat-owning households contained only one (75.8%) or two (18.7%) cats, with an average number of 1.3. This is slightly less than the average of 1.47 recorded in previous surveys of Australian cats (Alexander 2000; cited by Ref. 3), but almost identical to the survey of Perth pets where an average of 1.32 cats were kept by cat-owning households.²⁵ It is the authors' view that keeping more than two or three cats increases likelihood of behavioural anomalies

(such as inappropriate urination and aggression) and transmission of infectious disease agents (such as feline coronaviruses),¹² so it is gratifying that such problems are likely to be encountered in less than 5% of respondent households.

Diets

As expected, the majority of cat owners fed a heterogeneous diet consisting of dry and canned food (38.1%) or commercial (dry and/or canned) food and fresh meat (41.8%) to their cats. Only 1.6% of households fed fresh meat alone, providing a potential explanation why thiamine deficiency is so rare in clinical practice despite the widespread use of sulphite preservatives in kangaroo meat designated for consumption by pets.²⁷ This is because diets containing constituents other than 'pet meat' typically contain sufficient thiamine to prevent development of a deficiency state, especially if the other foods are fed at a different time of day. It was interesting that few owners commented on feeding chicken wings or drumsticks, or other types of 'raw meaty bones', despite the perceived health and behavioural benefits of eating this type of ration as a component of the diet.^{28,29} Interestingly, some 13% of households fed a diet consisting exclusively of dry cat food; the majority of these (18/26 households) fed 'premium diets' obtained from veterinarians or pet stores. Recent data have emphasised that it is 'unphysiological' to exclusively feed a calorically dense, high fat/high carbohydrate diet to a species that evolved as an obligate carnivore.³⁰ Feeding of such high glycaemic index diets, especially when they are fed 'free choice' (ie, virtually *ad libitum*), has been linked with the development of obesity, diabetes mellitus, hepatic lipidosis, osteoarthritis and idiopathic cystitis.³⁰⁻³³ As pedigree cats were more likely to be fed such diets according to our survey, the increased risk of these conditions in certain breeds may be related to dietary factors, additional genetic predispositions, or the interaction between these factors.

Age, gender and reproductive status of owned cats

The demographics of the sampled feline population were of great interest. The mean and median ages (approximately 7 and 6 years, respectively) were higher than has been reported previously for feline populations overseas where the recorded mean and median ages of cats are in the order of 3-5 years.⁴⁻⁹ Presumably this is in accord with the notion that cats are currently living longer than in the past. Although there is no direct evidence, possible explanations may include changes in husbandry and preventative disease measures, such as vaccination, widespread neutering, increased dental care, decreased free-roaming tom cats, and implementation of 'cat curfews', with attendant health benefits of reduced vehicular trauma

events, less cat fight infections and so forth. The 'ageing' of the feline population is also consistent with the current decline in the owned cat population, reflecting the impact of widespread desexing prior to sexual maturity resulting in smaller number of kittens being born each year as a proportion of the entire feline population.

Importantly, approximately 97% of cats were neutered. This is higher than the 84.5% reported for pet cats in Perth in 1990,²⁵ and substantially higher than in surveys of cats from overseas. Clearly, it is germane to the analysis of Australia's declining pet cat population.

The overall preponderance of female cats, especially for older age groups, is a critical finding and must be borne in mind when assessing alleged over-representation of one gender over another in relation to particular diseases. A decrease in the male to female ratio with age was also detected in a telephone survey of pet ownership in Perth.²⁵ The most likely explanation for this is a greater morbidity and mortality associated with behaviours of young male cats, such as the propensity to roam and fight, and thus be at risk for vehicular trauma, falls and infections related to fighting (bite abscesses, FIV and infections with environmental saprobes).^{34,35} The tendency for this difference to be accentuated in cats older than 10 years may represent the impact of a cumulative risk over a normal life-span, but it is possible also that delayed effects are referable to the lag period for long-standing FIV infection to cause terminal conditions, eg, lymphoma.¹⁵ As has been emphasised recently in a study of renal disease in Australian cats,¹⁰ the male:female ratio in 'normal cats' must be considered when looking for gender associations in specific diseases. Conditions previously documented to have a male preponderance, such as FIV infection^{15,16} lymphosarcoma,²⁰ nocardiosis,¹⁸ feline infectious peritonitis¹¹ and cryptococcosis¹⁷ would be even more likely to be strongly linked with male gender considering the data for normal cats presented here.

Breed considerations

The ratio of crossbred cats to pedigree cats was approximately 3.3:1. Amongst the domestic crossbreds, shorthairs were approximately nine-times more common than longhairs. Interestingly, Burmese was the most popular breed (15/60 pedigree cats; 25%) and to our knowledge Australia is the only country in which this breed is pre-eminent. Data from the NSW Cat Fancy Association are consistent with our survey in that 30% of kittens registered in the 2006 financial year were Burmese. In Europe and North America the Siamese/Oriental, Maine Coon and Persian breeds tend to predominate.³⁶ Perhaps this is why hereditary diseases of Burmese cats such as hypokalaemic polyomyopathy,³⁷ cutaneous aesthesia (Greg Burton,

personal communication), storage diseases, the propensity to develop diabetes mellitus³⁸ and lipid aqueous^{39,40} have a high index of suspicion for Australian clinicians.

Many published surveys of disease concerning Australian cats quote reference hospital populations that comprise 30%, or even 46% pedigree cats,¹⁶ rather than the 23.4% recorded in this survey. This is potentially because owners of purebred cats are more likely to seek veterinary attention and especially referral to specialist centres compared to 'moggies'. Alternatively, pedigree cats may actually be more likely to develop various disease conditions than crossbred cats. With the availability of the data presented here, it will be straightforward to perform comparative statistical analyses to help distinguish between these possibilities, at least when considering feline data drawn from the Sydney metropolitan region.

In this study pedigree cats were found to be younger than crossbreds. This may indicate that pedigree cats are less long-lived than their domestic crossbred cats and therefore have a higher 'turnover'. Data on longevity of cats would be required to confirm this and should be a focus for further work.

Lifestyle

Most cats (72.9%) lived an indoor/outdoor lifestyle, presumably with most owners attempting to bring them indoors at dusk to reduce the likelihood of fighting with unrestrained tom cats at night or being subjected to vehicular trauma. A further 7.7% of cats were limited to spending most of their life outdoors. Only 19.7% of cats were limited to indoors and/or 'modular pet park' type enclosures, with pedigree cats four times more likely to be housed in this fashion than crossbreds. Although there may be some behavioural issues with an exclusively indoor lifestyle, there is no doubt in the authors view that cats restricted to an environmentally enriched indoors setting and prevented from becoming obese have substantial health and longevity benefits compared to cats with access to outdoors, with the attendant risks of vehicular trauma, degenerative joint disease (from jumping and falling) and diseases transmitted by cat fights, including FIV.

Vaccination status

An impressive 90% of cats had been vaccinated at least once, and 72.2% had been vaccinated in the last 3 years, a time frame expected to produce protective humoral immunity against the three 'core' viral diseases of cats.⁴¹ This data, although potentially influenced by response bias, appears to contradict the commonly touted statement that 'there is a large, unknown number of owned pets that never or rarely attend veterinary practices'.² Indeed, the data points towards success in preventive medicine campaigns

by veterinarians, and provides a potential explanation for the rare occurrence of feline infectious enteritis/panleukopenia in Sydney, and for the reduction in severity and prevalence of feline upper respiratory disease compared to the 1960s and 1970s (Victor Menrath, Daria Love and Richard Malik, personal observations). There was a trend for pedigree cats to have more likely received a vaccination during the preceding 12 months compared to crossbred cats. Older cats were significantly less likely to have been vaccinated in the preceding 3 years compared to younger cats. Although this possibly echoes the recent trend to recommend 3-yearly vaccinations for mature cats, it also may equally reflect owner's perceptions that older cats require less frequent vaccinations.

Veterinary visitation

Only 5.8% of cats were reported to have never attended a veterinary clinic. For the remaining 94.2%, the mean period since the last visit was 1.5 years. This suggests that most cat owners are prepared to regularly seek veterinary services as required, or to respond to postal reminder systems for annual 'wellness examinations'. The reported reason for veterinary visits includes a broad range of ailments and procedures. Vaccinations, neutering, traumatic injuries including cat fight abscesses and teeth/gum issues accounted for the majority of consultations. Similar to the finding for vaccination, older cats were significantly more likely to have visited a veterinarian >1 year ago compared to younger cats. This reduction in likelihood of veterinary attention with age probably reflects that neutering and traumatic injury are less common among older cats and also that some owners believe they require less frequent vaccinations.

Concluding comments

This survey has provided many insights into pet ownership in general, and cat ownership in particular. The authors hope it will 'open the door' to more detailed studies and surveys of cat and dog related health and longevity issues, in Australia and elsewhere. Without this type of objective data, it is not possible to make informed decisions and recommendations in relation to pet ownership, preventative medicine, the need for veterinary services and a true understanding of human animal relationships.

Acknowledgments

The study was generously funded by the Valentine Charlton Bequest of the CVE of Veterinary Science of the University of Sydney. The help and enthusiasm of the graduating year of 2008 were instrumental in conducting the mail out. The staff of the CVE assisted greatly in the second and third

mail outs, and also in the general handling of correspondence. Ms Nicole Schembri provided timely assistance with construction of the relational database. Dr Nigel Perkins made many incisive and helpful suggestions that helped crystallise our vision for this study, and he suggested the involvement of one of the senior authors (J-A LMT). The paper is dedicated to the memory of Dr Chris Baldock who did the ground breaking work concerning modelling owned cat populations in Australia and Professor Daria Love whose involvement with the Cat Protection Society was of seminal importance to this survey.

Supplementary data

Supplementary data associated with this article can be found in the online version, at [doi:10.1016/j.jfms.2008.06.010](https://doi.org/10.1016/j.jfms.2008.06.010).

References

- Paxton DW. Dog and cat keeping in the Australian Capital Territory. *Aust Vet J* 1993; **1994**(71): 27–8.
- McGreevy PD, Fourgere B, Collins H, Bartimote KM, Thompson PC. Trends in the populations of cats and dogs attending Sydney Metropolitan Practices. *Aust Vet J* 2002; **80**: 740–5.
- Baldock FC, Alexander L, More SJ. Estimated and predicted changes in the cat population of Australian households from 1979 to 2005. *Aust Vet J* 2003; **81**: 289–92.
- Schneider R, Vaida ML. Survey of canine and feline populations: Alameda and Contra Costa Counties, California, 1970. *J Am Vet Med Assoc* 1975; **166**: 481–6.
- Nasser R, Mosier JE. Feline population dynamics: a study of Manhattan, Kansas, feline population. *Am J Vet Res* 1980; **43**: 167–70.
- Nasser R, Mosier JE. Projections of pet populations from census demographic data. *J Am Vet Med Assoc* 1991; **198**: 1157–9.
- Nasser R, Fluke J. Pet population dynamics and community planning for animal welfare and animal control. *J Am Vet Med Assoc* 1991; **198**: 1160–4.
- Leslie BE, Meek AH, Kawash GF, McKeown DB. An epidemiological investigation of pet ownership in Ontario. *Can Vet J* 1994; **35**: 218–22.
- Patronek GJ, Beck AM, Glickman LT. Dynamics of dog and cat populations in a community. *J Am Vet Med Assoc* 1997; **210**: 637–42.
- White JD, Norris JM, Baral RM, Malik R. Naturally-occurring chronic renal disease in Australian cats: a prospective study of 184 cases. *Aust Vet J* 2006; **84**: 188–94.
- Norris JM, Bosward KL, White JD, Baral RM, Catt MJ, Malik R. Clinicopathological findings associated with feline infectious peritonitis in Sydney, Australia: 42 cases (1990–2002). *Aust Vet J* 2005; **83**: 666–73.
- Bell ET, Malik R, Norris JM. The relationship between the feline coronavirus anti-body titre and the age, breed, gender and health status of Australian cats. *Aust Vet J* 2006; **84**: 2–7.
- Malik R, Kendall K, Cridland J, Coulston S, Stuart A, Snow D, Love DN. Prevalences of feline leukaemia and feline immunodeficiency virus infection in cats in Sydney. *Aust Vet J* 1997; **75**: 323–7.
- Norris JM, Packiarajah MJD, Malik R, Love DN. Associations amongst age, feline immunodeficiency virus status and periodontal disease in domestic cats in Australia. *Aust Vet Pract* 1999; **29**: 74–8.
- Gabor LJ, Love DN, Malik R, Canfield PJ. Feline immunodeficiency virus status of Australian cats with lymphosarcoma. *Aust Vet J* 2001; **79**: 540–5.
- Norris JM, Bell ET, Hales L, et al. Prevalence of feline immunodeficiency virus infection in domesticated and feral cats in eastern Australia. *J Feline Med Surg* 2007; **9**: 300–8.
- O'Brien CR, Krockenberger MB, Wigney DI, Martin P, Malik R. A retrospective study of feline and canine cryptococcosis in Australia from 1981 to 2001: 195 cases. *Med Mycol* 2003; **42**: 449–60.
- Malik R, Krockenberger MB, O'Brien CR, et al. Nocardia infections in cats: a retrospective multi-institutional study of 17 cases. *Aust Vet J* 2006; **84**: 235–45.
- Malik R, Hughes MS, James G, et al. Feline leprosy: two different clinical syndromes. *J Feline Med Surg* 2002; **4**: 43–59.
- Gabor LJ, Malik R, Canfield PJ. Clinical and anatomical features of lymphosarcoma in 118 cats. *Aust Vet J* 1998; **76**: 725–32.
- Dillman DA. Mail and telephone surveys: the total design method. (2nd edn) New York: John Wiley & Sons, 2000.
- Cole FL, Hodgeson DR, Reid SWJ, Mellor DJ. Owner-reported equine health disorders: results of an Australia-wide postal survey. *Aust Vet J* 2005; **83**: 490–5.
- Reisner IR, Houpert KA, Shofer FS. National survey of owner-directed aggression in English Springer Spaniels. *J Am Vet Med Assoc* 2005; **227**: 1594–603.
- Hotchkiss JW, Reid SWJ, Christley RM. A survey of horse owners in Great Britain regarding horses in their care. Part 1: horse demographic characteristics and management. *Equine Vet J* 2007; **39**: 294–300.
- Robertson ID, Edwards JR, Shaw SE, Clark WT. A survey of pet ownership in Perth. *Aust Vet Pract* 1990; **20**: 210–4.
- Wise JK, Yang JJ. Dog and cat ownership, 1991–1998. *J Am Vet Med Assoc* 1994; **204**: 1166–70.
- Malik R, Sibraa D. Thiamine deficiency due to sulphur dioxide preservative in 'pet meat' – a case of déjà vu. *Aust Vet J* 2005; **87**: 408–11.
- Lonsdale T. Raw meaty bones promote health. Rivetco, 2001.
- Malik R. Feeding cats for health and longevity: a personal perspective. The Veterinarian 2007. http://www.rawmeatybones.com/articles-others/Malik_feedingcats_Aug2007.pdf; 2007. [accessed 05.05.08].
- Zoran DL. The carnivore connection to nutrition in cats. *J Am Vet Med Assoc* 2002; **221**: 1559–67.
- Gunn-Moore DA. Feline lower urinary tract disease. *J Feline Med Surg* 2003; **5**: 133–8.
- Bartges JW, Kirt CA. Nutrition and lower urinary tract disease in cats. *Vet Clin N Am Small Anim Pract* 2006; **36**: 1361.
- German AJ. The growing problem of obesity in dogs and cats. *J Nutr* 2006; **136**(suppl): 1940S–6.
- Love DN, Malik R, Norris JM. Bacteriological warfare amongst cats: what have we learned about cat bite infections? *Vet Microbiol* 2000; **74**: 179–93.

35. Malik R, Vogelnest L, O'Brien CR, et al. Infections and some other conditions affecting the skin and subcutis of the naso-ocular region of cats – clinical experience 1987–2003. *J Feline Med Surg* 2004; **6**: 383–90.
36. McCann TM, Simpson KE, Shaw DJ, Butt JA, Gunn-Moore DA. Feline diabetes mellitus in the UK: the prevalence within an insured cat population and a questionnaire-based putative risk factor analysis. *J Feline Med Surg* 2007; **9**: 289–99.
37. Jones BR, Swinney GW, Alley MR. Hypokalaemic myopathy in Burmese kittens. *N Z Vet J* 1988; **36**: 150–1.
38. Rand J. Current understanding of feline diabetes: part 1, pathogenesis. *J Feline Med Surg* 1999; **1**: 143–53.
39. Hardman C, Stanley RG. Blue eye in a cat. *Aust Vet J* 1998; **76**: 595–6.
40. Kluger EK, Hardman C, Govendir M, et al. Triglyceride response following an oral fat tolerance test in Burmese cats, other pedigree cats and domestic crossbred cats. *J Feline Med Surg*, in press.
41. Day MJ, Horzinek MC, Schultz RD. Compiled by the vaccination guidelines group (VGG) of the world small animal veterinary association (WSAVA). *J Small Anim Pract* 2007; **48**: 528–41.

Available online at www.sciencedirect.com

