J Vet Intern Med 2009;23:1175–1183

Mortality of Life-Insured Swedish Cats during 1999–2006: Age, Breed, Sex, and Diagnosis

A. Egenvall, A. Nødtvedt, J. Häggström, B. Ström Holst, L. Möller, and B.N. Bonnett

Background: A cat life insurance database can potentially be used to study feline mortality.

Hypothesis: The aim was to describe patterns of mortality in life-insured Swedish cats.

Cats: All cats (< 13 years of age) with life insurance during the period 1999–2006 were included.

Methods: Age-standardized mortality rates (MR) were calculated with respect to sex (males and females), age, breed, and diagnosis. Survival to various ages is presented by time period and breed.

Results: The total number of cats insured was 49,450 and the number of cat-years at risk (CYAR) was 142,049. During the period, 6,491 cats died and of these 4,591 cats (71%) had a diagnosis, ie, were claimed for life insurance. The average annual MR was 462 deaths per 10,000 CYAR (95% confidence interval, 431–493). Sex-specific rates did not differ significantly. The overall mortality of the Persian and the Siamese groups was higher than that of several other breeds. Overall and breed-specific (for most breeds) survival increased with time when analyzed by 2-year periods. The 6 most common diagnostic categories (ignoring cats recorded as dead with no diagnosis) were urinary, traumatic, neoplastic, infectious, cardiovascular, and gastrointestinal. The MR within diagnostic categories varied by age and breed.

Conclusions and Clinical Importance: In this mainly purebred, insured cat population, the overall mortality varied with age and breed but not with sex. The increase in survival over time is likely a reflection of willingness to keep pet cats longer and increased access to and sophistication of veterinary care.

Key words: Cardiomyopathy; Epidemiology; FIP; Theriogenology.

Information regarding the common causes of death in an animal species is useful to veterinary practitioners, owners, breeders, and other stakeholders. It is a cornerstone of informed clinical decision making, when planning breeding programs or for deciding on disease prevention measures in populations. Valid population-based statistics must include information both on the denominator (the animals in the background population) and the numerator (the cases of disease or death).

Population-based figures on cat mortality and morbidity are limited. In a large telephone survey of North American households, a crude yearly death rate of 8.3 cat deaths/100 cats was found in the (presumably) general owned cat population.[1] Information on feline mortality also has been obtained from case series or case control studies, where measures of proportional mortality may be found. Risk factors for mortality at 23 British adoption centers were analyzed in a case control study, reporting an overall mortality of 4.7%. Cats < 7 weeks and > 7 years were at increased risk of death in this population.[2] In a German case series, cause of death was reported for 4,561 cats based on postmortem investigations from 1969 to 1982. Infectious disease (dominated by feline panleukopenia) was the most common reason for mortality.[3] More recently, cause of death among cats admitted to a French incineration facility was reported, and accidental death, followed by infectious disease, was most common.[4]

Abbreviations:

ASMR	age-standardized mortality rate
CI	confidence interval
CYAR	cat-years at risk
MR	mortality rate
NS	nonsignificant
PM	proportional mortality

The Swedish Agria insurance[a] database has been utilized to study morbidity and mortality in dogs and horses insured for veterinary care and life, respectively.[5,6] In general, veterinary care insurance reimburses the owner for the cost of veterinary treatments up to a certain limit when the costs are above the deductible (which is paid by the owner). Life insurance reimburses the owner for a certain set value (life insurance value) if the animal dies or is euthanized.

According to Agria's market estimates, approximately one-third of the officially registered pure-bred cats in Sweden were insured for life with Agria (Ib Ahlen, personal communication). Because of the large proportion, this database may provide a valid source of population-based mortality rates (MR) in purebred cats. Because of the high number of individuals included, mortality can be stratified and presented by sex, age group, breed, and diagnosis. We are unaware of any other population-based feline mortality studies of a similar scale in the veterinary literature.

The aim was to describe patterns of mortality in Swedish cats covered by a life insurance plan between 1999

From the Department of Clinical Sciences, Faculty of Veterinary Medicine and Animal Science, Swedish University of Agricultural Sciences, SE-750 07 Uppsala, Sweden (Egenvall, Häggström, Ström Holst); Norwegian Veterinary School, Oslo, Norway (Nødtvedt); Agria Insurance, SE-107 23 Stockholm, Sweden (Möller); and The Department of Population Medicine, Ontario Veterinary College, University of Guelph, Guelph, ON, Canada N1G 2W1 (Bonnett). This work was done at the Department of Clinical Sciences, Uppsala.

Corresponding author: Agneta Egenvall, Department of Clinical Sciences, Faculty of Veterinary Medicine and Animal Science, P.O. Box 7054, Swedish University of Agricultural Sciences, SE-750 07 Uppsala, Sweden; e-mail: agneta.egenvall@kv.slu.se.

Submitted May 14, 2009; Revised July 28, 2009; Accepted August 5, 2009.

10.1111/j.1939-1676.2009.0396.x

and 2006, with respect to sex, age, breed, and diagnosis and to present survival to various ages crudely, by breed and time period.

Materials and Methods

Description of the Insurance Process 1999–2006

In order to qualify for life insurance at Agria, a cat must be vaccinated against feline panleukopenia and have a market value, which is the maximum sum for which the cat can be life-insured (a cat acquired for free may get a low-life insurance value, ≤1,000 Swedish Crowns [SEK]). Therefore, in general only purebred cats have life insurance, usually acquired at young age, even though cats can enter life insurance until 6 years of age (if >2 years a health certificate from a veterinarian must accompany the application). Cats can be life-insured up to 13 years of age. Life insurance is renewed annually but can be terminated by the owner at any time if he or she so wishes.

When a life-insured cat dies, a claim is processed using forms completed by the attending veterinarian. Information includes a summary of the cat's disease problems. The form may be accompanied by the complete medical record, if requested by the insurance company. Veterinarians classify the cause of death using a standardized diagnostic registry as has been described.[5] The exception is in some cases of traumatic death, where the owner, with witnesses, can state that the cat was, for example, killed in a traffic accident. The insurance does not pay claims for lost cats. In general, only 1 diagnostic code is used per claim. The registry includes both specific and general codes.[7]

Data Management

Data on all cats insured between 1999 and 2006 were downloaded from the Agria insurance database. Variables used in this study included cat identification, sex, date of birth, breed, life insurance coverage, and diagnostic codes for cause of death. Dates of visits to veterinarians and when cats entered or left the insurance program and reasons for leaving insurance were included. Cats were assigned to the age category they had January 1st of each year (0 < 1 years, 1 < 2, etc).

Sex was either male or female as recording and timing of neutering was not reliable in the database. In the insurance data, 41 breed codes were used to classify breeds. Breeds that were considered closely related were combined. Abyssinians and Somalis were combined to Abyssinians; Persians, Chinchilla, Colorpoint Persians, and Exotic shorthairs to the Persian group; and Siamese, Balinese, Foreign White, Javanese, Oriental shorthair, and Seychelliosis to the Siamese group. Data have been presented for individual breeds with at least 1,000 cat-years at risk (CYAR). "Domestic" cats included domestic shorthair and longhair cats. The "other" group included various breeds.

Diagnoses were amalgamated into broad diagnostic categories or problems: ascites, allergy, anorexia, behavior, cardiovascular, dead/no diagnosis, ears, eyes, gastrointestinal, hormonal/metabolic, infections, locomotor problems, lost, neoplastic, neurological, surgery/complications thereof, reproductive, respiratory, integumentary, symptomatic (eg, fever, pain, unspecified), traumatic, and urinary. Diagnoses also were presented on a specific-diagnosis level (usually the original code or combination of extremely similar codes). A complete list of diagnoses is available from the 1st author (AE).

Data Analysis

Descriptive statistics were calculated. Cats were at risk from either the 1st of January 1999 or the start date of insurance (if later), and until the date of death or withdrawal from insurance.

Cats for which the owner either submitted a life claim or simply reported the animal as dead were used as the numerator for mortality. MR calculations were used with the exact time at risk as the denominator. Age-standardized MRs (ASMR, which adjusts for differences in age distributions across groups or categories) have been calculated both for the whole period and yearly and are expressed as deaths per 10,000 CYAR (data on age category 9 < 10 years and over were amalgamated for standardization). "Age category-specific" MRs were calculated directly. Standard errors times 1.96 yielded 95% confidence intervals (95% CI) for ASMRs[8] and age category-specific MRs.[9]

Age standardized MRs, and MRs, respectively, have been calculated crudely, yearly, by sex, breed group, breed, diagnostic category, diagnosis, and by combinations thereof as well as for withdrawal unrelated to death. Mortality was calculated for breed groups and for specific breeds with at least 1,000 CYAR. Proportional mortality was calculated as percent of all deaths, both for diagnostic categories and for specific diagnoses. Unusually high breed group-specific ASMRs were examined in detail (original or amalgamated diagnosis) to provide additional insight into the specific types of health issues in those breeds (CIs not presented). This was done when there were at least 10 cats in each breed or breed group.

Survival curves were constructed crudely, by sex, as well as by breed group and sex. The survival at 5, 7.5, 10, and 12.5 years of age is reported and was calculated: crudely for the years 1999–2000, 2001–2002, 2003–2004, and 2005–2006 and by breed for the years 1999–2002 and 2003–2006. Cox regression without covariates was used to construct the survival estimates, which have been presented, together with 95% CI. Data handling was performed by SAS version 9.1.[b]

Results

The Population

The total number of cats insured was 49,450. The total CYAR was 142,049, varying from 15,576 CYAR in 2001 to 21,916 CYAR in 2006 and is shown by age category in Figure 1. The 10th, 50th, and 90th percentiles for the CYAR contributed by an individual cat were 4 months, 2.2 years, and 6.7 years. The median age at enrollment

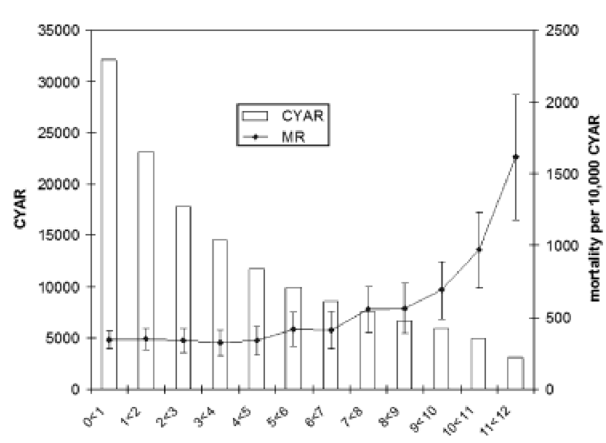

Fig 1. Average total mortality (MR) by age category, with 95% confidence intervals, and the total number cat-years at risk (CYAR) per age category (the last category excluded). Estimates are calculated for discrete age categories.

Table 1. Breed-specific age standardized total mortality rate (ASMR), with 95% confidence intervals (CIs) for cats covered by life insurance during 1999–2006 at a Swedish insurance company, ranked by the total mortality.

Breed	CYAR	Deaths	ASMR	95% CI Lower	95% CI Upper	With Diagnosis (%)
Abyssinian group	4,851	202	464	290	639	75
Bengalese	1,569	40	285	7	562	80
Birman	25,546	906	373	301	444	79
Domestic	8,257	355	414	277	551	54
British Shorthair	6,987	222	386	238	533	77
Burma	4,970	206	387	241	533	75
Cornish Rex	3,794	126	475	[a]		71
Devon Rex	3,325	94	337	132	542	74
European Shorthair	1,759	88	464	177	751	58
Maine Coon	6,807	243	525	312	739	76
Norwegian Forest Cat	18,870	715	419	329	508	75
Ocicat	1,603	51	378	76	681	82
Other breeds	1,857	131	437	76	798	62
Persian group	33,152	2,241	627	553	701	65
Ragdoll	5,939	229	426	247	605	82
Russian Blue	2,196	78	285	113	457	77
Siamese group	7,909	458	663	498	828	73

[a]CI not estimable.
CYAR, cat-years at risk

was 3.5 months, and 80% of the cats had been enrolled before 1 year of age.

The number of CYAR was 74,094 for males and 67,955 for females. The mean and median age of the analyzed population progressed during the time analyzed. The mean age, described by the age category on January 1 of each year, decreased from 4.0 to 2.9 years (median, from 3 to 2) during the time period. The breeds with the highest CYAR were the Persian group, the Birman, and the Norwegian Forest cat (Table 1). The overall average yearly withdrawal rate was 1,424 withdrawals per 10,000 CYAR (averaged 95% CI, 1,375–1,474).

Overall Mortality

In total, 6,491 cats died with no clear time trend across years for mortality. The minimum annual ASMR was 423 (95% CI, 396–452) in 2003 and the maximum was 519 (95% CI, 485–552) in 2000; the average was 462 (95% CI, 431–493) deaths per 10,000 CYAR. Figure 1 shows MRs by age with 95% CIs (omitting the oldest age category because of few cats).

In total, 3,540 of the deaths were males and 2,951 were females. The ASMR was 476 (95% CI, 433–520) and 447 (95% CI, 403–492) deaths per 10,000 CYAR for males and females, respectively.

For breeds with at least 1,000 CYAR, mortality is presented in Table 1 including CYAR, number of deaths, the ASMR with 95% CI, the risk percent and the percent of deaths for which a diagnosis was available. Overall, 4,591 cats died and were given a diagnosis (specific or unspecific). Therefore, 71% of the deaths were claimed and had a diagnosis.

Survival

Figure 2 demonstrates that the survival for the whole population by period increases considerably with time (ie, in 1999–2000 approximately 34% of cats died by 10 years of age, whereas only 10% were dead by 10 years in 2005–2006). The same results are shown by breed in Table 2. For all breeds other than the Ragdoll, survival to 10 years was considerably higher in the last half compared with the 1st half of the study period (most comparisons are statistically significant, based on non-overlapping CIs). Omitting cats first insured after 18 months of age had almost no effect on the survival esti-

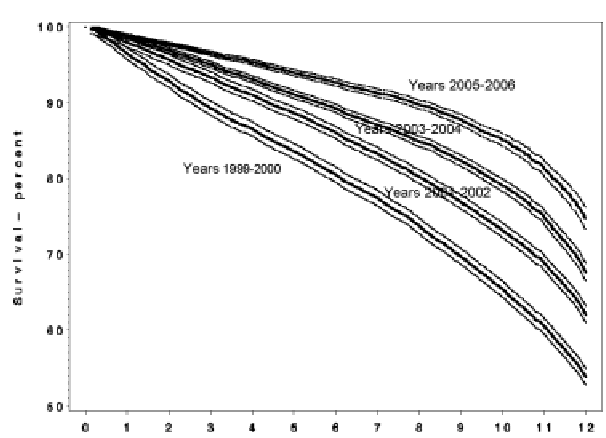

Fig 2. Overall survival with 95% confidence intervals by age and the 4 time periods. The population consists of cats with life insurance at a Swedish insurance company during years 1999–2006, with a total of 142,049 cat-years at risk.

Table 2. Probability of survival, for breeds with > 5,000 cat-years at risk, based on total mortality by ages 5, 7.5, 10, and 12.5 years derived using Cox regression in cats life insured at a Swedish animal insurance company during 1999–2006.

		5 Years		7.5 Years		10 Years		12.5 Years	
Breed	Period	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Birman	1999–2002	85	84, 87	79	78, 81	72	70, 74	58	54, 62
	2003–2006	92	91, 93	88	87, 89	83	81, 85	68	63, 73
British Shorthair	1999–2002	89	86, 91	84	81, 87	72	68, 77	46	38, 57
	2003–2006	95	93, 96	90	88, 93	82	78, 86	54	42, 69
Domestic	1999–2002	83	80, 87	76	73, 80	69	66, 73	55	50, 59
	2003–2006	90	88, 92	86	83, 88	80	77, 83	62	56, 69
Maine Coon	1999–2002	80	68, 95	73	61, 86	61	51, 73	41	31, 54
	2003–2006	90	88, 92	84	81, 87	74	69, 79	54	44, 65
Norwegian	1999–2002	85	83, 87	78	75, 80	68	66, 71	51	47, 56
Forest Cat	2003–2006	91	90, 92	87	85, 88	80	78, 83	62	55, 68
Persian group	1999–2002	79	77, 81	69	67, 71	57	55, 59	39	37, 41
	2003–2006	89	88, 91	83	81, 85	76	74, 77	52	49, 55
Ragdoll	1999–2002	84	81, 87	73	68, 78	62	55, 71	—[a]	—
	2003–2006	84	81, 87	73	69, 78	63	56, 71	—[a]	—
Siamese group	1999–2002	83	80, 86	73	70, 76	57	53, 61	33	28, 38
	2003–2006	87	85, 89	80	77, 83	68	64, 72	42	36, 50

[a]not estimable.

mates (overall 0.6 percent difference of the point estimates at 10 years of age).

Diagnostic Category-Specific Mortality

Table 3 shows category-specific ASMRs for the 11 diagnostic categories with at least 80 deaths, and for the 31 specific diagnoses within these with at least 20 deaths each. By sex, there were no significant differences for any of the categories. Figure 3 demonstrates the age-specific MRs for the 6 most common diagnostic categories, ignoring cats that were recorded as dead/no diagnosis. Figure 4 shows diagnostic category-specific ASMRs by breed group for the same 6 categories. Although point estimates vary widely, CIs often overlap.

Diagnosis-Specific Mortality

The following ASMRs are based on at least 10 cases per breed or breed group. For the somewhat amalgamated diagnosis upper urinary problems, the ASMRs, in deaths per 10,000 CYAR, were Ragdoll 141, European Shorthair 76, Persian group 74, Siamese group 73, Abyssinian group 45, Norwegian Forest cat 45, Birman 43, Russian Blue 35, British Shorthair 30, Devon Rex 31, Maine Coon 30, Burmese 25, and domestic 20.

For traffic accidents, the ASMRs, in deaths per 10,000 CYAR, were domestic 78, European Shorthair 63, Abyssinian group 60, Norwegian Forest cat 48, Cornish Rex 39, Maine Coon 38, Burmese 35, Birman 22, Persian 18, and Siamese 16. For FIP infection, the ASMRs, in deaths per 10,000 CYAR, were Birman 54, Devon Rex 43, Abyssinian group 41, Persian group 27, Siamese group 26, British Shorthair 23, Ragdoll 19, and Norwegian Forest cat 18. For the combined diagnosis cardiomyopathy, the ASMRs, in deaths per 10,000 CYAR, were Birman 24, Maine Coon 20, Persian group 16, Ragdoll 12, and Norwegian Forest cat 6. For mammary tumors the ASMRs, in deaths per 10,000 CYAR, were Siamese 51, Norwegian Forest cat 14, Persian group 9, and Birman 6. For the somewhat merged diagnosis lower urinary problems 2 breeds had at least 10 deaths in total: the Persian with an ASMR of 16 and the Norwegian Forest cat with 14 deaths per 10,000 CYAR. For the code cystic kidneys an ASMR of 19 deaths per 10,000 CYAR was found in the Persian group (74 cases), whereas point estimates below 4 were found in other breeds. The Burmese had an ASMR for diabetes mellitus of 16 deaths per 10,000 CYAR, the domestic cat 8 deaths per 10,000 CYAR, the Norwegian Forest cat 7 deaths per 10,000 CYAR and Persian groups 3 deaths per 10,000 CYAR.

Discussion

Age and Sex

The MR was (not surprisingly) low during the 1st 5 age categories (< 400 deaths per 10,000 CYAR) and reaching over 1,600 deaths per 10,000 CYAR in age category 11 < 12 years. By diagnostic category, urinary, neoplastic, and cardiovascular (nonsignificantly [NS] judged by overlapping CIs) and gastrointestinal (NS) increased with age whereas infections and traumatic causes (NS) decreased with age. Most of these results are similar to clinical perceptions or, where relevant comparisons can be made, published results from dogs. Case series based on pathology data show that infections and trauma are the most common causes of death in cats.[3,4] Traumatic road accidents have been shown to decrease in frequency with increasing age.[10] Data from studies presenting proportional mortality figures suggest that young cats often die from infections, whereas this is less common for older

Table 3. Age-standardized mortality rates (ASMR; per 10,000 cat-years at risk) with 95% confidence intervals (95% CI), by diagnostic category for categories with at least 80 deaths and for the most common specific diagnostic codes (≥ 20 deaths) in cats covered by life insurance during 1999–2006 at a Swedish animal insurance company.

Category	Specific Diagnosis	Deaths	ASMR	95% CI	PM (%)
Urinary		907	64	52, 75	20
	Kidney/ureter[a]	713	50	39, 60	16
	Lower urinary problems	194	14	8, 19	4
Traumatic		582	42	32, 51	13
	Traffic accidents[b]	411	29	21, 38	9
	Other traumatic deaths	153	11	6, 16	3
Neoplastic		528	37	28, 46	12
	Mammary tumor	147	10	6, 15	3
	Stomach/intestinal	87	6	3, 10	2
	Lymphoma/lymphosarcoma	54	4	1, 7	1
	Lung tumor	42	3	0, 5	1
	Tumor in the mouth	24	2	0, 4	1
	Tumor (unspecified)	23	2	0, 3	1
	Abdominal/peritoneal tumor	20	1	0, 3	0
	Liver tumor	21	1	0, 3	0
Infections		437	33	24, 41	10
	Infection—viral origin[c]	407	31	22, 39	9
	Infection (unspecified)	24	2	0, 4	1
Dead, no diagnosis		428	30	22, 39	9
Cardiovascular		421	30	22, 38	9
	Cardiomyopathy	181	13	8, 18	4
	Heart (other)	80	6	2, 9	2
	Anemia	62	4	1, 7	1
	Thrombosis	44	3	1, 5	1
Gastrointestinal		383	28	20, 35	8
	Vomiting	139	10	5, 15	3
	Liver	127	9	5, 13	3
	Constipation	33	2	0, 4	1
	Mouth problems	25	2	0, 3	1
Respiratory		279	20	13, 26	6
	Chylo/hemo/pyothorax	70	5	2, 8	2
	Lower respiratory (other)	62	4	1, 7	1
	Pneumonia	55	4	1, 7	1
	Dyspnea	33	2	0, 4	1
	Rhinitis/sinusitis	30	2	0, 4	1
Neurological		138	10	5, 14	3
	Neurological (unspecified)	42	3	1, 5	1
	Neurological-peripheral nervous system	38	3	0, 5	1
	Neurological-central nervous system	26	2	0, 4	1
	Epilepsy	26	2	0, 4	1
Hormonal/metabolic		98	7	3, 11	2
	Diabetes mellitus	83	6	2, 9	2
Anorexia		80	6	2, 9	2

Also shown is the proportional mortality (PM) in percent for each system (number of cases with a specific diagnosis divided by the total number of cases (n=4,591) with a diagnosis).

[a]Seventy-nine of the 713 (11%) cases had the original diagnosis "cyst in kidney."

[b]Twenty-one of the 411 cases (5%) had the original diagnosis "fall from height."

[c]Three hundred and fifty of the 407 cases (86%) had the original diagnosis "FIP infection."

animals.[3,4,11] No significant differences were found between sex for the overall ASMRs. Unfortunately, data on deaths in cats over 13 years were not recorded. Cats can have veterinary care insurance until older ages and analysis of that data may shed some light on diseases affecting older cats. However, from the perspective of preventing premature death, the mortality in the "youngest" cats (ie, <13 years of age) is undoubtedly of the highest importance.

Survival

At 5, 7.5, and 10 years of age, many breeds showed a decrease in mortality over time (based on nonoverlapping CIs between time periods). However, in Ragdolls there are no differences and in Maine Coons the CIs clearly overlap. As none of the survival curves reach 50% even in the highest age category, it is evident that that median age of death in these life-insured cats is >12 years of age.

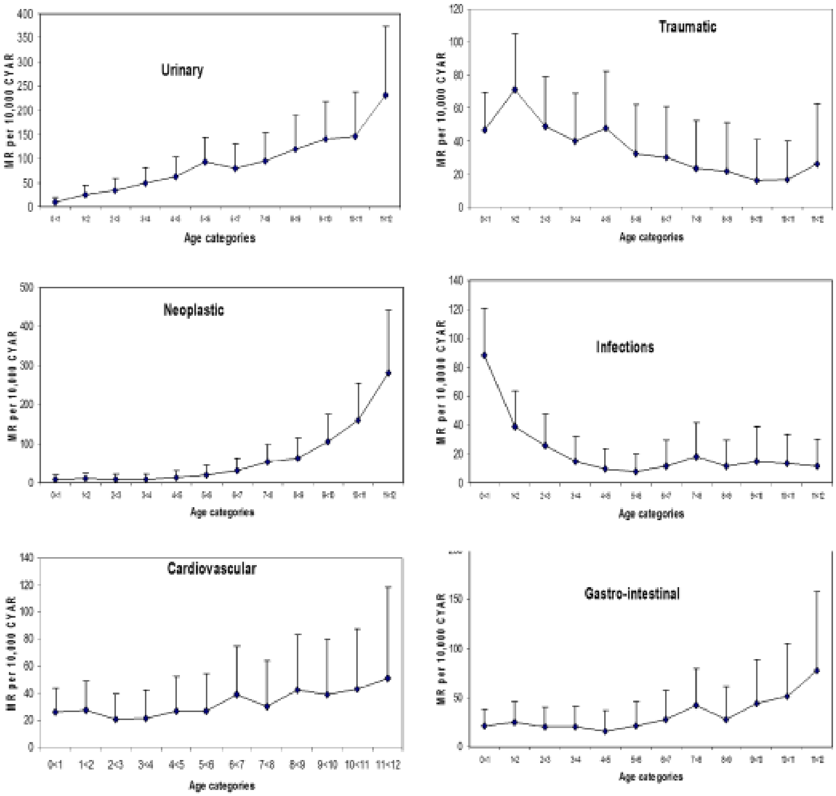

Fig 3. Age-specific mortality rates (MR, with upper 95% confidence intervals) for 6 diagnostic categories (omitting age category 12 < 13 years). The population consists of cats with life insurance at a Swedish insurance company during years 1999–2006, with a total of 142,049 cat-years at risk (CYAR).

Breed

Breed-specific mortality varied from 664 in the Siamese to 285 deaths per 10,000 CYAR in the Bengalese (Table 1). In particular for the breed-specific analysis, the MRs were age standardized to avoid the effect of differing age distributions, as caused by waxing and waning popularities for some breeds, or changes in insurance enrollment. Domestic cats have an ASMR just below the average mean. In this database, the domestic cats may differ from the total population of domestic cats in Sweden. From the survival analysis of the more common breeds, Siamese and Ragdolls have the lowest survival to 10 years.

Diagnosis

Population-based research on these insurance data is facilitated by the mandatory use of a standardized, hierarchical diagnostic registry by all contributing veterinarians.[7,12] Previous studies have validated the accuracy of the diagnostic information for dog and cat data.[13] In the cats, we found that both demographic (breed, sex, and year of birth) and diagnostic information was correctly coded in ≥89% of the cases. However, we are unable to determine the level of certainty of the veterinarians' diagnoses, or the amount of ancillary information that underlies the diagnosis (eg, whether specific-neoplasia diagnoses are based on histologic confirmation or not). However, the use of diagnostic categories allows us to group the data at levels for which we are more confident in the validity of the information.

"Dead no diagnosis" has been shown to be one of the most common recorded "causes" of death in these cats, as has been seen in studies of dogs and horses. This likely is a reflection of the realities of veterinary practice where cautious veterinarians are unable or unwilling to commit to a specific diagnosis in the absence of a diagnostic evaluation. There might also be a tendency to use a nonspecific code for convenience. However, certain categories of disease (eg, heart failure) might be more likely to be "missed" and placed in the no diagnosis category because of lack of diagnostic evaluation or postmortem examination than cases of, for example, traumatic death. Space does not allow a detailed discussion of all of the major diagnostic categories for deaths in these cats and we have chosen to highlight the 5 most common specific categories.

Although CIs have been calculated, their interpretation is difficult. These data essentially represent a census of deaths in the complete population of life-insured cats. In the subsequent discussions we have therefore chosen to focus on the point estimates in discussing differences. Extrapolation and generalization of these findings to other populations of cats should be done with extreme caution. In addition, readers may note that the CIs for the ASMRs become considerably wider than CIs of raw rates (unpublished information).

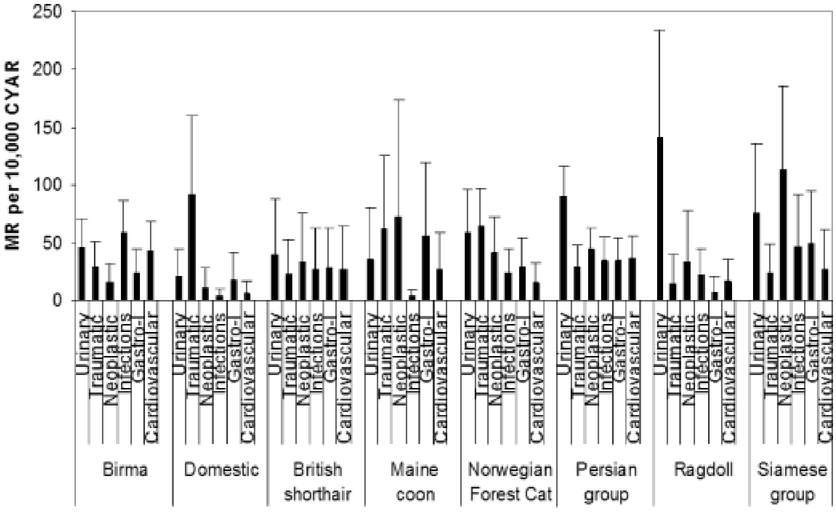

Fig 4. Breed group specific age-standardized mortality rates (ASMR), with upper 95% confidence intervals by diagnostic category. The population consists of cats with life insurance at a Swedish insurance company during years 1999–2006, with a total of 142,049 cat-years at risk.

Urinary disease was the most common cause of death in total and in the Persians, British shorthair, and Ragdolls. In the 8 breeds in Figure 4, only the Ragdolls had a very high ASMR for urinary problems. The main 2 categories within ''urinary'' are kidney/ureter and lower urinary problems, with the former, having an ASMR approximately 3 times the latter. The Persian group had a considerably higher ASMR for urinary disease than the domestics. Within this breed, polycystic kidney disease accounted for a proportional mortality within the diagnostic category urinary of 20% and the Persian group actually does have a somewhat higher proportion of upper compared with lower urinary disease compared with the other breeds. Accordingly, only a part of the high rate is likely because of the known predisposition for polycystic kidney disease.[14] As death because of urinary disease increases with age, it can be assumed that it will be a common cause of death in these breeds also after 12 years of age.

Traumatic causes of death were primarily traffic accidents and falls from a height, and were most common in domestic cats, Norwegian Forest cats, and Maine Coons. This may be a reflection of the degree to which these breeds have access to the outdoors, and be opposite to the situation postulated for urinary deaths[10] (ie, indoor cats tend to get obese or develop disease because of lack of exercise but are less at risk for severe trauma). In 25% of Swedish breeding catteries, some or all of the cats had free access to outdoors.[15]

Neoplastic disorders are the 3rd most common cause, with considerable variation among breeds. For the Maine Coon and Siamese groups, neoplastic disease, dominated by mammary tumors in the Siamese, was the most common cause of death, even though these are relatively young cats. Significant breed differences in cancer risk are described for dogs, and a genetic component exists for some cancers in dogs. Studies have shown that Siamese cats are at increased risk of developing mammary carcinoma, although the mechanism is unknown.[16]

In the total population, infectious disease was the most common cause of death. This is probably because all cats must be vaccinated against feline panleukopenia before enrollment into life insurance. Domestic and Maine Coon cats had low MRs attributed to infections compared with several other breeds. Infections, dominated by FIP, were the most common cause of death in Birmans. FIP is a sporadic disease caused by mutation of an endemic virus (feline coronavirus, FCoV).[17] Inheritance of susceptibility to FIP previously has been described for Persians and Birmans,[17] and an overrepresentation of other breeds also has been described.[17] As cats would not be covered for death because of FIP occurring within a year after the start of insurance, and because FIP can be challenging to confirm,[17] the number of FIP cases may be even higher than shown here. Regardless, infections dominated by FIP were the most common diseases in Birmans up to 12 years of age. One contributing factor to the high incidence of infections in Birmans may be that a number of cats with ascites or hydrothorax because of restrictive cardiomyopathy are falsely diagnosed as having exudative FIP. Death because of cardiovascular reasons was the 3rd most common cause in Birmans, and these diagnoses can be difficult to differentiate without further clinical testing, such as echocardiography.[18]

The most common specific diagnosis within the cardiovascular category was, not surprisingly, cardiomyopathy. However, feline cardiomyopathies are a heterogenous group of diagnoses. Depending on the morphologic appearance and pathophysiology, cardiomyopathy in cats is frequently classified as hypertrophic, dilated, restrictive, arrhythmogenic, and ''unclassified'' cardiomyopathy.[18,19] The specific-feline cardiomyopathy often was not specified in the database, but based on the literature and clinical experience, hypertrophic cardiomyopathy, was the most likely diagnosis in most of the cases in most of the breeds. This disease is well documented in almost all of the breed groups in this study as a major contributor to cardiovascular disease.[19,20] The present study could not show a difference in sex, which is in agreement with previous studies.[20] The domestic cat group stands out as having a lower cardiovascular ASMR than other breeds. This finding may not completely reflect the true incidence of cardiomyopathy in this population because domestic cat owners may not be as motivated as pure bred cat owners or breeders to establish an exact diagnosis or to treat chronic disease.

We have closely considered whether the interesting result on survival (ie, the increase over this 8-year period for cats <13 years of age) could have arisen as a consequence of insurance policies or been a function of the research method. However, we found both of these unlikely to account for the magnitude of the differences seen. As regards statistics, given that the method is stratified on and uses the available information at each age span to calculate the statistics, if there were no cats or deaths in an interval (ie, ''young''), problems may arise at older ages, but this was not the case here. It is anecdotally assumed that owners are more willing to access veterinary care for their cats and to engage in treatment for chronic diseases (eg, diabetes) than was the case in the past. Presumably, increased access to veterinary care would be facilitated by having health care insurance (which almost all life-insured cats have). A similar pattern of decreased mortality over time has been shown in dog data from the Agria database (Brenda Bonnett, personal communication). The extent to which increased survival can be attributed to veterinary care per se or to the attitudes of owners with regard to willingness to treat older animals and those with chronic disease is impossible to determine based on our results.

With regard to the whole population (however, not between breeds, see breed section above) the yearly MRs (data not shown) and the ASMRs were similar. Reasons for varying overall rates over the years include random variation, varying breed-age distributions (in the unadjusted rates) and undefined systematic variation relative to the insurance process or other factors.

Concluding Remarks

We believe the cats insured at Agria are relatively representative of the purebred cat population in Sweden, with the limitation that cats over 13 years of age are not included, and the median age of death is >12.5 years. The life-insured domestic cats are likely not representative of the total population of owned domestic cats in Sweden. The overall mortality varied with age and breed but not with sex. Cause-specific mortality varied with age and breed. Urinary problems, trauma, neoplasia, infections, and cardiovascular problems were the 5 most common categories of causes of death. The fact that the overall survival increased with time period likely reflects both a willingness to keep pet cats longer and the increased level of veterinary care. The limitations of the diagnostic information have been discussed, but are reflective of veterinary practice and such issues are common in population-based research using secondary data. Given the scarcity of population-level information on cats, these limitations do not outweigh the usefulness of the data.

Footnotes

[a] Agria Insurance, SE-107 23 Stockholm, Sweden
[b] SAS Institute Inc, Cary, NC

Acknowledgments

This work has been supported by grants from the Foundation for Research, Agria Insurance.

Financial support: This study was supported by grants from the Foundation for Research, Agria Insurance.

References

1. New JC Jr, Kelch WJ, Hutchison JM, et al. Birth and death rates estimates of cats and dogs in US households and related factors. J Appl Anim Sci 2004;7:229–241.
2. Murray JK, Skillings E, Gruffydd-Jones TJ. A study of risk factors for cat mortality in adoption centres of a UK cat charity. J Feline Med Surg 2008;10:338–345.
3. Landes C, Kriegleder H, Lengfelder KD. Causes of death and disease in cats based on 1969–1982 post mortem statistics. Tierarzt Praxis 1984;12:369–382.
4. Moreau D, Cathelain R, Lacheretz A. Comparative study of causes of death and life expectancy in carnivorous pets (II). Rev Med Vet 2003;154:127–132.
5. Egenvall A, Bonnett BN, Olson P, et al. Gender, age, breed and geographic pattern of morbidity and mortality in insured dogs during 1995 and 1996. Vet Rec 2000;146:519–525.
6. Egenvall A, Penell JC, Bonnett BN, Olson P, Pringle J. Mortality of Swedish horses with complete life insurance between 1997 and 2000 variations with sex, age, breed and diagnosis. Vet Rec 2006;158:397–406.
7. Svenska Djursjukhusf ö reningen (Swedish Animal Hospital Association). Diagnosregister för häst, hund och katt (Diagnostic registry for the horse, the dog and the cat), 1st ed. Taberg, Sweden: Svenska Djursjukhusföreningen; 1993:1–235.
8. Dohoo I, Martin W, Stryhn H. Veterinary Epidemiolog Research, 1 st ed. Charlottetown, Canada: AVC Inc; 2003:76–81.
9. Breslow NE, Day NE. Statistical Methods in Cancer Research, Vol. 2. The Design and Analysis of Cohort Studies, 1st ed. Lyon, France: International Agency for Research on Cancer; 1987, 59.
10. Rochlitz I. Study of factors that may predispose domestic cats to road traffic accidents: Part 1. Vet Rec 2003;153:549–553.
11. Isler D, Lott-Stolt G. Kleintierpraxis. 1978;23:333–334, 336–337.
12. Egenvall A, Bonnett BN, Nødtvedt A, et al Insurance data for research and clinical decision-making in companion animals: benefits and limitations. Acta Vet Scand (in press).
13. Egenvall A, Bonnett BN, Olson P, et al. Validation of computerized Swedish dog and cat insurance data against veterinary practice records. Prev Vet Med 1998;36:51–65.
14. Barthez PY, Rivier P, Begon D. Prevalence of polycystic kidney disease in Persian and Persian related cats in France. J Feline Med Surg 2003;5:345–347.
15. Ström Holst B, Frössling J. The Swedish breeding cat: Population description, infectious diseases and reproductive performance evaluated by a questionnaire. J Feline Med Surg 2009, doi:10.1016/j.jfms.2009.01.008.

16. Hayes HM, Milne KL, Mandell CP. Epidemiological features of feline mammary carcinoma. Vet Rec 1981;108:476–479.

17. Pedersen NC. A review of feline infectious peritonitis virus infection: 1963–2008. J Feline Med Surg 2009;11:225–258.

18. Ferasin L. Feline myocardial disease 1: Classification, pathophysiology and clinical presentation. J Feline Med Surg 2009;11:3–13.

19. Kittleson MD. Feline myocardial disease. In: Ettinger SJ, Feldtman E, eds. Textbook of Veterinary Internal Medicine, 6th ed. Philadelphia, PA: Elsevier Saunders Co; 2005:1082–1104.

20. Fox PR, Liu SK, Maron BJ. Echocardiographic assessment of spontaneously occurring feline hypertrophic cardiomyopathy. An animal model of human disease. Circulation 1995;92:2645–2651.