

Methods and mortality results of a health survey of purebred dogs in the UK

OBJECTIVES: To collect information on the cause of death and longevity of dogs owned by members of the numerically largest breed clubs of 169 UK Kennel Club-recognised breeds.

METHODS: A cross-sectional study was carried out. Approximately 58,363 questionnaires were sent out to breed club members in 2004 (nine clubs failed to report the exact number of questionnaires sent out). Owners reported age at death and cause(s) of death for all dogs that had died within the previous 10 years.

RESULTS: A total of 13,741 questionnaires (24% response rate) containing information on 15,881 deaths were included in the analysis. Breed-specific response rates ranged from 64.7 to 4.5%. The median age at death was 11 years and 3 months (minimum=2 months, maximum=23 years and 5 months) and it varied by breed. The most common causes of death were cancer (n=4282, 27%), "old age" (n=2830, 18%) and cardiac conditions (n=1770, 11%).

CLINICAL SIGNIFICANCE: This survey shows breed differences in lifespan and causes of death, and the results support previous evidence that smaller breeds tend to have longer lifespan compared with larger breeds. Although many of the breeds in the study may not be representative of the general pedigree dog population in the UK, the results do contribute to the limited information currently available.

V. J. ADAMS, K. M. EVANS*,
J. SAMPSON† AND J. L. N. WOOD‡

Journal of Small Animal Practice (2010)
51, 512–524

DOI: 10.1111/j.1748-5827.2010.00974.x

Accepted: 15 June 2010

Veterinary Epidemiology Consultant,
PO Box 80, Bury-St Edmunds, Suffolk,
IP28 9BF

*Animal Health Trust, Kentford, Suffolk,
CB8 8UU

†Kennel Club, 1-5 Clarges Street, Piccadilly,
London W1J 8AB

‡Cambridge Infectious Diseases Consortium,
Department of Veterinary Medicine, University
of Cambridge, Madingley Road, Cambridge
CB3 0ES

INTRODUCTION

Baseline data on canine mortality provide an important frame of reference for future research into the mechanisms of disease. The wide variety of pedigree dogs that exists today underlies the need for breed-specific information. Recently developed genetic and molecular techniques that are available to study the causes of death and disease require knowledge of the pattern of occurrence of diseases within the breed of interest.

There have been few population studies on canine longevity and causes of death. Many studies have used veterinary teaching hospital populations that invariably include a high proportion of

referral cases. For example, Patronek and others (1997) reported on mortality data for 23,535 dogs taken from the Veterinary Medical Data Base in North America. Another study reported age at death and cause of death taken from necropsy data from 1962 to 1976 for 2002 dogs from the Angell Memorial Animal Hospital in Boston (Bronson 1982). A Japanese study reported expected lifespans from pet cemetery data (Hayashidani and others 1988). A Swedish group reported mortality risks and causes of death for over 200,000 dogs based on records of a Swedish pet insurance company (Bonnett and others 1997; Egenvall and others 2000a). This group also reported the age patterns for risk of death in selected breeds of dogs insured for life (Egenvall and others 2000b). Michell (1999) reported the results of a questionnaire survey of UK pet owners in 1999 that included age at death and cause of death for 3126 dogs. Longevity estimates for UK dogs have also been reported using information from a Pedigree Masterfoods survey of pet ownership (Reid and Peterson 2000). A recent study reported cause of death and age at death data for 2928 dogs from a survey of members of the Danish Kennel Club (KC) carried out in 1997 (Proschowsky and others 2003). Unfortunately, none of these studies address longevity and cause of death in the general canine population and, as such, have inherent sampling biases. Results from these studies provide wide-ranging estimates of lifespan and must be interpreted with caution.

This survey was initiated following meetings with the KC/British Small Animal Veterinary Association Scientific Committee in order to provide better evidence upon which to base advice to breeders, funding bodies and policy makers. The overall aims of the survey were to identify important breed-specific problems for future genetic research and to provide baseline information against which the success of future control schemes could be measured. The

specific aim of this study was to collect information on the cause of death and longevity of UK pedigree dogs. Additional health information, including the occurrence of disease in 36,006 live dogs, will be reported separately.

MATERIALS AND METHODS

Sampling frame and data collection

A cross-sectional study was carried out to collect health information on pedigree dogs owned by members of the numerically largest ("parent") breed clubs in the UK. There are over 700 breed clubs in the UK with a lot of overlap in membership, particularly among regional and national clubs. Therefore, to limit the probability of individual breed club members receiving multiple questionnaires, only the numerically largest club for each breed was included in the survey. The KC also recommended sending out questionnaires to 18 additional breed clubs for 11 breeds to improve coverage of those breeds that had a very small number of clubs and few annual registrations with the KC or where the clubs were very large or regionalised. As a result, one additional club was included for the beagle, Bernese mountain dog, border terrier, Finnish spitz, Scottish terrier and West Highland white terrier breeds, and two additional clubs were included for the akita, collie, golden retriever, Staffordshire bull terrier, Welsh corgi and Yorkshire terrier breeds.

Packages were sent out to 170 UK KC-recognised breeds via 188 breed club secretaries. The initial mailing to the breed club secretaries took place in December 2003 with individual clubs mailing out to their members starting in January 2004. The number of questionnaires sent out to each breed club was based on numbers of members reported to the KC plus 10%. Monthly reminders were sent out from the UK KC via the dog press from January to April with a deadline for return of completed questionnaires of April 31, 2004. This was extended to June 30 to allow for slow responders, and completed questionnaires returned by October 2004 were included.

Owners were sent a postal questionnaire with a self-addressed prepaid return envelope and they were asked to complete the questionnaire for all dogs of the breed for which they belonged to the breed club that mailed them the questionnaire. The survey was anonymous in that the questionnaire did not ask for the owners name or any other identifying feature.

Questionnaire

The questionnaire consisted of four sections containing 22 questions in total. Section A asked about all dogs that were alive and currently owned by these owners and contained 14 questions covering 12 body systems, cancer and other conditions. Section B contained seven questions on breeding of females that had been owned and bred in the previous 10 years and included questions on the numbers of litters and puppies born. Section C contained one question on the occurrence of birth defects and conditions affecting puppies in the first 8 weeks of life during the previous 10 years. Section D contained one question on the age at death and cause(s) of death of all dogs that had died within the previous 10 years. Questions were developed, pretested and refined for use in a pilot study of two breeds (Norfolk terrier and German spitz). Owners were asked to be as specific as possible when describing a disease condition, cause of death or congenital condition, using the diagnosis made by their veterinary surgeon whenever possible. We also suggested that owners consider contacting their veterinary surgeon to ask for help if they had difficulty remembering the diagnosis. Veterinary surgeons in the UK were informed of the survey via a letter to The Veterinary Record at the start of the study. An appendix list of names and synonyms of example conditions was included for each body system question in section A as well as for congenital conditions in section C. The questionnaire, appendix, overall results and breed-specific reports are available on the UK KC website at <http://www.the-kennel-club.org.uk/>.

Data processing

Specialised information capture software (Verity [was Cardiff] TELEform®) was used to scan the returned questionnaires.

Data entry involved scanning and verifying of the electronically acquired data. The scanned and verified data were exported into an Access® (Microsoft) database for checking and recoding. When the verifier module of Teleform checks and codes the scanned data, the software is set so that if the system reads a number with a certain accuracy, it will not ask for the information to be verified. For example, with age at death, when the software was 90% certain that what it had scanned in was the number 4, then it recorded the number scanned as a 4 and did not bring the number up for verification. For the numerical information, during the initial scanning of the forms, almost 100 forms were scanned and verified several times, allowing us to look at the reliability of the scanning software. Although the exact error rates were not recorded, the software appeared to be very reliable in that it recorded the same information each time a form was repeatedly scanned. For the free text boxes, what was written in the box was entered manually during the verification process as the system did not reliably scan handwritten text. The coding of the causes of death was done by choosing a cause of death from a drop down list developed by the first author before data entry began. As data entry progressed and the first forms were repeatedly scanned, the list of possible causes of death was lengthened and refined as necessary by the first author. When it was not clear what the cause of death should be coded as, the form was marked "for review" and the first author reviewed and coded these causes of death and added any required new terms to the list used for coding. This was an iterative process that continued through the first several days of data entry and then as needed throughout the remainder of data entry. A similar system of using lists of diagnoses for the various body systems was used for the disease conditions affecting live dogs.

Diagnostic categories were developed for cause of death by firstly grouping diseases by organ system affected. Organ system categories included cardiac, cardiovascular, cerebral vascular, dermatologic, endocrine, gastrointestinal, hepatic, musculoskeletal, neurologic, ocular, reproductive, respiratory and urologic

as used on the questionnaire. When a cause of death was interpreted to affect more than one body system and a diagnosis could be attributed to such a cause, separate categories were included for these specific causes of death. Thus, additional categories were created for behaviour, cancer, collapse, drowning, hyperthermia, immune-mediated, infection, internal haemorrhage, perioperative, pining, poisoning, portosystemic shunt, senility, septicaemia, sudden death, systemic and trauma. A category for combinations was used when two or more specifically codeable causes of death were stated for one dog. A category for "old age" was used when either age or "old age" was stated as the sole cause of death or when age was stated together with another condition such as heart failure, kidney failure, arthritis, incontinence, colitis or senility. Dogs with senility or dementia stated as the sole cause of death were coded as senility. A category called unknown was created when the stated cause of death could not be categorised into any one of the above groups ("uncodeable" causes of death) or when the words "unknown," "undiagnosed," "died" or "sudden death" were used. Uncodeable causes of death included those conditions reported by owners that could not be placed into any of the other categories, such as weakness, loss of limb function or weight loss.

Statistical analysis

Longevity results, as overall and breed-specific age at death, are reported as median (range), as is appropriate for skewed data. Age at death for groups of dogs was compared using non-parametric tests (Wilcoxon rank sum for two groups). The association between age at death and the size of the breed was assessed using published values for average "ideal" bodyweight (Alderton 1993). Linear regression was used to examine the association between median age at death and ideal bodyweight with the hypothesis being that larger dog breeds would have a shorter average lifespan compared with smaller dog breeds. Descriptive statistics and hypothesis testing were performed using SPSS (Statistical Package for the Social Sciences v. 13.0, SPSS Inc. 2004, Chicago, IL, USA). The level

of significance was set at $P < 0.05$ for all hypothesis tests.

The most common causes of death are reported overall and as breed-specific proportional mortalities for the four most commonly affected organ systems/categories. Breed-specific proportional mortalities were calculated as the number of deaths affecting a specific organ system divided by the total number of deaths for a specific breed and are reported with 95% confidence limits. Breeds with a response rate of $>15\%$ and having had >50 deaths reported were included as separate breeds, and the remaining breeds were combined into "other breeds" in order to avoid reporting less accurate results for breeds with very low response rates and/or very few deaths reported. Proportional mortality computations were performed using SAS (version 8, SAS Institute 2000, Cary, NC, USA).

RESULTS

Response rate

A total of 72,832 questionnaires were sent out to breed club secretaries, and approximately 58,363 questionnaires were sent out to their members. As nine clubs failed to report the exact number of questionnaires sent out to their members, the exact number of questionnaires sent out was unknown. Approximately 600 (4%) questionnaires had data that were unuseable and not entered (due to failure to report the breed, reporting on >1 breed on a questionnaire or unsolicited photocopied questionnaires). A total of 13,791 questionnaires were entered (24% response rate), of which 13,759 were useable (32 questionnaires were entered in duplicate and were removed from the database). The responses for the German shepherd dog were excluded from further analyses as 1425 questionnaires were sent out to the British Association for German shepherd dogs, but only 18 questionnaires were returned and the breed club did not report how many questionnaires were sent out. After excluding German shepherd dogs, 13,741 questionnaires were available for further analysis. Breed-specific response rates ranged from a high of 64.7% to a low of 4.5% with a median of 23.9% (Table 1).

There were 13,367 questionnaires with information on 36,006 live dogs, 7125 of which also reported deaths, and there were 374 questionnaires that only reported deaths to give a total of 7499 forms with information on 15,881 deaths. Deaths were reported for 165 breeds with the Bergamasco, Bolognese, Ibizan hound and Lagotto Romagnolo each having no reported deaths. There were 72 breeds with a response rate of $>15\%$ and with >50 deaths reported, and there were 93 breeds included in the "other breeds" category for estimation of proportional mortalities. Overall, 931 of the 15,881 reported deaths (5.9%) had a post-mortem examination. For those dogs that underwent a post-mortem examination, the median age at death was 7.17 years (0.17 to 20.00), and 20% (191) were made up of five breeds: flatcoated retriever (50), golden retriever (42), Labrador retriever (35), cavalier King Charles spaniel (34) and Bernese mountain dog (30). The median age at death for those dogs that underwent a post-mortem examination was significantly lower than the median age at death for those that did not (11.5 years, $P < 0.0001$). The most commonly reported cause of death in those dogs that underwent a post-mortem was cancer (337), although the majority of these were still reported as type unspecified. Only 17 of the 597 dogs that were reported to have died due to a stroke, and 19 of 291 dogs that were reported to have died of a heart attack, underwent post-mortem examination and it was not clear from what was reported whether the post-mortem confirmed the diagnosis. Owners did not indicate whether the post-mortem helped to provide the reported cause of death or not.

Lifespan

The overall median age at death was 11 years and 3 months (2 months to 23 years and 5 months; Fig 1). Only 20% of dogs remained alive at 14 years of age and this had fallen to $<10\%$ by 15 years. Breed-specific age at death is shown in Table 1. Median age at death was significantly negatively correlated with average ideal bodyweight with 40% of the variability in age at death explained by bodyweight for 81 breeds with published values for ideal bodyweights ($P < 0.0001$; Fig 2).

Table 1. For each of the 165 breeds experiencing a total of 15,881 deaths over the 10 years before 2004: the number of questionnaires sent out and returned for each breed, breed-specific questionnaire response rates, number and percent of deaths, and minimum, median and maximum age at death as well as the Kennel Club breed group

Breed name	Questionnaires			Deaths		Age at death			Breed weight group†
	Numbers sent	Number of returns	% RR*	Number of deaths	% of all deaths	Minimum	Median	Maximum	
Affenpinscher	225	66	29.3	21	0.10	0.25	11.42	15.17	2
Afghan hound	206	58	28.2	143	0.90	0.83	11.92	16.58	4
Airedale terrier	260	66	25.4	81	0.50	0.67	10.75	16.17	3
Akita	176	23	13.1	28	0.20	0.33	9.92	13.67	4
Alaskan Malamute	185	57	30.8	14	0.10	2.17	10.71	13.5	3
American cocker spaniel	198	33	16.7	60	0.40	0.17	10.33	17.33	3
Anatolian/Karabash	180	22	12.2	23	0.10	4.42	10.75	13.42	4
Australian cattle dog	83	22	26.5	11	0.10	1.5	11.67	15.92	3
Australian shepherd	132	49	37.1	22	0.10	3	9	15	3
Australian silky terrier	37	7	18.9	5	0.00	11.08	14.25	15.33	1
Australian terrier	74	12	16.2	11	0.10	3.92	12.08	15	1
Basenji	171	40	23.4	46	0.30	0.92	13.54	17.5	2
Basset Fauve de Bretagne	125	41	32.8	15	0.10	0.92	10.42	13.92	3
Basset Griffon Vendéen	306	135	44.1	76	0.50	1.25	12.04	17.33	3
Basset hound	500	88	17.6	142	0.90	0.25	11.29	16.67	3
Beagle	585	177	30.3	241	1.50	1.17	12.67	17.75	2
Bearded collie	729	239	32.8	278	1.80	0.33	13.5	19.5	3
Bedlington terrier	200	61	30.5	48	0.30	1.17	13.38	18.42	2
Belgian shepherd	339	98	28.9	113	0.70	1.5	12.5	18.17	4
Bergamasco‡	14	4	28.6	‡			‡		4
Bernese mountain dog	1200	361	30.1	394	2.50	0.42	8	15.17	4
Bichon frise	161	34	21.1	34	0.20	3.25	12.92	16.42	1
Bloodhound	180	46	25.6	82	0.50	0.92	6.79	12.08	5
Bolognese‡	36	2	5.6	‡			‡		3
Border collie	558	96	17.2	106	0.70	0.17	12.25	17.33	3
Border terrier	528	152	28.8	177	1.10	0.17	14	22.08	2
Borzoi	182	42	23.1	87	0.50	0.58	9.08	14.25	4
Boston terrier	110	25	22.7	42	0.30	5.17	10.92	15.75	2
Bouvier Des Flandres	140	45	32.1	39	0.20	0.75	11.33	18.33	4
Boxer	450	68	15.1	130	0.80	0.33	10.25	15.25	4
Bracco Italiano§	43	11	25.6	1	0.00		2.67 ^s		3
Briard	238	75	31.5	71	0.40	1	11.17	16.75	4
Brittany	225	59	26.2	28	0.20	0.67	12.88	16.08	3
Bull terrier	864	156	18.1	209	1.30	0.5	10	18.5	3
Bulldog	841	143	17.0	180	1.10	0.83	6.29	14.42	3
Bullmastiff	491	80	16.3	96	0.60	1.33	7.46	13.5	4
Cairn terrier	397	96	24.2	124	0.80	0.25	14	18.33	2
Canaan dog	35	15	42.9	2	0.00	13.08	14.63	16.17	3
Cavalier King Charles spaniel	1150	306	26.6	682	4.30	0.17	11.38	18.5	2
Cesky terrier	65	13	20.0	9	0.10	5.58	8.42	12.67	2
Chesapeake Bay retriever	277	58	20.9	45	0.30	0.75	10.75	15.67	3
Chihuahua	407	37	9.1	71	0.40	0.17	12.42	19.83	1
Chinese crested	68	13	19.1	14	0.10	4.83	10.08	16.17	1
Chow Chow	345	23	6.7	80	0.50	0.33	9.38	14.17	3
Clumber spaniel	388	54	13.9	69	0.40	0.92	10.33	16	4

(continued overleaf)

Table 1. (Continued)

Breed name	Questionnaires			Deaths		Age at death			Breed weight group†
	Numbers sent	Number of returns	% RR*	Number of deaths	% of all deaths	Minimum	Median	Maximum	
Cocker spaniel	1000	206	20.6	289	1.80	0.42	11.17	17.25	3
Collie	329	42	12.8	79	0.50	0.17	12.67	17.08	3
Curly coated retriever	100	35	35.0	40	0.30	0.92	10.75	15	4
Dachshund	810	155	19.1	245	1.50	0.33	12.67	19	2
Dalmatian	686	210	30.6	199	1.30	0.17	12.5	17	4
Dandie Dinmont terrier	207	65	31.4	62	0.40	4	12.17	17.75	2
Deerhound	570	238	41.8	287	1.80	0.17	8.67	16.75	5
Dobermann	300	58	19.3	100	0.60	1.08	10.5	16.5	4
Dogue de Bordeaux	249	41	16.5	5	0.00	0.67	3.83	16	4
English setter	952	254	26.7	384	2.40	0.83	11.58	20	4
English springer spaniel	353	71	20.1	90	0.60	1.17	12	19.5	3
English toy terrier	152	28	18.4	19	0.10	1.42	12	15.92	1
Estrela mountain	35	14	40.0	3	0.00	9.75	9.75	12.83	3
Field spaniel	235	56	23.8	68	0.40	1.25	11.63	17.25	3
Finnish Lapphund	180	28	15.6	5	0.00	0.67	7.33	10.25	2
Finnish spitz	133	51	38.3	42	0.30	1.5	11.13	15.92	3
Flat-coated retriever	1556	472	30.3	610	3.80	0.33	9.83	16.92	4
Fox terrier	239	45	18.8	44	0.30	0.83	13.13	17.25	2
French bulldog	334	72	21.6	71	0.40	0.42	9	14.67	2
German longhaired pointer	42	12	28.6	2	0.00	8	10.5	13	3
German pinscher	55	24	43.6	24	0.20	5.92	11.38	17.92	2
German shorthaired pointer	680	192	28.2	159	1.00	0.92	12	17	4
German spitz	165	55	33.3	43	0.30	1.08	11.33	16.33	2
German wirehaired pointer	58	66	113.8	41	0.30	0.92	10	15.58	4
Giant schnauzer	190	69	36.3	39	0.20	0.67	10	16.92	4
Glen of Imaal terrier	93	35	37.6	6	0.00	7.75	10.42	14.5	3
Golden retriever	3282	538	16.4	927	5.80	0.42	12.25	17.25	4
Gordon setter	545	126	23.1	157	1.00	0.33	11.08	16.25	3
Grand Bleu de Gascogne	21	7	33.3	6	0.00	2.5	4.54	10.08	3
Great Dane	360	72	20.0	171	1.10	0.33	6.5	14.17	5
Greenland dog	11	3	27.3	2	0.00	7.5	8.46	9.42	3
Greyhound	75	33	44.0	69	0.40	0.33	9.08	14.17	4
Griffon Bruxellois	207	72	34.8	71	0.40	0.42	12	19.75	1
Hamiltonstovare	60	15	25.0	6	0.00	3.67	10.13	16.08	3
Havanese	50	11	22.0	3	0.00	4	10.25	18.17	3
Hovawart	110	33	30.0	19	0.10	7	12.92	14.75	3
Hungarian Puli	98	30	30.6	26	0.20	1	12.42	17.92	3
Hungarian vizsla	300	36	12.0	38	0.20	0.5	12.92	17	4
Hungarian wirehaired vizsla	136	54	39.7	15	0.10	2	9.83	15	3
Ibizan hound‡	44	2	4.5	‡			‡		2
Irish red & white setter	215	139	64.7	179	1.10	0.92	11.42	17.5	3
Irish setter	1298	235	18.1	451	2.80	0.33	12	17.08	4
Irish terrier	150	11	7.3	2	0.00	14.5	14.83	15.17	2
Irish water spaniel	210	90	42.9	95	0.60	0.58	9.33	17.17	4
Irish wolfhound	261	40	15.3	112	0.70	1.17	7.04	11.83	5
Italian greyhound	287	42	14.6	46	0.30	0.5	13.5	18	1

(continued overleaf)

Table 1. (Continued)

Breed name	Questionnaires			Deaths		Age at death			Breed weight group†
	Numbers sent	Number of returns	% RR*	Number of deaths	% of all deaths	Minimum	Median	Maximum	
Italian Spinone	376	122	32.4	47	0.30	0.58	9	16	4
Japanese Chin	158	25	15.8	38	0.20	0.58	9.25	14.08	1
Japanese spitz	100	8	8.0	10	0.10	1	12.29	15	1
Keeshond	275	78	28.4	104	0.70	1.83	12.21	16.08	3
Kerry Blue terrier	120	16	13.3	20	0.10	3	11.5	15.17	3
King Charles spaniel	170	24	14.1	50	0.30	1	10.04	23.42	2
Komondor	27	10	37.0	10	0.10	3	9.13	13.17	5
Kooikerhondje	35	9	25.7	7	0.00	0.5	3.92	13.92	3
Labrador retriever	1775	369	20.8	574	3.60	0.17	12.25	19	4
Lagotto Romagnolo‡	205	33	16.1	‡			‡		3
Lakeland terrier	183	26	14.2	14	0.10	2.08	15.46	18.08	2
Lancashire heeler	208	66	31.7	30	0.20	0.17	11.75	21.83	2
Large Munsterlander	220	99	45.0	69	0.40	1.5	11.33	16.58	4
Leonberger	350	109	31.1	47	0.30	0.42	7.08	12.67	5
Lhasa apso	225	52	23.1	84	0.50	1	14.33	18.42	2
Lowchen	75	12	16.0	9	0.10	1.08	10	16.5	1
Maltese	247	37	15.0	42	0.30	1.08	12.25	19.17	1
Manchester terrier	178	59	33.1	32	0.20	0.92	12.83	17.5	1
Maremma sheepdog	64	13	20.3	19	0.10	1.17	10	14.5	4
Mastiff	424	51	12.0	80	0.50	0.75	6.83	16.33	5
Miniature bull terrier	95	25	26.3	20	0.10	0.67	6.08	13.17	2
Miniature pinscher	249	30	12.0	27	0.20	2.5	13	17.92	1
Miniature poodle	81	26	32.1	23	0.10	6.5	13.92	18.5	2
Miniature schnauzer	583	289	49.6	214	1.30	0.58	12.08	18.17	2
Neopolitan mastiff	80	9	11.3	7	0.00	0.67	2.33	16.08	4
Newfoundland	890	233	26.2	269	1.70	0.42	9.67	15.83	5
Norfolk terrier	598	233	39.0	189	1.20	1.5	11	17	2
Norwegian buhund	84	29	34.5	17	0.10	3.5	12.67	16.17	2
Norwegian elkhound	268	71	26.5	71	0.40	0.25	13.17	17.17	3
Norwich terrier	200	71	35.5	56	0.40	1.33	13.38	16.75	2
Nova Scotia duck tolling retriever	175	60	34.3	9	0.10	0.75	8	14.33	3
Old English sheepdog	66	32	48.5	65	0.40	1.33	10.75	15.08	4
Otterhound	139	20	14.4	54	0.30	1	10.21	15	4
Papillon/butterfly dog	475	78	16.4	57	0.40	1.25	13.08	19	1
Parson Russell terrier	248	37	14.9	17	0.10	0.25	13	17.17	2
Pekingese	174	33	19.0	87	0.50	1	11.42	18.17	1
Pharaoh hound	30	8	26.7	15	0.10	3	11.83	17.17	3
Pointer	386	93	24.1	145	0.90	0.5	12.42	16.42	3
Polish lowland sheepdog	134	21	15.7	11	0.10	2.83	9.58	15.08	3
Pomeranian	141	22	15.6	29	0.20	0.58	9.67	17.25	1
Portuguese water dog	46	11	23.9	6	0.00	4.25	11.42	15.25	3
Pug	1200	196	16.3	163	1.00	0.17	11	17	2
Pyrenean mountain dog	539	74	13.7	66	0.40	0.75	9.58	16	5
Pyrenean sheepdog	22	3	13.6	4	0.00	3.67	5.79	7	4
Rhodesian ridgeback	535	172	32.1	183	1.20	1	11	16.17	4
Rottweiler	252	67	26.6	137	0.90	0.42	8.92	16.75	4
Russian black terrier	111	23	20.7	4	0.00	0.25	1.79	11.5	3

(continued overleaf)

Table 1. (Continued)

Breed name	Questionnaires			Deaths		Age at death			Breed weight group†
	Numbers sent	Number of returns	% RR*	Number of deaths	% of all deaths	Minimum	Median	Maximum	
Saluki/gazelle hound	232	74	31.9	132	0.80	1.92	12	16.33	4
Samoyed	425	173	40.7	223	1.40	0.33	12.5	17	4
Schipperke	109	21	19.3	36	0.20	0.5	13	17.5	2
Schnauzer (standard)	860	76	8.8	52	0.30	1	11.96	20.08	3
Scottish terrier	278	47	16.9	59	0.40	0.5	10.25	17.5	2
Sealyham terrier	100	21	21.0	12	0.10	2.17	12.25	14.92	2
Shar pei	447	47	10.5	60	0.40	1.92	6.29	16.5	3
Shetland sheepdog	1003	207	20.6	364	2.30	0.17	12.5	19	2
Shiba Inu (Japanese)	78	17	21.8	3	0.00	4.5	7	9	2
Shih-tzu	265	63	23.8	83	0.50	1.5	13.17	19.33	2
Siberian husky	956	188	19.7	129	0.80	0.42	12.58	18.08	3
Skye terrier	130	28	21.5	37	0.20	1.92	11	15.58	2
Sloughi§	30	8	26.7	1	0.00		5.00§		4
Soft coated wheaten terrier	824	380	46.1	111	0.70	0.5	12.5	17	3
St Bernard	130	24	18.5	53	0.30	0.5	7	12.75	5
Staffordshire bull terrier	833	132	15.8	117	0.70	1.17	12.75	17.17	3
Standard poodle	237	83	35.0	118	0.70	1.25	12	18	4
Sussex spaniel	191	60	31.4	42	0.30	1.08	11.13	16.5	3
Swedish vallhund	71	16	22.5	17	0.10	4	14.42	18.83	2
Tibetan mastiff	60	23	38.3	10	0.10	3.58	11.92	17.17	4
Tibetan spaniel	314	99	31.5	125	0.80	1.5	14.42	19.08	2
Tibetan terrier	314	103	32.8	95	0.60	0.5	12.17	18.25	2
Toy poodle	48	11	22.9	20	0.10	1.75	14.63	18.92	1
Weimaraner	1296	357	27.5	242	1.50	0.67	11.13	18.83	4
Welsh corgi Cardigan∞				53	0.30	4.08	12.17	16.5	2
Welsh corgi Pembroke∞	416	95	22.8	116	0.70	1.42	12.21	17.58	2
Welsh springer spaniel	560	190	33.9	157	1.00	1	12.58	16.67	3
Welsh terrier	238	66	27.7	23	0.10	0.5	12.67	18	2
West Highland white terrier	628	89	14.2	127	0.80	0.58	13	18.17	2
Whippet	846	374	44.2	486	3.10	0.17	12.79	18.17	2
Yorkshire terrier	276	26	9.4	46	0.30	0.25	12.67	17.33	1
Total				15,881	100.00	0.17	11.25	23.42	

*RR = response rate = (number of returned forms/number of forms sent out)×100

†1 = toy; 2 = small; 3 = medium; 4 = large; 5 = giant for breed weight group

‡Bergamasco, Bolognese, Ibizan hound and Lagotto Romagnolo each had no reported deaths

§Bracco Italiano and Sloughi each had only one reported death

∞Questionnaires were sent out to the Welsh Corgi Club and League but returns were separated into Welsh Corgi Cardigan and Welsh Corgi Pembroke for further analysis

Of the 14 breeds with the highest median age at death (≥ 13.5 years), 21% were toy, 64% were small and 14% medium (Table 2). Long-lived breeds were reported to die of diseases normally associated with ageing, including cancer and chronic renal failure. Of the 11 breeds with the lowest median age at death (< 8 years), it is not unexpected that 6 (55%) were giant and 2 (18%) were large (Table 3). Additionally, 2 (18%) were medium breeds, the

British bulldog and the shar pei, both with a median age at death of only 6.3 years. Short-lived breeds succumbed more frequently to cardiac diseases, particularly cardiomyopathy and valvular disease, and gastrointestinal diseases, particularly gastrointestinal dilatation/volvulus.

Causes of death

The three most commonly reported causes of death overall were cancer

($n=4282$, 27%), "old age" ($n=2829$, 18%) and cardiac conditions ($n=1770$, 11%). The most common causes of death overall are presented in Table 4. A category called "other" was used for the remaining causes of death that affected 3% of dogs and included, in descending order, senility, internal bleeding, collapse, infection, ocular, dermatologic, portosystemic shunt, septicemia, systemic, cardiovascular, pinning, hyperthermia and drowning. Greater

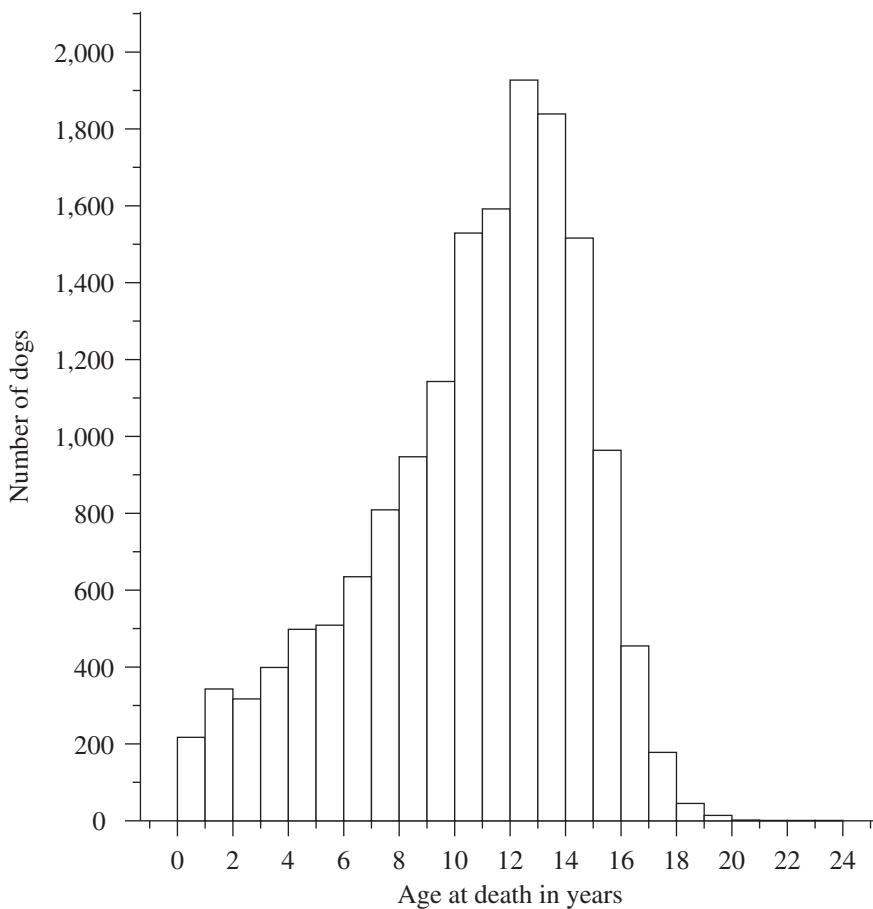


FIG 1. Histogram of the overall longevity for 165 breeds with reported deaths: overall median age at death was 11 years and 3 months (minimum=2 months, maximum=23 years and 5 months); mean age at death was 10 years and 6 months (sd=4 years)

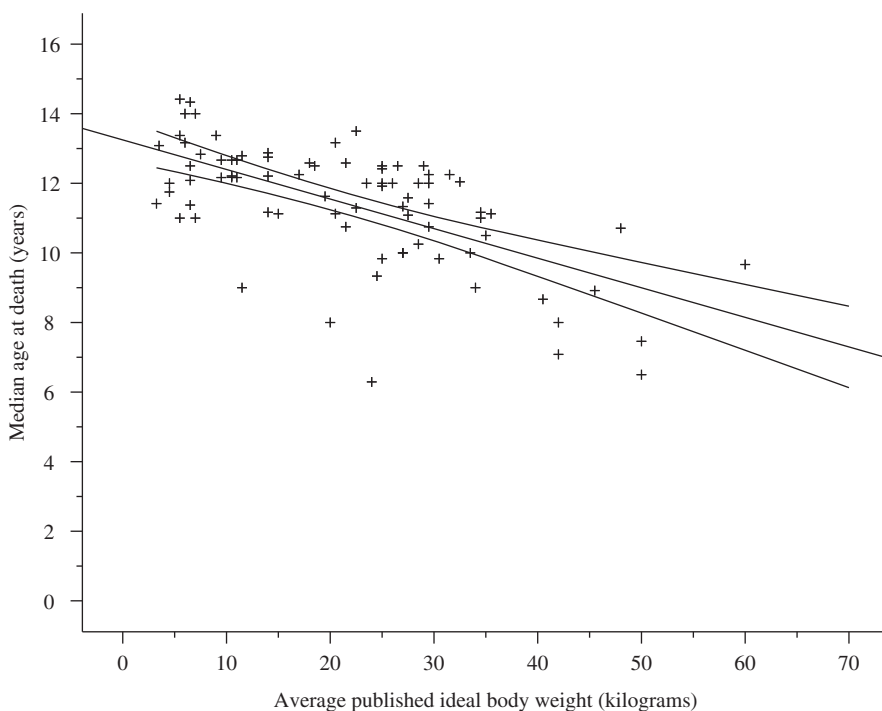


FIG 2. Association of median age at death with average ideal bodyweight by breed (age at death in years = 12.6-0.08×bodyweight in kilograms, r=0.4, P<0.0001)

than 75% of the cancers were reported as having an unspecified type (3319 of 4282; Table 4). For these tumours of unspecified type, the most common locations were the liver (339), mammary glands (278) and brain (234) with the location being unspecified in 545 dogs. When the type of tumour was specified, lymphosarcoma was the most frequently reported type (368 dogs), followed by carcinoma (128 dogs). Owners did not report whether they had contacted their veterinary surgeon to ask for help if they had difficulty remembering a specific diagnosis of cause of death.

Breed-specific proportional mortalities are presented for the four most common causes of death in 72 breeds (Table 5). The breeds with the highest proportional mortalities for cancer included, in descending order, Irish water spaniel, Flat-coated retriever, Hungarian wirehaired vizsla, Bernese mountain dog, Rottweiler, Italian Spinone, Leonberger, Staffordshire bull terrier, Welsh terrier and giant schnauzer. Breeds with “old age” as the highest breed-specific proportional mortality included, in descending order, Lhasa apso, Manchester terrier, border terrier, Norwich terrier, cairn terrier, papillon, Tibetan spaniel, Dalmatian, whippet and bearded collie. Breeds with a cardiac condition as the highest breed-specific proportional mortality, in descending order, included cavalier King Charles spaniel, Norfolk terrier, deerhound, Griffon Bruxellois and British bulldog.

Discussion

The median age at death in the present study of 11.25 years is similar to the median age at death of 12 years found in an earlier UK study (Michell 1999) and 10 years found in a Danish KC survey (Proschowsky and others 2003). All of these median ages at death are higher than the mean of 6.4 years found in USA necropsy study (Bronson 1982), and this is likely due to the much different population of dogs that would have been presented to a Veterinary Teaching Hospital for post-mortem examination. Such a population would be likely to have included more sudden deaths and deaths due to trauma which often occur at a younger age.

Table 2. The 14 breeds with the highest median age at death (≥ 13.5 years) showing the Kennel Club breed group that these breeds belong to, the published values for average "ideal" bodyweight (Alderton, 1993), number of deaths in each breed and median age at death

Breed group	Breed	Average bodyweight (kg)	Median age at death (year)	Number of deaths
Small	Lakeland terrier	5.5	15.46	14
Small	Irish terrier	11.5	14.83	2
Medium	Canaan dog	20.5	14.63	2
Toy	Toy poodle	5.0	14.63	20
Small	Swedish vallhund	13.0	14.42	17
Small	Tibetan spaniel	5.5	14.42	125
Small	Lhasa apso	6.5	14.33	84
Toy	Australian silky terrier	4.5	14.25	5
Small	Border terrier	6.0	14.00	177
Small	Cairn terrier	7.0	14.00	124
Small	Miniature poodle	13.0	13.92	23
Small	Basenji	10.0	13.54	46
Medium	Bearded collie	22.5	13.50	278
Toy	Italian greyhound	4.0	13.50	46

Table 3. The 11 breeds with the lowest median age at death (< 8 years) showing the Kennel Club breed group that these breeds belong to, the published values for average "ideal" bodyweight (Alderton, 1993), number of deaths in each breed and median age at death

Breed group	Breed	Average bodyweight (kg)	Median age at death (year)	Number of deaths
Large	Bullmastiff	50.0	7.46	96
Giant	Leonberger	42.0	7.08	47
Giant	Irish wolfhound	47.5	7.04	112
Giant	St Bernard	70.0	7.00	53
Small	Shiba Inu (Japanese)	11.5	7.00	3
Giant	Mastiff	83.0	6.83	80
Giant	Bloodhound	43.0	6.79	82
Giant	Great Dane	50.0	6.50	171
Medium	Bulldog	24.0	6.29	180
Medium	Shar pei	18.0	6.29	60
Large	Dogue de Bordeaux	47.5	3.83	5

Similar to other studies, smaller breeds such as the terriers, beagle, bearded collie, bichon frise, dachshund, miniature pinscher, miniature poodle, toy poodle and whippet lived longer, and giant breeds such as Bernese mountain dog, deerhound, Leonberger, Irish wolfhound, St Bernard, mastiff and bloodhound had shorter lifespan (Bronson 1982; Michell 1999; Proschowsky and others 2003). These results and the negative correlation of age at death with bodyweight were as expected based on previous studies. The ideal bodyweight was used here as there are no published studies that report average bodyweights for the breeds included in this study. The same results were obtained when the breeds were categorised according to body size into giant, large, medium, small and toy breeds (breed weight group

in Table 1). Interestingly, three medium-sized breeds had the shortest lifespan with a median age at death of 6.3 years for the British bulldog (180 deaths) and Shar pei (60 deaths) and 6.08 years for the miniature bull terrier (20 deaths).

Due to the difficulties associated with random sampling of the pedigree dog population in the UK, this study took the approach of obtaining a convenience sample. Thus, the results of this study cannot necessarily be generalised to all dogs or breeds. The breed-specific response rates were highly variable and affect the generalisability of the results on a breed by breed basis. The limitations of owner-reported causes of death means that some of the results must be interpreted with caution. For example, reported causes of death due to a stroke

or cerebral vascular accident were not supported by a post-mortem examination in 97.5% of cases in this study. Strokes are relatively uncommon with less than 50 cases of brain infarction in dogs reported in the veterinary literature to date (Garosi and others 2005). The prognosis for brain infarction is considered to be fair to good as more than 66% of the 33 dogs reported in the study by Garosi and others (2005) either returned to normal or experienced considerable improvement in their neurologic status. Although it appears that a stroke rarely kills, a suspected or confirmed stroke could leave a dog in a condition where euthanasia was chosen as the most humane method of treatment. The same could also be said for the reporting of heart attack as an unconfirmed cause of death in this study. Since only a small proportion of the dogs that were reported to have died due to a stroke or heart attack underwent post-mortem examination and it was not clear whether the post-mortem confirmed the cause of death, these diagnoses must be considered with caution. Given that the most commonly reported cause of death overall and in those dogs that underwent a post-mortem was cancer and that the majority of these were still reported with an unspecified cell type, this suggests that either tissues were not sent to a laboratory for histopathological diagnosis or that the owners were not told of the final diagnosis. An additional limitation is the bias associated with asking owners about dogs that had died in the previous 10 years (recall bias). We attempted to minimise the effect of recall bias by asking owners to be as specific as possible and to contact their veterinary surgeon if they had difficulty remembering the cause of death. The final limitation is that the survey was anonymous in order to encourage participation and this meant that we were not able to verify cause of death information with the owners or their veterinary surgeons. The three most commonly reported causes of death in the present study, cancer, "old age" and cardiac conditions, were slightly different from the top three causes of death in the Danish KC study, age ($n=609$, 20.8%), cancer ($n=425$, 14.5%) and behaviour ($n=188$, 6.4%) based on 2650 purebred and 278 mixed breed dogs (Proschowsky

Table 4. The most frequently reported causes of death overall for 165 breeds experiencing 15,881 deaths

Cause of death	N	%	Specific causes reported
Cancer*	4282	27.0	Unspecified type (3319), lymphosarcoma (368), carcinoma (128), other (467)
"Old age"	2829	17.8	Either "age" or "old age" or one of these in combination with another cause
Cardiac†	1770	11.1	Failure (815), unspecified defect (310), attack (291), CMP (136), MVD (102), cardiomegaly (78), congenital defect (18), murmur (11), other (9)
Unknown	828	5.2	"Unknown," "undiagnosed," "died," "sudden death" (71), other uncodeable causes of death
Urologic	783	4.9	Unspecified urinary tract disease (468), chronic or unspecified renal failure (232), acute renal failure (21), other (62)
Combinations	723	4.6	Combinations including kidney (181) ± cardiac (164) ± liver (151) most commonly
Neurologic	673	4.2	Seizure disorder (328) – ["epilepsy" (174), unspecified seizures (154)], intervertebral disc disease (62), Wobblers (15), unspecified (129), other (139)
Gastrointestinal‡	652	4.1	Bloat/GDV (388), pancreatitis (53), unspecified (35), foreign body (24), colitis/diarrhoea (23), HGE (21), unspecified GE (20), megaesophagus (16), other (72)
Cerebrovascular	615	3.9	Stroke or cerebral vascular accident or CVA
Trauma	385	2.4	Road traffic accident (195), unspecified (133), spinal trauma (29), attacked by dog (17)
Hepatic	336	2.1	Chronic or unspecified failure (232), unspecified disease (71), acute failure (21), other (12)
Musculoskeletal	272	1.7	Arthritis/osteoarthritis/DJD (167), hip dysplasia (54), other (51)
Endocrine	234	1.5	Hyperadrenocorticism (106), diabetes mellitus (76), hypoadrenocorticism (38), other (14)
Perioperative	222	1.4	Perioperative or anaesthetic-related (121), postoperative (101)
Behaviour	209	1.3	Aggression (151), unspecified (55), other (3)
Respiratory	192	1.2	Unspecified disease or failure (61), pneumonia (46), laryngeal paralysis (30), choked (14), bronchitis (11), tracheal collapse (8), other (22)
Immune mediated§	159	1.0	Unspecified (88), AIHAe (42), ITPf (12), Evans' syndrome (3), other (14)
Reproductive	144	0.9	Pyometra (106), prostatic disease (18), other (20)
Poisoning	84	0.5	Unspecified
Subtotal	15,392	96.9	
Other∞	489	3.1	Other causes of death that did not fit into any of the above categories
Total	15,881	100	

*Cancer: lymphosarcoma includes lymphoma and leukaemia

†Cardiac: MVD = mitral valve disease

‡Gastrointestinal: GDV = gastric dilatation/volvulus; HGE = haemorrhagic gastroenteritis

§Immune mediated: AIHA = autoimmune haemolytic anaemia; ITP = immune-mediated thrombocytopenia

∞Other included the following reported causes of death in descending order: senility, internal bleeding, collapse, infection, ocular, dermatologic, portosystemic shunt, died, septicaemia, systemic, cardiovascular, pining, hyperthermia and drowning

and others 2003). The proportional mortality of 26.9% for cancer in the present study is higher than that found in the Danish KC study (14.5%; Proschowsky and others 2003) and the earlier UK study (15.7%; Michell 1999), but it is similar to that found in other studies such as the USA necropsy study (23%; Bronson 1982) and a German study of life expectancy (27.3%; Eichelberg and Seine 1996). The breeds with the highest proportional mortalities for cancer in the present study are similar to those breeds that have been reported previously. The overall proportional mortality of 17.8% for "old age" in the present study is similar to that found in the Danish KC study (20.8%; Proschowsky and others 2003) and the earlier UK study (20.7%; Michell 1999). Deaths were coded as "old age" in this study even when another condition was reported since many of the additional causes of death given were non-specific and appeared to be a reason for euthanasia, such as arthritis, incontinence or

colitis. It would have been useful to know whether the dog had died or had been put to sleep so that the causes of death and euthanasia could be separated but, unfortunately, this was not asked on the questionnaire. Although behaviour has been reported to be a much more common cause of death as a reason for euthanasia in other studies (Patronek and Dodman 1999), behaviour problems had a very low proportional mortality in this study of 1.3% as well as in the Danish KC study (6.4%; Proschowsky and others 2003). There are many potential reasons why behaviour problems were not a commonly reported cause of death. It may be that in our study and the Danish study, owners of pedigree dogs were more committed to continuing to care for their dogs in spite of behaviour problems or it may have been that the dogs were surrendered for rehoming if they had behaviour problems. The median age at death due to a behaviour problem was low at 4.58 years and this is consistent with other studies.

Further work is continuing in the UK using breed-specific surveys to gather confidential health information on dogs. There are many diseases, particularly those complex diseases such as the various forms of valvular heart disease, cardiomyopathy, cruciate ligament injury and immune-mediated diseases, that have both genetic and environmental components to their causation. These complex diseases require a combination of research efforts that include input from veterinary surgeons in practice and in research, epidemiologists and geneticists. Research requirements for future disease surveillance measures include the need for clear case definitions of disease and accurate and validated data collection on the health status of clinically affected and non-affected dogs that can be linked to the pedigree for analysis and future work on estimated breeding values. This work must be done in cooperation with the breed club health coordinators and the KC.

Table 5. Overall and breed-specific proportional mortalities for the four most common causes of death in 72 breeds, excluding the 828 (5.2%) of deaths due to unknown/unreported causes

Breed	Cause of death																					
	All deaths	Cancer												Old age			Cardiac			Urologic		
	N	N	%	95% CI		N	%	95% CI		N	%	95% CI		N	%	95% CI						
Afghan hound	143	44	30.8	23.2	38.3	29	20.3	13.7	26.9	15	10.5	5.5	15.5	7	4.9	1.4	8.4					
Airedale terrier	81	32	39.5	28.9	50.2	11	13.6	6.1	21.0	6	7.4	1.7	13.1	7	8.6	2.5	14.8					
Alaskan Malamute	14	5	35.7	10.6	60.8	2	14.3	0.0	32.6	0	0.0	0.0	0.0	0	0.0	0.0	0.0					
Basset Griffon Vendéen	76	25	32.9	22.3	43.5	18	23.7	14.1	33.2	5	6.6	1.0	12.2	4	5.3	0.2	10.3					
Basset hound	142	44	31.0	23.4	38.6	19	13.4	7.8	19.0	11	7.7	3.3	12.1	8	5.6	1.8	9.4					
Beagle	241	79	32.8	26.9	38.7	38	15.8	11.2	20.4	30	12.4	8.3	16.6	8	3.3	1.1	5.6					
Bearded collie	278	54	19.4	14.8	24.1	72	25.9	20.7	31.0	16	5.8	3.0	8.5	22	7.9	4.7	11.1					
Belgian shepherd	113	26	23.0	15.2	30.8	15	13.3	7.0	19.5	6	5.3	1.2	9.4	3	2.7	0.0	5.6					
Bernese mountain dog	394	180	45.7	40.8	50.6	24	6.1	3.7	8.5	20	5.1	2.9	7.2	16	4.1	2.1	6.0					
Border collie	106	25	23.6	15.5	31.7	19	17.9	10.6	25.2	7	6.6	1.9	11.3	4	3.8	0.1	7.4					
Border terrier	177	34	19.2	13.4	25.0	54	30.5	23.7	37.3	5	2.8	0.4	5.3	12	6.8	3.1	10.5					
Boxer	130	50	38.5	30.1	46.8	28	21.5	14.5	28.6	9	6.9	2.6	11.3	1	0.8	0.0	2.3					
Briard	71	27	38.0	26.7	49.3	6	8.5	2.0	14.9	5	7.0	1.1	13.0	4	5.6	0.3	11.0					
Brittany	28	5	17.9	3.7	32.0	6	21.4	6.2	36.6	1	3.6	0.0	10.4	0	0.0	0.0	0.0					
Bull terrier	209	48	23.0	17.3	28.7	27	12.9	8.4	17.5	30	14.4	9.6	19.1	31	14.8	10.0	19.7					
Bulldog/British bulldog	180	33	18.3	12.7	24.0	16	8.9	4.7	13.0	36	20.0	14.2	25.8	4	2.2	0.1	4.4					
Bullmastiff	96	36	37.5	27.8	47.2	4	4.2	0.2	8.2	6	6.3	1.4	11.1	5	5.2	0.8	9.7					
Cairn terrier	124	24	19.4	12.4	26.3	35	28.2	20.3	36.1	11	8.9	3.9	13.9	10	8.1	3.3	12.9					
Cocker spaniel/English cocker	289	85	29.4	24.2	34.7	50	17.3	12.9	21.7	27	9.3	6.0	12.7	15	5.2	2.6	7.7					
Dachshund (all)	245	41	16.7	12.1	21.4	53	21.6	16.5	26.8	35	14.3	9.9	18.7	12	4.9	2.2	7.6					
Dalmatian	199	38	19.1	13.6	24.6	54	27.1	21.0	33.3	13	6.5	3.1	10.0	10	5.0	2.0	8.1					
Dandie Dinmont terrier	62	14	22.6	12.2	33.0	7	11.3	3.4	19.2	6	9.7	2.3	17.0	2	3.2	0.0	7.6					
Deerhound	287	54	18.8	14.3	23.3	35	12.2	8.4	16.0	70	24.4	19.4	29.4	6	2.1	0.4	3.7					
Dobermann	100	26	26.0	17.4	34.6	22	22.0	13.9	30.1	15	15.0	8.0	22.0	3	3.0	0.0	6.3					
English setter	384	126	32.8	28.1	37.5	72	18.8	14.8	22.7	27	7.0	4.5	9.6	18	4.7	2.6	6.8					
English springer spaniel	90	24	26.7	17.5	35.8	16	17.8	9.9	25.7	5	5.6	0.8	10.3	4	4.4	0.2	8.7					
Field spaniel	68	20	29.4	18.6	40.2	12	17.6	8.6	26.7	3	4.4	0.0	9.3	2	2.9	0.0	7.0					
Finnish spitz	42	9	21.4	9.0	33.8	4	9.5	0.6	18.4	3	7.1	0.0	14.9	3	7.1	0.0	14.9					
Flat-coated retriever	610	331	54.3	50.3	58.2	54	8.9	6.6	11.1	38	6.2	4.3	8.1	8	1.3	0.4	2.2					
French bulldog	71	27	38.0	26.7	49.3	6	8.5	2.0	14.9	1	1.4	0.0	4.1	1	1.4	0.0	4.1					
German shorthaired pointer	159	47	29.6	22.5	36.7	30	18.9	12.8	24.9	6	3.8	0.8	6.7	1	0.6	0.0	1.9					
German spitz/klein or mittel	43	7	16.3	5.2	27.3	10	23.3	10.6	35.9	6	14.0	3.6	24.3	0	0.0	0.0	0.0					
German wirehaired pointer	41	10	24.4	11.2	37.5	8	19.5	7.4	31.6	1	2.4	0.0	7.2	1	2.4	0.0	7.2					
Giant schnauzer	39	16	41.0	25.6	56.5	4	10.3	0.7	19.8	6	15.4	4.1	26.7	1	2.6	0.0	7.5					
Golden retriever	927	360	38.8	35.7	42.0	172	18.6	16.1	21.1	50	5.4	3.9	6.8	36	3.9	2.6	5.1					
Gordon setter	157	46	29.3	22.2	36.4	26	16.6	10.7	22.4	23	14.6	9.1	20.2	7	4.5	1.2	7.7					
Hungarian wirehaired vizsla	15	7	46.7	21.4	71.9	2	13.3	0.0	30.5	2	13.3	0.0	30.5	0	0.0	0.0	0.0					
Irish red & white setter	179	54	30.2	23.4	36.9	34	19.0	13.2	24.7	14	7.8	3.9	11.8	12	6.7	3.0	10.4					
Irish setter	451	123	27.3	23.2	31.4	101	22.4	18.5	26.2	45	10.0	7.2	12.7	9	2.0	0.7	3.3					
Irish water spaniel	95	53	55.8	45.8	65.8	10	10.5	4.4	16.7	1	1.1	0.0	3.1	1	1.1	0.0	3.1					
Italian Spinone	47	21	44.7	30.5	58.9	7	14.9	4.7	25.1	1	2.1	0.0	6.3	4	8.5	0.5	16.5					
Keeshond	104	33	31.7	22.8	40.7	27	26.0	17.5	34.4	6	5.8	1.3	10.3	7	6.7	1.9	11.5					
Labrador retriever	574	179	31.2	27.4	35.0	132	23.0	19.6	26.4	42	7.3	5.2	9.4	11	1.9	0.8	3.0					
Lancashire heeler	30	8	26.7	10.8	42.5	8	26.7	10.8	42.5	2	6.7	0.0	15.6	1	3.3	0.0	9.8					

(continued overleaf)

Table 5. Continued

Breed	All deaths		Cause of death														
	N	N	Cancer			Old age			Cardiac			Urologic					
			%	95% CI	N	%	95% CI	N	%	95% CI	N	%	95% CI				
Large Munsterlander	69	17	24.6	14.5	34.8	8	11.6	4.0	19.1	4	5.8	0.3	11.3	1	1.4	0.0	4.3
Leonberger	47	21	44.7	30.5	58.9	1	2.1	0.0	6.3	5	10.6	1.8	19.5	0	0.0	0.0	0.0
Lhasa apso	84	15	17.9	9.7	26.0	27	32.1	22.2	42.1	3	3.6	0.0	7.5	6	7.1	1.6	12.7
Manchester terrier	32	7	21.9	7.6	36.2	10	31.3	15.2	47.3	1	3.1	0.0	9.2	3	9.4	0.0	19.5
Miniature schnauzer	214	46	21.5	16.0	27.0	36	16.8	11.8	21.8	25	11.7	7.4	16.0	7	3.3	0.9	5.7
Newfoundland	269	73	27.1	21.8	32.5	52	19.3	14.6	24.0	43	16.0	11.6	20.4	6	2.2	0.5	4.0
Norwegian elkhound	71	23	32.4	21.5	43.3	16	22.5	12.8	32.3	8	11.3	3.9	18.6	4	5.6	0.3	11.0
Norwich terrier	56	12	21.4	10.7	32.2	17	30.4	18.3	42.4	7	12.5	3.8	21.2	3	5.4	0.0	11.3
Nova Scotia duck tolling retriever	9	3	33.3	2.5	64.1	0	0.0	0.0	0.0	1	11.1	0.0	31.6	0	0.0	0.0	0.0
Pointer	145	30	20.7	14.1	27.3	35	24.1	17.2	31.1	6	4.1	0.9	7.4	7	4.8	1.3	8.3
Rhodesian ridgeback	183	56	30.6	23.9	37.3	33	18.0	12.5	23.6	11	6.0	2.6	9.5	5	2.7	0.4	5.1
Rottweiler	137	62	45.3	36.9	53.6	14	10.2	5.1	15.3	7	5.1	1.4	8.8	4	2.9	0.1	5.7
Saluki/gazelle hound	132	47	35.6	27.4	43.8	17	12.9	7.2	18.6	19	14.4	8.4	20.4	2	1.5	0.0	3.6
Samoyed	223	59	26.5	20.7	32.2	46	20.6	15.3	25.9	11	4.9	2.1	7.8	6	2.7	0.6	4.8
Shetland sheepdog	364	81	22.3	18.0	26.5	54	14.8	11.2	18.5	28	7.7	5.0	10.4	63	17.3	13.4	21.2
Shih-tzu	83	12	14.5	6.9	22.0	17	20.5	11.8	29.2	15	18.1	9.8	26.4	13	15.7	7.8	23.5
Siberian husky	129	41	31.8	23.7	39.8	21	16.3	9.9	22.6	8	6.2	2.0	10.4	4	3.1	0.1	6.1
Soft coated wheaten terrier	111	29	26.1	18.0	34.3	23	20.7	13.2	28.3	4	3.6	0.1	7.1	9	8.1	3.0	13.2
Staffordshire bull terrier	117	52	44.4	35.4	53.4	23	19.7	12.5	26.9	8	6.8	2.3	11.4	6	5.1	1.1	9.1
Standard poodle	118	35	29.7	21.4	37.9	21	17.8	10.9	24.7	6	5.1	1.1	9.0	5	4.2	0.6	7.9
Sussex spaniel	42	8	19.0	7.2	30.9	8	19.0	7.2	30.9	6	14.3	3.7	24.9	0	0.0	0.0	0.0
Tibetan spaniel	125	29	23.2	15.8	30.6	34	27.2	19.4	35.0	14	11.2	5.7	16.7	4	3.2	0.1	6.3
Tibetan terrier	95	30	31.6	22.2	40.9	21	22.1	13.8	30.4	9	9.5	3.6	15.4	8	8.4	2.8	14.0
Weimaraner	242	58	24.0	18.6	29.3	33	13.6	9.3	18.0	28	11.6	7.5	15.6	4	1.7	0.0	3.3
Welsh corgi Cardigan	53	15	28.3	16.2	40.4	13	24.5	12.9	36.1	2	3.8	0.0	8.9	1	1.9	0.0	5.5
Welsh corgi Pembroke	116	33	28.4	20.2	36.7	26	22.4	14.8	30.0	9	7.8	2.9	12.6	10	8.6	3.5	13.7
Welsh springer spaniel	157	42	26.8	19.8	33.7	29	18.5	12.4	24.5	7	4.5	1.2	7.7	12	7.6	3.5	11.8
Welsh terrier	23	10	43.5	23.2	63.7	5	21.7	4.9	38.6	0	0.0	0.0	0.0	1	4.3	0.0	12.7
Other breeds (n=93)	4524	806	17.8			811	17.9			808	17.9			268	5.9		
Total	15,881	4282	27.0			2829	17.8			1770	11.1			783	4.9		

This study shows breed differences in lifespan and causes of death, and the results support previous evidence that smaller breeds tend to have longer lifespan compared with larger breeds. The long-lived breeds died of diseases appropriate to their longevity with cancer, old age and chronic renal failure representing the highest proportional mortalities for these breeds. Although many of the breeds in the study were not representative for the breed club or the general pedigree dog population in the UK, the results do contribute to the limited information currently available on canine mortality.

Acknowledgements

The authors wish to thank the UK KC Charitable Trust for funding this survey as well as the KC/British Small Animal Veterinary Association Scientific Committee and the participating breed club secretaries and members for their assistance in this study.

Conflict of interest

None of the authors of this article has a financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

References

- ALDERTON, D. (1993) Dogs. London: Dorling Kindersley
- BONNETT, B. N., EGENVALL, A., OLSON, P. & HEDHAMMAR, A. (1997) Mortality in insured Swedish dogs: rates and causes of death in various breeds. *Veterinary Record* **141**, 40-44
- BRONSON, R. T. (1982) Variation in age at death of dogs of different sexes and breeds. *American Journal of Veterinary Research* **43**, 2057-2059
- EICHELBERG, H. & SEINE, R. (1996) Life expectancy and cause of death in dogs: the situation in mixed breeds and various dog breeds. *Berliner und Münchener tierärztliche Wochenschrift* **109**, 292-303
- EGENVALL, A., BONNETT, B. N., SHOUKRI, M., OLSON, P. & HEDHAMMAR, A. (2000a) Gender, age, breed and distribution of morbidity and mortality in insured dogs in Sweden during 1995 and 1996. *Veterinary Record* **146**, 519-525
- EGENVALL, A., BONNETT, B. N., SHOUKRI, M., OLSON, P., HEDHAMMAR, A. & DOHOO, I. (2000b) Age pattern of mortality in eight breeds of insured dogs in

- Sweden. *Preventive Veterinary Medicine* **46**, 1-14
- GAROSI, L. S., McCONNELL, J. F., PLATT, S. R., BARONNE, G., BARON, J. C., DE LAHUNTA, A. & SCHATZBERG, S. J. (2005) Results of diagnostic investigations and long-term outcome of 33 dogs with brain infarction (2000-2004). *Journal of Veterinary Internal Medicine* **19**, 725-731
- HAYASHIDANI, H., OMI, Y., OGAWA, M. & FUKUTOMI, K. (1988) Epidemiological studies on the expectation of life for dogs computed from animal cemetery records. *Japanese Journal of Veterinary Science* **50**, 1003-1008
- MICHELL, A. R. (1999) Longevity of British breeds of dogs and its relationship with sex, size, cardiovascular variables and disease. *Veterinary Record* **145**, 625-629
- PATRONEK, G. J. & DODMAN, N. H. (1999) Attitudes, procedures, and delivery of behavior services by veterinarians in small animal practice. *Journal of the American Veterinary Medical Association* **215**, 1606-1611
- PATRONEK, G. J., WATERS, D. J. & GLICKMAN, L. T. (1997) Comparative longevity of pet dogs and humans: implications for gerontology research. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences* **52**, B171-B178
- PROSCHOWSKY, H. F., RUGBJERG, H. & ERSBOLL, A. K. (2003) Mortality of purebred and mixed-breed dogs in Denmark. *Preventive Veterinary Medicine* **58**, 63-74
- REID, S. W. J. & PETERSON, M. M. (2000) Methods of estimating canine longevity. *Veterinary Record* **147**, 630-631