



# Mastiff breed mortality: A study of owner experience, dog age and longevity

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## ABSTRACT

Despite being ranked 33 in Americas most popular breeds (American Kennel Club, 2020), there is a lack of research addressing longevity and death related health problems of Mastiff dog breeds and specifically commonly kept Bull Mastiffs and English Mastiffs. Likely a result of small founder populations and minimal breeding geographical locations, limited genetic variation is found making it important to determine key health concerns which may reduce longevity. The purpose of this study was to report findings from an online global survey of owners of deceased Mastiffs detailing breed, age at death, and if known, cause of death. Owner information was also collected including location by continent and country and the owners breeding or hobbyist experience. A closed-question survey was used via an online network of global Mastiff clubs and associations totalling a useable sample of 1036 dogs across a range of breeds. Notably, it is reported that age and cause of death varied dependant on breed. Results indicate that the median age of death for all dogs was 8 years with mean age of death in Europe as 7.72 years and 8.17 years in North America. The most common cause of death identified for all dogs was cancer (47%), old age (16%), cardiac problems (8%) and gastric problems including GDV and bloat (7%). The mean age of death for cancer dogs was 7.85 years with 23 types of cancer stated with Osteosarcoma being the most commonly recorded and specifically for neutered animals. As the survey was aimed at hobbyist and registered breeders, study findings contribute to knowledge of Mastiff mortality with the aim of promoting welfare of the breed.

## 1. Introduction

### 1.1. The present-day dog

With over 400 dog (*Canis lupus familiaris*) breeds recorded globally obvious morphological and conformational differences exist varying across breeds and within breed standard groups. It is ever more prominent with large and giant breeds like the Mastiff group where breeding for specific excessive morphological and conformational traits is common (Fogle, 2009). Within the United Kingdom (UK) alone, the PDSA (2020a) estimate that there are around 12 million dogs with at least 26.6% of the population owning at least one dog during 2021 (Statista, 2021). Due to their popularity, demand for specific breeds further pressurises the 'intense' breeding of popular breeds making some breeds with known predisposed inherited conditions more likely to be excessively bred. As one of the most admired pets, establishing breed influencing factors for inherited health conditions or reduced longevity is important to ensure optimum health exists and thus, a prolonged

lifespan.

### 1.2. Breed concerns

Less commonly kept pedigree breeds like the Mastiff group, are often bred from small founder populations with specialist breeders using key breeding individuals. Due to their large size, breeding complications and the initial financial outlay, some individuals are consequently over-represented with specific breeding traits highly represented across the local populations. O'Neill et al., (2013) identified the cause of death for pure-bred dogs to be breed specific, with large and giant breeds like the Mastiff group and specifically the Dogue de Bordeaux having a shorter life expectancy due to conformational changes and inherited breed conditions. Yordy et al., (2019) found that mixed breed dogs live about 1.2 years longer than pedigree breeds of a similar size suggesting that there is an accelerated rate of ageing in larger breeds. The UK Kennel Club (2014) found the mean age of death for a UK pedigree dog to be around 10 years compared to 11 years and 3 months in 2004 concluding

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that dogs were now dying younger. Less dogs were found to be living to an old age with 13.8% of their 2014 respondents dying from ageing conditions compared to 17.8% ten years prior (KC, 2004; 2014). [Michell \(1999\)](#) earlier found that 64% of the 3000 UK dogs analysed were euthanised or died due to disease with cancer being responsible for 16% and heart disease 32% ([Kraus et al., 2013](#)). Exploring risk factors for specific breed groups is essential to maximise breed-specific longevity.

### 1.3. Mastiff breed standards

Registered under specific breed standards set by national organisations like the American Kennel Club or The Kennel Club, the Mastiff group consists of 19 obviously morphologically different breeds including the commonly known Bull Mastiff, English Mastiff (Mastiff herein) and Great Dane with some breeds banned under UK legislation due to perceived historical aggressive characteristics ([GOV.UK, 2020](#)) ([Table 1](#)).

As with all breed groups, national breed standards exist with some of the most well-renowned locations for Mastiff breeding, the UK and North America, not current members of the Federation Cynologique Internationale (FCI) who as the largest known global canine organisation aim to safeguard pedigree dog health ([FCI, 2021](#)). With the Mastiff group historically described by the [FCI \(2011\)](#) as a 'Molossoid breed' used in ancient times as livestock guardian dogs, breed standards aim to maintain appearance and temperament across all breeds. The UK Kennel Club standards list seven Mastiff breeds ([KC, 2015](#) and [2020a,c](#)) compared to 18 by the American Kennel Club ([AKC, 2020b,c](#)) with naming differences including the 'Mastiff (England)' in America or the 'Mastiff' in the UK ([KC, 2014; 2015](#)). Differing breed differences and life expectancies are stated varying between 6–10 years for the Mastiff and 7–9 years for the Bull Mastiff ([AKC, 2020a,b](#)).

### 1.4. Mastiff group concerns

Despite their rise in popularity as companion dogs, [The Kennel Club \(2014; 2020c\)](#) have identified the Mastiff group as 'vulnerable' with less than 300 registrations per year and as one of the most traditional breed groups within the UK, [The Old English Mastiff Club \(2020\)](#) report a 43% decline over the last ten years ([KC, 2020c; KC, 2020b](#)). The Mastiff group is also identified as 'category three' under The Kennel Club current 'Breed Watch' scheme, aiming to discourage the positive promotion of breeds with exaggerated conformations and susceptibility to specific health conditions. Beyond the Mastiff group, the [Bateson Inquiry \(2010\)](#) investigated pedigree dogs to address global breed problems ([Nicholas, 2011](#)) with concern from poor breeding for exaggerated characteristics

**Table 1**  
2019 Mastiff breeds worldwide [\* denotes breeds banned in the UK under the Dangerous Dogs Act 199] ([KC, 2014; GOV.UK, 2020](#))

Breed	Name	Country
Abruzzese Mastiff	Mastino Abruzzese	Italy
Alangu Mastiff	Bully Kutta	Pakistan
American Mastiff	Mastiff x Turkish Mastiff	USA
Argentinian Mastiff*	Dogo Argentino	Argentina
Boerboel	South African Mastiff	South Africa
Brazilian Mastiff *	Fila Brasileiro	Brazil
Bull Mastiff	Mastiff	United Kingdom
Canary Mastiff	Presa Canario	Canary Islands
English Mastiff	English Mastiff	United Kingdom
German Mastiff	German Mastiff	Germany
Italian Mastiff	Cane Corso	Italy
Japanese Mastiff *	Tosa Inu	Japan
Korean Mastiff	Dosa Gae	Korea
Neapolitan Mastiff	Neapolitan	Italy
Pyrenean Mastiff	Pyrenean Mastiff	Spain
Spanish Mastiff	Mastin Espanol	Spain
Tibetan Mastiff	Tibetan Mastiff	Tibet
Turkish Mastiff	Kangal, Anatolian Mastiff	Turkey

and increased rates of reduced fecundity, higher 'infant mortality', and shorter lifespans with cross breeds found to have significantly longer average life expectancies. Within the North American Mastiff community, such concern exists with unpublished results from [Stivason \(2015\)](#) exploring links between size, health, and longevity suggesting that genetic diversity is steadily being lost in the breed group.

### 1.5. Key Mastiff health concerns

Following the Bateson Inquiry within the UK, ten major recommendations were proposed to improve health and welfare of dog breeding with one to 'Evaluate all breed standards in terms of their implications for health and welfare' ([Nicholas, 2011](#)). This is of benefit to the Mastiff community, with limited genetic variation from repeated breeding from a small number of key sires and dams further accelerating the breed group's higher risk of inherited conditions ([MCOA, 2020a; KC, 2021](#)). Age of death is often affected with limited genetic variation and as such further promotes breed-specific conditions which limit the lifespan and increases the likelihood of ageing younger. The median age of death found by [Adams et al., \(2010\)](#) was 11 years and 3 months varying by breed with a wide varying median age at death across the Mastiff group including; Neapolitan Mastiff 2.33 years, Dogue de Bordeaux 3.83 years, Great Dane 6.5 years, Mastiff 6.83 years, Bull Mastiff 7.46 years and Tibetan Mastiff 11.92 years. 18% were reported as dying from old age and specifically 4.2% of Bull Mastiffs. Furthermore, 55% of the 11 pedigree breeds found with the lowest median age of death were giant breeds and 18% large breeds including four Mastiff breeds suggesting size is influential in longevity. [Lewis et al., \(2018\)](#) states 'old age' accounted for at 13.8% mortality of The Kennel Club registrations compared to a much lower 4.2% from [Adams et al., \(2010\)](#).

### 1.6. Breed predisposition to cancer

Following old age as the main cause of pedigree and mixed breed deaths, [Proschowsky et al., \(2003\)](#) earlier found that cancer was also common with the national UK survey by [The Kennel Club \(2014\)](#) stating cancer attributed to 27% of deaths with early ageing instrumental in younger deaths. Cancer as a cause of death amongst large and giant breeds is well known despite limited research for Mastiff breeds ([Michell, 1999](#)). [Dobson \(2013\)](#) highlighted an underlying genetic predisposition to specific cancers and that Osteosarcoma almost exclusively affects the large and giant breeds. [The Mastiff Club of America \(2020a\)](#) suggested that cancer is present within 50% of Mastiff breeds and 27% of all recorded deaths including 37.5% for Bull Mastiff's by [Adams et al. \(2010\)](#). [Edwards et al., \(2004\)](#) earlier recorded a higher incidence of Lymphoma in middle aged and older age groups of UK Bull Mastiffs, with increasing age a general risk factor ([Pittaway et al., 2019](#)). Osteosarcoma was found by [The Mastiff Club of America \(2020a\)](#) to be one of the most diagnosed cancers of Mastiffs annually affecting 8000–10,000 dogs in the USA. [Breen \(2011\)](#) also earlier found that Lymphoma accounts for 25% of all dog cancers with around 300,000 dogs being diagnosed per year in the USA and Hemangiosarcoma as [Dobson \(2013\)](#) stated, accounts for 57% of cancers occurring in middle to old age large and giant breeds.

### 1.7. Other common causes of Mastiff death

Due to their exaggerated conformation and consequent body size, cardiac disease is also common within Mastiff breeds with Dilated cardiomyopathy reported as the most common cause of heart failure ([AKC, 2020c; MCOA, 2020b](#)) with [Adams et al., \(2010\)](#) reporting 11% of dog deaths and 6.3% for Bull Mastiff's. [Grognet \(2016\)](#) and [The Kennel Club \(2020c\)](#) also suggest that gastric conditions like Gastric Dilatation-Volvulus (GDV) and bloat are common with large and giant breeds weighing more than 45 kg ([Ward, 2020](#)) and specifically for deep chested breeds like the Great Dane. Reduced lifespan is therefore, noted

with Evans and Adams (2010) determining the median age of diagnosis of UK dogs with GDV at 5 years and the median age of death at 7.92 years. Conformation related problems including hip and elbow dysplasia, often leading to Degenerate Myelopathy is also a concern with the Mastiff Club of America advising breeders to test for and euthanise if suspected (MCOA, 2020c,d). Furthermore, and beyond the scope of this study, Torres de la Riva et al., (2013) suggest, cancer correlates with early and late neutering suggesting breed predisposition. Other Mastiff group common conditions include; Cervical Spondylomyelopathy or 'Wobbler Syndrome', Cystinuria (Brons et al., 2013; Henthorn, 2009; MCOA, 2020e), epilepsy, hypothyroidism, entropion, 'Cherry eye' and atopy suggesting predisposed breed conditions exist (PDSA, 2020b). Although difficult to determine without veterinary case notes, euthanasia due to their exaggerated size and strength and potential risk, could be more common with younger dogs than as with other medium and small breeds with Mikkelsen and Lund (1999) reporting this for 51% aggression and 44% anxiety related cases and only 2% with Michell (1999). Euthanasia for older dogs despite ageing being a natural process, may be considered earlier, as it is often progressively more obvious to observe with the breeds larger body size. Many Mastiffs are euthanised at around 7–8 years as a 'senior' age for the breed which is younger than for other smaller or medium sized breeds being 7 years for a Great Dane (Elfenbein, 2019) compared to the West Highland Terrier for example, living to 12.71 years (Lewis et al., 2018).

### 1.8. Determining breed longevity

As Mastiff breed life expectancies vary between 5–11 years, it is difficult to determine what is 'old age' for these breeds and when ageing is appropriate or the main cause of death as both are multifactorial (Huston, 2012). Being able to determine the likelihood of realistic life-spans for specific breeds and potential causes for mortality is important for improving breed longevity. Michell (1999) earlier found that the mean age of death of all ages and causes of British dogs in their sample was 11 years and one month with only 8% living beyond 15 years with 64% dying of disease, Adams et al., (2010) also attempted to address the limited evidence of longevity and cause of death in UK pedigree breeds finding that current evidence of breed age of death is somewhat contradictory or limited. The aim of this study therefore, was to attempt to collate age and cause of death information for companion Mastiff dogs across a global platform. Findings aimed to established common causes of death and to suggest median and mean age of death across breeds, location and owner experience.

## 2. Methodology

### 2.1. Survey format and distribution

With the endorsement of The Mastiff Association, an 11-question survey was distributed via social media and shared globally to Mastiff associations, owners, and breeders. The aim of the survey was to collect data on deceased Mastiffs with owners asked to confirm that their dog had died before completion. Questions were kept simple to maximise completion with the option of inputting up to four deceased dogs per survey link. Each owner was asked to report their location and experience of the Mastiff breed and complete the following per dog; pedigree status, breed to include main breeds if mixed breed, sex, breeding status, and age of death and cause of death if known. Owner responses were assumed as accurate as the aim of the study was for self-declared responses on previously owned Mastiffs and not to confirm pedigree status.

### 2.2. Participant and dog demographics

For ease of analysis, categories were grouped and coded accordingly with data representing 1036 deceased dogs. As most Mastiff owners

completed the survey from two main continents, Europe and North America, responses were grouped into three locations; Europe (n330), North America (n644) and other (n62) used when no location was stated or no response given. Self-declared owner experience per dog was grouped as; 'Experienced' for Mastiff breeders (n215) and experienced (n700) who have previously owned a Mastiff and 'First time owner' (n121) for owners who were completing the survey for their first Mastiff. Dogs were grouped by the breed stated and other used when total dogs per breed was less than 20 dogs (Table 2). When no known pedigree status was present, mixed breed was used with the number of breeds known per dog additionally stated (Table 2). Dog breeding status was recorded by the owner within two main categories; 'Neutered' and 'Entire'.

### 2.3. Mortality information

Dog age of death was stated by the owner in whole years (y) and was categorised into three main groups; 'Young' for all dogs dying under 3 years, 'Adult' between 4–7 years and 'Mature' for +8 years. Cause of death was recorded as an open-ended response so not to exclude more than one condition and to indicate the owners perceived most prominent cause of death. The main cause of death was as stated by the owner and assumed as correct as had not necessarily been confirmed by a veterinarian. Cause of death was grouped into five main categories; 'Cancer', 'Cardiac' for any heart conditions, 'Gastric' for general gastric concerns, GDV or bloat conditions, 'Old age' when euthanised due to age or died of natural causes and 'Other' for all other known conditions. As 'Old age' is likely a risk factor of ageing conditions and other ailments, this category was used when owners stated ageing or similar phrases.

### 2.4. Statistical analysis

All data were statically analysed with Excel and Minitab Ver. 19 presenting median and mean values and a Chi-square Test for Association was used where relevant between factor and response. Data deemed non-parametric using the Anderson–Darling Normality test was tested using Kruskal–Wallis or One-way ANOVA for parametric, to test for statistical differences. Median values were presented when available to minimise breed skews in the data and mean values when median values did not differ.

## 3. Results

### 3.1. Breed age of death

For all dogs with a known age of death, the median age was 8.00 years and mean 8.00 years. Pedigree dogs (n1008) died slightly younger with the mean age of death at 8.00 years and mixed breed dogs (n26) at

**Table 2**  
Survey responses by breed (other denotes breeds with responses less than 4).

Type	Breed	Breed standard listing	No. of dogs	% of sample
Pedigree	Boerboel	Boerboel (South Africa)	4	0.4
Pedigree	Bull Mastiff	Bull Mastiff (England)	232	22.4
Pedigree	Cane Corso	Italian Mastiff	11	1.1
Pedigree	Dogue de Bordeaux	Dogue de Bordeaux (France)	26	2.5
Pedigree	Great Dane	Great Dane (Germany)	28	2.5
Pedigree	Mastiff	Mastiff (England)	641	61.9
Mixed breed	Mixed breed Mastiff	N/A	24	2.3
Pedigree	Neapolitan Mastiff	Neapolitan Mastiff (Italy)	33	3.2
Pedigree	Other Mastiff	N/A	39	3.8

8.10 years with 8.00 years median for both. Breed differences were found with the Boerboel (n4) dying the youngest at 7.72 years and the Neapolitan Mastiff (n31) living the longest at 8.17 years with all other breeds at 8.16 years. No significant association was found between pedigree or mixed breed type and mean age of death ( $X^2$  4.199,  $P$  0.123) (Table 3 & 4). A significant difference was found for mean age of death for the Bull Mastiff (n232), Mastiff (n659) and 'others' (n145) ( $F$  3.92,  $DF$  2,  $P$  0.022). The highest percentage of study dogs died within the mature age group with 58% over 8 years and 34% as adult dogs from six main breeds. For all pedigree dogs, 59% died when mature, 33% adult and 8% young with a highly significant association between specific breed and mean age of death ( $X^2$  29.275,  $P$  0.001).

### 3.2. Location and age of death

Mean age of death differed between location with North American dogs (8.17 years) living slightly longer than European (8 years) and other (7.63 years) dogs. A median of 8 years was found for European and North American dogs and 7.5 years for other locations (Fig. 1). A higher percentage of North American dogs died in the mature group at 61% compared to 54% for European dogs. Breed differences in age of death between locations is seen yet no significant association was found for all dogs ( $X^2$  7.965,  $P$  0.903) or for North American pedigree and mixed breed dogs ( $X^2$  0.717,  $P$  0.699). A highly significant difference was found for all European and North American breeds and mean age of death ( $H$  27.46,  $DF$  8,  $P$  0.001) and specifically for the Bull Mastiff and the Mastiff ( $H$  12.81,  $DF$  1,  $P$  <0.001) (Table 5).

### 3.3. Owner experience and age of death

Owner experience affected mean age of death, with breeder dogs dying at 8.20 years and experienced owners who did not breed at 7.95 years. Northern American breeder dogs lived the longest. For breeder dogs, the Boerboel died the youngest at 4.50 years and the Bull Mastiff the oldest at 10.40 years (Table 6). A significant association was found for all dogs with experienced owners including breeders ( $X^2$  10.035,  $P$  0.007) (Table 7). Dogs of first time owners died at a mean age of 7.86 years despite no significant association found between owner experiences ( $X^2$  2.916,  $P$  0.233) (Table 7). No significant difference was found between individual locations of experienced owners and the mean age of the dog's death ( $H$  3.61,  $DF$  1,  $P$  0.057) or for European ( $X^2$  2.693  $P$  0.260), North American ( $X^2$  4.852,  $P$  0.088) and other ( $X^2$  3.574,  $P$  0.167) dogs (Fig. 2).

### 3.4. Sex and neutering status and age of death

Female dogs (n495) lived longer than males (n538) with a mean age of death at 8.41 years at 7.61 years respectively with a highly significant association between sex and age of death ( $X^2$  13.145,  $P$  0.001) (Table 8). 63% of all females died in the senior age group and 32% as adult and for males 54% senior and 36% as adults. By main locations, North American

**Table 3**  
Mean age (y) of death per breed.

Breed	No. dogs	Mean age of death (y)	Percentage (%) of group		
			Young	Adult	Mature
Boerboel	4	7.72	25	50	25
Bull Mastiff	232	8.01	5	25	70
Cane Corso	11	7.89	9	18	72
Dogue de Bordeaux	26	7.95	8	57	35
Great Dane	28	8.00	4	46	50
Mastiff	659	8.00	10	34	56
Mixed breed Mastiff	25	8.10	12	50	38
Neapolitan Mastiff	31	8.17	14	40	46
Other Mastiff	37	8.16	5	41	54

**Table 4**

$X^2$  test for association contributions for mean age (y) of death and breed (Expected value in brackets).

Factor	Group	Number of young dogs	Number of adult dogs	Number of mature dogs	Comparison
Breed type	Mixed breed	3 (2)	12 (8)	9 (14)	$X^2$ 4.12, $P$ >0.05
	Pedigree	82 (83)	335 (339)	589 (584)	
Breed	Bull Mastiff	11 (19)	58 (78)	162 (134)	$X^2$ 29.28, $P$ <0.01
	Dogue de Bordeaux	2(2)	14 (8)	9 (15)	
	Mastiff	60 (53)	360 (370)	218 (215)	
	Mixed breed	3 (2)	12 (8)	9 (14)	
	Neapolitan Mastiff	4 (3)	13 (11)	15 (19)	
	Other	5 (7)	32 (27)	43 (47)	

Note: Breed type  $X^2$  tests are for 2 df and breed 10 df.

females lived 0.72 years longer than European and 0.68 years longer than all other locations with males from all three main locations living a similar age. Breed sex differences were seen with all females living longer except for Boerboel females who lived 0.33 years less than males (Table 9). Significant differences were found between sex of dogs and European and North American Bull Mastiff's and Mastiffs ( $H$  17.31,  $DF$  2,  $P$  < 0.001).

Neutered dogs lived longer than entire dogs with mean age of death at 8.40 years and 7.48 years respectively. Neutered females lived the longest of all dogs with known sex and breeding status with a mean age of death at 8.86 years, castrated males at 7.86 years, entire females at 7.63 years and entire males at 7.39 years (Fig. 3). A highly significant association was found between breeding status and sex ( $X^2$  26.408,  $P$  < 0.001) and a significant difference between neutered females breed and age of death ( $F$  3.92,  $DF$  2,  $P$  0.022). Noted breed differences include neutered male Bull Mastiff's and entire male Mastiffs dying the youngest (Table 10).

### 3.5. Cause of death

Cause of death differed between dogs with 47% of all dogs dying with cancer and all others from 21 other causes. As expected, old age had the highest mean age of death at 11.32 years, with old age used as the main cause of death if stated with no other cause, and 16% of all dogs from cancer dying at 6.79 years. Location differences were seen with 46% of European and 49% North American dogs dying with cancer with a significant association between location and cause of death ( $X^2$  27.080,  $P$  0.001) (Fig. 4 & Table 11). A significant association was also found between owner experience and cause of death with cancer accounting for 38% of breeder dogs, 48% experienced and 55% of first time owners ( $X^2$  16.372,  $P$  0.037).

23 types of cancer were stated including three common cancers; 50% Osteosarcoma, 14.3% Lymphoma and 7.1% Hemangiosarcoma, with no significant difference between sex of dog and cancer type ( $H$  4.984,  $DF$  3,  $P$  0.173). A higher number of males (n96) died of cancer than females (n76) with European and North American females living slightly longer at 7.96 years than males at 7.04 years. Cancer type and dog status differed, with 65% of Osteosarcoma deaths for neutered females (n62) and 54% castrated males (n59) with much lower deaths of entire females (n8) and males (n17). Lymphoma was more common in males than females accounting for 40% of all recorded male cancer deaths bordering a significant difference ( $H$  3.59,  $DF$  1,  $P$  0.058). No difference was found between breeding status of males and females dying from Lymphoma ( $H$  1.61,  $DF$  2,  $P$  0.446), Osteosarcoma ( $H$  1.16,  $DF$  1,  $P$  0.282) and Hemangiosarcoma ( $H$  2.02,  $DF$  1,  $P$  0.155).

Breed differences were found with European and North American Bull Mastiffs having a higher rate of Lymphoma (44%) and Osteosarcoma for Mastiffs (50%). The Bull Mastiff's age of death from Osteosarcoma, Lymphoma or Hemangiosarcoma was slightly higher at 7.78

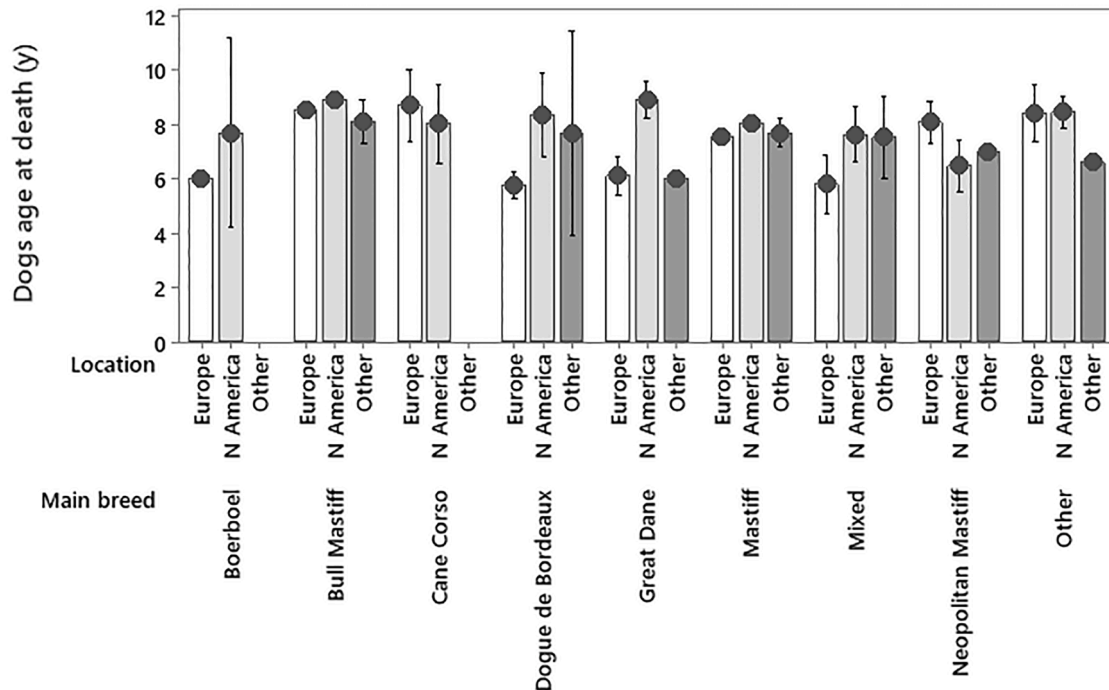


Fig. 1. Owner location and dog breed and mean (±SE mean) dog age (y) of death

Table 5

X<sup>2</sup> test for association contributions for mean age (y) of death and location (Expected value in brackets)

Factor	Dogs	Group	Number of young dogs	Number of adult dogs	Number of mature dogs	Comparison
Location	All	Europe	23 (27)	126 (110)	179 (190)	X <sup>2</sup> 7.97, P >0.05
		North America	54 (53)	198 (216)	388 (372)	
		Other	8 (5)	23 (21)	31 (36)	
Breed	North American	Pedigree	52 (53)	194 (194)	381 (380)	X <sup>2</sup> 0.71, P >0.05
		Mixed	2 (1)	4 (4)	7 (8)	

Note: Breed type X<sup>2</sup> tests are for 4 df. X<sup>2</sup> tests could not be calculated for Europe due to values less than 5 present

Table 6

Experienced pedigree owners and mean age of death per breed.

Breed	Owner experience	No. dogs	Mean age of death (y)
Boerboel	Breeder	2	4.50
	Experienced	2	10
Bull Mastiff	Breeder	15	10.40
	Experienced	179	8.55
Cane Corso	Experienced	9	7.55
	Experienced	20	6.32
Dogue de Bordeaux	Breeder	2	8.50
	Experienced	19	7.32
Mastiff	Breeder	193	8.15
	Experienced	390	7.84
Neopolitan Mastiff	Breeder	2	6
	Experienced	25	7.80
Other Mastiff	Experienced	31	8.06

years compared to 7.49 years for Mastiffs. For Mastiffs a higher number of neutered dogs (n71) died from cancer than entire dogs (n30) and neutered Bull Mastiff's (n33) than entire Bull Mastiffs (n13). No significant difference was found between the top three cancers and breeding status for all dogs (*H* 4.52, *DF* 2, *P* 0.104) and males (*H* 0.07, *DF* 1, *P* 0.796) but was for females (*H* 7.00, *DF* 2, *P* 0.030). Age of cancer death differed by dog status and location with the highest at 9.85 years for

North American neutered Bull Mastiff females compared to unneutered females at 2.50 years. The highest age of cancer death for English Mastiff's was 9.25 years for neutered females in Europe and the lowest for unneutered European females at 5.00 years.

#### 4. Discussion

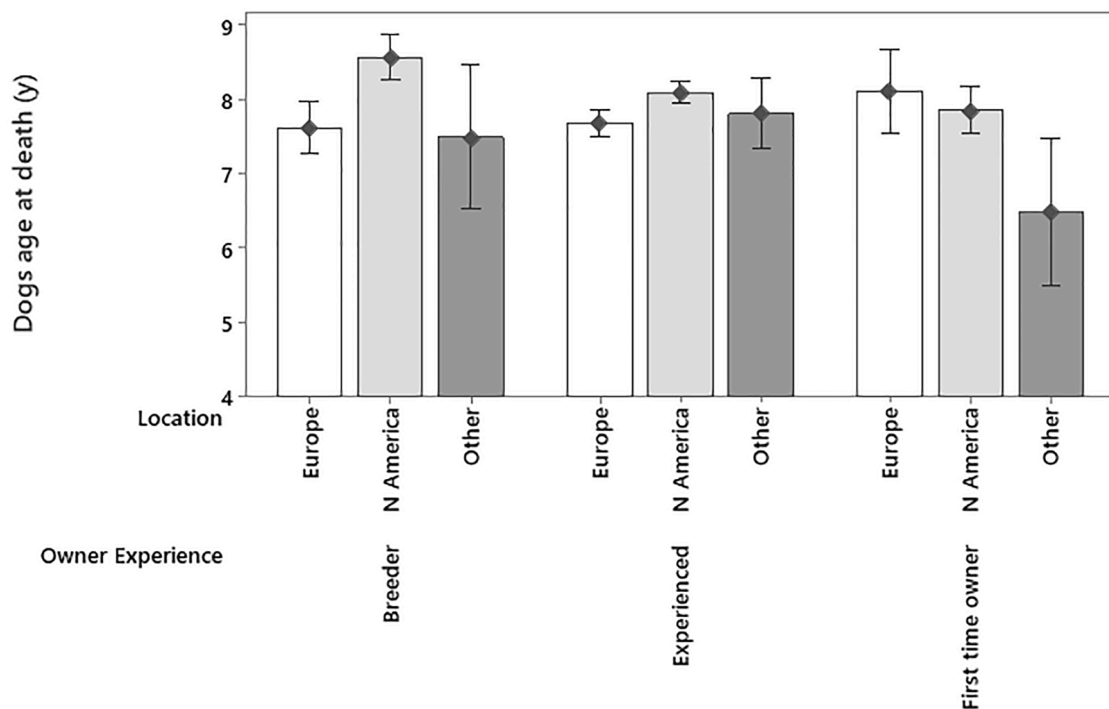
##### 4.1. Age of death

As stipulated by varying national breed standards, the mean life span of Mastiff breeds differ with old age and cancer being the two most prominent causes of death in the study. The median age of death for all dogs was 8.00 years and did not differ per breed. A mean age of death for all dogs also at 8.00 years differed per breed, ranging between 7.72 years and 8.17 years. As expected, old age had the highest mean age of death within the sample, likely influenced by the mature age group ranging from 8 to 16 years of age. As [Michell \(1999\)](#) found, 8% of their study dogs lived longer than 15 years which in comparison, the study dogs are much lower at 0.96%. The senior age of death at 8 years for the study dogs is low in comparison to the median age of all dogs found by [Lewis et al., \(2018\)](#) at 10.33 years or around 11 years as earlier found by [Michell \(1999\)](#) with British dogs. Study dogs dying of old age had a mean age of death at 11.3 years accounting for 16% of the sample, being

**Table 7**  
X<sup>2</sup> test for association contributions for mean age (y) of death and owner experience (Expected value in brackets).

Dogs	Factor	Group	Number of young dogs	Number of adult dogs	Number of mature dogs	Comparison
All	Owner experience	Experienced	77 (75)	299 (307)	539 (529)	X <sup>2</sup> 2.92, P >0.05
		First time owner	8 (10)	48 (40)	62 (69)	
	Experienced owners	Breeder	26 (18)	54 (70)	134 (126)	X <sup>2</sup> 10.04, P <0.01
	Experienced	51 (59)	285 (229)	402 (410)		
European	Owner experience	Breeder	7 (5)	21 (29)	39 (36)	X <sup>2</sup> 2.69, P >0.05
		Experienced	14 (16)	93 (88)	122 (125)	
North American	Owner experience	Breeder	16 (12)	31 (40)	88 (83)	X <sup>2</sup> 4.85, P >0.05
		Experienced	33 (37)	134 (125)	258 (263)	
Other	Owner experience	Breeder	3 (2)	2 (4)	7 (6)	X <sup>2</sup> 3.57, P >0.05
		Experienced	4 (6)	18 (16)	22 (23)	

Note: Breed type X<sup>2</sup> tests are for 2 df.



**Fig. 2.** Owner experience and location and mean (±SE mean) dog age (y) of death

**Table 8**  
X<sup>2</sup> test for association contributions for mean age (y) of death and dog sex (Expected value in brackets).

Dogs	Factor	Group	Number of young dogs	Number of adult dogs	Number of mature dogs	Comparison
All	Sex	Female	26 (39)	153 (163)	301 (278)	X <sup>2</sup> 13.15, P <0.01
		Male	56 (43)	189 (179)	284 (307)	
	Breeding status	Neutered	26 (46)	184 (193)	358 (330)	X <sup>2</sup> 26.41, P <0.001
		Entire	56 (36)	159 (151)	229 (258)	

Note: Breed type X<sup>2</sup> tests are for 2 df.

slightly higher than Lewis et al., (2018) 13.8% or the Kennel Club (2014) 13.8%. The median age of all dogs dying was much lower at 8.00 years than 10.33 years for Lewis et al., (2018) UK dogs and 10 years for The Kennel Club (2014). As ageing is a known risk factor for other conditions and diseases, the increase in dogs within the mature group would have impacted this. Furthermore, with a senior age classified much ‘younger’ for large and giant breeds like the Mastiff at 6–10 years under the American Kennel Club (2020a,b), it was likely that a large number of dogs died within this group. Ranges across all dog breeds for example,

differs greatly with small breeds living between 10–15 years classed as senior at 9–12 years and medium sized dogs between 10–13 years and 7–10 years accordingly.

Despite findings suggesting that the dog age of death is lower than The Kennel Club (2014) and Lewis et al., (2018) to name a few, it is likely that recording the age of death in whole years and not total months may have affected the overall median and mean values recorded. Reporting by mean values, may also have influenced this as this did not account for skewed data due to limited breed representatives. Yordy

**Table 9**  
Mean age of death for male and female dogs by breed.

Breed	Owner experience	No. dogs	Mean age of death (y)
Boerboel	Female	1	7
	Male	3	7.33
Bull Mastiff	Female	134	8.97
	Male	97	8.27
Cane Corso	Female	2	9
	Male	9	8.22
Dogue de Bordeaux	Female	6	6.67
	Male	20	6.58
Great Dane	Female	7	8
	Male	19	7.42
Mastiff	Female	305	8.27
	Male	335	7.51
Mixed breed Mastiff	Female	11	7
	Male	14	6.5
Neapolitan Mastiff	Female	15	7.93
	Male	17	7.38
Other Mastiff	Female	13	8.46
	Male	23	7.91

et al., (2019) for example, used age at death categories up to and over 15 years which is beyond the projected breed standard life expectancies for the Mastiff group and thus, cannot be used as a direct comparison. With only 0.96% of all study dogs living past 15 years, it is fair to suggest that this would not be suitable.

4.2. Breed influences

Study breed differences were found with smaller Mastiff breeds living different mean ages to larger Mastiff breeds. For the breed group with a median age of 8.00 years at death, a younger age was noted by O'Neill et al., (2013) as 7.10 years and 6.83 years by Adams et al., (2010). Although larger breeds are expected to live less due to the faster acceleration of growth and subsequent quicker ageing, this does not

appear to be the case with breed standard senior life stage stated by the American Kennel club (2020a,b) as 6–10 years for the Mastiff and 7–9 years for the Bull Mastiff. The mean age of death for the most represented breeds in the sample as the Bull Mastiff and the Mastiff both at 8 years supporting breed standards median life expectancies are similar to the median age stated by Dobson (2013) at 7.46 years. Adams et al., (2010) noted, a varying median age at death across the Mastiff group including a range between 2.33 years for the Neapolitan Mastiff, 3.83 years for the Dogue de Bordeaux and 11.92 years for the Tibetan Mastiff. Study findings contradict findings with the Neapolitan Mastiff living the longest at 8.17 years and the Dogue de Bordeaux at 7.95 years which are much higher than what Adams et al., (2010) and O'Neill et al., (2013) found. Study findings support the breed standard life expectancy for these breeds at 7–9 years and 5–8 years respectively (AKC, 2020a,b). Suggestions by O'Neill et al., (2013) that mixed breeds live on average 1.2 years longer than pedigree breeds is not reflected here with a mean age of death at 8 years for pedigree and 8.10 years for mixed breeds. Further consideration of specific mixed breed types could be explored to determine whether there are any specific breeds which influence the lower mean life span than would be expected.

**Table 10**  
Bull Mastiff and Mastiff sex and status and age of death.

Breed	Sex	Dog status	Mean age of death (y)
Bull Mastiff	Female	Neutered	9.23
		Entire	8.27
	Male	Neutered	8.19
		Entire	8.37
Mastiff	Female	Neutered	8.74
		Entire	7.61
	Male	Neutered	7.70
		Entire	7.38

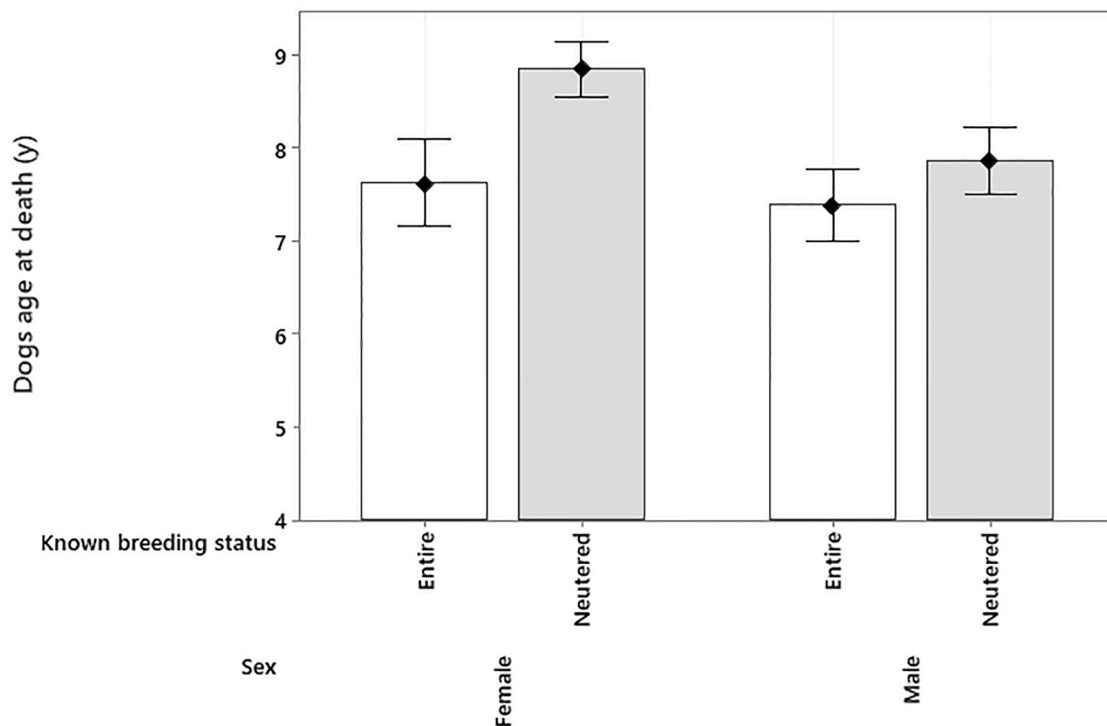


Fig. 3. Dog sex and breeding status and mean (±SE mean) age (y) of death

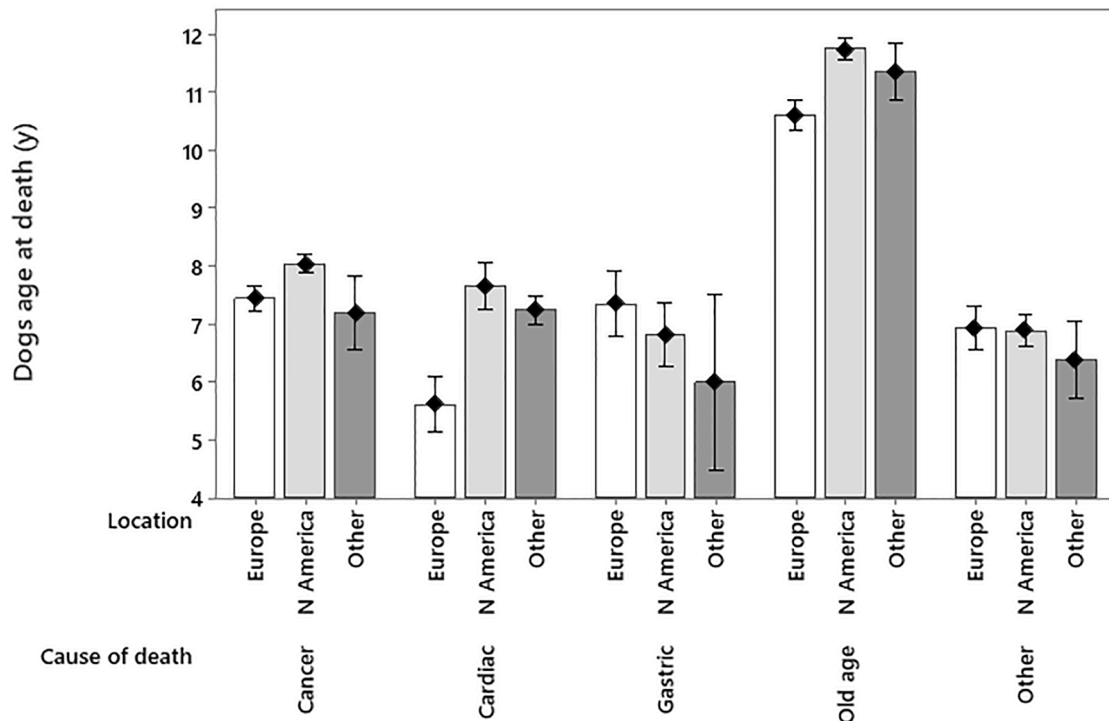


Fig. 4. Cause of death by location and mean (±SE mean) age (y) of death

Table 11

X<sup>2</sup> test for association contributions for mean age (y) of death and stated cause (Expected value in brackets).

Factor	Group	Cancer	Cardiac	Gastric	Old age	Other	Comparison
Location	Europe	146 (147)	29 (24)	31 (22)	557 (52)	52 (71)	X <sup>2</sup> 27.08, P < 0.01
	North America	286 (274)	39 (44)	34 (42)	89 (96)	141 (133)	
	Other	15 (26)	4 (4)	3 (4)	11 (9)	23 (13)	
Owner experience	Breeder	78 (95)	16 (15)	16 (15)	46 (34)	49 (46)	X <sup>2</sup> 16.37, P < 0.05
	Experienced	311 (302)	49 (49)	47 (46)	102 (106)	140 (146)	
	First time owner	58 (49)	7 (8)	5 (8)	9 (17)	27 (240)	

Note: Breed type X<sup>2</sup> tests are for 8 df.

### 4.3. Other influencing factors

Interestingly, of experienced Mastiff owners a differing age of death was found with breeder dogs higher at 8.20 years than experienced owner dogs at 7.95 years compared to first time owners at 7.86 years. The lowest age of death for breeder dogs was the Boerboel at 4.50 years who had the shortest mean age of death across all breeds and the longest Bull Mastiff's at 10.40 years. North American breeder dogs lived the longest than other location breeders with 61% of all North American dogs dying in the mature age group (8+) compared to 54% of all European dogs. The mean age of death differed between male and female dogs with the mean age of death higher at 8.41 years for females compared to 7.61 years for males with 63% of all females dying within the mature age group compared to 54% of males and 32% as adult females 36% adult males. Across the study, females lived longer for all breeds as found by [Michell \(1999\)](#) except the Boerboel who had the lowest mean age of death overall. Breeding status was found to affect the mean age of death as by [Michell \(1999\)](#), with neutered females living significantly longer than castrated males or intact females with a mean age of death at 8.86 years, living on average a year longer than intact females. Neutered or castrated dogs were found to have a mean age of death at 8.40 years compared to a shorter 7.48 years for intact or entire

dogs suggesting this may have some influence on longevity as also found by [Michell \(1999\)](#). Breed differences were also found with neutered female Bull Mastiff and entire male Mastiffs dying the youngest across all stated breeds. Location differed in mean age of death of males and females with North American females living 0.72 years on average longer than European and 0.68 years than other locations. [Hoffman et al., \(2013\)](#) stated that 50–75% of North American dogs are electively surgically sterilised and may likely influence extended lifespan reflected with more study dogs dying in the mature group but not necessarily for more dogs with cancer as a stated cause of death.

### 4.4. Cause of death

For known causes of death, 22 causes were concluded with cancer accounting for 47% of all reported death causes. In comparison to earlier work from [Merlo et al., \(2008\)](#) the presence of cancer here is much greater than the estimated true incidence rate of 0.75% (per 100,000 dogs likely to be at risk) and 0.85% for North American dogs between 1994–1997. [Adams et al., \(2010\)](#) found that cancer, 'old age' and cardiac disease were the most reported cause of death of pedigree dogs with [Proschowsky et al., \(2003\)](#) earlier reporting that 20.8% of Danish pedigree dogs died of 'old age' and 14.5% of cancer. With much lower



rates, Lewis et al., (2018) found that cancer only accounted for 8.7% of known causes of death and 'old age' as 13.8%. For UK dogs specifically, Adams et al., (2010) reported lower cancer deaths at 27%, 18% 'old age' and 11% cardiac with Lymphoma as the most frequently reported cancer responsible for 37.5% Bull Mastiffs' death suggesting breed susceptibility as also supported by Dobson's (2013). Study findings were much higher with Osteosarcoma accounting for almost 50% of all cancer deaths and specifically 50% of all Mastiff's or English Mastiffs as often known.

As the two most recorded causes of death recorded in previous literature, both old age and cancer were common in this study despite differing in ranking highlighting a possible susceptibility for the breed group. Reflected in The Kennel Club national survey (2004) and in unpublished findings on the Mastiff group by Stivason (2015), the most frequently recorded causes of death were also old age and cancer but also cardiac disease which despite difference in ranking, include the most stated causes of death. Stivason (2015) reported that 38% of survey Mastiffs died of cancer and a further 20% from 'old age', similar to this survey with cancer accounting for 47% of deaths and 'old age' 16%. Caution should be given however, as 'old age' was self-declared by the owner with veterinary history unknown, it is possible that this may be somewhat exaggerated as a more 'acceptable' cause of death. Due to the nature, complexity and expense of the breed, it is possible that a key diagnosis may have not been declared or may have been missed due to ageing often being more obvious with larger breeds like the Mastiff group or the extensive expense needed to treat costly conditions such as cancer. Without individual evidence it is difficult to confirm whether other conditions or diseases had actually been diagnosed.

Furthermore, differences between the average life span of 10 years stated by The Kennel Club and the study 8.00 years are noted with senior age classifications across breed standards differing greatly (KC, 2014). Similar in ranking of cause of death, study findings support Lewis et al., (2018) with old age being the most prominent cause of death at 13.8% of their sample and cancer as 8.7%. Within The Kennel Club (2014) survey, however, 'old age' was found to be the most prominent stated known cause of attributer to death with cancer second, opposite to the results stated here but as supported by earlier findings of Michell (1999) with cancer following cardiac conditions and disease which was almost double. Albeit much higher at 47%, study results show that cancer was the most recorded cause or attribution to death with a lower mean age of death at 6.79 years compared to old age at 11.32 years. Cardiac problems did not feature as prominent in this study with Michell (1999) reporting this as the most prominent cause of death and Lewis et al., (2018) as 4.9% of their sample with study findings at 3.5% of all European dogs and only 0.17% of North American dogs. The presence of cancer differed across owner experience with the lowest rate at 38% amongst breeders and 48% of experienced owners with the highest representation of first time Mastiff owners at 55%. Albeit only a preliminary consideration, it may be possible that breeders anecdotally 'screen' for sire and dam cancer predispositions and so, do not breed from them. It may also be possible that new owners may be more likely to become aware or treat cancer due to their inexperience of this breed group and their initial financial outlay or otherwise due to the costly financial burden. Interesting ideas however, which seemingly warrant further discussion across the breed group.

Breed specific cancers were reported within the study at 64% for Bull Mastiffs, with Osteosarcoma the most stated type of cancer for all breeds, and a higher rate of Lymphoma for Bull Mastiffs. An earlier survey by Onions (1984) recorded a lower rate of Lymphoma at 15% for Bull Mastiff cause of death potentially suggesting a rise in prevalence within the breed group as reflected in findings by Adams et al., (2010) as cancer was the main noted cause of death. Sex differences show a higher male cancer mortality rate with median age of death of females with cancer at 8.00 years and males at 7.00 years. European and North American females lived slightly longer than males at 7.95 years and 7.19 years respectively and almost half of both North American and European

dogs dying from cancer at 49% and 46% respectively. Breeding status could also be influential with a higher number of neutered than entire Mastiffs for example, dying from cancer. Neutering status, age of neutering and longevity therefore, requires further investigation across the breed group but also other large and giant breeds and specifically for cancer type if known. Villamil et al., 2009 showed that entire female dogs had a lower risk of developing Lymphoma compared to neutered and entire males. Within the Mastiff group, Stivason (2015) also found similar results in unpublished data with 33 of the 43 Mastiffs recorded that died of cancer neutered. For further investigation and beyond the focus of this study, White et al., (2011) found that mast cell tumours were prevalent in large and giant breed neutered females as noted by Zink et al., (2014) where the younger the age of neutering, the earlier the diagnosis of Hemangiosarcoma and Lymphoma. Furthermore, Hoffman et al., (2017) found that entire males had a slightly higher life span which was much greater for neutered females with earlier work by Hoffman et al., (2013) suggesting that sterilised dogs were more likely to die of neoplasia than infectious, degenerative or vascular disease.

In summary, other causes of death were noted with a high incidence of immobility with hip and elbow dysplasia common with the breed group (MCOA, 2020d) where breed morphology and conformation may have influenced dog age and cause of death alongside sex and breeding status. Breed predispositions are considered with Cooley et al., (2002) suggesting a 13% incidence of Rottweilers with Osteosarcoma castrated under 12 months of age. Rosenberger et al., (2007) earlier suggested that increased height and weight correlated with rapid growth and weight bearing during adolescence, potentially predicative factors to Osteosarcoma in large and giant breeds. Torres de la Riva et al., (2013) also suggested that breeding status may be influential in health conditions or death type with juvenile male hip dysplasia double than that of entire males. Although not explored further within the analysis, it is possible that mobility problems may too be a concern for the Mastiff group as gastric and cardiac problems, two more commonly reported causes of death in this study, are also linked to conformation of their large and giant breed size and consequent rapid ageing (Kraus et al., 2013). Although not explored in detail, gastric causes of mortality including general digestive problems, GDV and bloat also featured in the top causes of death within survey results with a significant association found for location, with Europe reporting a higher number of deaths compared to North America and North America a higher rate of cardiac concerns.

## 5. Conclusions

Breed specific surveys on life expectancy and reasons for mortality of pedigree breeds are limited with the importance for the need of such work highlighted by the study findings. It is abundantly clear that cancer is a concern within the Mastiff group with location, owner experience and neutering status appearing to influence this. Breed specific age and cause of death is highlighted with specific breeds perceived to more likely die younger and others more likely to live to 'old age'. It is of interest to compare breed standard life expectancies of large and giant breeds outside of the Mastiff group as a direct comparison to medium or small breeds is not as reliable. Further studies are needed on specific breed groups to assess how ageing as a risk factor for other conditions and diseases like cancer, occurs. Furthermore, as cause of death was self-declared by owners, it is likely that ageing has impacted upon the number of conditions experienced or interpreted by the owner. Without veterinary records, beyond the accessibility of this survey, results achieved are to be considered with the possibility of both under and over exaggeration of owner-perceived cause of death. Considering this however, this study provides an insight into an under-studied, yet popular breed group which is deemed threatened by reputable breed standard organisations.

## Ethical statement

As the study was of a qualitative nature, no animals were directly used in the data collection. Prior to the survey being distributed, the project proposal was passed by the institutions ethical review process.

## Declaration of Competing Interest

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

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## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.vas.2021.100194](https://doi.org/10.1016/j.vas.2021.100194).

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