THE KENNEL CLUB
DOG HEALTH

Breed Health and Conservation Plan

Bernese Mountain Dog

2018

BHCP/Version 1/July 2018

INTRODUCTION

The Kennel Club launched a dynamic new resource for breed clubs and individual breeders – the Breed Health and Conservation Plans (BHCP) project – in September 2016. The purpose of the project is to ensure that all health concerns for a breed are identified through evidence-based criteria, and that breeders are provided with useful information and resources to support them in making balanced breeding decisions that make health a priority.

The Breed Health and Conservation Plans take a holistic view of breed health with consideration to the following issues: known inherited conditions, complex conditions (i.e. those involving many genes and environmental effects such as nutrition or exercise levels, for example hip dysplasia), conformational concerns and population genetics.

Sources of evidence and data have been collated into an evidence base (Section 1 of the BHCP) which gives clear indications of the most significant health conditions in each breed, in terms of prevalence and impact. Once the evidence base document has been produced it is discussed with the relevant Breed Health Coordinator and breed health committee or representatives if applicable. Priorities are agreed and laid out in Section 2. A collaborative action plan for the health of the breed is then agreed and incorporated as Section 3 of the BHCP. This will be monitored and reviewed.

SECTION 1: EVIDENCE BASE

Demographics

The Bernese Mountain Dog is a Breed Watch category 1 breed, meaning that there are no current visible points of concern for judges to consider when at a judging appointment. The numbers of new registrations of the breed per year are shown in Table 1, and appear to be relatively stable although with a possible slight decrease most recently.

Table 1: Number of Bernese Mountain Dogs registered per year between 2007 and 2017

Year	Number of new Bernese Mountain Dog registrations	Percentage of breed out of total annual registrations
2007	631	0.23%
2008	680	0.25%
2009	706	0.29%
2010	613	0.24%
2011	730	0.30%
2012	494	0.22%
2013	636	0.28%
2014	652	0.29%
2015	459	0.21%
2016	654	0.29%
2017	541	0.22%

The number of Bernese Mountain Dogs registered by year of birth between 1980 and 2017 are shown in Figure 1. The 1980 registrations figure appears depressed for all breeds due to registrations moving across to the electronic system from paper files. The trend of registrations over year of birth (1980-2014) was +10.79 per year (with a 95% confidence interval of +4.91 to +16.67), reflecting the overall increase in registrations. [Put simply, 95% confidence intervals (C.I.s) indicate that we are 95% confident that the true estimate of a parameter lies between the lower and upper number stated.]

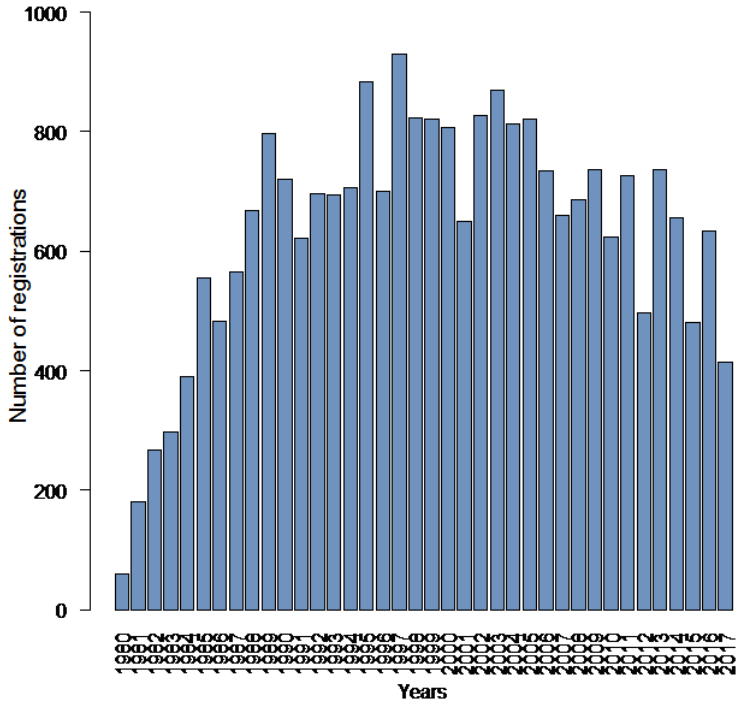

Figure 1: Number of registrations of Bernese Mountain Dog per year of birth, 1980 – 2017

Literature review

The literature review lays out the current scientific knowledge relating to the health of the breed. We have attempted to refer primarily to research which has been published in peer-reviewed scientific journals. We have also attempted to acknowledge possible limitations of the studies reported, including when the research involved dogs in other countries. Whilst there are often strong links between populations of a breed in different countries, there are also often differences between the populations and issues seen in one country may not be seen (or may have a different prevalence) in another. However, it may also be useful for United Kingdom (UK) breeders to be aware of conditions occurring in the breed in other countries which have not yet been seen in the UK population, especially given that movement of breeding stock does occur between countries.

Cardiovascular conditions

No scientific references to conditions in this category could be found for the breed.

Dermatological conditions

Pyotraumatic dermatitis ('hot spot'): Breeds with heavy fur and dense undercoat, including the Bernese Mountain Dog, tend to be predisposed to this condition. A study of 44 cases in all breeds seen at a Small Animal Hospital in Gothenburg, Sweden between 1995 and 1997 reported that the breed had a relative risk of 1.36 compared to dogs of other breeds (Holm et al, 2004). No more recent reports, nor prevalence estimates, were found in the literature.

Endocrine conditions

No scientific references to conditions in this category could be found for the breed.

Gastrointestinal conditions

No scientific references to conditions in this category could be found for the breed.

Haematological conditions

Factor I (fibrinogen) and VII (proconvertin) deficiencies: These autosomal recessive inherited coagulopathies (blood clotting disorders) were reported in an American review to occur in the Bernese Mountain Dog, but no prevalence estimates were provided (Brooks, 1999).

Hepatic conditions

Hepatocerebellar degeneration: see under neurological conditions.

Immunological conditions

No scientific references to conditions in this category could be found for the breed.

Musculoskeletal conditions

Elbow dysplasia: The Bernese Mountain Dog was reported to be at elevated risk of fragmented coronoid process (FCP) and ununited anconeal process (UAP; both forms of elbow dysplasia), with breed-associated odds ratio compared to mixed breeds of 140.1 and 50.5 (95% C.I. 62.2-301.4 and 25.9-98.6) respectively, based on dogs which had attended veterinary teaching hospitals in the USA between 1986 and 1995; however these results were only based on 9 cases and 2 non-cases of FCP and16 cases and 4 non-cases of UAP in the breed (LaFond et al, 2002). A more recent study of electronic patient records of 90,004 dogs examined at the University of California-Davis Veterinary Medical Teaching Hospital, USA, between 1st January 1995 to 1st January 2010 found the Bernese Mountain Dog to be the most frequently affected breed with elbow dysplasia, with a breed-specific prevalence of 13.91% compared to a mixed breed-prevalence of 0.90% (Bellumori et al, 2013).

Hip dysplasia: The breed was reported to be at elevated risk of hip dysplasia, with a breed-associated odds ratio compared to mixed breeds of 7.2 (95% C.I. 4.2-12.3), based on dogs which had attended veterinary teaching hospitals in the USA; however this result was based on 55 cases and 12 non-cases in the breed (LaFond et al, 2002). A study of radiographs submitted for screening by the French Kennel Club, comparing the 1993-1999 with the 2000-2006 period, reported a 30% decrease in hip dysplasia prevalence in the Bernese Mountain Dog (Genevois et al, 2008).

Osteochondrosis (OCD) of the shoulder: The breed was reported to be at elevated risk of OCD of the shoulder, with a breed-associated odds ratio compared to mixed breeds of 47.1 (95% C.I. 26.4-84.0), based on dogs which had attended veterinary teaching hospitals in the USA; however this result was based on just 17 cases and 6 non-cases in the breed (LaFond et al, 2002).

Panosteitis: The Bernese Mountain Dog was reported to be at elevated risk of panosteitis, with a breed-associated odds ratio compared to mixed breeds of 2.8 (95% C.I. 1.6-5.0), based on dogs which had attended veterinary teaching hospitals in the USA; however this result was based on just 15 cases and 36 non-cases in the breed (LaFond et al, 2002).

Neoplastic conditions

Histiocytic sarcoma complex (disseminated histiocytoma, malignant histiocytosis): A full review of the literature relating to histiocytic sarcoma in the Bernese Mountain Dog is beyond the scope of this document; however, some key points and recent highlights are described here. The breed has long been known to be predisposed to this neoplastic condition since a report of the condition in 13 dogs of the breed in America (Moore and Rosin, 1986). Systemic histiocytosis was first described in six closely related Bernese Mountain Dogs in the USA (Moore, 1984), and was initially thought to be different to ‘malignant histiocytosis’.

A study of cases of the condition in Japan reported that the Bernese Mountain Dog had an odds ratio of 45.0 (95% C.I. 26.3-77.2; 14 out of 73 cases) compared to all dogs, indicating a greatly increased risk (Takahashi et al, 2014).

Analysis of the pedigrees of 127 cases of systemic histiocytosis suggested that the trait had a polygenic mode of inheritance, and the heritability of the trait was estimated as 0.30 (Padgett et al, 1995). The inheritance of histiocytic sarcoma complex has subsequently been described as oligogenic i.e. under the control of several genes (Abadie et al, 2009). A genomic study of affected and unaffected dogs of the breed in North America and Europe found a single haplotype spanning *MTAP* and part of *CDKN2A* which was present in 96% of affected Bernese Mountain Dogs (Shearin et al, 2012). The Canine Genetics team at the University of Rennes in France, in collaboration with international researchers, has developed a genetic selection tool based on the statistical analysis of genetic markers from their research data.

Lymphoma: A recent German study of 411 cases of multicentric lymphoma, between 1997 and 2011, compared the cases to the total own clinic population of 52,142 dogs, and 123,423 dogs with health insurance in Germany over the same time period. There were 22 cases in the Bernese Mountain Dog, and the odds ratios were 2.4 (95% C.I. 1.6-3.6; 1260 dogs) compared to dogs of all breeds in the own clinic population and 2.0 (95% C.I. 1.3-3.0; 3620 dogs) compared to dogs of all breeds in the insured population, showing an apparent increased risk (Ernst et al, 2016).

Osteosarcoma: The breed was also found to be at high risk of malignant bone tumours in a study of Swedish Agria insurance data. Each full year a dog was insured contributed to one dog-year at risk (DYAR). The Bernese Mountain Dog had an overall incidence of 26 cases (95% C.I. 17-35) per 10,000 DYAR compared to the risk in all breeds combined of 5.5 cases per 10,000 DYAR (Egenvall et al, 2007).

Neurological conditions

Alexander disease: This rare, neurodegenerative disorder has been described in 12 dogs in the literature in papers from Austria and Poland, of which six were Bernese Mountain Dogs and one was Bernese cross (Weissenböck et al, 1996; Wrzosek et al, 2015). It is considered to be sporadic and non-familial in humans, but it has been suggested that it may be hereditary in dogs and it is worth noting given that half of the reported cases have occurred in dogs of the breed.

Cervical spondylomyelopathy (cervical vertebral malformation, Wobbler syndrome): This disorder is characterised by compression of the cervical spinal cord and/or nerve roots, and is a relatively common neurological of the cervical vertebral column in large breed dogs. Seven cases of the condition were reported in Bernese Mountain Dogs in North America, and the authors suggested that the condition should be considered as an important differential diagnosis for young to middle-aged dogs of the breed presenting with cervical spinal cord disease (Eagleson, 2009).

Degenerative myelopathy (DM): DM is a progressive neurodegenerative condition in dogs, with clinical signs usually not manifesting until eight years of age or older. Affected dogs initially show signs of ataxia of the pelvic limbs and a definitive diagnosis can only be by made post mortem. A mutation associated with the condition was first described in 2009; a missense mutation in the superoxide dismutase 1 gene (*SOD1*) on chromosome 31, *SOD1:c.118G>A*, with homozygosity for the A allele being strongly associated with the DM phenotype (Awano et al, 2009). The mutation appears to be autosomal recessive with incomplete penetrance, suggesting the involvement of additional loci and/or environmental factors, and has been found to be widespread and common in many breeds. A case of DM in a Bernese Mountain Dog which was homozygous wildtype for the *SOD1:c.118G>A* mutation was then reported in America, and the dog was found to be homozygous for a novel missense mutation in the same gene, *SOD1:c.52A>T* (Wininger et al, 2011). Subsequently several cases of DM in the breed were reported in Germany, in which the affected dogs were heterozygous for both mutations, and it was suggested that heterozygosity at both loci might increase the risk of DM (Pfahler et al, 2014). When all 33,746 DNA samples which had been submitted to the University of Missouri up to 5th April 2013, the *SOD1:c.118G>A* mutation was found to have an allele frequency of 38% in the Bernese Mountain Dog (Zeng et al, 2014). The *SOD1:c.52A>T* is much rarer, with an allele frequency of 3.5%, and appears to be unique to the breed. DNA tests are available for both mutations.

Hepatocerebellar degeneration: A syndrome characterised by progressive cerebellar and hepatic disease was reported in seven related Bernese Mountain Dogs in three litters in the USA (Carmichael et al, 1996). Clinical signs onset at four to six weeks of age, and all affected puppies died or were euthanased. Pedigree analysis suggested an autosomal recessive inheritance pattern. No more recent reports, nor prevalence estimates, were found in the literature.

Hypomyelinogenesis ('Trembler'): This condition, which manifests clinically as a tremor of the limbs and head which intensifies with excitement or stress and disappears with sleep, was described in dogs of the breed in the UK in the late 1980s (Palmer et al, 1987). Preliminary pedigree analysis suggested that the condition may be inherited in an autosomal recessive fashion. No more recent reports, nor prevalence estimates, could be found in the literature.

Idiopathic epilepsy: One study has been published looking at idiopathic epilepsy in the breed in detail, involving 50 affected dogs from Switzerland (Kathmann et al, 1999). A possible gender predisposition was evident, with 62% of cases (31 dogs) occurring in males. Pedigree analysis suggested a polygenic mode of inheritance. No prevalence estimates relating to the condition win the breed were found in the literature.

Ocular conditions

Progressive retinal atrophy (PRA): PRA is the collective name for a group of inherited and progressive retinal diseases characterised by gradual retinal degeneration resulting in initial night blindness and progressing to total vision loss. An early onset form of PRA has been described in Bernese Mountain Dogs in France, with 8 of 62 dogs (12.9%) of the breed which were examined over a three year period being diagnosed with the condition (Chaudieu et al, 2004). Age at diagnosis ranged from three months to seven years of age.

Other ocular conditions: The American College of Veterinary Ophthalmologists (ACVO) consider the Bernese Mountain Dog to be predisposed to entropion, ectropion, distichiasis, persistent pupillary membranes, cataract, generalised retinal atrophy and ocular manifestations of systemic histiocytosis (Genetics Committee of the ACVO, 2015). In 2015, 734 dogs of the breed were examined by the ACVO and prevalence data are shown in Table 2 alongside data from previous years. Overall, 92.4% (678 of 734) of dogs of the breed examined in 2015 had healthy eyes unaffected by any disease conditions. However, it is important to consider that the dogs were from America.

Table 2: ACVO examination results for the Bernese Mountain Dog, 2000 - 2015

Disease Category/Name	Percentage of Dogs Affected		
	2000-2009 (n=8772)	**2010-2014** (n=3541)	**2015** (n=734)
Eyelids			
Entropion	1.7%	0.9%	0.7%
Ectropion	0.7%	0.5%	0.5%
Distichiasis	0.8%	1.0%	1.5%
Uvea			
Persistent pupillary membranes	4.2%	4.9%	3.4%
Lens			
Cataract, significance unknown	6.7%	5.5%	5.2%

Reproductive conditions

Prostate disease: The Bernese Mountain Dog was reported to be overrepresented in a French study of 481 cases out of 72,300 male dogs seen at the Alfort Veterinary Hospital, between 1st December 2001 and 1st September 2009, with an odds ratio of 2.5 (95% C.I. 1.3-4.7; 10 cases in 707 dogs of the breed) (Polica et al, 2016). The most frequently diagnosed prostatic disease was benign prostatic hyperplasia followed by prostatitis.

Pyometra: Analysis of Swedish Agria insurance data, considering female dogs enrolled for both veterinary care and life insurance during 1995 to 2006, estimated the disease incidence of pyometra in 260,000 female dogs. The overall incidence rate for pyometra was 199 cases per 10,000 DYAR (95% C.I. 196-202). The prevalence of pyometra in Bernese Mountain Dog bitches in this study was 66.0% (363 cases in 2,332 bitches), ranking the breed first out of 110 breeds in terms of breed-specific prevalence (Jitpean et al, 2012).

Respiratory conditions

No scientific references to conditions in this category could be found for the breed.

Urological conditions

Familial renal disease: Hereditary, progressive renal disease, histologically defined as membranoproliferative glomerulonephritis, was first described in 22 Bernese Mountain Dogs in Germany in two reports in 1994 (Minkus et al, 1994; Reusch et al, 1994). Pedigree analysis was reported to suggest that the condition was inherited as an autosomal recessive trait with expression affected by a second sex-linked locus. A recent study of Swedish insurance claim records from 1995-2006 reported an overall incidence of kidney disease of 15.8 (95% C.I. 15.3-16.2) cases per 10,000 dog years at risk (DYAR) for a population of 665,245 dogs; for Bernese Mountain Dogs the kidney disease incidence was 51 (95% C.I. 41-61) cases per 10,000 DYAR, based on 95 cases in 18,641 DYAR, suggesting that the breed is at increased risk of kidney disease compared with dogs of other breeds (Pelander et al, 2015). Considering 548,346 life insurance policies, the total kidney-related mortality was 9.7 (95% C.I. 9.3-10.2) deaths per 10,000 DYAR; for Bernese Mountain Dogs the kidney-related mortality was 49 (95% C.I. 39-60) per 10,000 DYAR, based on 80 deaths in 16,220 DYAR, again suggesting an increased risk of mortality due to kidney disease compared to dogs of other breeds.

Urolithiasis – struvite: The breed has been reported to be at increased risk of struvite uroliths (Gough, Thomas and O'Neill, 2018); however, no primary references or prevalence estimates could be found.

Purebred/pedigree dog health survey results

2004 Morbidity results: Health information was collected for 629 live Bernese Mountain Dogs of which 338 (54%) were healthy and 291 (46%) had at least one reported health condition. The top categories of diagnosis were musculoskeletal (31.5%, 161 of 511 reported conditions), reproductive (13.9%, 71 of 511 reported conditions), dermatologic (9.4%, 48 of 511 reported conditions), gastrointestinal (8.4%, 43 of 511 reported conditions) and ocular (6.8%, 35 of 511 reported conditions). The most frequently reported specific conditions were cruciate ligament rupture (7.3% prevalence, 46 cases), pyometra (4.7%, 17 cases in the 362 female Bernese Mountain Dogs in the dataset), undiagnosed skin irritation (3.5% prevalence, 22 cases), otitis externa (3.0% prevalence, 19 cases) and hip dysplasia (2.9% prevalence, 18 cases).

2004 Mortality results: A total of 394 deaths were reported for the breed. The median age at death for Bernese Mountain Dogs was 8 years (min = 5 months, max = 15 years and 2 months). The most frequently reported causes of death by organ system or category were cancer (45.7%, 180 of 394 deaths), musculoskeletal (6.1%, 24 deaths) and old age (6.1%, 24 deaths). Apart from cancer and old age, the most frequently reported specific causes of death were weakness (4.1%, 16 deaths), chronic renal failure (3.8%, 15 deaths) and GDV (3.6%, 14 deaths).

2014 Morbidity results: Health information was collected for 190 live Bernese Mountain Dogs of which 100 (52.6%) had no reported conditions and 90 (47.4%) were reported affected by at least one condition. The most frequently reported specific conditions were cruciate disease (8.4% prevalence, 16 cases), umbilical hernia (6.8%, 14 cases), lipoma (5.4%, 11 cases) and elbow dysplasia (3.9%, 8 cases).

2014 Mortality results: A total of 78 deaths were reported for the breed. The median age at death for Bernese Mountain Dogs was 8 years (min = 0 year, max = 15 years). The most frequently reported causes of death were cancer unspecified (18.0%, 14 deaths), lymphoma (10.3%, 8 deaths), bone tumour (7.7%, 6 deaths) and histiocytosis (5.1%, 4 deaths).

VetCompass results

No VetCompass data relating to the Bernese Mountain Dog were available.

Insurance data

UK Agria data

Insurance data were available for Bernese Mountain Dogs insured with Agria UK. 'Exposures' are equivalent to one full policy year; in 2016 there were 302 free exposures, 131 full exposures and 235 claims, in 2017 these figures were 323, 136 and 254 respectively. Full policies are available to dogs of any age. Free policies are available to breeders of Kennel Club registered puppies and cover starts from the time the puppy is collected by the new owner; cover under free policies lasts for five weeks from this time. It is possible that one dog could have more than one settlement for a condition within the 12-month period shown. The top 10 conditions by number of settlements, for authorised claims where treatments started between 1st October 2016 and 31st September 2017, are shown in Table 3 below.

Table 3: Top 10 conditions and number of settlements for each condition between 1st October 2016 and 31st September 2017 for Bernese Mountain Dogs insured with Agria UK

Condition	**Number of settlements**
Cruciate ligament disorders	39
Skin allergy	19
Congenital, developmental & growth disorders – radius, ulna	16
Seizures, epileptic convulsions	15
Lymphosarcoma, malignant lymphoma, leukaemia	12
Lameness	12
Ununited anconeal process	8
Infection or inflammatory disorders - skin	7
Polyarthritis (inflammatory disease only)	5
Vomiting	5

Swedish morbidity and mortality insurance data were also available from Agria for the Bernese Mountain Dog. Reported rates are based on dog-years-at-risk (DYAR) which takes into account the actual time each dog was insured during the period (2006-2011). The number of DYAR for the Bernese Mountain Dog in Sweden during this period was between 1,000 and 2,000.

Swedish Agria insurance morbidity data

The most common specific causes of veterinary care episodes (VCEs) for Agria-insured Bernese Mountain Dogs in Sweden between 2006 and 2011 are shown in Figure 2. The top five specific causes of VCEs were pain/locomotor signs, dermatitis/pyoderma/folliculitis, skin tumour, vomiting/diarrhoea/gastroenteritis and pyometra or endometritis.

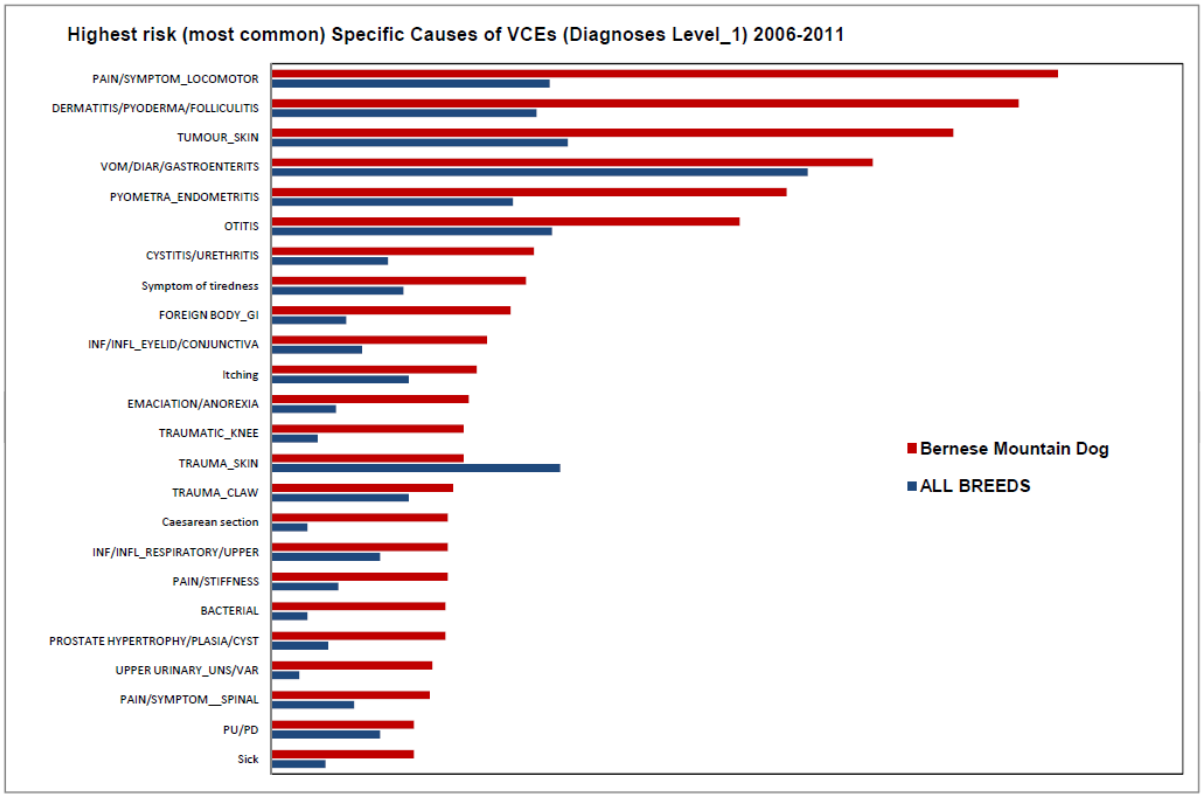

Figure 2: The most common specific causes of VCEs for the Bernese Mountain Dog compared to all breeds in Sweden between 2006 and 2011, from Swedish Agria insurance data.

When relative risk of specific causes of VCEs was compared for the Bernese Mountain Dog to all breeds, a couple of interesting findings were reported. The specific causes of VCEs ordered by relative risk are shown in Figure 3. In this analysis, the top specific causes of VCEs ordered by relative risk were infection of inflammation of the central nervous system, tumour of the lower respiratory tract, entropion, uraemia, OCD and panosteitis.

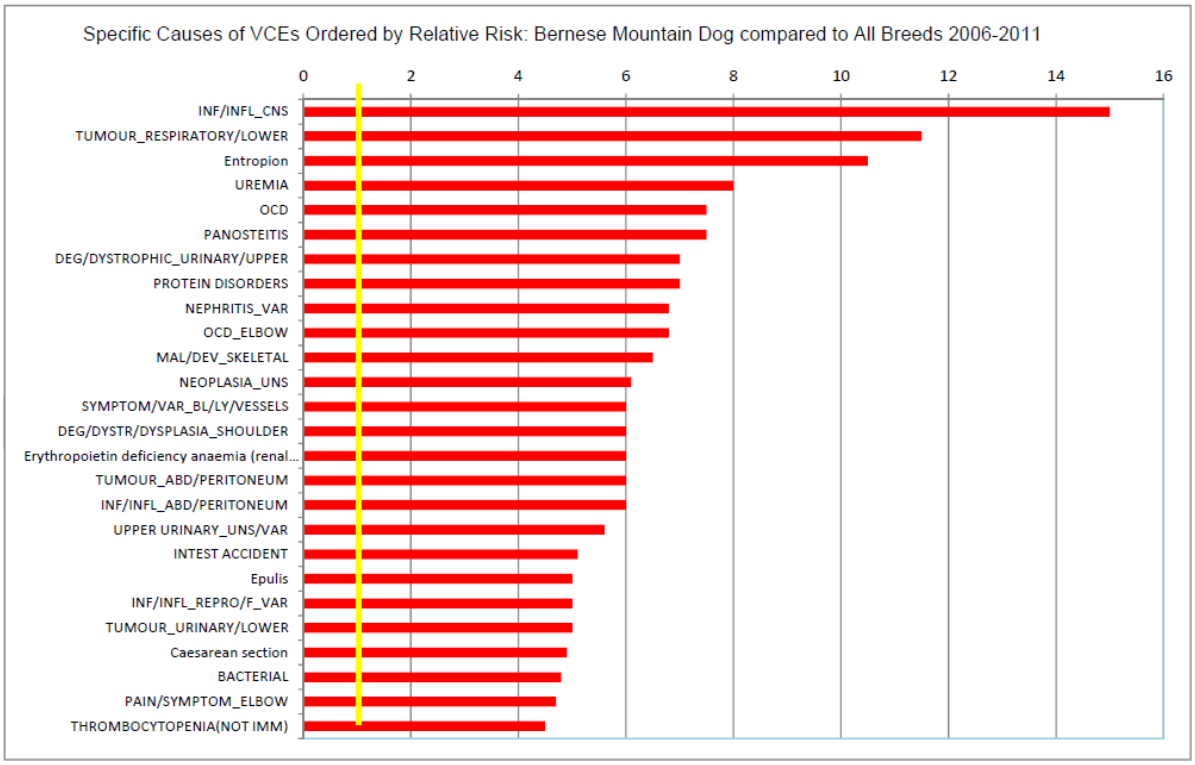

Figure 3: The specific causes of VCEs for the Bernese Mountain Dog ordered by relative risk compared to all breeds in Sweden between 2006 and 2011, from Swedish Agria insurance data. The yellow line indicates the baseline risk for all breeds.

Swedish Agria insurance mortality data

Median age at death for the Bernese Mountain Dog from Swedish Agria insurance data was 5.5 years for males and 5.6 years for females. Agria has a maximum age to which a dog can be life insured, which varies somewhat across breeds and years. Many owners also choose not to insure their dogs after a certain age, as the cost of the premiums become more expensive. For these reasons the median age at death from the Swedish Agria insurance data is artificially depressed for all breeds compared to that reported from surveys or other sources. The most common specific causes of death or euthanasia for Agria-insured Bernese Mountain Dogs in Sweden between 2006 and 2011 are shown in Figure 4. The most common specific causes of death were lymphoma/lymphosarcoma, tumour of the lower respiratory tract, hip dysplasia, unspecified/various upper urinary tract condition and unspecified neoplasia.

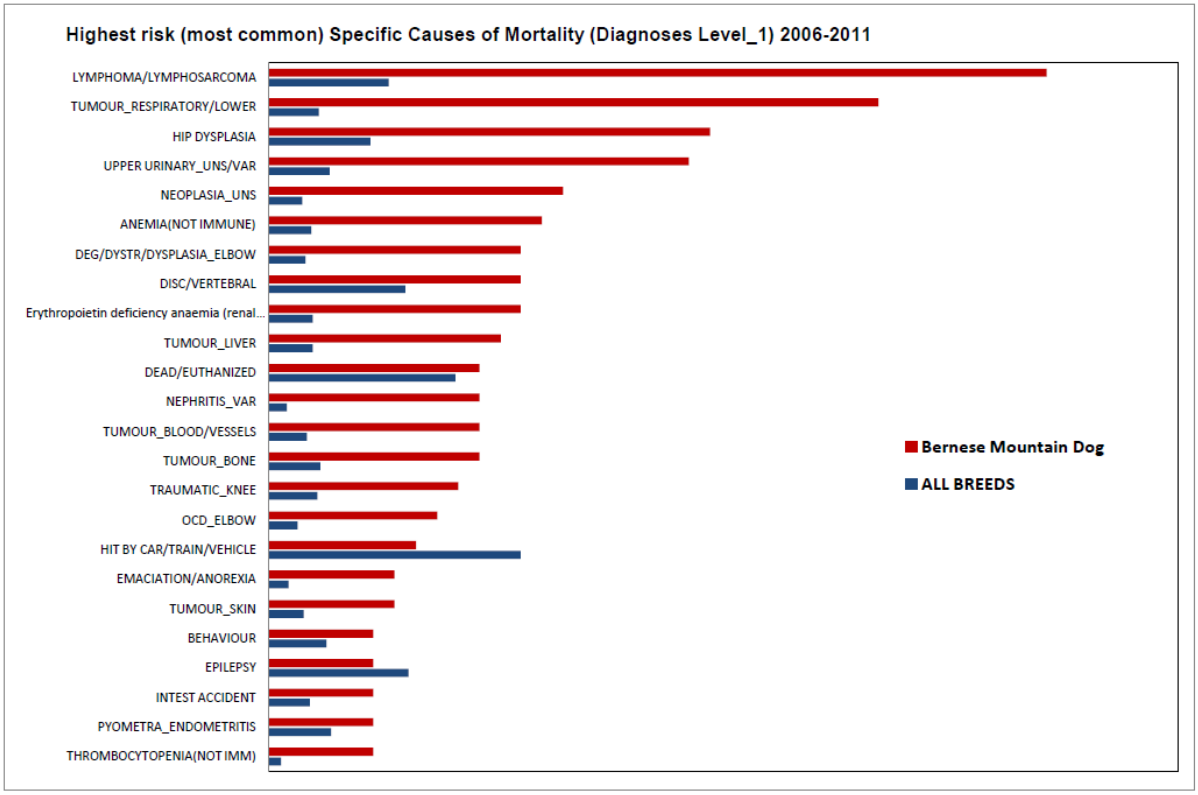

Figure 4: The most common specific causes of death for the Bernese Mountain Dog compared to all breeds in Sweden between 2006 and 2011, from Swedish Agria insurance data.

Breed-specific health surveys

The Bernese Mountain Dog Club of Great Britain has been running a rolling deaths survey since December 2016. Owners are requested to complete as and when their Bernese Mountain Dog dies, indicating cause of and age at death. The survey can be completed and submitted directly online: http://bernese.co.uk/health/bernese-death-survey-form/ , or owners can choose to print it out and submit by post or email a scanned copy. By the end of May 2016, the cause of and age at death had been reported for 186 British Bernese Mountain Dogs. The most frequently reported causes of death, and the average age at death due to that condition, are shown in Table 4 below. Full analysis of reports received up to this time are available here: http://bernese.co.uk/health/wp-content/uploads/sites/3/Death-Survey-Summary-March-2018.pdf

Table 4: Most frequently reported causes of death, and average age at death due to that condition, for 186 Bernese Mountain Dogs reported to the UK Bernese Mountain Dog Death Survey.

Condition	Number of deaths	Percentage of deaths	Average age at death (years)
Cancer	84	45.2%	7.82
'Histio'	42	22.6%	7.27
No cause of death given/known	11	5.9%	8.53
Kidney failure	10	5.4%	7.07
Orthopaedic - rear	9	4.8%	9.54
Heart failure	6	3.2%	7.14
Bloat	4	2.2%	8.64
Old age	3	1.6%	11.41
Orthopaedic - hips	3	1.6%	8.58
Orthopaedic – not specified	3	1.6%	11.34

Visual health check reports/clinical reports/judges' health monitoring

These are not mandatory for this breed, as they are on Breed Watch category one with no reported visual points of concern, and no optional forms have been received.

Breed Club health activities

The breed has an active Breed Health Coordinator and dedicated health pages on at least one breed club's website: http://bernese.co.uk/health/

There is also an international website relating to the health of the breed, which includes an international open health registry: http://www.bmdinfo.org/index.php

BHC annual report

The Breed Health Coordinators Annual Health Report 2016 yielded the following response to 'please list and rank the three health and welfare conditions that the breed considers to be currently the most important to deal with in your breed': 1 histiocytic sarcoma, 2 elbow dysplasia and 3 degenerative myelopathy. In terms of what the breed has done in the last year to help address these listed health and welfare concerns the following responses were given: 1 Publicising use of the screening programme to select breeding stock; 2 Not much on this last year, advice about breeding on web site and 3 Club paid for 120 samples to be tested to establish scale of problem in Britain to end speculation. Results on web site and club supports general worldwide view in the breed of not to breed at risk dogs i.e. as long as every mating has a 'clear' tested dog the condition will not be produced. Such advice is given out in magazines and on the website.

In the 2017 Annual Health Report the BHC listed the three health and welfare conditions as 1 cancer including malignant histiocytosis and 2 elbow dysplasia. New actions listed were launched a death survey and tried to raise awareness and get people to accept this is not totally random and bad luck.

DNA test results

DNA tests are available for the Bernese Mountain Dog for vWD Type 1, vWD Type 3 and for two mutations which increases risk of degenerative myelopathy (DM). In addition, Antagene market a 'histiocytic sarcoma test' in collaboration with the University of Rennes, which provides an index result (low risk, neutral, high risk). However, results of these tests are not currently recorded by The Kennel Club. DNA test results are only recorded for Official Kennel Club DNA Testing Schemes which involve collaboration between the Kennel Club, the breed clubs and the DNA testing facilities.

Canine Health Scheme results and EBVs

Under the Kennel Club's Assured Breed Scheme (ABS), participation in the British Veterinary Association (BVA)/Kennel Club (KC) Hip Dysplasia Scheme and the BVA/KC Elbow Dysplasia Scheme are requirements. All the BVA/KC Health Schemes are open to dogs of any breed, and the results for Bernese Mountain Dogs which have been presented for assessment under the BVA/KC/International Sheep Dog Society (ISDS) Eye Scheme are also shown below.

HIPS

Some 2,017 Bernese Mountain Dogs were hip scored between 1st January 2001 and 31st December 2016. Hip scores for the breed ranged from 0-96 and the 15 year and 5 year median were the same at 9.

Hip score categories received by Bernese Mountain Dogs which participated in the BVA/KC Hip Dysplasia Scheme between 1990 and 2016 are shown in five year blocks (which can be considered to approximate to a generation) in Figure 4 below. The categories correspond to those assigned under the FCI (Europe)'s hip grading scheme; for one hip, a 'normal' hip scores 0-3, borderline scores 4-8, mild HD scores 9-18, moderate HD scores 19-30 and severe HD represents a score greater than 30. Further information on these categories can be found here: https://www.bva.co.uk/uploadedFiles/Content/Canine_Health_Schemes/chs-comparison-of-hd-schemes.pdf There is clear evidence of a decrease in the number of dogs of the breed being diagnosed with mild, moderate or severe hip dysplasia through the scheme.

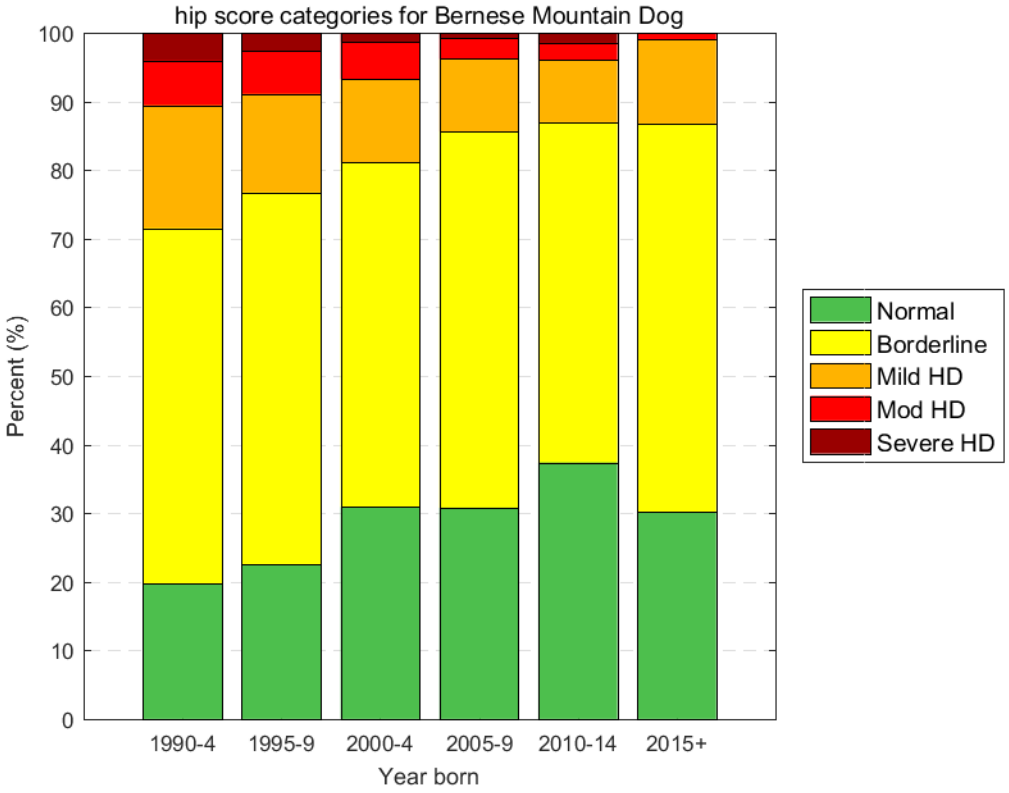

Figure 5 – Hip score categories for Bernese Mountain Dogs which participated in the BVA/KC Hip Dysplasia Scheme between 1990 and 2016, in 5-year blocks.

Estimated breeding values (EBVs) are available for hip score for the Bernese Mountain Dog. Figure 6 shows the five year rolling trend in EBVs by year of birth in the Bernese Mountain Dog. It can be seen that EBVs have generally decreased, indicating an improving (lowering) genetic risk of hip dysplasia as determined by the BVA/KC hip score, most likely as a result of selection. The variance also appears to have decreased, with a far smaller proportion with 'high risk' EBVs; more than 35% of dogs had EBVs greater than +20 in 1990, which had decreased to less than 10% by 2014.

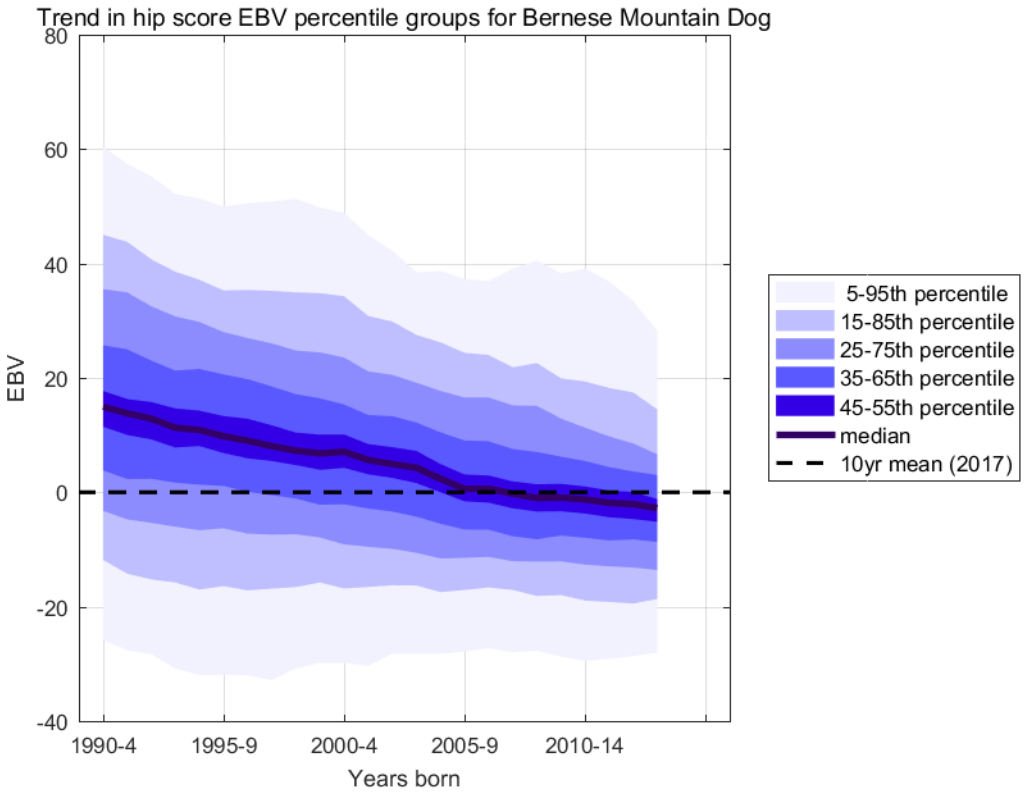

Figure 6: Trend in hip score EBV, with percentile groups, for the Bernese Mountain Dog for years of birth since 1990.

ELBOWS

A total of 1,922 Bernese Mountain dogs were elbow scored up to 31st December 2016; scores received are shown in Table 9. Some 36.7% (705 of 1,922 dogs) of dogs of the breed participating in the Scheme were diagnosed with some degree of elbow dysplasia.

Table 9: Elbow scores and number of dogs receiving those scores since 1998 for the 1,922 Bernese Mountain Dogs which have participated in the BVA/KC Elbow Dysplasia Scheme.

Elbow score	Number of dogs	Proportion
0	1217	63.3%
1	272	14.2%
2	280	14.6%
3	153	8.0%

Individual elbow scores received by Bernese Mountain Dogs which participated in the BVA/KC Elbow Dysplasia Scheme between 1998 and the end of 2016 are shown in five year blocks (which can be considered to approximate to a generation) in Figure 4 below. There is evidence of an increase in the number of elbows being scored 0, and a decrease in the number of elbows being scored 3 over this time.

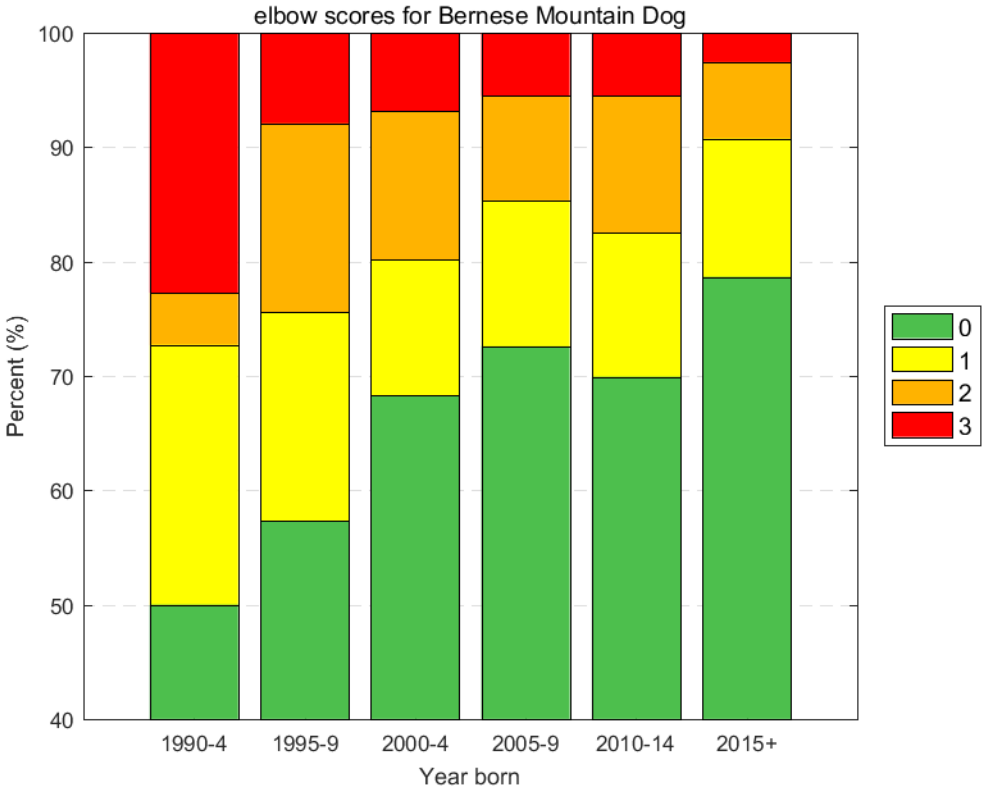

Figure 7 – Elbow scores for Bernese Mountain Dogs which participated in the BVA/KC Elbow Dysplasia Scheme between 1998 and the end of 2016, in 5-year blocks.

Estimated breeding values (EBVs) are available for elbow score for the Bernese Mountain Dog. Figure 8 shows the five year rolling trend in EBVs by year of birth in the Bernese Mountain Dog. It can clearly be seen that EBVs have generally decreased, indicating an improving (lowering) genetic risk of elbow dysplasia as determined by the BVA/KC elbow score, most likely as a result of selection.

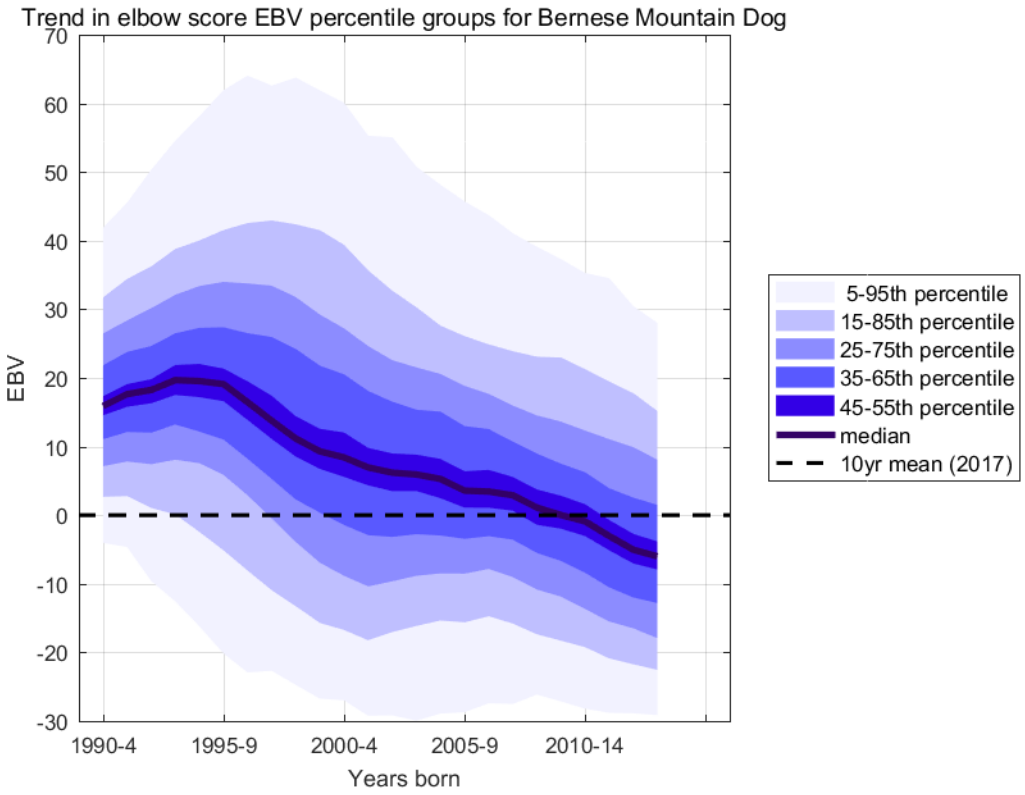

Figure 8: Trend in elbow score EBV, with percentile groups, for the Bernese Mountain Dog for years of birth since 1990.

EYES

The breed is not currently on Schedule A or B of the BVA/KC/ ISDS Eye Scheme for any condition. Schedule A lists the known inherited eye conditions in the breeds where there is enough scientific information to show that the condition is inherited in the breed, often including the actual mode of inheritance and in some cases even a DNA test. Schedule B lists those breeds in which the conditions are, at this stage, only suspected of being inherited. However, the BVA also record the results of dogs of other breeds which have participated in the scheme. The results of Eye Scheme examinations of the breed which have taken place since 2012 are shown in Table 6.

Table 6: Reports on dogs of the breed which have participated in the BVA/KC/ISDS Eye Scheme since 2012

Year	Number seen	Comments
2012	2 adults 0 litters	No comments
2013	0 adults 0 litters	Not applicable
2014	2 adults 0 litters	No comments
2015	1 adult 0 litters	No comments
2016	1 adults 0 litters	No comments

Breed Club Recommendations

The breed clubs recommend that bitches are not to produce a litter under two years of age.

Reported caesarean sections

When breeders register a litter of puppies, they are asked to indicate whether the litter was delivered (in whole or in part) by caesarean section. In addition, veterinary surgeons are asked to report caesarean sections they perform on Kennel Club registered bitches. The consent of the Kennel Club registered dog owner releases the veterinary surgeon from the professional obligation to maintain confidentiality (vide the Kennel Club General Code of Ethics (2)). There are some caveats to the associated data; it is doubtful that all caesarean sections are reported, so the number reported each year may not represent the true proportion of caesarean sections undertaken in each breed. In addition, these data do not indicate whether the caesarean sections were emergency or elective. The number of litters registered per year for the breed and the number and percentage of reported caesarean sections in the breed for the past 10 years are shown in Table 6.

Table 6: Number and percentage of litters of Bernese Mountain Dogs registered per year and number of caesarean sections reported per year, 2007 to 2017.

Year	Number of Litters Registered	Number of C-sections	Percentage of C-sections
2007	116	0	0
2008	118	0	0
2009	126	0	0
2010	106	3	2.8%
2011	126	5	4.0%
2012	84	17	20.2%
2013	102	27	26.5%
2014	108	28	25.9%
2015	82	27	32.9%
2016	112	29	25.9%
2017	76	19	25.0%

Genetic diversity measures

The effective population size is the number of breeding animals in an idealised, hypothetical population that would be expected to show the same rate of loss of genetic diversity (rate of inbreeding) as the population in question; it can be thought of as the size of the 'gene pool' of the breed. In the population analysis undertaken by the Kennel Club in 2015, the estimated effective population size was reported as n/a (estimated using the rate of inbreeding over the period 1980-2014). An effective population size of less than 100 (inbreeding rate of 0.50% per generation) leads to a dramatic increase in the rate of loss of genetic diversity in a breed/population (Food & Agriculture Organisation of the United Nations, "Monitoring animal genetic resources and criteria for prioritization of breeds", 1992). Where the rate of inbreeding is negative (implying *increasing* genetic diversity in the breed), effective population size is denoted 'n/a'.

Annual mean observed inbreeding coefficient (showing loss of genetic diversity) and mean expected inbreeding coefficient (from simulated 'random mating') over the period 1980-2014 are shown in Figure 4. Unusually, the rate of inbreeding for this breed between 1980 and 2014 is negative. This means that genetic variation within the breed appears to be increasing (possibly through the use of imported animals). It should be noted that, while animals imported from overseas may appear completely unrelated, this is not always the case. Often the pedigree available to the Kennel Club is limited in the number of generations, hampering the ability to detect true, albeit distant, relationships. For full interpretation see Lewis et al, 2015 https://cgejournal.biomedcentral.com/articles/10.1186/s40575-015-0027-4.

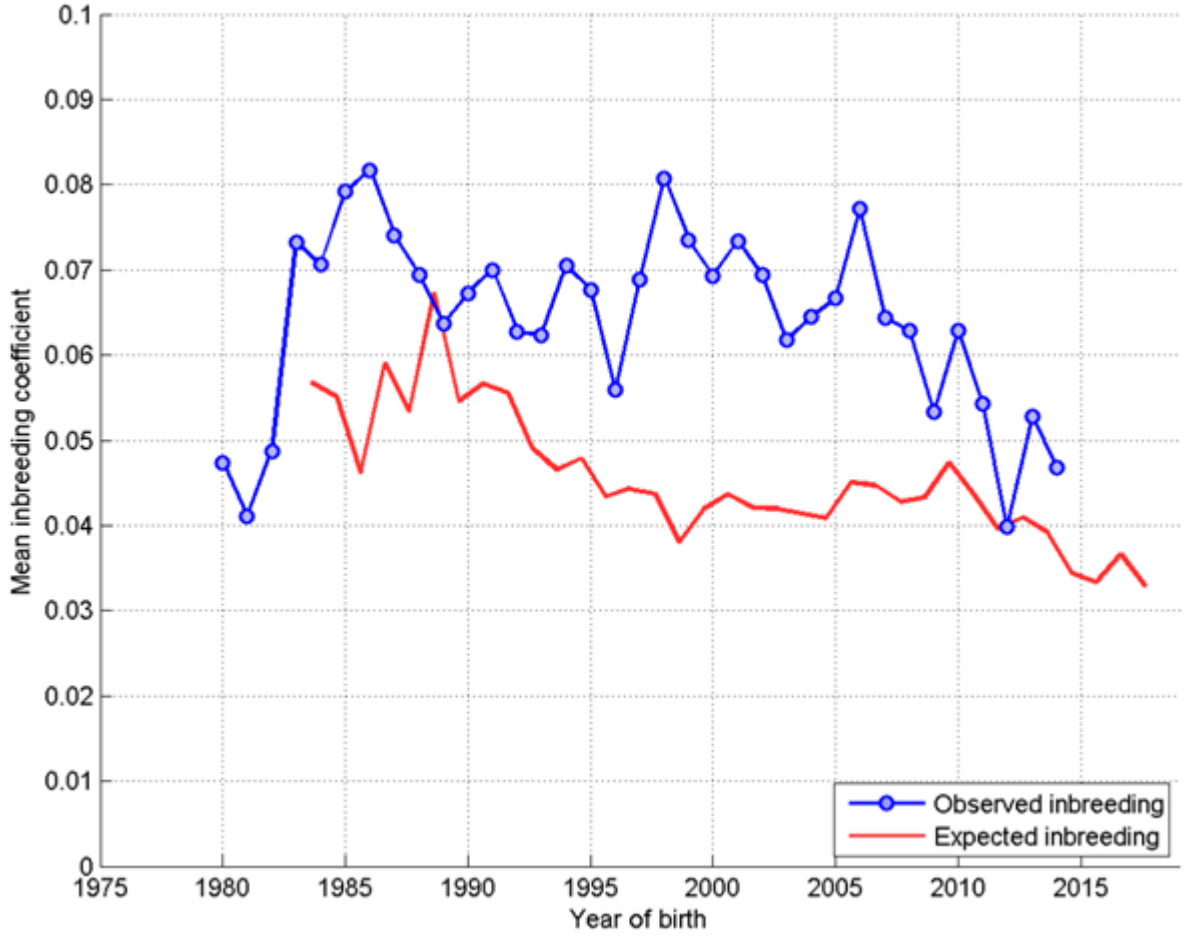

Figure 4: Annual mean observed and expected inbreeding coefficients. [The blurring around the expected inbreeding line indicates an approximate standard deviation around the estimate, in breeds with more than 2000 individuals born in a given year.]

The current annual breed average inbreeding coefficient is 5.0%. This value is calculated each June and represents the average inbreeding coefficient of all dogs of the breed registered between January and December of the previous year i.e. in 2016.

Below is a histogram ('tally' distribution) of number of progeny per sire and dam over each of seven five-year blocks (Figure 5). A longer 'tail' on the distribution of progeny per sire is indicative of 'popular sires' (few sires with a very large number of offspring, known to be a major contributor to a high rate of inbreeding). There appears to be extensive use of popular dogs as sires in this breed (the 'tail' of the blue distribution in figure 5).

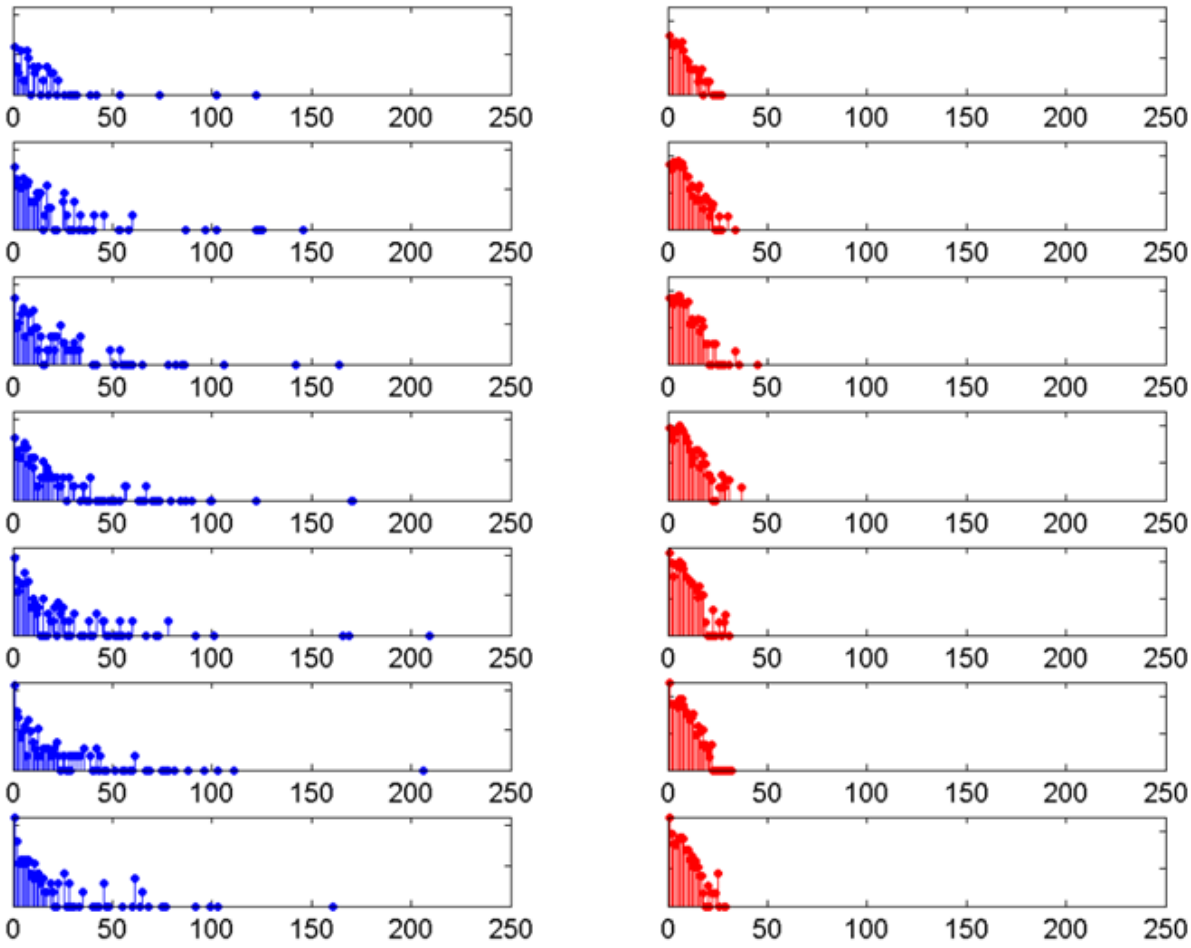

Figure 5: Distribution of progeny per sire (blue) and per dam (red) over 5-year blocks (1980-4 top, 2010-14 bottom). Vertical axis is a logarithmic scale.

Current research projects

There is ongoing research at the University of Rennes, with international collaboration, into the genetics of histiocytic sarcoma in the breed.

There is also research into histiocytic sarcoma in the breed at the University of California, Davis.

SECTION 2: PRIORITIES

A meeting was held with the Bernese Mountain Dog Breed Health Coordinator on 26th July 2018 to discuss Section 1 of the BHCP and agree the priority issues for the health of the breed.

One dermatological condition was found in the literature review, pyotraumatic dermatitis (hot spots). It was noted that whilst this has been seen anecdotally it is not currently considered a priority.

The haematological concern found, factor I (fibrinogen) and VII deficiencies was not believed to be a concern within the UK population, and it was noted that the paper was American and from 1999. Von Willebrand's Disease has been seen in imported dogs of the breed, but is not considered to be prevalent in the UK population.

Four musculoskeletal conditions were listed, elbow dysplasia, hip dysplasia and osteochondrosis dissecans (OCD) and panosteitis. The group discussed the breed's improvement in hip and elbow scores since the BVA/KC schemes were introduced, which is further reflected in the breed's EBV trends. With regard to OCD it was noted that this is rarely seen and appeared to peak in the 1980s. It was suggested that this could be due to changes in feeding habits and husbandry. Panosteitis is not often heard of in the UK and therefore not considered a concern.

The neoplastic or cancer category had four specific conditions listed: histiocytic sarcoma complex, lymphoma, mast cell tumours and osteosarcoma. Cancers are well known as a problem within the breed. There is concern that dogs presenting with specific cancers may be misdiagnosed or not definitively diagnosed, with particular tumours in different locations actually developing as a result of underlying histiocytic sarcoma complex, therefore giving skewed data. The breed are currently investigating the possibility of using a histiocytic sarcoma risk grading test to provide additional breeding guidelines but there is concern that many breeders are not engaged or willing to participate.

Six neurological conditions were found in the literature review: Alexander disease, cervical spondylomyelopathy, degenerative myelopathy, hepatocerebellar degeneration hypomyelinogenesis (Trembler) and idiopathic epilepsy. Alexander's disease was not considered to be seen often in the breed, and whilst anecdotally Trembler was seen in the late 1980s this is no longer believed to be prevalent. The breed have been found to possess two mutations of SOD1, but the difficulty in encouraging breeders to include carriers in the breeding population to keep the gene pool diverse was highlighted. Within recent years the breed clubs have provided funding for approximately 60 dogs to be tested for the mutations but to date only a few dogs have been found to be affected. It was further noted that the test results give an indication of risk and are not definitive, making it less attractive to breeders as a tool. With regard to epilepsy it was noted there is difficulty in correctly diagnosing the condition but it does not appear to be a concern to date.

Two reproductive conditions were found, prostate disease and pyometra. Prostate disease is heard of in older dogs and pyometra is seen anecdotally but not at a high prevalence.

Familial renal disease was considered a concern within the breed some time ago but has been bred away from, and is therefore no longer considered to be a concern within the breed.

The 2004 and 2014 Purebred and Pedigree Breed Health Survey results were reviewed. Cruciate ligament disorders, renal disease and umbilical hernias were noted to be at a high prevalence in this data. Whilst umbilical hernias are common in the breed, due to the small impact these have on welfare they are not considered to be a priority concern.

The insurance data were assessed by the group, with the findings showing the breed at a higher risk of cruciate disease, skin allergies, elbow dysplasia, seizures/epilepsy and lymphoma. The Swedish data presented the following top conditions in the breed: pain during movement, skin conditions and tumours. The breed was also noted to be at a higher risk of developing lower respiratory tumours and entropion. Dr Evans clarified the mortality appears to be depressed across breeds within the Swedish data, due to owners not continuing to insure older dogs, giving a bias to younger dogs' age at death.

Genetic diversity measures were discussed. An estimated effective population size could not be calculate in the 2014 population analysis due to the negative rate of inbreeding suggesting that genetic diversity was actually increasing. However, there is concern that several well-known breeders are still breeding closely and that this should be kept at watch. It is hoped that the population analyses will be repeated in 2020.

The group agreed from the information provided and their own experience that histiocytic sarcoma complex and other cancers, elbow dysplasia and maintenance of genetic diversity were the priorities for the Bernese Mountain Dog, and that degenerative myelopathy and hip dysplasia should remain at watch and continue to be monitored.

SECTION 3: ACTION PLAN

- The breed clubs to continue to encourage participation in the BVA/KC Hip and Elbow Schemes and use of the associated EBVs.

- The breed clubs to continue to encourage participation in the death survey.

- The Kennel Club to confirm receipt and outcome of requests to amend the Bernese Mountain Dog Club of Great Britain's code of ethics with regard to histiocytic sarcoma, DM and COIs.

- The breed clubs to work towards a majority inclusion of the code of ethics amendments which might allow these recommendations to become ABS recommendations.

- The breed clubs to establish a cruciate disease survey, with the Kennel Club to assist in dissemination.

- The Kennel Club to report back on the findings from the cruciate study at the University of Surrey.

- The Kennel Club to raise the problems in breeders using the OFA over the BVA scheme and implications this has under the ABS.

- Dr Lewis to investigate the conversion of OFA scores to BVA scores for inclusion in EBVs.

- The breed clubs to add a link for the histiocytic mating tool on the breed club websites.

- The Kennel Club will review progress with the Bernese Mountain Dog breed clubs in July 2019.

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