



THE KENNEL CLUB  
DOG HEALTH

# Breed Health and Conservation Plan

## Weimaraner Evidence Base

## CONTENTS

|   |    |
|---|----|
| INTRODUCTION.....                                   | 3  |
| DEMOGRAPHICS .....                                  | 3  |
| BREED HEALTH CO-ORDINATOR ANNUAL HEALTH REPORT..... | 4  |
| BREED CLUB HEALTH ACTIVITES .....                   | 5  |
| BREED SPECIFIC HEALTH SURVEYS.....                  | 5  |
| LITERATURE REVIEW .....                             | 9  |
| INSURANCE DATA.....                                 | 13 |
| BREED WATCH.....                                    | 15 |
| PERMISSION TO SHOW .....                            | 16 |
| ASSURED BREEDER SCHEME .....                        | 16 |
| BREED CLUB BREEDING RECOMMENDATIONS .....           | 16 |
| DNA TEST RESULTS.....                               | 16 |
| CANINE HEALTH SCHEMES .....                         | 16 |
| REPORTED CAESAREAN SECTIONS .....                   | 20 |
| GENETIC DIVERSITY MEASURES .....                    | 21 |
| CURRENT RESEARCH .....                              | 23 |
| PRIORITIES.....                                     | 24 |
| ACTION PLAN .....                                   | 25 |
| REFERENCES.....                                     | 26 |



## INTRODUCTION

The Kennel Club launched a 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 raise awareness of current health and welfare concerns in their breed, and support them in making balanced breeding decisions.

The Breed Health and Conservation Plans take a complete 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 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 Co-ordinator and breed health representatives where applicable. Priorities are agreed based on this data and incorporated into a list of actions between the Kennel Club and the breed to tackle these health concerns. These actions are then monitored and reviewed on a regular basis.

## DEMOGRAPHICS

The number of Weimaraners registered by year of birth between 1990 and 2020 are shown in Figure 1. The trend of registrations over year of birth (1990-2020) was -36.5 per year (with a 95% confidence interval of -57.6 to -15.4) reflecting the overall decrease in the breed's numbers during this time. However, the breed has remained relatively stable since 2012, with approximately 1,300 dogs registered per year.

[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.]

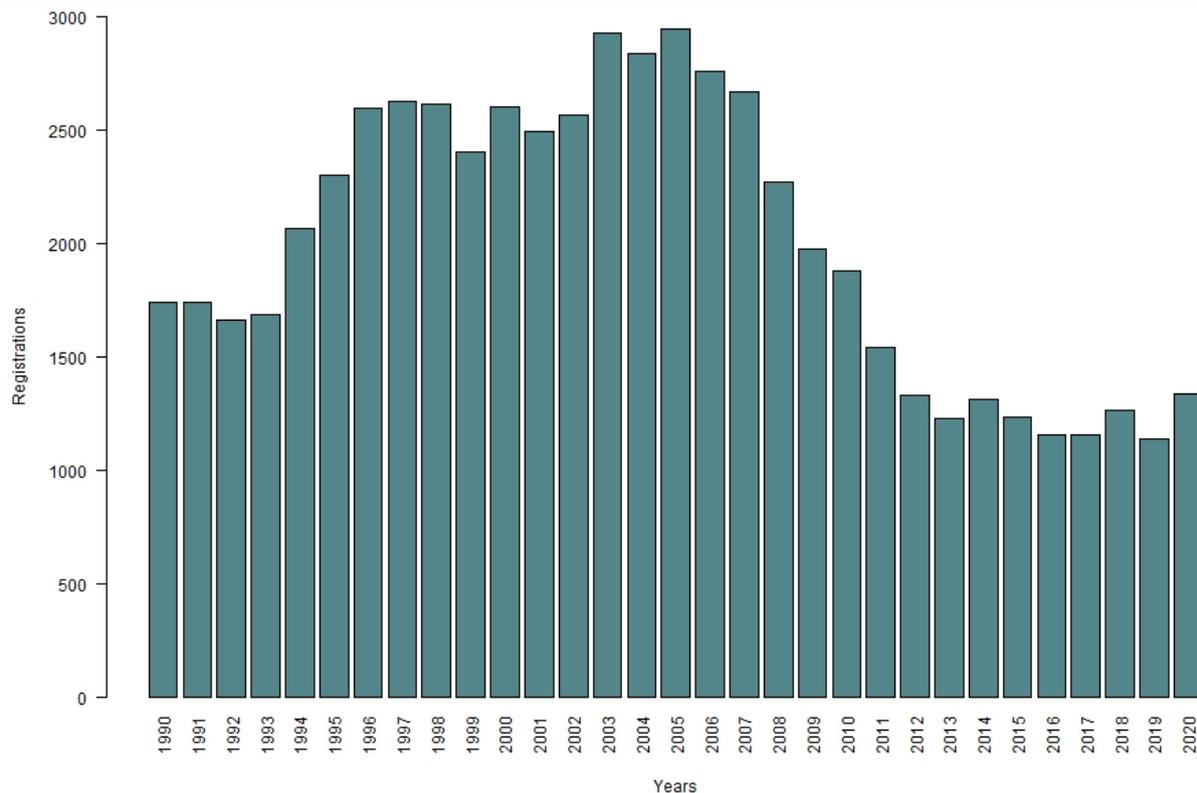


Figure 1: Number of registrations of Weimaraners per year of birth, 1990 – 2020.

## BREED HEALTH CO-ORDINATOR ANNUAL HEALTH REPORT

Breed Health Co-ordinators (BHCs) are volunteers nominated by their breed to act as a vital conduit between the Kennel Club and the breed clubs with all matters relating to health.

In July 2020, the BHC completed a short questionnaire regarding Weimaraner health. The following response was given to ‘What are the top health or welfare concerns in your breed at this time?’

1. Bloat
2. Cancer of the liver and spleen
3. Heart disease
4. Mast cell tumour
5. Hypertrophic osteodystrophy (HOD)
6. Movement disorders

The BHC’s Annual Health Report 2019, 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. Mast cell tumour
2. Intersexuality
3. Gastric dilatation and volvulus (GDV)

In terms of what the breed has done to help tackle these listed health and welfare concerns, the breed continues to educate owners by providing information on the above health concerns on their club websites, magazines and social media. They continue to record and monitor health conditions, including cases of liver and spleen cancer, to monitor the prevalence within the breed, and are currently looking at pedigrees of dogs affected with HOD to see if there is a possible genetic link. The breed have also sent samples to the Animal Health Trust (AHT) to contribute to their 'Give a Dog a Genome' project, which aims to investigate a genetic link for mast cell tumours in the Weimaraner. It is hoped that following the trust's closure in July 2020 this research will be reinstated at the University of Cambridge. The North of England Weimaraner Society are also working with the University of Glasgow on an ongoing survey, which aims to collate information on movement disorders in the breed.

## BREED CLUB HEALTH ACTIVITIES

The Weimaraner has an active BHC and webpages dedicated to health on their club websites, these can be found at:

- <https://www.weimaranerclubofgreatbritain.org.uk/index.php/the-breed/weimaraner-health>
- [https://www.northern-weimaraner.org.uk/breed\\_health.htm](https://www.northern-weimaraner.org.uk/breed_health.htm)

## BREED SPECIFIC HEALTH SURVEYS

### Kennel Club Purebred and Pedigree Dog Health Surveys

The Kennel Club Purebred and Pedigree Dog Health Surveys were launched in 2004 and 2014 respectively for all of the recognised breeds at the time, to establish common breed-specific and breed-wide conditions.

**2004 Morbidity results:** Health information was collected for 557 live Weimaraners of which 295 (53%) were healthy and 263 (47%) had at least one reported health condition. The top specific conditions were lipoma (7.3%, 37 of 506 reported conditions), GDV/ bloat (4.9%, 25 of 506), kennel cough (4.3%, 22 of 506), colitis/ large bowel diarrhoea (3.4%, 17 of 506), and ear infection/ otitis externa (2.8%, 14 of 506).

**2004 Mortality results:** A total of 242 deaths were reported for the Weimaraner. The median age at death was 11 years and 2 months (min = 8 months, max = 18 years and 10 months). The most frequently reported specific causes of death by organ system or category were GDV/ bloat (11.2%, 27 of 242), old age - unspecified (9.1%, 22 of 242), heart failure (6.2%, 15 of 242), aggression (3.7%, 9 of 242), and cancer - unspecified (3.3%, 8 of 242).

**2014 Morbidity results:** Health information was collected for 372 live Weimaraner of which 209 (56.2%) had no reported conditions and 163 (43.8%) were reported to

be affected by at least one condition. The most frequently reported conditions were lipoma (18.8% prevalence, 70 cases), skin (cutaneous) cyst (5.7% prevalence, 21 cases), skin lump (3.2% prevalence, 12 cases), hypersensitivity (allergic) skin disorder (3.0% prevalence, 11 cases), and food allergy (2.7% prevalence, 10 cases).

**2014 Mortality results:** A total of 76 deaths were reported for the breed. The median of age at death for the Weimaraner was 10 years. The most frequently reported causes of death by organ system or category were old age (17.6%, 13 of 76), cancer - unspecified (12.2%, 9 of 76), cardiac heart failure (9.5%, 7 of 76), GDV/ bloat (8.1%, 6 of 76), and unknown (8.1%, 6 of 76).

### Breed-Specific Health Survey Report

In 2019, the Weimaraner Club of Great Britain launched a longevity and cause of death survey. A total of 950 individual responses were collected for the survey. Figure 2 shows the dog's age (in years) when he/ she died, with the median age at death being 11 years old.

DRAFT

Figure 2: Respondents answers to ‘How old was your dog when it died?’

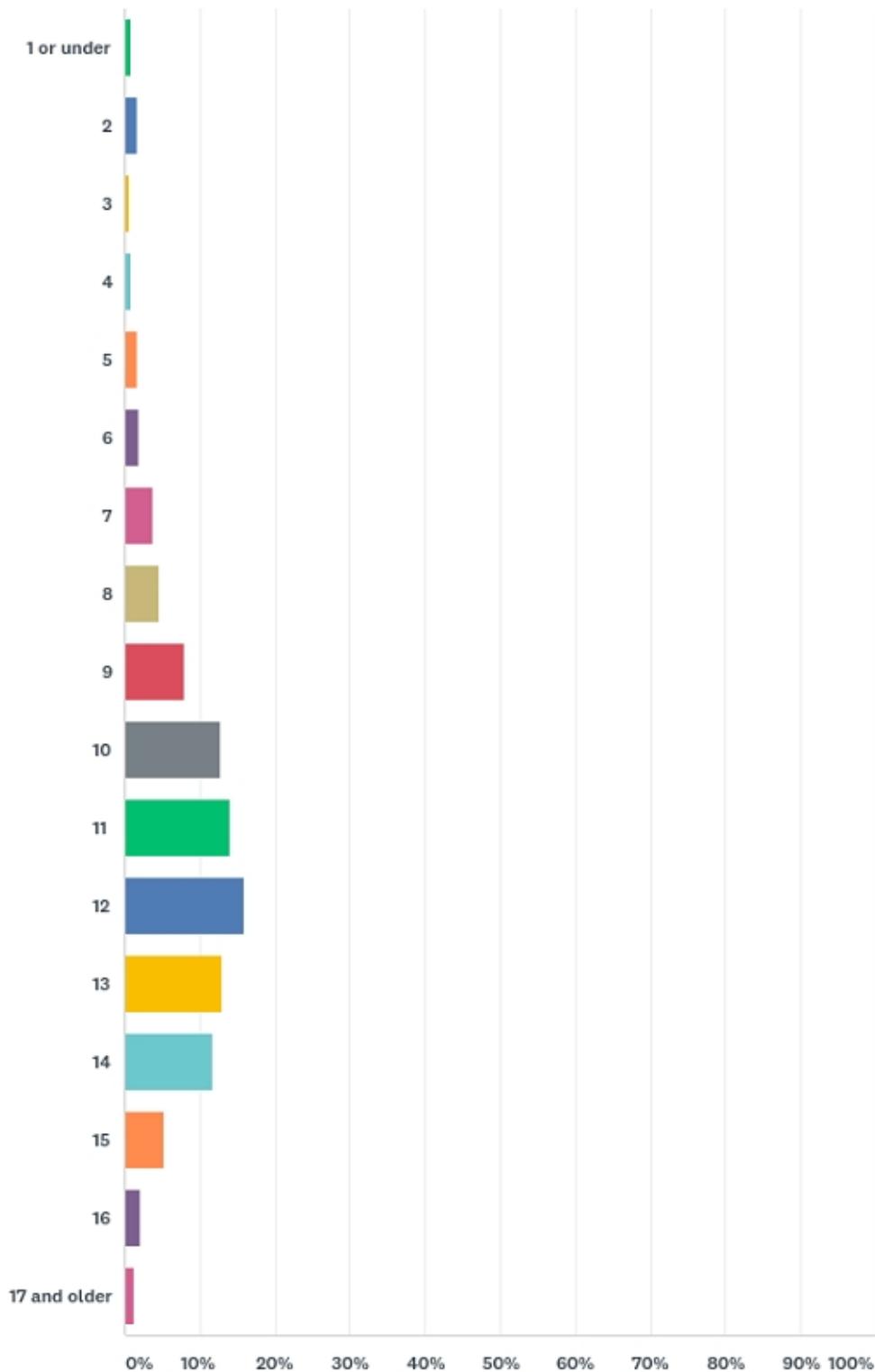
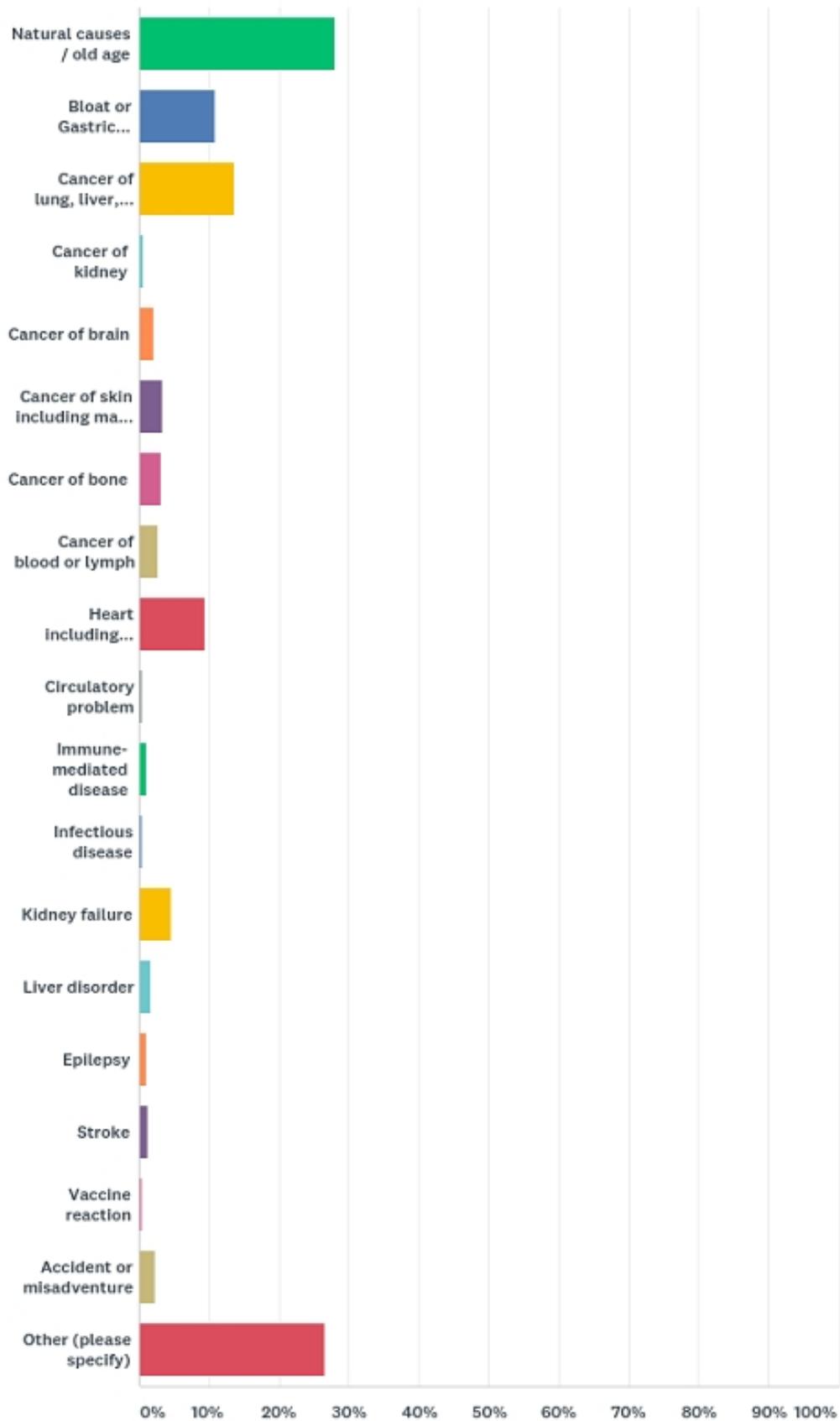


Figure 3 shows the reported causes of death for the dogs included in the survey. The most frequently reported specific cause of death was ‘natural causes/ old age’, followed by ‘cancer of the lung, liver or ...’ then ‘bloat or gastric dilatation and volvulus (GDV)’.

Figure 3: Respondents answers to 'What was the cause of death (if known)'.



The Neurology and Neurosurgery department of the Small Animal Hospital at the University of Glasgow have developed an ongoing survey to collect information about a recently identified movement disorder, which affects the Weimaraner. This research aims to identify Weimaraners affected by the disorder and gather information about the clinical signs.

Owners of dogs who have presented signs of episodic muscle stiffness/ weakness/ collapse triggered by exercise or excitement, are being encouraged to complete the following survey:

<https://www.surveymonkey.com/r/Weimaraner>

## 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 incorporated literature that was released relatively recently to try to reflect current publications and research relating to the breed.

### Cancerous conditions

*Mast cell tumour (MCT)*: MCTs are common tumours of the skin that can affect any breed. The Weimaraner has been reported to be at increased risk of MCT suggesting that this breed may have an underlying genetic predisposition to this type of cancer (Dobson, 2013). A VetCompass study assessing the prevalence and risk factors for MCTs in dogs found the Weimaraner to be at increased risk of MCTs compared to crossbred dogs (Shoop et al, 2015). Of 168,636 dogs attending 94 veterinary practices in England between 2007 and 2013, 453 dogs met the case inclusion criteria. Overall MCT prevalence was estimated at 0.27%. The Weimaraner was one of the breeds that exceeded this with MCT prevalence of 0.85% (95% C.I. 0.17% - 1.53%).

### Gastrointestinal conditions

*Gastric dilatation and volvulus (GDV)/ bloat*: GDV is generally an acute, life-threatening condition in dogs, characterised by increased intragastric pressure caused by a rapid accumulation of gas, fluid and/or food in the stomach, and rotational twisting of the stomach, frequently leading to the development of cardiogenic shock (Glickman et al, 2000a). There are many risk factors associated with the development of GDV, however breed has been suggested to be the most significant risk factor in dogs (Piras et al, 2020). There are a number of studies that report the Weimaraner to be at high risk of developing GDV (Glickman et al, 1994; O'Neill et al, 2017).

A prospective cohort study compared incidence and breed-related risk factors for GDV across 11 breeds, including the Weimaraner (Glickman et al, 2000a). The total incidence of GDV for the 57 large breeds was 23 cases/1,000 dog-years at risk (DYAR – the number of years for which data is available for insured individuals)

(95% C.I. 17 - 29), compared to the breed-specific incidence of GDV in the Weimaraner, which was 21 cases/1,000 dog-years at risk (95% C.I. 0 - 42).

A subsequent study found that factors significantly associated with an increased risk of GDV in large breeds were increasing age, having a first-degree relative with a history of GDV, increased speed of eating, having a raised feeding bowl and restricting water intake before and after eating (Glickman et al, 2000b).

An American paper also set to look at the lifetime risk of GDV in a number of breeds, and established this to be 19.1% in the Weimaraner (95% CI 0.0% – 34.9%) with the lifetime mortality at 4.8% (95% CI 0.0% - 8.7%), and a median life expectancy of 10 years (Ward et al, 2003). The benefits of using preventative surgery (gastropexy) was considered, and found to have the potential to significantly reduce the risk of mortality due to disease. However, the authors did also note the importance of considering the ethical and financial consequences of this route.

Most recently, a VetCompass cross-sectional study of 77,088 dogs attending 50 Vets Now practices across the UK between 2012 and 2014, found that the Weimaraner had a breed-specific prevalence of 7.1% (95% C.I. 5.0% - 9.8%, 34 cases in 480 dogs of the breed) and an odds ratio for GDV of 50.8 (95% C.I. 25.2 - 102.7) compared with crossbred dogs (O'Neill et al, 2017).

### **Immunological conditions**

*Steroid-responsive meningitis-arteritis (SRMA):* A UK study investigated causative factors for breeds, and found that none other than breed-predisposition could account for the increased incidence of disease, with the Weimaraner established as having a possible predisposition (Rose et al, 2014). Affected dogs show clinical signs such as fever, hypersensitivity around the neck, and waxing and waning of consciousness, and can be triggered by certain drugs, vaccinations, infections or other immune-mediated conditions. A total of 60 cases were included for analysis, with two of these being affected Weimaraners. Based on the breed's appearance in comparison to the unaffected population an odds ratio of 12.04 (95% CI 1.03 – 141.55) was established for the breed.

*Recurrent infections:* Several older papers have suggested in case reports that dogs of the breed may be predisposed to recurrent pathogenic infections, due to immune system dysfunction (Hansen et al, 1995; Couto et al, 1989; Roth et al, 1980). In affected dogs the levels of serum immunoglobulin G (IgG - an antibody involved in the regulation of the immune system), and IgM were lower than controls, as well as having abnormal neutrophil function (immunoregulatory cells). However, no recent research could be found pertaining to this breed and condition.

### **Musculoskeletal conditions**

*Hypertrophic osteodystrophy (HOD):* HOD is a developmental disease that occurs in young dogs of fast growing and larger breeds. The condition has been known in the breed since the early 1980s (Woodard, 1982) with affected puppies showing abnormal calcification of cartilage, bone pain, defective bone formation and abnormally thin dental enamel. Subsequent studies have also found systemic signs

associated with disease, including those associated with the gastrointestinal, respiratory and nervous systems, specifically fever, anorexia, depression and vomiting/ diarrhoea (Abeles et al, 1999). Although the underlying aetiology for HOD remains unknown, the complex manifestation of the disease, including the variation in severity of clinical signs, suggests a multifactorial cause.

Safra et al (2014) evaluated medical records of 53 Weimaraners with HOD between 2009 and 2011, and found that 28 (52.8%) had littermates affected with HOD, supporting other reports that suggest an inherited factor plays a role in the development of the disease in this breed.

Given that reports have indicated a possible immune response, with some affected dogs showing clinical signs following vaccination, the link between disease and dog leukocyte antigens (DLA – a group of genes associated with the maintenance of the immune system) have been further studied, specifically the DQA1 allele in a cohort of 33 American dogs (Crumlish et al, 2006). Whilst no association in this study could be found, the authors noted that other immune-response genes may be involved in the onset of disease and should be considered. It was concluded that no specific vaccine is responsible for the onset of disease.

More recently the levels of immune markers (pro-inflammatory cytokines) were compared in dogs affected with HOD against those in unaffected individuals (Safra et al, 2016). All affected dogs had their first episode during periods of accelerated growth (7-18 weeks) and responded well to non-steroidal anti-inflammatories (NSAIDs) or steroidal treatment. Seven serum markers were significantly raised in affected dogs, indicating again an immunological basis for disease. Interestingly, dogs in remission showed similar, if not higher, levels of these markers when compared to dogs showing clinical signs, indicating a possible predisposing feature and mechanism for disease.

### **Neurological conditions**

*Hypomyelination:* This condition has been found in US populations as well as described in European individuals, with affected dogs showing onset of tremors and a hopping gait at the age of 12 – 14 days of age (Kornegay et al, 1987; Millan et al, 2010; Pemberton et al, 2014). These signs diminished by the time of 3 – 4 months of age, although some showed a residual tremor in their hind limbs. Genome wide sequencing was undertaken on three unrelated pedigrees (n=48) with a mutation identified within the *FNIP2* gene. The authors suggested this mutation is inherited in an autosomal recessive mode of inheritance, and a commercial DNA test is available.

*Neural tube defects (NTDs)/ spinal dysraphism:* This congenital disorder manifests in the embryo and is characterised by incomplete closure of the neural tube, resulting in clinical problems from birth. Clinical signs include a kinked tail, scoliosis, a bunny hopping gait, partial paralysis and an abnormal pain reflex. Following presentation of affected dogs in the past, several research colonies have been bred to identify the mode of inheritance, with this seeming to have a more complex mode of inheritance than initially thought (Engel et al, 1982; Draper et al, 1976). A more recent study

looked at four dogs of the breed showing typical clinical signs and genotyped them to attempt to identify any causative mutations (Safrá et al, 2013). A mutation in the *NKX2-8* gene (involved in the development of the central nervous system) was identified, and suggested as having a role in the development of NTDs.

### Ocular conditions

*Progressive retinal atrophy (PRA)*: PRA is a common inherited disease which results in a degeneration in the retina, causing visual abnormalities and, in severe cases, blindness. A German study of two affected littermates (Kropatsch et al, 2016) identified a mutation in *RPGR* as consequential for disease. Following pedigree analysis and genetic testing of immediate relatives, the authors concluded that the mutation is inherited in a recessive x-linked mode of inheritance, meaning that it is passed down maternally, and males will be the severely affected dogs, with females of carrier (heterozygous) status likely to either be asymptomatic or possibly present with a milder disease.

### VETCOMPASS

The Kennel Club work closely with VetCompass at the Royal Veterinary College. VetCompass is a broad welfare research programme that collects anonymised clinical information from more than 1800 UK veterinary practices and includes over 7.5 million dogs. VetCompass research can be used to identify common breed-specific conditions, or condition-specific concerns which affect a range of breeds. Whilst no breed specific VetCompass paper has yet been published for the Weimaraner, the Weimaraner is included in the condition-specific studies detailed below:

#### Dermatological conditions

*Lipomas*: Lipomas are relatively common benign masses consisting of fat cells, also known as adipocytes. They can grow to a variation of sizes, usually in the subcutaneous layer of tissue. Pegram et al (2020) reported that certain breeds, including the Weimaraner, were associated with increased odds of developing a lipoma.

A VetCompass study of 384,284 dogs under veterinary care at 215 primary practice clinics in the UK during 2013, identified 2,765 lipoma cases giving an overall prevalence during this year of 1.94% (95% C.I. 1.87% - 2.01%). The Weimaraner had a breed-specific prevalence for lipomas of 7.84% (95% C.I. 6.46% - 9.40%) and an odds ratio of 3.16 (95% C.I. 2.26 - 4.42,  $P < 0.001$ ) compared with crossbred dogs (O'Neill et al, 2018).

#### Neurological conditions

*Seizure*: A VetCompass study of 455,553 dogs attending primary care practices in the UK during 2013, found that the prevalence of Weimaraners having at least one seizure during this one-year period was 1.15% (18 cases, 95% C.I. 0.62% - 1.68%),

compared to the overall prevalence of 0.82% across all breeds (3,731 cases, 95% CI 0.79% - 0.84%) (Erlen et al, 2018).

### Urinary conditions

*Urinary incontinence:* Urinary incontinence is defined as the involuntary leakage of urine. Early studies have reported the Weimaraner as predisposed to urinary incontinence (Holt and Thrusfield, 1993). VetCompass researchers found the Weimaraner had increased odds of urinary incontinence compared with non-designer crossbreeds (OR 5.83; 95% C.I. 1.25 - 27.28) and identified increased odds of urinary incontinence diagnosis in heavier and older bitches (Pegram et al, 2019a).

A more recent Vetcompass study evaluated the hazard of urinary incontinence and association with neutering across breeds. Consistent with other studies, the findings showed that Weimaraner bitches had an increased hazard of early-onset urinary incontinence from both the date of birth (HR 2.66; 95% CI 1.22 to 5.81; P=0.014) and the date of neuter (HR 3.07; 95% C.I. 1.40 - 6.75, P=0.005) compared to non-designer crossbreeds (Pegram et al, 2019b).

### INSURANCE DATA

There are some important limitations to consider for insurance data:

- Accuracy of diagnosis varies between disorders depending on the ease of clinical diagnosis, clinical acumen of the veterinarian and facilities available at the veterinary practice
- Younger animals tend to be overrepresented in the insured population
- Only clinical events that are not excluded and where the cost exceeds the deductible excess are included

However, insurance databases are too useful a resource to ignore as they fill certain gaps left by other types of research; in particular they can highlight common, expensive and severe conditions, especially in breeds of small population sizes, that may not be evident from teaching hospital caseloads.

#### Swedish Agria Data

Swedish morbidity insurance data were available from Agria for the Weimaraner. Reported rates are based on dog-years-at-risk (DYAR) which take into account the actual time each dog was insured during the period (2011-2016), for example one whole year of insurance is equivalent to one DYAR. The number of DYAR for the Weimaraner in Sweden during this period was 1,000 < 2,500.

A summary is given below, with the full report available from: [www.dogwellnet.com](http://www.dogwellnet.com)

The most common specific causes of veterinary care episodes (VCEs) for Agria-insured Weimaraners in Sweden between 2011 and 2016 are shown in Figure 4. The top five specific causes of VCEs were skin trauma, vomiting/ diarrhoea/ gastroenteritis, pyometra/ endometritis, skin tumours, and teeth.

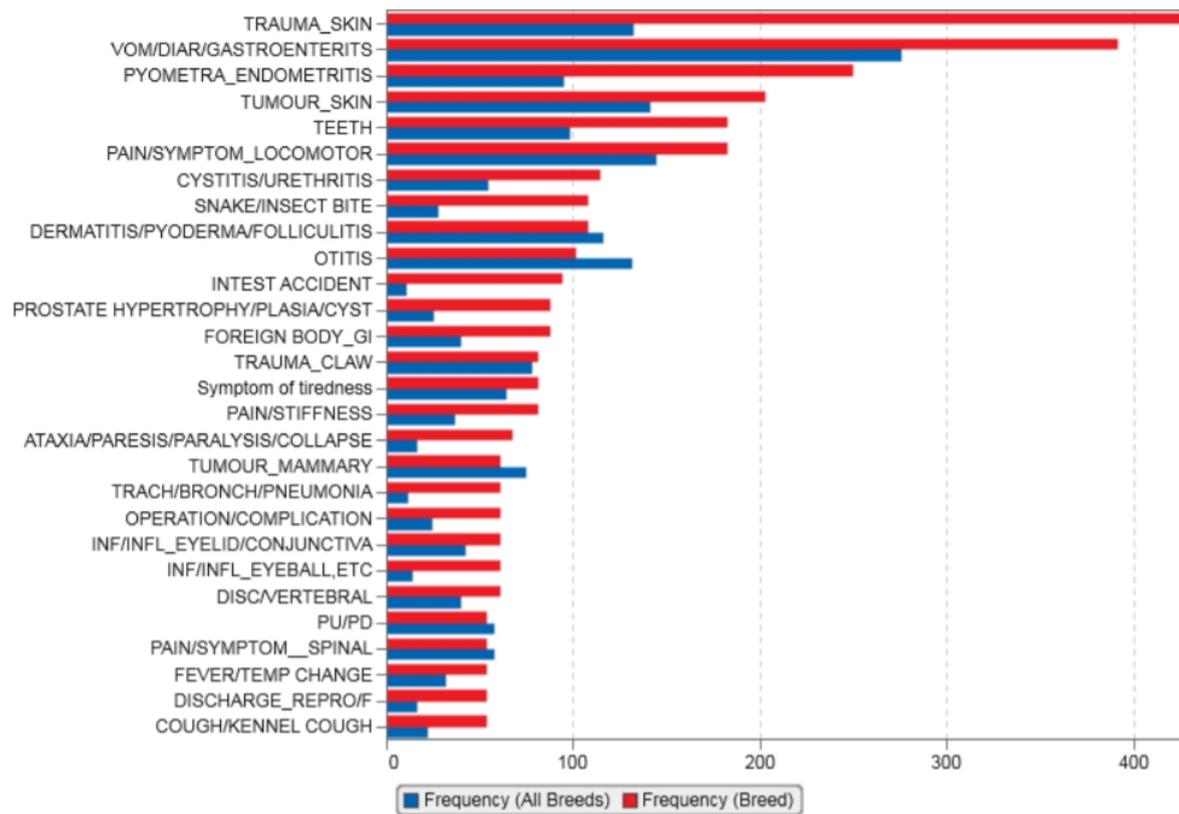


Figure 4: The most common specific causes of VCEs for the Weimaraners compared to all breeds in Sweden between 2011 and 2016, from Swedish Agria insurance data.

The specific causes of VCEs ordered by relative risk for the Weimaraner are shown in Figure 5. In this analysis, the top five specific causes of VCEs ordered by relative risk were intestinal accident, tracheitis/ bronchitis/ pneumonia, infection/ inflammation of the eyeball, ataxia/ paresis/ paralysis/ collapse, and snake/ insect bite.

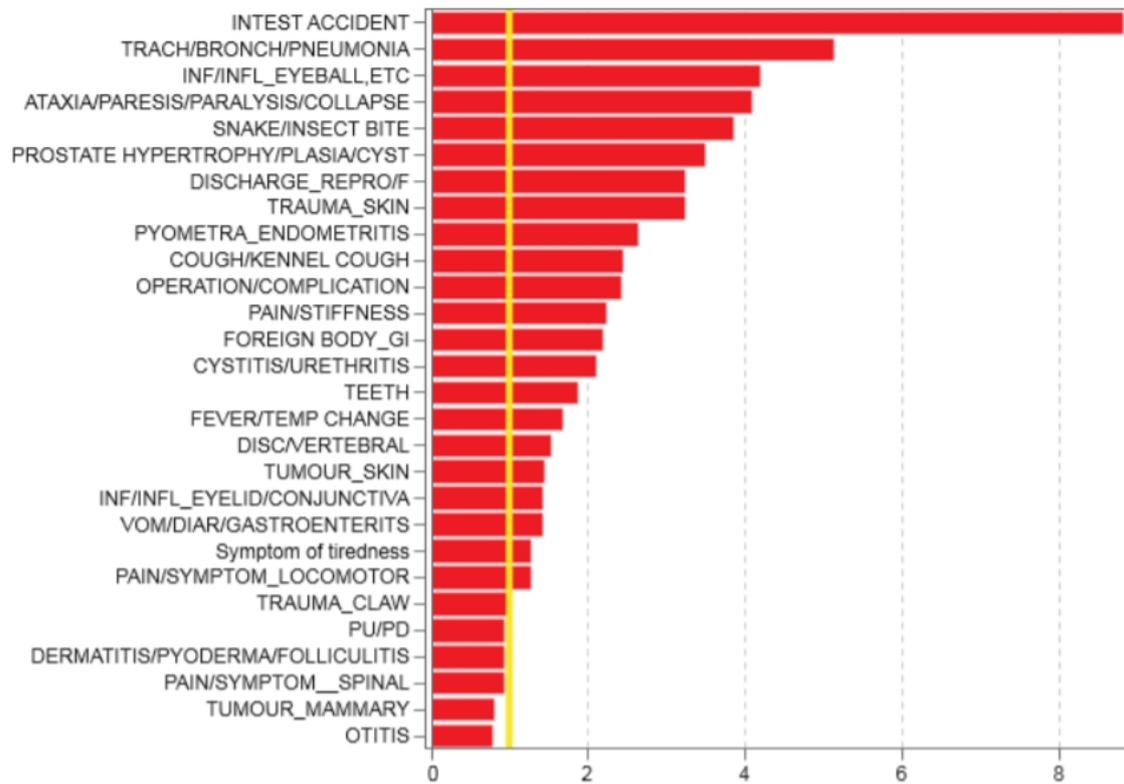


Figure 5: The specific causes of VCEs for the Weimaraner ordered by relative risk compared to all breeds in Sweden 2011 - 2016, from Swedish Agria insurance data.

Further analysis of locomotor disorders found the Weimaraner to be at an increased relative risk of unspecified skeletal and spinal locomotor problems (Figure 6).

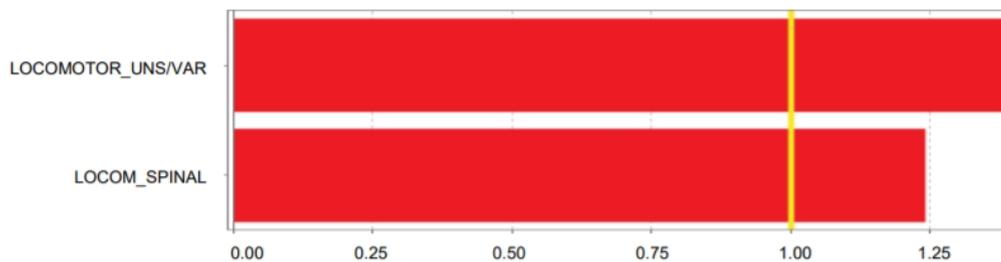


Figure 6: Relative risk morbidity for locomotor disorders in the Weimaraner in Sweden between 2011 - 2016, from Swedish Agria insurance data.

### BREED WATCH

The Weimaraner is a category one breed, meaning judges are not required to complete mandatory monitoring forms following an appointment as championship certificate level. To date no optional reports have been received for the breed.

## PERMISSION TO SHOW

As of the 1<sup>st</sup> January 2020 exhibits for which permission to show (PTS) following surgical intervention has been requested will no longer be published in the Breed Record Supplement and instead will be detailed in BHCPs, and a yearly report will be collated for the BHC. To date (Feb 2021), 83 PTS have been granted for the Weimaraner (not including neutering or caesarean sections), with seventy nine being for the 'legal docking of a working dog's tail', two for 'tail amputation due to trauma', one for the 'removal of tumours', and one for the 'removal of a tooth/ teeth',

## ASSURED BREEDER SCHEME

Currently within the Kennel Club (KC)'s Assured Breeder Scheme there are the following requirements for the Weimaraner:

- Hip scoring under the BVA/KC Hip Dysplasia Scheme

There are the following recommendations for the breed:

- Bitches under two years not to produce a litter
- Bitches not to produce more than one litter within a 12-month period

## BREED CLUB BREEDING RECOMMENDATIONS

The Kennel Club include a breed club breeding recommendation which is detailed under the Assured Breeder Scheme sub-heading above.

## DNA TEST RESULTS

There are currently no recognised DNA tests for the Weimaraner.

Whilst DNA tests may be available for the breed, results from these will not be accepted by the Kennel Club until the test has been formally recognised, the process of which involves collaboration between the breed clubs and the Kennel Club in order to validate the test's accuracy.

## CANINE HEALTH SCHEMES

All of the British Veterinary Association (BVA)/Kennel Club (KC) Canine Health Schemes are open to dogs of any breed with a summary given of dogs tested to date below.

## HIPS

To date (Feb 2021), 1,947 Weimaraners have been hip scored under the BVA/KC Hip Dysplasia Scheme since 2000, with a median hip score of 10 (range 0 - 69). Figure 7 shows the mean hip score per year between 2000 and 2019 for the Weimaraner per year of birth.

The trend shows an overall decline in mean hip score over this period, indicating an improvement in hip health. It is worth noting that scores for later years will reflect younger dogs and therefore these will have had fewer years for disease to manifest and a generally lower mean score.

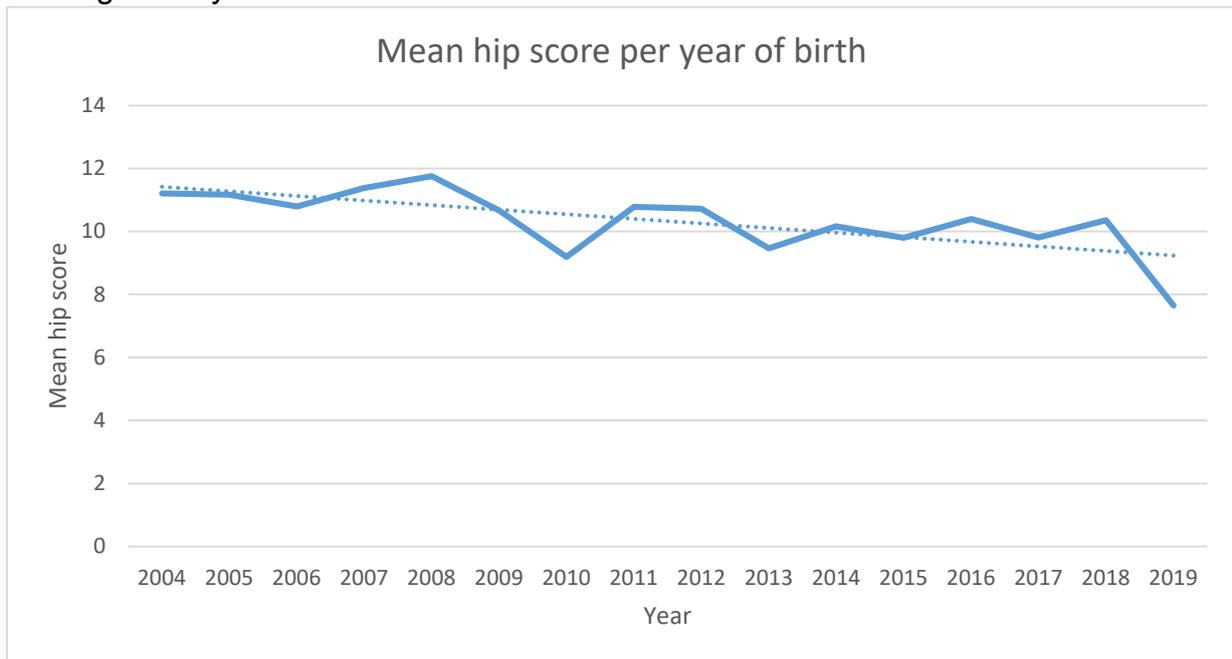


Figure 7: Mean hip score per year for the Weimaraner per year of birth between 2000 and 2019.

The proportion of dogs scored per year are also shown in Figure 8 below, with this having risen to a peak in 2011, and since declined, with this most notable as of 2018.

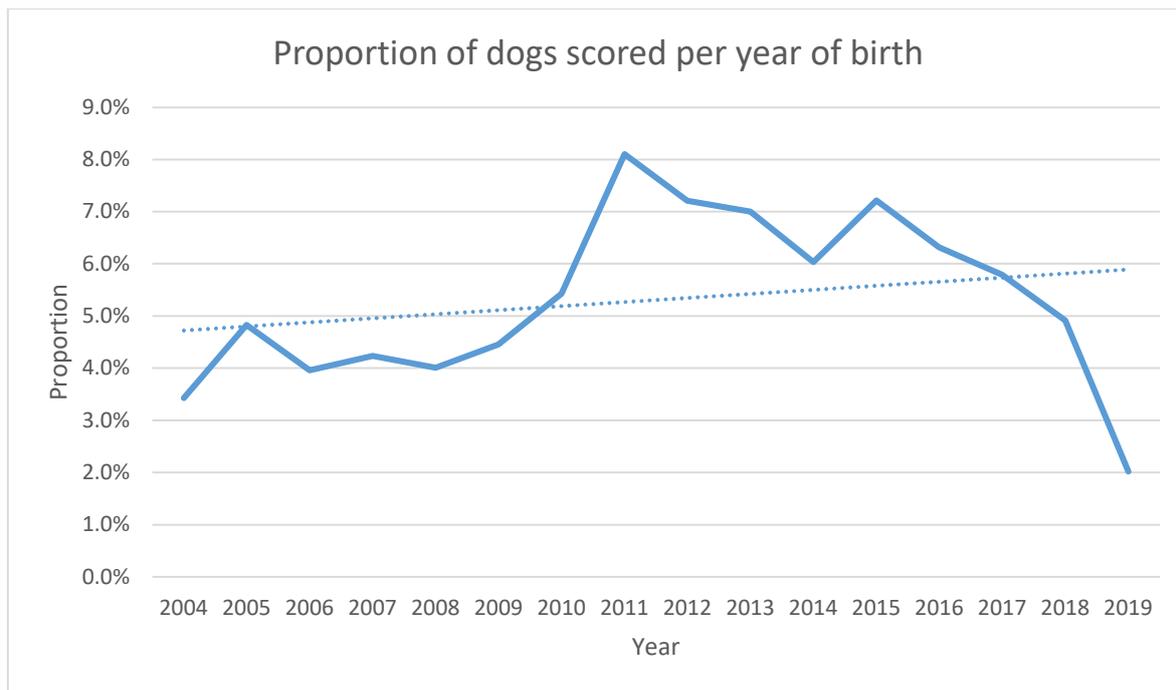


Figure 8: Proportion of hip scores received per year of birth for the Weimaraner between 2000 and 2019.

### ELBOWS

To date (Feb 2021), 37 Weimaraner have been elbow graded under the BVA/KC Elbow Dysplasia Scheme since 2000. One dog received a grade 1 in 2012, one dog received a grade 2 in 2019 and the rest received grade 0.

### EYES

The breed is not currently on the BVA/KC/ISDS Known Inherited Ocular Disease (KIOD) list (formally Schedule A) for any condition under the BVA/KC/International Sheep Dog Society (ISDS) Eye Scheme.

KIOD 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 has been replaced with the sightings report which lists those breeds in which the conditions are, at this stage, only suspected of being inherited (Table 1).

Table 1: Reports on Weimaraner which have participated in the BVA/KC/ISDS Eye Scheme since 2012.

| Year | Number Tested          | Comments   |
|------|------------------------|--|
| 2012 | 6 adults               | 1 – distichiasis   |
| 2013 | 8 adults               | 3 – distichiasis<br>1 – other cataract<br>1 – multifocal retinal dysplasia (MRD) |
| 2014 | 7 adults               | 1 – distichiasis<br>1 – persistent hyperplastic primary vitreous (PHPV)          |
| 2015 | 5 adults               | 2 – distichiasis   |
| 2016 | 1 adult                | No comments  |
| 2017 | 4 adults               | No comments  |
| 2018 | No adults              | No comments  |
| 2019 | <i>Awaiting report</i> |  |

### AMERICAN COLLEGE OF VETERINARY OPHTHALMOLOGISTS (ACVO)

Results of examinations through ACVO are shown in Table 2 below. Between 2015 and 2019, 548 Weimaraner were examined, of which 56.8% (311 of 548 dogs) were found to be unaffected by any eye condition.

Whilst it is important to note that these data represent dogs in America, the organisation tend to examine a higher number of dogs than that in the UK, and therefore are a valuable source of information.

Table 2: ACVO examination results for Weimaraner, 1991 – 2019.

| Disease Category/Name  | Percentage of Dogs Affected |                      |
|--|-----------------------------|----------------------|
|  | 1991-2014<br>(n=1,550)      | 2015-2019<br>(n=548) |
| <b>Eyelids</b>   |                             |                      |
| Distichiasis   | 29.6%                       | 27.6%                |
| <b>Cornea</b>  |                             |                      |
| Corneal dystrophy  | 1.8%                        | 1.5%                 |
| <b>Uvea</b>  |                             |                      |
| Persistent pupillary membranes (lens pigments foci/no strands) | 0.0%                        | 1.3%                 |
| <b>Lens</b>  |                             |                      |
| Cataract (suspect not inherited/significant unknown)           | 5.7%                        | 6.6%                 |
| Significant cataracts (summary)                                | 6.9%                        | 9.5%                 |

Adapted from: <https://www.ofa.org/diseases/eye-certification/blue-book>

## 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.
- These data do not indicate whether the caesarean sections were emergency or elective.
- In all breeds, there was an increase in the number of caesarean sections reported from 2012 onwards, as the Kennel Club publicised the procedure to vets.

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 3.

Table 3: Number of Weimaraner litters registered per year, and number and percentage of caesarean sections reported per year, 2009 to 2019.

| Year | Number of Litters Registered | Number of C-sections | Percentage of C-sections | <i>Percentage of C-sections out of all KC registered litters (all breeds)</i> |
|------|------------------------------|----------------------|--------------------------|---|
| 2009 | 302                          | 0                    | 0.00%                    | 0.15%   |
| 2010 | 286                          | 1                    | 0.35%                    | 0.35%   |
| 2011 | 239                          | 4                    | 1.67%                    | 1.64%   |
| 2012 | 200                          | 12                   | 6.00%                    | 8.69%   |
| 2013 | 186                          | 8                    | 4.30%                    | 9.96%   |
| 2014 | 189                          | 10                   | 5.29%                    | 10.63%  |
| 2015 | 180                          | 12                   | 6.67%                    | 11.68%  |
| 2016 | 173                          | 9                    | 5.20%                    | 13.89%  |
| 2017 | 168                          | 12                   | 7.14%                    | 15.00%  |
| 2018 | 188                          | 11                   | 5.85%                    | 17.21%  |
| 2019 | 170                          | 12                   | 7.06%                    | 15.70%  |

## 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 2020, an estimated effective population size of **102.5** was reported (estimated using the rate of inbreeding over the period 1980-2019).

Below an effective population size of 100 (inbreeding rate of 0.50% per generation) the rate of loss of genetic diversity in a breed/population increases dramatically (Food & Agriculture Organisation of the United Nations, "Monitoring animal genetic resources and criteria for prioritization of breeds", 1992).

Annual mean observed inbreeding coefficient (showing loss of genetic diversity) and mean expected inbreeding coefficient (from simulated 'random mating') over the period 1980-2019 are shown in Figure 9. The observed inbreeding has steadily increased between 1980 and 2005, however the trend levels and then decreases from 2005, implying a maintenance of genetic diversity during this time. The blurring of the expected inbreeding is due to a limited amount of information, with the true value expected to be within this range.

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>.

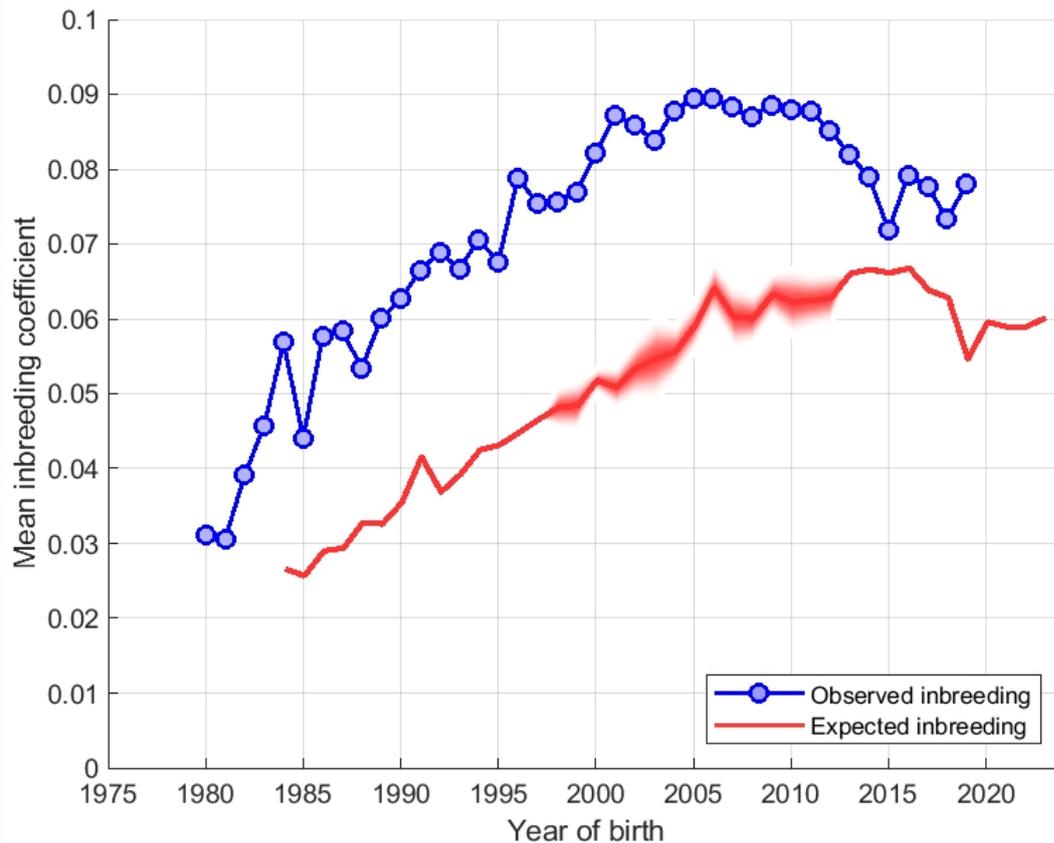


Figure 9: Annual mean observed and expected inbreeding coefficients.

The current breed average inbreeding coefficient for the Weimaraner is **7.8%**.

Below is a histogram ('tally' distribution) of number of progeny per sire and dam over each of eight 5-year blocks (Figure 10). 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 have been an increasing use of several popular sires in the past 15 years, with one sire responsible for almost 4% of progeny registered between 2015 and 19. Continued use of such sires, and their immediate family, can result in rapid loss of genetic health.

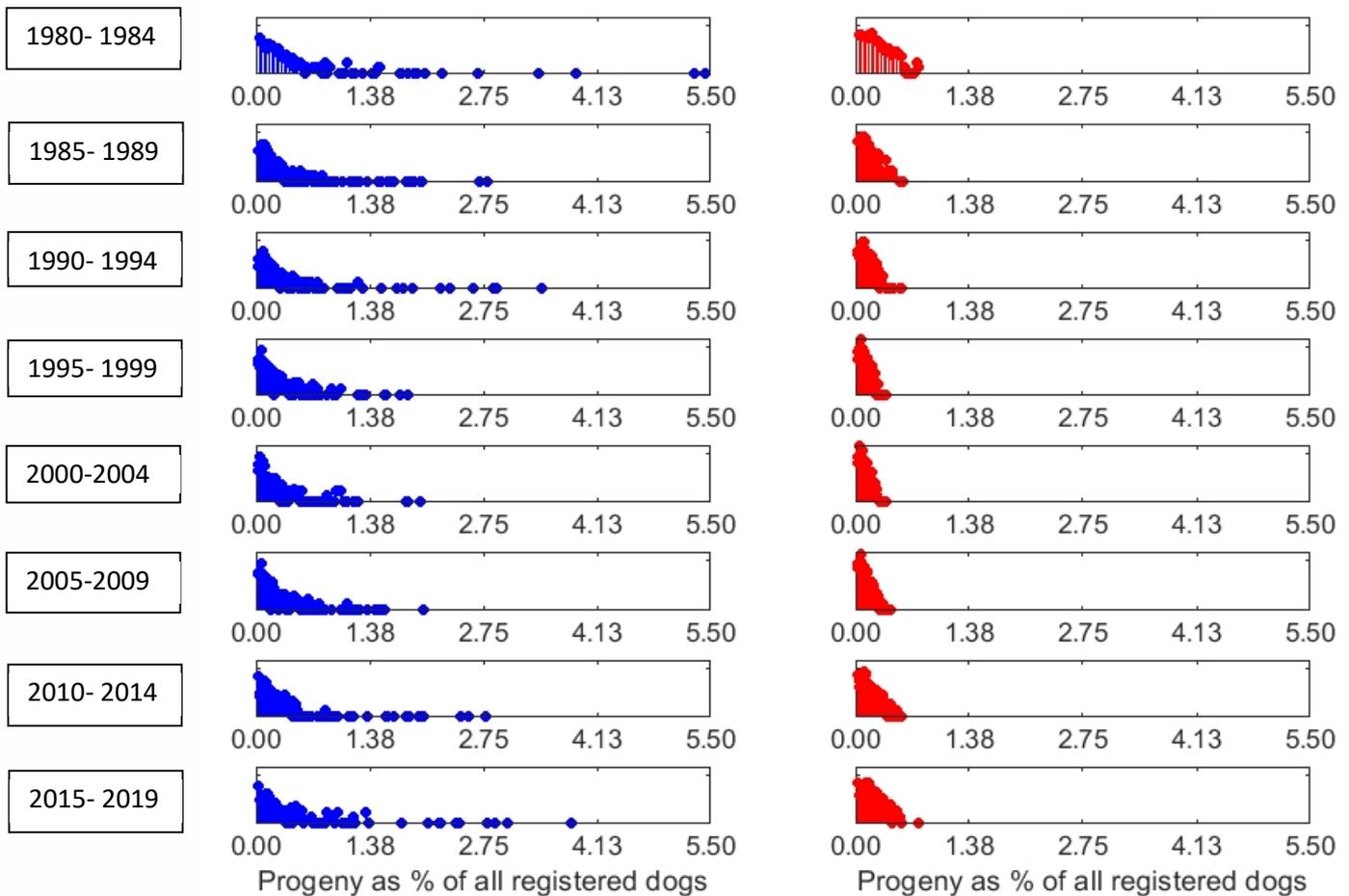


Figure 10: Distribution of the number of progeny per sire (blue) and per dam (red) over 5-year blocks (1980-4 top, 2015-19 bottom). Vertical axis is a logarithmic scale.

## CURRENT RESEARCH

The Neurology and Neurosurgery department of the Small Animal Hospital at the University of Glasgow have developed an ongoing survey to collect information about a recently identified movement disorder, which affects the Weimaraner. This research aims to identify Weimaraners affected by the disorder and gather information about the clinical signs. Pedigree information from the affected dogs will allow the researchers to determine whether there is an underlying genetic cause and thereby enable them to potentially identify the gene(s) responsible for the disorder so that a genetic test can be developed to eradicate it from the breed.

If you currently own or have previously owned a Weimaraner, who presented signs of episodic muscle stiffness/ weakness/ collapse triggered by exercise or excitement, please spend a few minutes to complete the following survey:

<https://www.surveymonkey.com/r/Weimaraner>

The breed have also contributed samples to the AHT for their continued research, which aims to investigate the potential genetic predisposition of mast cell tumours in the Weimaraner. It is hoped that this work will be continued at the University of Cambridge following the trust's closure.

## **PRIORITIES**

Correspondence between the breed representatives and the Kennel Club was undertaken in March 2021 to discuss the evidence base of the BHCP and agree the priority issues for the health of the breed. The group agreed from the evidence base that the priorities for the Weimaraner were:

- Mast cell tumour
- Gastric dilatation and volvulus (GDV)/ bloat

DRAFT

## ACTION PLAN

Following the correspondence between the Kennel Club and the breed regarding the evidence base of the Breed Health & Conservation Plans, the following actions were agreed to improve the health of the Weimaraner. Both partners are expected to begin to action these points prior to the next review.

### **Breed Club actions include:**

- The Breed Clubs to continue to encourage hip scoring for all breeding stock
- The Breed Clubs to continue reporting and monitoring health conditions in the breed
- The Breed Clubs to continue research with the University of Glasgow to collect information about movement disorders in the breed and report back any findings to the Kennel Club
- The Breed Clubs to monitor the use of popular sires and raise awareness of the importance of considering genetic diversity when breeding

### **Kennel Club actions include:**

- The Kennel Club to investigate whether the breed can be included in the ongoing GDV/ bloat research at the University of Nottingham
- The Kennel Club to hold heart testing days and invite breeders of the breed to help in the collation of heart data
- The Kennel Club to monitor research possibilities for MCTs and keep the breed updated as to any opportunities for participation

## REFERENCES

- Abeles, V., Harrus, S., Angles, J.M., Shalev, G., Aizenberg, I., Peres, Y., Aroch, I. (1999) Hypertrophic osteodystrophy in six Weimaraner puppies associated with systemic signs. *Veterinary Record* **145(5)**: 130-134 doi: 10.1136/vr.145.5.130.
- Couto, C.G., Krakowka, S., Johnson, G., Ciekot, P., Hill, R., Lafrado, L., Kociba, G. (1989) In vitro immunologic features of Weimaraner dogs with neutrophil abnormalities and recurrent infections. *Veterinary Immunology and Immunopathology* **23(1-2)**: 103-112
- Crumlish, P.T., Sweeney, T., Jones, B., Angles, J.M. (2006) Hypertrophic osteodystrophy in the Weimaraner dog: lack of association between DQA1 alleles of the canine MHC and hypertrophic osteodystrophy. *The Veterinary Journal* **171**: 308-313
- Dobson, J.M. (2013) Breed-Predispositions to Cancer in Pedigree Dogs. *ISRN Veterinary Science* **2013**: <https://doi.org/10.1155/2013/941275>
- Draper, D.D., Kluge, J.P., Millerw, J. (1976) Clinical and pathological aspects of spinal dysraphism in dogs. *Thessaloniki* **1**: 134-137
- Engel, H.N., Draper, D.D. (1982) Comparative prenatal development of the spinal cord in normal and dysraphic dogs: embryonic stage. *Journal of American Veterinary Research* **43(10)**: 1729-1734
- Erlen, A., Potschka, H., Volk, H.A., Sauter-Louis, C., O'Neill, D.G. (2018) Seizure occurrence in dogs under primary veterinary care in the UK: prevalence and risk factors. *Journal of Veterinary Internal Medicine* **32(5)**: 1665– 1676
- Glickman, L.T., Glickman, N.W., Pérez, C.M., Schellenberg, D.B., Lantz, G.C. (1994) Analysis of risk factors for gastric dilatation and dilatation-volvulus in dogs. *Journal of the American Veterinary Medical Association* **204(9)**: 1465-1471
- Glickman, L.T., Glickman, N.W., Schellenberg, D.B., Raghavan, M., Lee, T.L. (2000a) Incidence of breed-related risk factors for gastric dilatation-volvulus in dogs. *Journal of the American Veterinary Medical Association* **216(1)**: 40-45
- Glickman, L.T., Glickman, N.W., Schellenberg, D.B., Raghavan, M., Lee, T.L. (2000b) Non-dietary risk factors for gastric dilatation-volvulus in large and giant breed dogs. *Journal of the American Veterinary Medical Association* **217(10)**: 1492-1499
- Hansen, O., Clercx, C., Henroteaux, M., Rutten, V.P.M.G., Bernadina, W.E. (1995) Neutrophil phagocyte dysfunction in a Weimaraner with recurrent infections. *Journal of Small Animal Practice* **36(3)**: 128-131
- Holt P.E. and Thrusfield M.V. (1993) Association in bitches between breed, size, neutering and docking, and acquired urinary incontinence due to incompetence of the urethral sphincter mechanism. *Vet Record*. **133(8)**: 177-80

- Kornegay, J.N., Goodwin, M.A., Spyridakis, L.K. (1987) Hypomyelination in Weimaraner dogs. *Acta Neuropathologie* **72(4)**: 394-491 doi: 10.1007/BF00687272.
- Kropatsch, R., Akkad, D.A., Frank, M., Rosenhagen, C., Altmüller, J., Nürnberg, P., Epplen, J.T., Dekomien, G. (2016) A large deletion in *RPGR* causes XLPRA in Weimaraner dogs. *Canine Genetics and Epidemiology* **3**: 7 DOI 10.1186/s40575-016-0037-x
- Millan, Y., Mascort, J., Blanco, A., Costa, C., Masian, D., Guil-Luna, S., Pumarola, M., De Las Mulas, J.M. (2010) Hypomyelination in three Weimaraner dogs. *Journal of Small Animal Practice* **51**: 594-598 DOI: 10.1111/j.1748-5827.2010.00997.x
- O'Neill, D.G., Case, J., Boag, A.K., Church, D.B., McGreevy, P.D., Thomson, P.C. and Brodbelt, D.C. (2017) Gastric dilation-volvulus in dogs attending UK emergency-care veterinary practices: prevalence, risk factors and survival. *Journal of Small Animal Practice* **58** (11):629-638
- O'Neill, D.G., Corah, C.H., Church, D.B., Brodbelt, D.C., Rutherford, L. (2018) Lipoma in dogs under primary veterinary care in the UK: prevalence and breed associations. *Canine Genetics and Epidemiology* **5(9)**: <https://doi.org/10.1186/s40575-018-0065-9>
- Pegram, C., O'Neill, D.G., Church, D.B., Hall, J., Owen, L., Brodbelt, D.C. (2019a) Spaying and urinary incontinence in bitches under UK primary veterinary care: a case-control study. *Journal of Small Animal Practice*. **60(7)**: 395-403
- Pegram, C., Brodbelt, D.C., Church, D.B., Hall, J., Owen, L., Chang, Y.M., O'Neill, D.G. (2019b) Associations between neutering and early-onset urinary incontinence in UK bitches under primary veterinary care. *Journal of Small Animal Practice*. **60(12)**; 723-733
- Pegram, C.L., Rutherford, L., Corah, C., Church, D.B., Brodbelt, D.C., O'Neill, D.G. (2020). Clinical management of lipomas in dogs under primary care in the UK. *The Veterinary record* **187(10)**
- Pemberton, T.J., Choi, S., Mayer, J.A., Li, F-Y., Gokey, N., Svaren, J., Safra, N., Bannasch, D.L., Sullivan, K., Breuhaus, B., Patel, P.I., Duncan, I.D. (2014) A mutation in the canine gene encoding folliculin-interacting protein 2 (FNIP2) associated with a unique disruption in spinal cord myelination. *Glia* **62(1)**: 39-51
- Piras, I.S.; Perdigones, N.; Zismann, V.; Briones, N.; Facista, S.; Rivera, J.L.; Rozanski, E.; London, C.A.; Hendricks, W.P.D. (2020) Identification of Genetic Susceptibility Factors Associated with Canine Gastric Dilatation-Volvulus. *Genes* **11(11)**
- Rose, J.H., Kwiatkowska, M., Henderson, E.R., Granger, N., Murray, J.K., Harcourt-Brown, T.R. (2014) The impact of demographic, social, and environmental factors on the development of steroid-responsive meningitis-arteritis (SRMA) in the United Kingdom. *Journal of Veterinary Internal Medicine* **28**: 1199-1202
- Safra, N., Bassuk, A.G., Ferguson, P.J., Aguillar, M., Coulson, R.L., Thomas, N., Hitchens, P.L., Dickinson, P.J., Vernau, K.M., Wolf, Z.T., Bannasch, D.L. (2013)

Gemone-wide association mapping in dogs enables identification of the homebox gene, *NKX2-8*, as a genetic component of neural tube defects in humans. *PLoSone* **9(7)** e1003646

Safra, N., Hitchens, P.L., Maverakis, E., Mitra, A., Korff, C., Johnson, E., Kol, A., Bannasch, M.J., Pederson, N.C., Bannasch, D.L. (2016) Serum levels of innate immunity cytokines are elevated in dogs with metaphyseal osteopathy (hypertrophic osteodystrophy) during active disease and remission. *Veterinary Immunology and Immunopathology* **179**: 32-35

Safra, N., Johnson, E.G., Lit, L., Foreman, O., Wolf, Z.T., Aguilar, M., Karmi, N., Finno, C.J., Bannasch, D.L. (2014) Clinical manifestations, response to treatment, and clinical outcome for Weimaraners with hypertrophic osteodystrophy: 53 cases (2009-2011). *Journal of the American Veterinary Medical Association*. **242(9)**:1260-1266

Shoop, S.J., Marlow, S., Church, D.B., English, K., McGreevy, P.D., Stell, A.J., Thomson, P.C., O'Neill, D.G., Brodbelt, D.C. (2015) Prevalence and risk factors for mast cell tumours in dogs in England. *Canine Genetics and Epidemiology* **2(1)**: <https://doi.org/10.1186/2052-6687-2-1>

Ward, P.M., Patronek, G.J., Glickman, L.T. (2003) Benefits of prophylactic gastropexy for dogs at risk of gastric dilatation-volvulus. *Preventative Veterinary Medicine* **60**: 319-329

Woodard, J.C. (1982) Canine hypertrophic osteodystrophy, a study of the spontaneous disease in littermates. *Veterinary Pathology* **19(4)**: 337-354