THE KENNEL CLUB
DOG HEALTH

Breed Health and Conservation Plan

Dachshund (Miniature Smooth Haired)

BHCP/Version 1/June 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

The Miniature Smooth Haired Dachshund is currently a category two breed which indicates that it has one or more Breed Watch points of concern. The particular point of concern listed for the breed in Breed Watch is:

- Body weight/condition

Demographics

The numbers of new registrations of the breed per year are shown in Table 1, and have increased steadily and markedly over this time.

Table 1: Number of Miniature Smooth Haired Dachshunds registered per year between 2007 and 2017

Year	Number of new registrations	Percentage of breed out of total annual registrations
2007	2112	0.78%
2008	2566	0.94%
2009	2511	1.03%
2010	2802	1.09%
2011	2857	1.17%
2012	2854	1.25%
2013	2871	1.28%
2014	3129	1.41%
2015	3450	1.57%
2016	4576	2.01%
2017	5747	2.36%

The numbers of Miniature Smooth Haired Dachshunds 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 +64.96 per year (with a 95% confidence interval of +52.50 to +77.41), reflecting the 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.]

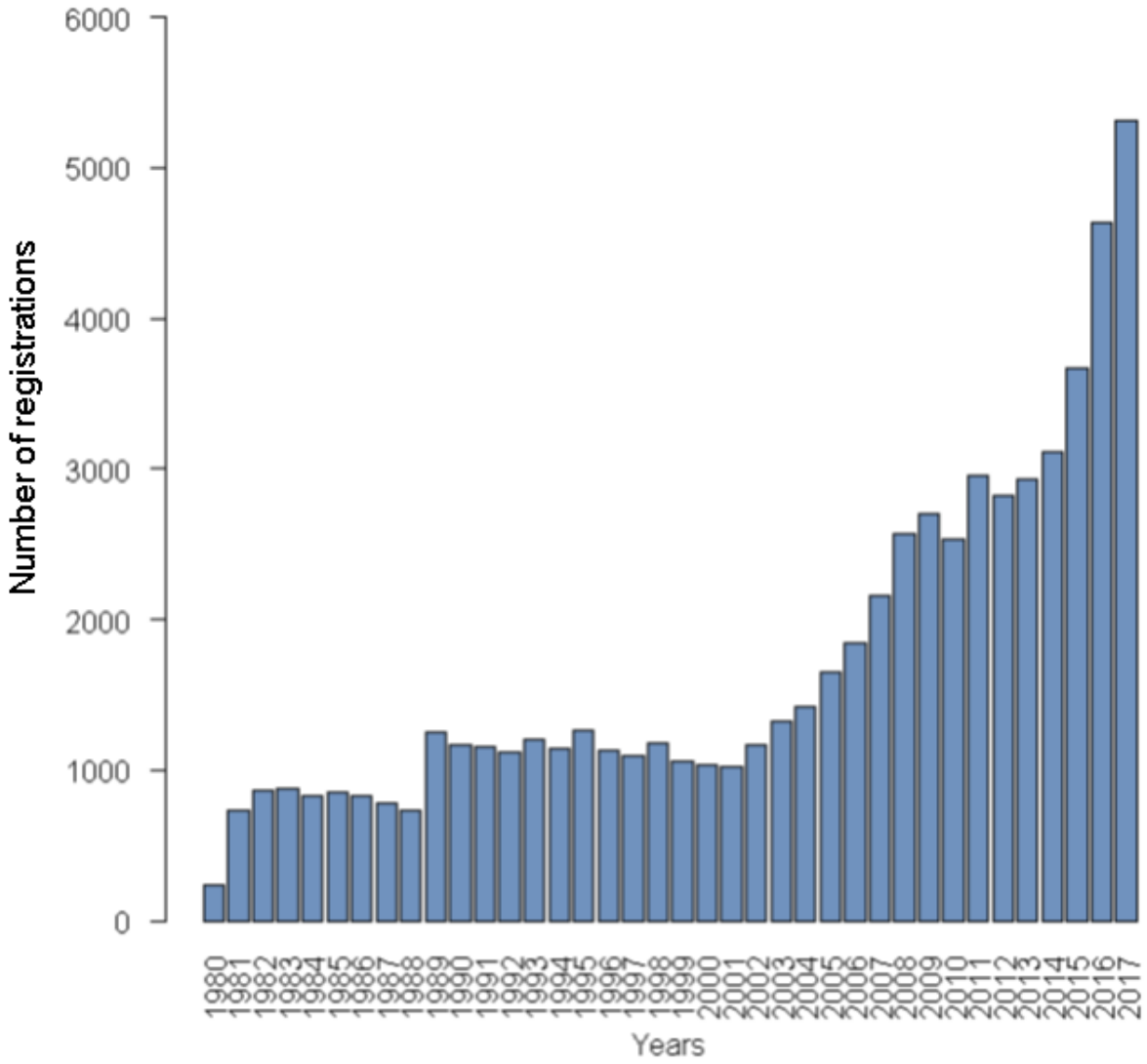

Figure 1: Number of registrations of Miniature Smooth Haired Dachshunds per year of birth, 1980 – 2017

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

Mitral valve disease (MVD): The Dachshund has been described as predisposed to mitral regurgitation due to myxomatous mitral valve disease. Mitral valve prolapse, diagnosed by echocardiography, is an important prognostic factor for the development of mitral regurgitation. A Danish study of 190 Dachshunds involved clinical examination, echocardiography; although 71% (135 dogs) of study participants had no mitral murmur, 86% of the Dachshunds in the study were found to have some degree of mitral valve prolapse (Olsen et al, 1999). The coat type of the dogs appeared to be correlated with the presence and severity of mitral valve prolapse; Long Haired Dachshunds were more affected than Smooth Haired Dachshunds, which in turn appeared to be more affected than Wire Haired Dachshunds. Standard and Miniature Dachshunds of all coat types were represented, except there were no Miniature Smooth Haired individuals. The study authors noted that they were aware of another study which had found that Wire Haired and Smooth Haired Dachshunds were more likely to have mitral murmurs than Long Haired Dachshunds, suggesting that there may be geographic differences in coat type associations. Mitral valve prolapse appears to be inherited, and the mode of inheritance seems to be polygenic (Olsen et al, 1999).

A subsequent French study of six small breed dogs (excluding the Cavalier King Charles Spaniel, which is considered to be the most predisposed breed to MVD) included dogs which attended the National Veterinary School of Alfort and two veterinary hospitals in Paris between September 1991 and June 2004. Dogs which were attending for a specialised cardiology consultation were excluded. In total 942 dogs were included in the study, of which 162 were Dachshunds. The prevalence of left systolic apical murmurs, the first clinical sign of MVD, was 14.4% (±2.2 95% C.I.s) across all six breeds; for the Dachshund the prevalence was 22.2%±6.4, ranking the breed second out of the six breeds (Serfass et al, 2006). Size and coat type was not specified.

Dermatological conditions

Atopic dermatitis (atopy): An Italian reference to Dachshunds being at increased risk of atopy has been reported (Gough, Thomas and O'Neill, 2018); however, no primary references or UK prevalence estimates could be found in the literature.

Colour dilution alopecia: Seven unrelated Dachshunds in Belgium were reported to have been affected with this late onset inherited alopecia, and pedigree analysis suggested the condition had an autosomal recessive mode of inheritance (Beco et al, 1996). The condition has subsequently been reported in two blue Dachshunds in Korea (Kim et al, 2005).

Sterile nodular panniculitis: A Japanese retrospective case series reported Miniature Dachshunds to be predisposed to this skin condition, involving nodular inflammation of the subcutaneous fat. Forty three cases of the condition treated in veterinary clinics in or near Tokyo between 2001 and 2006 were analysed, and Miniature Dachshunds represented 51.2% of cases (22 of 43) but only 10.3% of the general canine hospital population, suggesting that they were at increased risk compared to dogs of other breeds (Yamagishi et al, 2007).

Endocrine conditions

Diabetes mellitus: Dachshunds have been reported to be at increased risk of diabetes mellitus (Gough, Thomas and O'Neill, 2018), but no prevalence estimates could be found in the literature. Dachshunds were reported to be more likely to develop anti-insulin antibodies than crossbreeds in a study of blood samples collected in the UK between 2002 and 2010 from 942 cases (including 14 Dachshunds) and 100 controls (Holder et al, 2015). Development of anti-insulin antibodies can lead to higher doses of insulin being needed to control blood glucose levels.

Hyperadrenocorticism (Cushing's syndrome): This condition involves excessive production of cortisol by the adrenal glands and in dogs is most commonly caused by a benign tumour of the pituitary gland. In a study of 157 dogs with this pituitary-dependent hyperadrenocorticism examined at the University of California Davis Veterinary Medical Teaching Hospital between 1st December 1989 and 18th August 2005, Dachshunds were one of nine breeds described as being 'commonly affected' (Wood et al, 2007). However the actual number of dogs of the breed represented, or seen for other conditions during this time period, was not given. No other references to this as a possible breed predisposition, nor prevalence estimates, could be found in the literature.

Hypothyroidism: Dachshunds have been reported to be at increased risk of hypothyroidism (Gough, Thomas and O'Neill, 2018); however, no primary references or prevalence estimates could be found to support this.

Gastrointestinal conditions

Bacterial cholecystitis and bactibilia: This condition involves bacterial infection of the gall bladder. Dachshunds were overrepresented in a retrospective American study of cases of the condition at the Oregon State University College of Veterinary Medicine from 1st January 2010 to 15th February 2014, with half of the ten cases seen occurring in Dachshunds, which the authors suggested could indicated a breed predisposition (Lawrence et al, 2015). Dachshunds and Dachshund crosses represented just 2.8% of all dogs visiting the hospital in the study period.

Colorectal polyps: Miniature Dachshunds were overrepresented in a study of dogs found to have colorectal polyps at the Veterinary Medical Center of the University of Tokyo between April 2006 and March 2009, representing 48% 1(6 of 33 cases) of cases while making up 14% of dogs (1126 of 7988) referred to the hospital over this time period (Ohmi et al, 2012). The odds ratio for the breed was 5.8 compared to dogs of other breeds, suggesting an increased risk. Polyps can be inflammatory, benign tumours or cancerous tumours. In a subsequent study of cases of polyps seen at the University of Tokyo or the Japan Small Animal Medical Center between 2008 and 2013, all 26 cases of inflammatory polyps, and 7 of the 18 cases of adenoma (benign tumour) occurred in Miniature Dachshunds (Uchida et al, 2016).

Pancreatitis: Dachshunds were reported to be at increased risk of acute pancreatitis in a study of 80 dogs diagnosed with the condition at the veterinary school hospital in Budapest between 2000 and 2003, representing 12.5% (10 dogs) of cases (Pápa et al, 2011). The odds ratio for Dachshunds was 3.19 (95% C.I. 1.64 – 6.19) compared to dogs of other breeds.

Sialocoele (salivary mucocoele): This is a cystic swelling of a salivary gland. Dachshunds were significantly overrepresented in a study of 60 cases of the condition seen at the Sydney University Veterinary Teaching Hospital (Bellenger and Simpson, 1992). No more recent studies or prevalence estimates could be found in the literature.

Haematological conditions

Haemophilia A (Factor VIII deficiency): This X-linked recessive coagulopathy (blood clotting disorder) has been reported in an American review to occur sporadically in the Miniature Dachshund, but no prevalence estimate was provided (Brooks, 1999).

Pyruvate kinase deficiency (PKD): This inherited deficiency causes congenital haemolytic anaemia and has been described in many breeds of dog including the Dachshund (Harvey, 2006). It has an autosomal recessive mode of inheritance and a DNA test for the mutation is available.

von Willebrand's disease (vWD): vWD is the most common heritable canine bleeding disorder. There are three types; type I vWD is characterised by a low concentration of structurally normal vW factor (vWf) and relatively mild clinical signs and this form has been reported in the Dachshund in an American review (Brooks, 1999).

Hepatic conditions

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

Immunological conditions

Immunoglobulin deficiency: Combined variable immunodeficiency, involving low levels of immunoglobulins A, G and M, has been described in Miniature Dachshunds in South Africa and may be inherited (Lobetti et al, 1996; Lobetti, 2000). Affected dogs usually present with pneumonia, caused by a protozoa (*Pneumocystis carinii*), and sometimes also skin disease with signs generally beginning before one year of age.

Musculoskeletal conditions

The Dachshund is a chondrodystrophic breed (Parker et al, 2009). This means that they have abnormal cartilage and bone growth resulting in characteristic disproportionate dwarfism. This is considered to be a breed characteristic in the Dachshund and a number of other breeds (including Basset Hounds and Corgis) rather than a disease condition.

Avascular necrosis of the femoral head (Legg-Calvé-Perthes disease): Dachshunds were reported to be at elevated risk of this condition with a breed-associated odds ratio compared to mixed breeds of 4.8 (with a 95% C.I. 2.0 – 11.2), based on dogs which had attended veterinary teaching hospitals in the USA between January 1986 and December 1995; however this result was only based on 8 cases and 30 non-cases in the breed (LaFond et al, 2002).

Osteogenesis imperfecta (OI): OI is a congenital, inherited disease involving defects of type I collagen, with affected individuals therefore having fragile, fracture-prone bones and other signs. It has been described in dogs as long ago as 1960, but was first documented in two litters of Wire Haired Dachshunds in Germany in 2003 (Seeliger et al, 2003). A causative missense mutation, c.977C>T,p.L326P, in the *SERPINH1* gene was identified, and a DNA test made available (Drögemüller et al, 2009). Subsequently, 1352 Dachshunds of all sizes and coat types from 12 different European countries were genotyped for the mutation; the overall frequency of carriers was 12.9%, while Wire Haired Dachshunds of both sizes were overrepresented with 17.3% carriers (Eckardt et al, 2013).

Pes varus: This condition, in which the outside part of the growth plate of the tibia closes later than the inner part leading to inward deviation of the tibia and a bow-legged appearance, has been described as affecting Dachshunds most commonly (Radasch et al, 2008). It is suggested that the condition may have an autosomal recessive mode of inheritance.

Other musculoskeletal conditions: Dachshunds were reported to be at increased risk of inguinal or scrotal herniation in an Australian veterinary hospital study, and olecranon fracture, patellar luxation and congenital tail anomalies in three old German case series (Gough, Thomas and O'Neill, 2018); however, the original references could not be accessed and no other reports or prevalence estimates could be found in the literature.

Neoplastic conditions

Cardiac haemangiosarcoma: Miniature Dachshunds were overrepresented in a Japanese retrospective case series of 51 dogs diagnosed with this primary malignant tumour of the heart between 2002 and 2011 at Tokyo University; 13 of 51 cases occurred in Miniature Dachshunds (Yamamoto et al, 2013).

Mammary neoplasia: A Czech retrospective case series of 185 dogs treated for mammary tumours at the Small Animal Clinic of the University of Brno between 1997 and 2001 found an increased risk in Dachshunds compared to all dogs; Dachshunds had an odds ratio of 1.6 compared to all dogs, with 43 cases in 2053 dogs of the breed (Zatloukal et al, 2005).

Squamous cell carcinoma of digit: An American retrospective case series of 64 dogs diagnosed with digital tumours at 9 veterinary institutions between January 1980 and December 2000 reported that Dachshunds were overrepresented with squamous cell carcinoma of the digit, accounting for three of 33 cases (Henry et al, 2005)

Other cancers: Dachshunds were reported to be at increased risk of mast cell tumours in a German case series, melanoma in a Brazilian and a Thai case series and oral fibrosarcoma in a Polish case series (Gough, Thomas and O'Neill, 2018); however, the original references could not be accessed and no other reports or prevalence estimates could be found in the literature.

Neurological conditions

Idiopathic epilepsy: An American study thirty years ago describing a possible familial form of idiopathic epilepsy in Dachshunds has been reported (Gough, Thomas and O'Neill, 2018); however, the original paper could not be accessed and no subsequent reports could be found in the literature.

Intervertebral disc disease (IVDD): Dachshunds have long been known to be predisposed to IVDD. A full review of the literature relating to IVDD in the breed is beyond the scope of this document; however, some key points and recent highlights are described here. A 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 Dachshund to be the most frequently affected breed with IVDD, with a breed-specific prevalence of 34.92% compared to a mixed breed-prevalence of 4.43% (Bellumori et al, 2013). An American study of 61 dogs of the breed found that Dachshunds with less than three calcified intervertebral discs at 24 months of age were less likely to develop, and had less severe, IVDD than dogs with several disc calcifications (Jensen et al, 2008).

In Finland, Denmark and Norway screening spinal radiography for intervertebral disc calcification (IDC) has been used for more than 15 years. A study of the 1553 Finnish Dachshunds which had been radiographically screened up to 1st May 2015 reported that the number of calcified discs was highest in the Miniature Smooth Haired and lowest in the Miniature Long Haired and standard Long Haired variants (Lappalainen et al, 2015). The authors estimated a heritability of 53.4% (standard error 5.2%) for the number of calcified discs, suggesting that phenotypic selection against the number of calcified discs should be possible and effective, but that estimated breeding values (EBVs) for the trait would enable faster genetic progress to be made. In 2017, an exciting American study identified a *FGF4* retrogene insertion on chromosome 12 which segregates with the chondrodystrophoid phenotype including limb length and Hansen's Type I IVDD and the authors suggested that this presented an opportunity for genetic testing over time to eliminate Type I IVDD (Brown et al, 2017). Additional information and UK prevalence estimates can be found in the breed-specific health surveys section.

Neuronal ceroid lipofuscinosis: This lysosomal storage disease, characterised by progressive neuropathy, was described in two mature Long Haired Dachshunds in Switzerland nearly 40 years ago (Vandevelde and Fatzer, 1980). Two different mutations which cause this phenotype have been identified, a single nucleotide insertion in exon 8 of the *PPT1* gene in Miniature Dachshunds (Sanders et al, 2010) and a single nucleotide insertion in exon 4 of the *CLN2* gene in Miniature Long Haired Dachshunds (Awano et al, 2006), and DNA tests for the mutations are available.

Vestibular disease: Dachshunds were overrepresented in a retrospective cases series of 81 cases of vestibular disease diagnosed in a veterinary teaching hospital in southern Brazil between 2006 and 2013 (Chaves et al, 2013); however, the numbers of cases and unaffected Dachshunds seen at the hospital were not presented in the English translation of the original research.

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. A form caused by a cone-rod dystrophy has been described in a breeding colony of Miniature Long Haired Dachshunds at the Animal Health Trust (Turney et al, 2007). The causal mutation was subsequently identified as a 44-nucleotide insertion in exon 2 of the *RPGRIP1* gene (Mellersh et al, 2006). A DNA test for the mutation, designated PRA (cord1) is available. However, after launch of the test doubt was cast on the penetrance of this mutation, with some homozygotes retaining vision until late in life. In 2016, researchers identified a 22kb deletion ~30Mb upstream from *RPGRIP1* as a modifier locus, fusing two genes (*MAP9* intron 10 and *MAP9* pseudogene) (Forman et al, 2016).

Other researchers have shown that these two genes are not sufficient to explain all cases, and posit that 'cord1 is a multigenic disease in which mutations in neither *RPGRIP1* nor *MAP9* alone lead to visual deficits, and additional gene(s) contribute to cone specific functional and morphological defects' (Das et al, 2017).

Sudden acquired retinal degeneration syndrome (SARDS): Dachshunds comprised 9% of cases in an American retrospective case series of 140 dogs presenting with acute onset vision loss and subsequently diagnosed with SARDS at two East Coast veterinary hospitals between 2000 and 2006 (Montgomery et al, 2008). This apparent overrepresentation has subsequently been found in three other North American veterinary hospital case studies (Heller et al, 2017; Leis et al, 2017; Auten et al, 2018).

Other ocular conditions: Dachshunds were reported to be overrepresented with keratoconjunctivitis sicca (KCS, 'dry eye') in an American retrospective case series (Gough, Thomas and O'Neill, 2018); however, the original paper could not be accessed and no more recent references or prevalence estimates for the condition could be found in the literature.

The American College of Veterinary Ophthalmologists (ACVO) consider Dachshunds to be predisposed to microphthalmia with multiple ocular defects, distichiasis, chronic superficial keratitis/pannus, punctate keratitis, corneal dystrophy, iris coloboma, persistent pupillary membranes (PPM), cataract, persistent hyaloid artery, generalised retinal atrophy, ceroid lipofuscinosis-associated retinopathy, retinal dysplasia, coloboma/staphyloma (Standard Smooth Haired only), optic nerve coloboma, optic nerve hypoplasia, micropapilla, dermoid and uveodermatologic syndrome (Genetics Committee of the ACVO, 2015). In 2015, 254 Dachshunds were examined by the ACVO and prevalence data are shown in Table 2 alongside data from previous years. Overall, 82.7% (210 of 254) of Dachshunds examined in 2015 had healthy eyes unaffected by any disease conditions. However, it is important to bear in mind that the dogs were from America.

Table 2: ACVO examination results for Dachshunds, 2000 - 2015

Disease Category/Name	Percentage of Dogs Affected		
	2000-2009 (n=2571)	**2010-2014** (n=938)	**2015** (n=254)
Globe			
Microphthalmia	0.5%	0.2%	0.8%
Eyelids			
Distichiasis	5.8%	12.2%	7.5%
Cornea			
Corneal dystrophy	0.8%	0.2%	1.2%
Uvea			
Persistent pupillary membranes	6.2%	15.5%	10.6%
Lens			
Cataract – all types/locations	9.1%	8.2%	8.7%
Vitreous			
Persistent hyaloid artery/remnant	0.8%	0.3%	0.4%
Retina			
Retinal dysplasia - folds	1.2%	0.9%	1.2%
PRA	1.6%	1.3%	1.6%
Optic nerve			
Micropapilla	0.3%	0.7%	1.2%
Optic nerve hypoplasia	0.4%	0.4%	1.2%
Optic disc coloboma	0.3%	0.3%	0.4%

Reproductive conditions

Dystocia: In a recent VetCompass study of 50 first-opinion emergency-care veterinary practices, the Miniature Dachshund had a dystocia prevalence of 9.6% based on 12 cases and 113 non-cases, giving an odds ratio of 7.9 (95% C.I. 4.0 to 15.4) compared to dogs of no recognisable breed (O'Neill et al, 2017).

Respiratory conditions

Pneumocystis carinii pneumonia: see under Immunological conditions.

Urological conditions

Urolithiasis – calcium oxalate: The Dachshund was found to be at slightly increased risk of calcium oxalate uroliths in a Canadian case series of urolith submissions between 1998 and 2001, with an odds ratio of 1.55 (95% C.I. 1.06-2.26; 129 cases) compared to crossbreeds (Ling et al, 2003).

Urolithiasis – cystine: Dachshunds were reported to be at increased risk of this type of urolith, with male dogs being predominantly affected (Gough, Thomas and O'Neill, 2018); however, no primary references or prevalence estimates could be found.

Purebred/pedigree dog health survey results

All six Dachshund varieties were grouped together in the 2004 Purebred Dog Health Survey.

2004 Morbidity results: Health information was collected for 509 live Dachshunds of which 322 (63%) were healthy and 187 (37%) had at least one reported health condition. The top categories of diagnosis were reproductive (19.7%, 58 of 294 reported conditions), neurologic (11.9%, 35 of 294 reported conditions), dermatologic (10.5%, 31 of 294 reported conditions), cardiac (8.8%, 26 of 294 reported conditions) and dental (8.8%, 26 of 294 reported conditions). The most frequently reported specific conditions were IVDD (4.5% prevalence, 23 cases), heart murmur (4.3%, 22 cases), false pregnancy (3.2% prevalence, 11 cases in the 346 female Dachshunds in the survey), alopecia (3.1% prevalence, 16 cases) and dental disease (2.8% prevalence, 14 cases).

2004 Mortality results: A total of 245 deaths were reported for all Dachshund varieties combined. The median age at death was 12 years and 8 months (min = 4 months, max = 19 years). The most frequently reported causes of death by organ system or category were old age (21.6%, 53 of 245 deaths), cancer (16.7%, 41 deaths), cardiac (14.3%, 35 deaths) and neurologic (11.0%, 27 deaths). The most frequently reported specific causes of death apart from old age and cancer were heart failure (4.9%, 12 deaths) and IVDD (4.1%, 10 deaths).

The Dachshund varieties were separated for the 2014 Pedigree Dog Health Survey.

2014 Morbidity results: Health information was collected for 296 live Miniature Smooth Haired Dachshunds of which 198 (66.9%) had no reported conditions and 59 (33.1%) were reported to be affected by at least one condition. The most frequently reported conditions were IVDD (10.1% prevalence, 30 cases), hypersensitivity (allergic) skin disorder (3.7% prevalence, 11 cases), anal gland/sac impaction/blockage (2.7% prevalence, 8 cases), dermatitis (2.7% prevalence, 8 cases) and unspecified skin, ear or coat. (2.7% prevalence, 8 cases).

2014 Mortality results: A total of 19 deaths were reported for the breed. The range of age at death for Miniature Smooth Haired Dachshunds was two years to 17 years. The most frequently reported causes of death were spinal disorder (5 cases), old age (3 cases), herniated vertebrae (2 cases) and IVDD (2 cases).

VetCompass results

Whilst a breed-specific VetCompass study has not yet been completed, some condition-specific studies have yielded findings relevant to Dachshunds. These results are summarised under the respective conditions above.

Insurance data

UK Agria data

Insurance data were available for Miniature Smooth Haired Dachshunds insured with Agria UK. 'Exposures' are equivalent to one full policy year; in 2016 there were 2679 free exposures, 1449 full exposures and 815 claims, in 2017 these figures were 3510, 2058 and 1162 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 Miniature Smooth Haired Dachshunds insured with Agria UK

Condition	Number of settlements
Disc herniation	210
Diabetes mellitus	54
Foreign body – stomach or intestine	44
Acute gastroenteritis	41
Infection or inflammatory disorders - skin	38
Undiagnosed disease - liver	34
Skin allergy	33
Lameness	30
Vomiting	27
Vomiting and diarrhoea	27

Swedish morbidity and mortality insurance data were also available from Agria for the three Miniature Dachshund varieties grouped together. Reported rates are based on dog-years-at-risk (DYAR) which take into account the actual time each dog was insured during the period (2006-2011). The number of DYAR for Miniature Dachshunds in Sweden during this period was between 500 and 1,000, meaning that these results should be interpreted cautiously.

Swedish Agria insurance morbidity data

The most common specific causes of veterinary care episodes (VCEs) for Agria-insured Miniature Dachshunds in Sweden between 2006 and 2011 are shown in Figure 2. The top five specific causes of VCEs were vomiting/diarrhoea/gastroenteritis, disc/vertebral, mammary tumour, skin tumour and pyometra/endometritis.

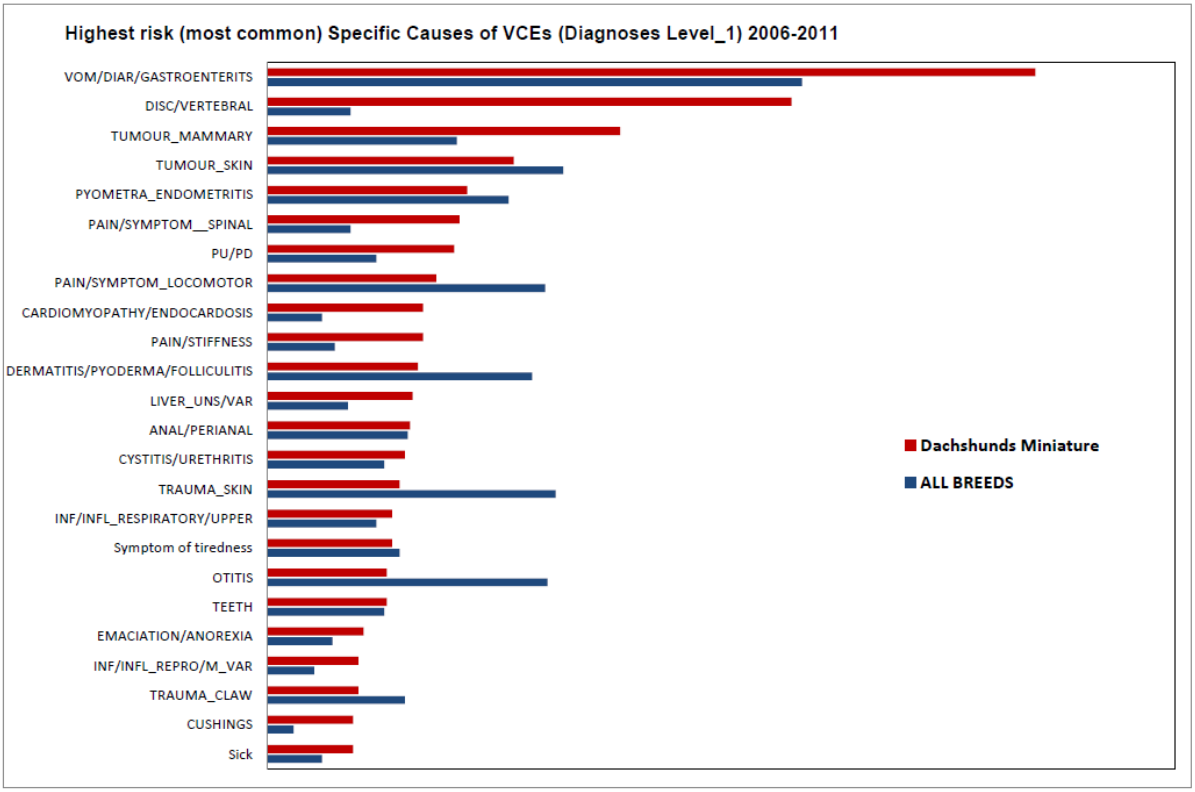

Figure 2: The most common specific causes of VCEs for Miniature Dachshunds compared to all breeds in Sweden between 2006 and 2011, from Swedish Agria insurance data.

When relative risk of specific causes of VCEs was compared for Miniature Dachshunds 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 five specific causes of VCEs ordered by relative risk were degenerative or dystrophic corneal condition, disc/vertebral, upper respiratory tumour, traumatic hernia and congenital hernia.

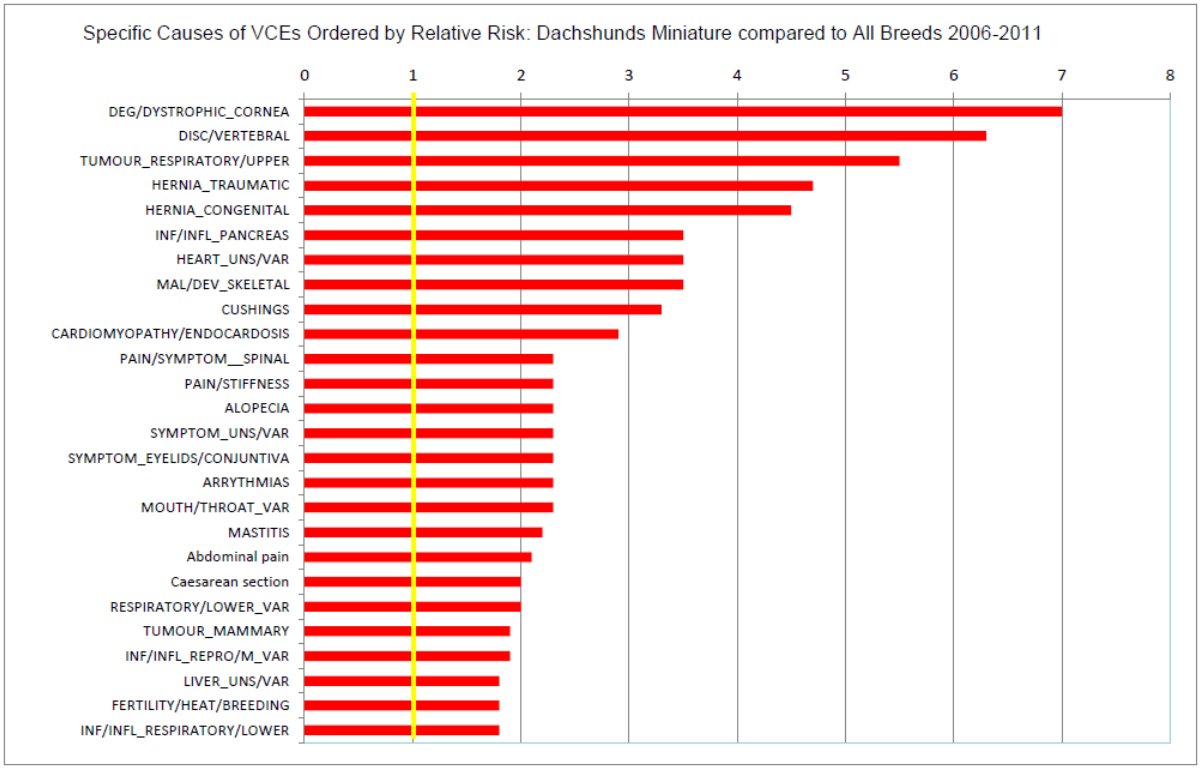

Figure 3: The specific causes of VCEs for Miniature Dachshunds ordered by relative risk compared to all breeds in Sweden between 2006 and 2011, from Swedish Agria insurance data. The yellow line indicates the baseline risk for all breeds.

Swedish Agria insurance mortality data

Median age at death for Miniature Dachshunds from Swedish Agria insurance data was 7.40 years for males and 7.50 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 Standard Dachshunds in Sweden between 2006 and 2011 are shown in Figure 4. By far the most common specific cause of death was disc/vertebral.

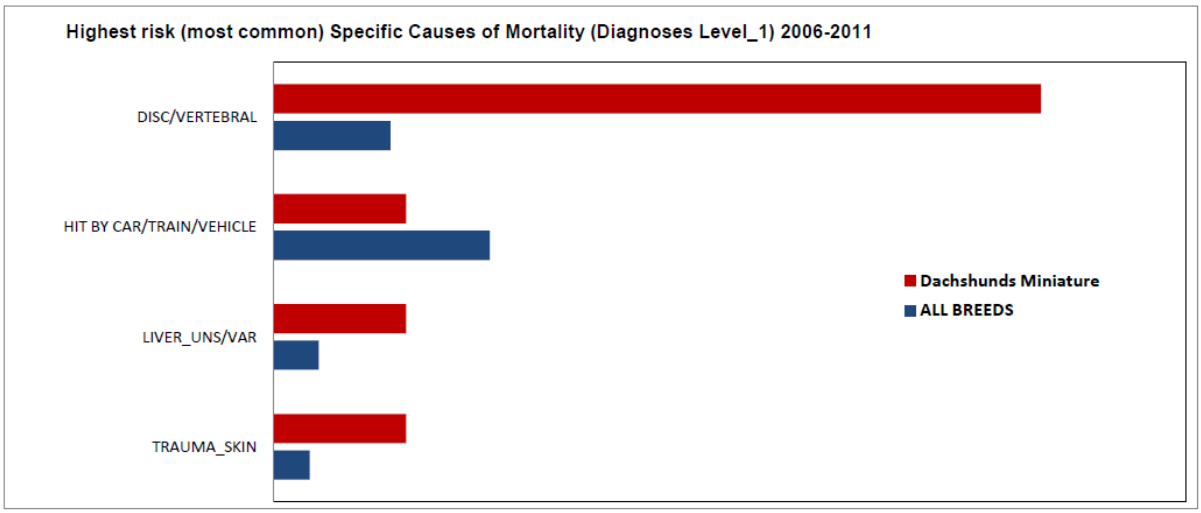

Figure 4: The most common specific causes of death for Miniature Dachshunds compared to all breeds in Sweden between 2006 and 2011, from Swedish Agria insurance data.

Breed-specific health surveys

DachsLife 2012

DachsLife 2012 was a survey of UK Dachshunds that was conducted between1st January 2012 and 31st March 2012. The survey was widely advertised among the Breed Club community, and also many owners of pet Dachshunds, via online discussion groups and Facebook. Responses were received for 1,464 Dachshunds. The survey results can be found here: https://sites.google.com/site/ukdachshundhealthreport/view-reported-health-statistics/dachs-life-2012

DachsLife 2015

A web-based survey 'Dachs-Life 2015: The UK Dachshund Breed Council's Back Disease (IVDD) and lifestyle survey' was carried out for ten weeks from January to April 2015. The survey was hosted by the UK Dachshund Breed Council and owners of Dachshunds with or without a history of IVDD were recruited online via social media and the Council's newsletter. Responses were received for 2031 individual Dachshunds. The overall prevalence of IVDD was 15.7% (95% C.I. 14.1 – 17.3; 310 cases, 1665 non-cases and 56 exclusions). Variety-specific IVDD prevalences are shown in Table 4 below.

Table 4: Prevalence of IVDD for the six varieties of Dachshunds, from the DachsLife 2015 survey

Breed	Cases	Total	IVDD prevalence (%)	95% C.I. (%)
Standard Wire Haired	18	252	7.1	5.97-8.23
Standard Smooth Haired	49	201	24.4	22.51-26.29
Standard Long Haired	16	127	12.6	11.14-14.06
Miniature Wire Haired	54	305	17.7	16.02-19.38
Miniature Smooth Haired	127	744	17.1	15.44-18.76
Miniature Long Haired	46	346	13.3	11.80-14.80

Full analysis of the results of the survey have been published (Packer et al, 2016) and are available here:
https://cgejournal.biomedcentral.com/track/pdf/10.1186/s40575-016-0039-8

Rolling online health survey

The Dachshund Breed Council have been running an online health survey since 2009. The number of reports of particular categories of health condition in the eight years the survey has been running are shown in Figure 5.

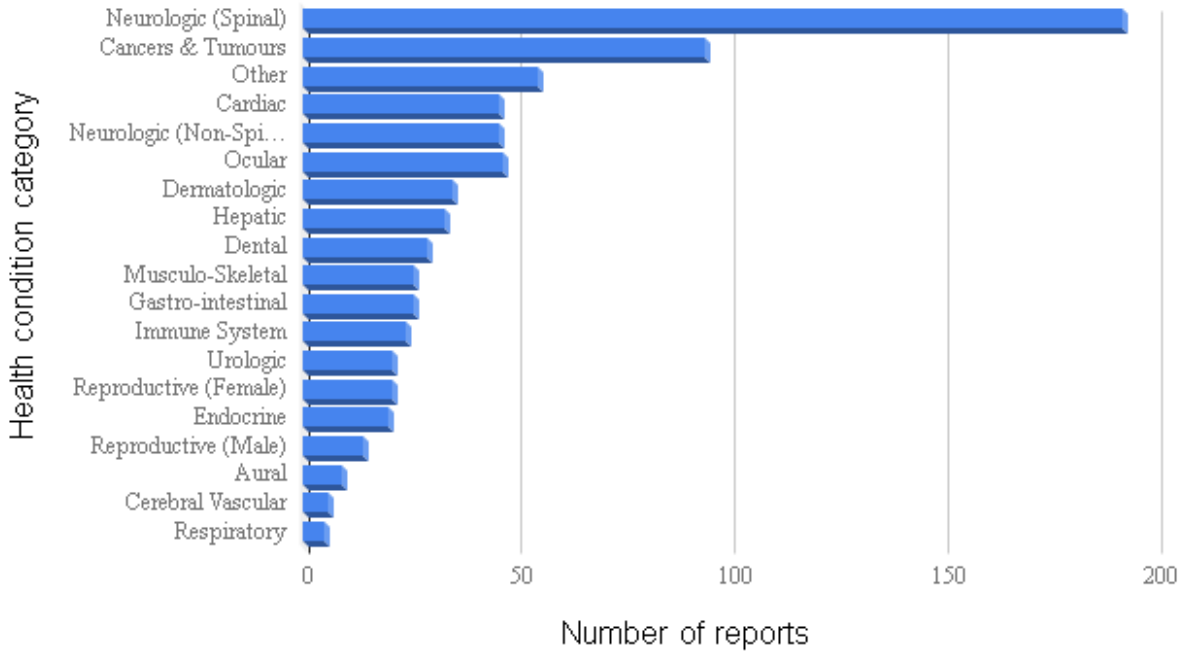

Figure 5: Number of reports of particular categories of health condition received over eight years in the Dachshund Breed Council's rolling online health survey.

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

As a category two breed judges' health monitoring forms are mandatory. The points of concern reported are shown below in Table 5.

Table 5: Percentage of Miniature Smooth Haired Dachshunds exhibited at dog shows with points of concern for 2015 - 2017. The points with an asterisk next to them indicate concerns reported by judges which are not listed for the breed.

Point of concern	**2015**	**2016**	**2017**
*Overweight	0%	0%	3%
Bodyweight / condition	20%	25%	1%
*Other	2%	2%	0%
Total dogs shown	**1333**	**1509**	**1607**

Breed Club health activities

The Dachshund has a health council, an active Breed Health Coordinator (BHC) and a dedicated health website: https://www.dachshundhealth.org.uk/ .

BHC annual report

The Breed Health Coordinator's Annual Health Report 2016, completed for all six Dachshund varieties together, 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 IVDD, 2 Lafora disease and 3 PRA. In terms of what the breed has done in the last year to help tackle these listed health and welfare concerns, the following actions were listed; for IVDD, the Dachshund Breed Council are currently setting up a radiographic screening trial to identify Dachshunds with the highest risk of IVDD by assessing the degree of disc calcification, which is correlated with IVDD. The information can then be used in breeding decisions to reduce IVDD in the Dachshund population. For Lafora's disease, a DNA screening test is available for Miniature Wire Haired Dachshunds and blood sampling sessions are organised regularly, the samples being sent to Toronto for testing. Results are recorded on the Kennel Club database for reference when choosing dogs for breeding. An increasing number of hereditarily clear dogs can now also be found on the website. For PRA, a DNA screening test for CORD1 PRA is available for Miniature Dachshunds and cheek swab samples are taken and tested under the KC scheme. Results are available on the KC website for reference when choosing dogs for breeding.

DNA test results

DNA tests are available for the Miniature Smooth Haired Dachshund for PRA-cord, Multi Drug Resistance (MDR1), mucopolysaccharidosis (MPS) IIIA, narcolepsy and osteogenesis imperfecta. 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.

Results for the PRA (cord1) DNA test have been recorded for the breed since May 2009, and the test has been a mandatory requirement under the Kennel Club's Assured Breeder Scheme (ABS) since January 2010. The results for dogs which had been DNA tested up to 04/06/2018 are shown in Table 6.

Table 6: PRA (cord1) DNA test results held by the Kennel Club for Miniature Smooth Haired Dachshunds up to 04/06/2018.

Total number results	**Clear**	**Carrier**	**Affected**	**Hereditarily clear**	**Hereditarily carrier**	**Hereditarily affected**
8103	788 (9.7%)	762 (19.4%)	134 (1.7%)	5940 (73.3%)	452 (5.6%)	27 (0.33%)

Canine Health Scheme results and EBVs

Currently no official health screening schemes are required or recommended for this breed within the ABS, apart from undertaking the DNA test for PRA (cord1) which is a mandatory requirement. However, all the British Veterinary Association (BVA)/Kennel Club (KC) Health Schemes are open to dogs of any breed.

HIPS

Two Miniature Smooth Haired Dachshunds have been examined under the BVA/KC Hip Dysplasia Scheme in the past fifteen years, and both dogs received a hip score of 15 indicating the presence of mild hip dysplasia.

ELBOWS

No Miniature Smooth Haired Dachshunds have been examined under the BVA/KC Elbow Dysplasia Scheme in the past fifteen years.

EYES

The Miniature Smooth Haired Dachshund is on Schedule A of the BVA/KC/International Sheep Dog Society (ISDS) Eye Scheme for generalised progressive retinal atrophy (GPRA). 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. The results of eye scheme examinations of Miniature Smooth Haired Dachshunds which have taken place since 2012 are shown in Table 7.

Table 7: Reports on dogs of the breed which have participated in the BVA/KC/ISDS Eye Scheme since 2012

Year	Number seen	Comments
2012	19 adults 4 litters	2 – distichiasis 1 – persistent pupillary membranes (PPM) 1 – unspecified other condition
2013	8 adults 0 litters	2 – distichiasis
2014	23 adults 3 litters	5 – distichiasis 1 – persistent hyperplastic primary vitreous (PHPV)
2015	13 adults 0 litters	1 – distichiasis
2016	8 adults 0 litters	4 – distichiasis 1 – PPM 1 – posterior polar subcapsular cataract (PPSC)

Breed Club Recommendations

There are not currently any Breed Club breeding recommendations listed on the Kennel Club's website for the breed.

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 8.

Table 8: Number and percentage of litters of Miniature Smooth Haired Dachshunds 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	596	1	0.17%
2008	729	0	0.00%
2009	772	1	0.13%
2010	721	4	0.55%
2011	847	14	1.65%
2012	794	70	8.82%
2013	795	77	9.69%
2014	834	79	9.47%
2015	963	90	9.35%
2016	1162	101	8.69%
2017	1365	99	7.25%

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, an estimated effective population size of 97.7 was reported (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).

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 6. As with most breeds, the rate of inbreeding was at its highest in this breed in the 1980s and 1990s. This represents a 'genetic bottleneck', with genetic variation lost from the population. However, since 2000 the rate of inbreeding has been negative, implying moderate replenishment of genetic diversity (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.

The current annual breed average inbreeding coefficient is 7.4%. 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.

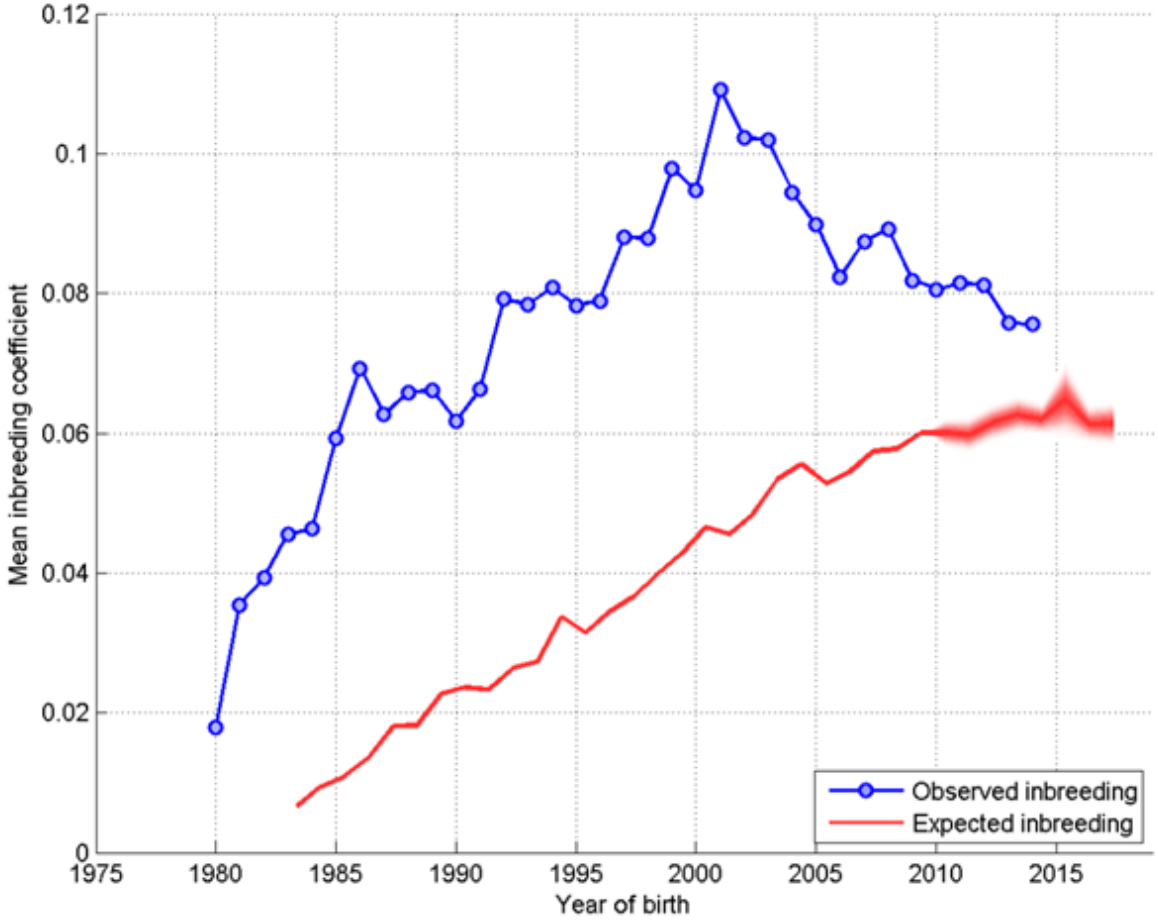

Figure 6: Annual mean observed and expected inbreeding coefficients. [The blurring around the expected inbreeding line indicates an approximate standard deviation around the estimate, in breeds with more than 2000 individuals born in a given year.]

Below is a histogram ('tally' distribution) of number of progeny per sire and dam over each of seven five-year blocks (Figure 7). 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). It appears that the extensive use of popular dogs as sires has increased (the 'tail' of the blue distribution increasing in Figure 7).

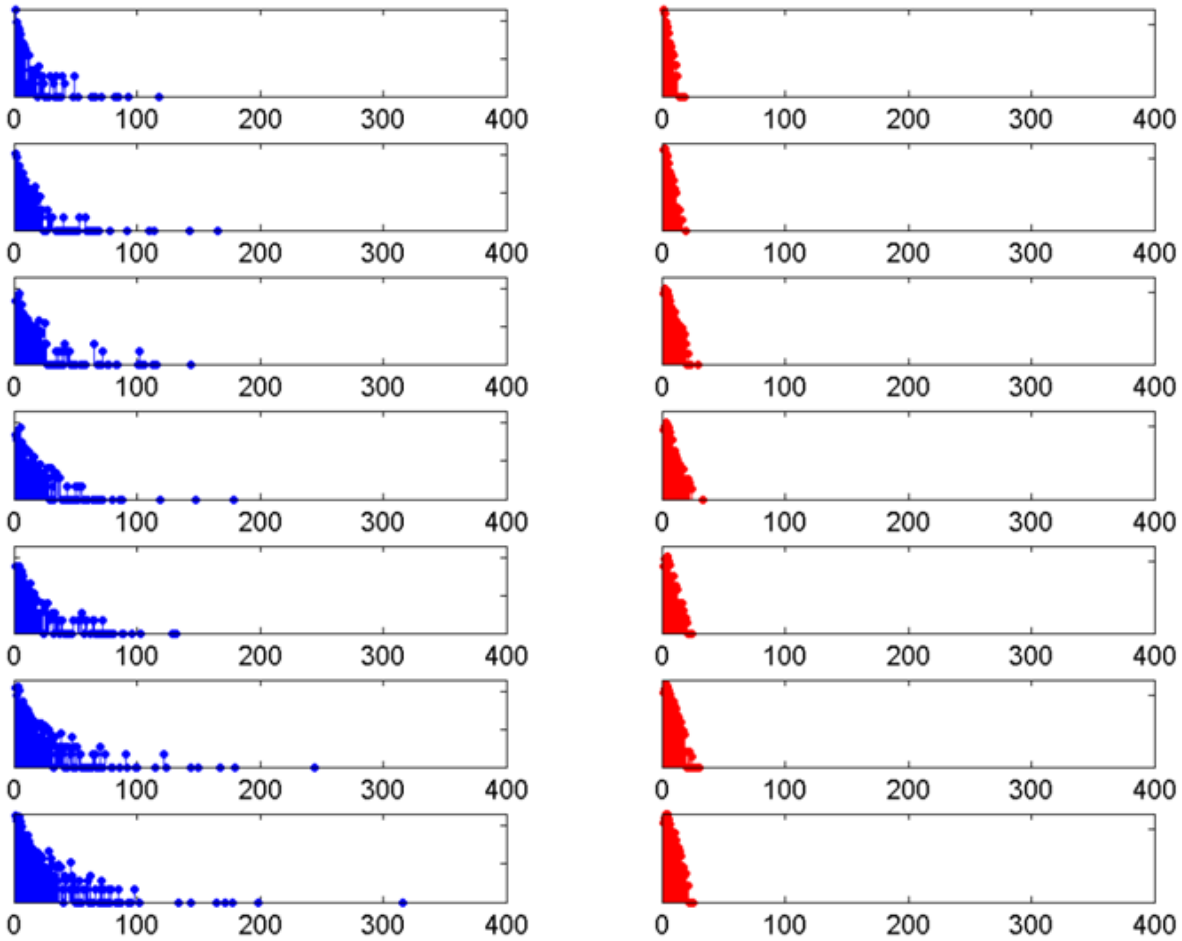

Figure 7: Distribution of progeny per sire (blue) and per dam (red) over 5-year blocks (1980-4 top, 2010-14 bottom). Vertical axis is a logarithmic scale.

Current research projects

Dachshunds are part of the Animal Health Trust (AHT)'s Give a Dog a Genome project; the health condition given as a concern in the breed was IVDD. A Miniature Long Haired Dachshund with PRA has been sequenced.

The AHT is also working with the Dachshund Breed Council to evaluate the potential utility of the IVDD mutation identified by Brown et al at the University of California Davis.

SECTION 2: PRIORITIES

A meeting was held with Dachshund breed club representatives on 12th July 2018 to discuss Section 1 of the BHCP and agree the priority issues for the health of the breed.

In the cardiovascular conditions category, the concern of mitral valve disease was discussed, with European studies finding a high prevalence of mitral valve prolapse in Dachshund varieties. It was noted that whilst the 2015 UK DachsLife survey results did not indicate specifically a high level of mitral valve disease, the results indicated a high prevalence of dogs affected by heart murmurs, with Standard Wirehaired and Standard Smooth affected at a 7.8% and 6.3% prevalence respectively. The group discussed the need for further data to be collated in order to decipher specific heart concerns as, in the previous survey, conditions were grouped under 'cardiac disease'; with the further necessity to include age of onset and mortality data.

The dermatological category found three conditions in the literature review, of which two had been seen in the breed in the UK. Atopy had been found to affect up to 20% of Standard Smooths in the 2015 DachsLife study. However, it was noted that an owner not familiar with veterinary terminology may find it difficult to correctly identify their dog's skin condition, and therefore atopy could be perceived as an overarching term. The group were particularly concerned for the apparent rise in dogs affected by colour dilution alopecia (CDA), with many owners reporting this condition on social media, specifically in dilute blues, isabellas and chocolate coats. This was agreed to be on the increase due to the rising popularity in rare colours, with the group having concerns that there is no current way to identify lines carrying the condition. It was agreed that further evidence is needed for CDA, including robust diagnosis.

Endocrine conditions listed in the literature review were diabetes mellitus, Cushing's disease and hypothyroidism. The group discussed that gestational diabetes anecdotally appears to be more common in Standard Smooths, causing complications during and post-whelping. Cushing's was discussed as being more commonly seen in Miniature Wirehaired and older Dachshunds.

Gastrointestinal conditions found in the literature review were bacterial cholecystitis, colorectal polyps, pancreatitis and sialocoele. Whilst Japanese studies had found 50% of dogs presenting with colorectal polyps to be Miniature Dachshunds, it does not appear to be common in the UK population, with only a handful of related Miniature Longhaired known to have been affected. Anecdotally, a small number of unrelated Miniature Longhaired have been known to be affected by pancreatitis but this could be impacted by lifestyle factors (e.g. a high fat diet). An online breed survey has suggested there could be a link between Lafora disease and pancreatitis

in Miniature Wirehaired, but further data is needed to support this. The breed noted their concern for gastric dilatation/volvulus syndrome (GDV/bloat), as the Dachshund is a deep chested breed and has anecdotally been known to be affected. It was agreed more data were needed. Similarly, megaoesphagus has been reported in Miniature Smooths, it was agreed these conditions should remain under watch. Haemophilia A, pyruvate kinase deficiency and von Willebrand's disease (vWD) were found under haematological conditions. It was noted that there were several cases of vWD several decades ago in some imported lines but was not considered a concern currently.

Whilst no hepatic conditions were found in the literature review, the breed noted their concern about liver shunt, with Miniature varieties most commonly affected. It was agreed that whilst this is a low prevalence condition, it is highly distressing for owners and dogs. More data are to be collected in regard to this condition.
The immunological condition found in the literature review, immunoglobulin deficiency, was not noted to be a concern within the UK population at this time.

Under musculoskeletal five conditions were reported, Legg-Calvé-Perthes disease, osteogenesis imperfecta, pes varus, inguinal or scrotal hernia, and patellar luxation. Dogs affected by osteogenesis imperfecta appear to have mostly German origins, with those bred within the UK testing clear for the causal mutation. The breed had discussed investigating this condition with the Animal Health Trust (AHT) but it had been decided not to pursue this due to its apparent low prevalence in the UK. With regard to pes varus, the breed noted their concern about this, particularly in the show ring, with exhibitors and judges deeming the condition part of the natural gait for a Dachshund, and not recognising it as a concern. With regard to patellar luxation, it was agreed more data were needed for this.

The neoplastic (cancer) conditions category had three specific conditions listed; cardiac haemangiosarcoma, mammary neoplasia, and squamous cell carcinoma of the digit. The group expressed their intention to run a cancer survey. It was noted that following the 2015 DachsLife survey there does not appear to be a correlation between neutering and the development of mammary tumours in Dachshunds but a further study could help support this finding. A cluster of lymphoma cases had been reported and the breed's 2018 survey will specifically ask about cancers.

Neurological conditions of interest were idiopathic epilepsy, intervertebral disc disease (IVDD), Lafora disease, neuronal ceroid lipofuscinosis and vestibular disease. Miniature Longhaired seem to have approximately four times the risk of developing epilepsy according to the 2015 DachsLife study. An online reporting tool appears to indicate that currently 50% of affected dogs are Miniature Longhaired. The breed highlighted their concern for the lack of uptake for their IVDD screening programme, with only 50 dogs having participated since 2016. Owners may be discouraged from screening due to several factors: with an examination costing ~£300, age of screening to be between 2 – 4 years, and the results not giving a

definitive answer but an indication of risk. With regard to Lafora disease, the breed have seen a dramatic drop in prevalence and are currently working with the AHT to establish a swab DNA test for the condition.

The ocular conditions PRA (cord1), SARDS and distichiasis were discussed. It was agreed that PRA (cord1) is no longer a concern for Miniature Wirehaired and there could be potential to request this is removed from the Assured Breeder Scheme requirements if this continues to be the case following a year. However, it was agreed it would be prudent to continue testing of imported dogs. SARDS has been infrequently reported, with eight cases seen in the past 10 years in the UK, but it was noted that this could be due to veterinarians misdiagnosing the condition. It was further highlighted that Longhaired varieties appear to be commonly affected by distichiasis, but this can be seen in all varieties.

For reproductive conditions, dystocia was found in the literature review. It was noted that Dachshunds can be slower at whelping, and that inexperienced breeders may be more likely to source veterinary intervention. Cases of undescended testicles were noted to be increasing within the breed, and this is to be monitored.

The 2004 and 2014 Purebred and Pedigree Breed Health Survey results were reviewed, with the results supporting the concerns discussed, with cancers, heart conditions and IVDD mentioned. The insurance data were subsequently assessed by the group, with the top three UK conditions noting IVDD, epilepsy, lameness, skin allergies, diabetes mellitus, Cushing's and pancreatitis across the varieties. Genetic diversity measures were discussed, with the smallest effective population size witnessed in the Standard Longhaired and Standard Smooth (40 and 59 respectively). The use of popular sires was discussed and the breed are to review the continuation of popular sire use after one year and discuss whether it would be prudent to add a guidance point to their code of ethics at this point on how many times a stud dog might be used.

The group agreed from the information provided and their own experience that IVDD, Lafora's in Miniature Wirehaired, eye disease were the priorities for Dachshunds with concerns also noted over colour dilution alopecia, mitral valve disease, pes varus and maintenance of genetic diversity.

SECTION 3: ACTION PLAN

- The breed council to send a list of genetically possible coat colours to the Kennel Club to be discussed at the next Colour Not Recognised working group meeting.

- The Kennel Club to review and assist in promoting the Dachshund cancer survey, to determine whether particular cancers should also be considered a priority issue.

- The breed council to continue to encourage participation in IVDD testing with the potential for subsidising tests.

- The Kennel Club to encourage participation in IVDD testing.

- A Breed Watch proposal to be made for all varieties. Incorrect hindquarter movement, especially in the miniatures, as a possible result of pes varus and sore or runny eyes which may be due to distichiasis.

- Two proposals to be made to the Assured Breeder Scheme for IVDD testing and participation in the BVA/KC/ISDS Eye Scheme to become recommendations across all Dachshund varieties.

- The Kennel Club to request an update from the AHT with regard to progress in development of a swab test for Lafora disease.

- The Kennel Club will review progress with the Dachshund breed club representatives in July 2019

References

Auten, C.R., Thomasy, S.M., Kass, P.H., Good, K.L., Hollingsworth, S.R. and Maggs, D.J. (2018) Cofactors associated with Sudden Acquired Retinal Degeneration Syndrome: 151 dogs within a reference population. *Veterinary Ophthalmology* **21** (3): 264-272

Beco, L., Fontaine, J., Gross, T.L and Charlier, G. (1996) Colour dilution alopecia in seven Dachshunds. A clinical study and the hereditary, microscopical and ultrastructural aspect of the disease. *Veterinary Dermatology* **7** (2): 91-97

Bellenger, C.R. and Simpson, D.J. (1992) Canine sialocoeles: 60 clinical cases. *Journal of Small Animal Practice* **33** (8): 376-380

Bellumori, T.P., Famula, T.R., Bannasch, D.L., Belanger, J.M. and Oberbauer, A.M. (2013) Prevalence of inherited disorders among mixed-breed and purebred dogs: 27,254 cases (1995-2010). *Journal of the American Veterinary Medical Association* **242** (11): 1549-1555

Brooks, M. (1999) A review of canine inherited bleeding disorders: biochemical and molecular strategies for disease characterisation and carrier detection. *The American Genetic Association* **90**: 112-118

Brown, E.A., Dickinson, P.J., Mansour, T., Sturges, B.K., Aguilar, M., Young, A.E., Korff, C., Lind, J., Ettinger, C.L., Varon, S., Pollard, R., Brown, C.T., Raudsepp, T. and Bannasch, D.L. (2017) *FGF4* retrogene on CFA12 is responsible for Chondrodystrophy and intervertebral disc disease in dogs. *PNAS* **114** (43): 11476-11481

Chaves, R.O., Beckmann, D.V., Copat, B., Souza, F.W., Fabretti, A.K., Gomes, L.A., Fighera, R.A. and Mazzanti, A. (2013) Vestibular disease in dogs: 81 cases (2006-2013) *Pesquisa Veterinária Brasiliera* **34** (12): 1210-1214

Das, R.G., Pompeo Marinho, F., Iwabe, S., Santana, E., Sierra McDaid, K., Aguirre, G.D. and Miyadera, K. (2017) Variabilities in retinal function and structure in a canine model of cone-rod dystrophy associated with *RPGRIP1* support multigenic etiology. *Scientific Reports* **7**: 12823 https://doi.org/10.1038/s41598-017-13112-w

Drögemüller, C., Becker, D., Brunner, A., Haase, B., Kircher, P., Seeliger, F., Fehr, M., Baumann, U., Lindblad-Toh, K. and Leeb, T. (2009) A missense mutation in the *SERPINH1* gene in Dachshunds with osteogenesis imperfecta. PLoS Genetics 5 (7): e1000579. doi:10.1371/journal.pgen.1000579

Eckardt, J., Kluth, S., Dierks, C., Philipp, U. and Distl, O. (2013) Population screening for the mutation associated with osteogenesis imperfecta in dachshunds. *The Veterinary Record* **172** (14): 364

Forman, O.P, Hitti, R.J., Boursnell, M., Miyadera, K., Sargan, D. and Mellersh, C. (2016) Canine genome assembly correction facilitates identification of a *MAP9* deletion as a potential age of onset modifier for *RPGRIP1*-associated canine retinal degeneration. *Mammalian Genome* **27**: 237-245

Genetics Committee of the American College of Veterinary Ophthalmologists (2015) Ocular disorders presumed to be inherited in purebred dogs, Eighth Edition http://www.acvo.org/new/diplomates/resources/ACVOBlueBook20158thEdition.pdf [Accessed 07/06/2018]

Gough, A., Thomas, A. and O'Neill, D. (2018) Breed dispositions to disease in dogs and cats. Third Edition. Blackwell Publishing Ltd, Oxford, UK

Harvey, J.W. (2006) Pathogenesis, laboratory diagnosis, and clinical implications of erythrocyte enzyme deficiencies in dogs, cats, and horses. *Veterinary Clinical Pathology* **35** (2): 144-156

Heller, A.R., van der Woerdt, A., Gaarder, J.E, Sapienza, J.S., Hernandez-Merino, E., Abrams, K., Church, M.L. and La Croix, N. (2017) Sudden acquired retinal degeneration in dogs: breed distribution of 495 canines. *Veterinary Ophthalmology* **20** (2): 103-106

Henry, C.J., Brewer Jr., W.G., Whitley, E.M., Tyler, J.W., Ogilvie, G.K., Norris, A., Fox, L.E., Morrison, W.B., Hammer, A., Vail, D.M. and Berg, J. (2005) Canine digital tumours: a Veterinary Cooperative Oncology Group retrospective study of 64 dogs. *Journal of Veterinary Internal Medicine* **19**: 720-724

Holder, A.L., Kennedy, L.J., Ollier, W.E.R. and Catchpole, B. (2015) Breed differences in development of anti-insulin antibodies in diabetic dogs and investigation of the role of dog leukocyte antigen (DLA) genes. *Veterinary Immunology and Immunopathology* **167**: 130-138

Jensen, V.F., Beck, S., Christensen, K.A. and Arnbjerg, J. (2008) Quantification of the association between intervertebral disk calcification and disk herniation in Dachshunds. *Journal of the American Veterinary Medical Association**233***: 1090-1095

Kim, J.-H., Kang, K.-I., Sohn, H.-J., Woo, G.-H., Jean, Y.-H. and Hwang, E.-K. (2005) Color-dilution alopecia in dogs. *Journal of Veterinary Science* **6** (3): 259-261

LaFond, E., Breur, G.J. & Austin, C.C. (2002) Breed Susceptibility for Developmental Orthopedic Diseases in Dogs. *Journal of the American Animal Hospital Association* **38**: 467-477

Lappalainen, A.K., Mäki, K. and Laitinen-Vapaavuori, O. (2015) Estimate of heritability and genetic trend of intervertebral disc calcification in Dachshunds in Finland. *Acta Veterinaria Scandinavica* **57**: 78 DOI 10.1186/s13028-015-0170-7

Lawrence, Y.A., Ruaux, C.G., Nemanic, S. and Milovancev, M. (2015) Characterization, treatment, and outcome of bacterial cholecystitis and bactibilia in dogs. *Journal of the American Veterinary Medical Association* **246**: 982-989

Leis, M.L., Lucyshyn, D., Bauer, B.S., Grahn, B.H. and Sandmeyer, S. (2017) Sudden acquired retinal degeneration syndrome in western Canada: 93 cases. *Canadian Veterinary Journal* **58**: 1195-1199

Lewis, T.W., Abhayaratne, B.M. and Blott, S.C. (2015) Trends in genetic diversity for all Kennel Club registered pedigree dog breeds. *Canine Genetics and Epidemiology* **2**:13 https://doi.org/10.1186/s40575-015-0027-4 [Accessed 08/06/2018]

Ling, G.V., Thurmond, M.C., Choi, Y.K., Franti, C.E., Ruby, A.L. and Johnson, D.L. (2003) Changes in proportion of canine urinary calculi composed of calcium oxalate or struvite in specimens analyzed from 1981 through 2001. *Journal of Veterinary Internal Medicine* **17**: 817-823

Lobetti, R.G., Leisewitz, A.L. and Spencer, J.A. (1996) *Pneumocystis carinii* in the miniature dachshund: Case report and literature review. *Journal of Small Animal Practice* **37**: 280-285

Lobetti, R. (2000) Common variable immunodeficiency in miniature dachshunds affected with *Pneumocystis carinii* pneumonia. *Journal of Veterinary Diagnostic Investigation* **12**: 39-45

Mellersh, C.S., Boursnell, M.E.G., Pettitt, L., Ryderm E.J., Holmes, N.G., Grafham, D., Forman, O.P., Sampson, J., Barnett, K.C., Blanton, S., Binns, M.M. and Vaudin, M. (2006) Canine *RPGRIP1* mutation establishes cone-rod dystrophy in miniature longhaired dachshunds as a homologue of human Leber congenital amaurosis *Genomics* **88**: 293-301

Montgomery, K.W., van der Woerdt, A. and Cottrill, N.B. (2008) Acute blindness in dogs: Sudden acquired retinal degeneration syndrome versus neurological disease (140 cases, 2000-2006). *Veterinary Ophthalmology* **11** (5): 314-320

O'Neill, D.G., O'Sullivan, O.M., Manson, E.A., Church, D.B., Boag, A.K., McGreevy, P.D. and Brodbelt, D.C. (2017) Canine dystocia in 50 UK first-opinion emergency-care veterinary practices: prevalence and risk factors. *Veterinary Record* DOI: 10.1136/vr.104108

Ohmi, A., Tsukamoto, A., Ohno, K., Uchida, K., Nishimura, R., Fukushima, K., Takahashi, M., Nakashima, K., Fujino, Y. and Tsujimoto, H. (2012) A retrospective study of inflammatory colorectal polyps in Miniature Dachshunds. *Journal of Veterinary Medical Science* **74** (1): 59-64

Olsen, L.H., Fredholm, M. and Pedersen, H.D. (1999) Epidemiology and inheritance of mitral valve prolapse in Dachshunds. *Journal of Veterinary Internal Medicine* **13**: 448-456

Pápa, K., Máthé, Á, Abonyi-Tóth, Z., Sterczer, Á., Psáder, R., Hetyey, C., Vajdovich, P. and Vörös, K. (2011) Occurrence, clinical features and outcome of canine pancreatitis (80 cases). *Acta Veterinaria Hungarica* **59** (1): 37-52

Parker, H.G., VonHoldt, B.M., Quignon, P., Margulies, E.H., Shao, S., Mosher, D.S., Spady, T.C., Elkahloun, A., Cargill, M., Jones, P.G., Maslen, C.L., Acland, G.M., Sutter, N.B., Kuroki, K., Bustamante, C.D., Wayne, R.K., and Ostrander, E.A. (2009) An expressed Fgf4 retrogene is associated with breed-defining chondrodysplasia in domestic dogs. *Science* **325**: 995-998

Radasch, R.M., Lewis, D.F., McDonald, D.E., Calfee, E.F. and Barstad, R.D. (2008) Pes varus correction in Dachshund using a hybrid external fixator. *Veterinary Surgery* **37**: 71-81

Sanders, D.N., Farias, F.H., Johnson, G.J., Chiang, V., Cook, J.R., O'Brien, D.P., Hofmann, S.L., Lu, J.-Y. and Katz, M.L. (2010) A mutation in canine *PPT1* causes early onset neuronal ceroid lipofuscinosis in a Dachshund. *Molecular Genetics and Metabolism* **100** (4): 349-356

Seeliger, F., Leeb, T., Peters, M., Brügmann, M., Fehr, M. and Hewicker-Trautwein, M. (2003) Osteogenesis imperfecta in two litters of Dachshunds. *Veterinary Pathology* **40**: 530-539

Serfass, P., Chetboul, V., Carlos Sampedrano, C., Nicolle, A., Benalloul, T., Laforge, H., Gau, C., Hébert, C., Pouchelon, J.-L. and Tissier, R. (2006) Retrospective study of 942 small-sized dogs: Prevalence of left apical systolic heart murmur and left-sided heart failure, critical effects of breed and sex. *Journal of Veterinary Cardiology* **8**: 11-18

Turney, C., Chong, N.H.V, Alexander, R.A., Hogg, C.R., Fleming, L., Flack, D., Barnett, K.C., Bird, A.C., Holder, G.E. and Luthert, P.J. (2007) Pathological and electrophysiological features of a canine cone-rod dystrophy in the Miniature Longhaired Dachshund. *Investigative Ophthalmology & Visual Science* **48** (9): 4240-4249

Uchida, E., Chambers, J.K., Nakashima, K. Saito, T., Ohno, K., Tsujimoto, H., Nakayama, H. and Uchida, K. (2016) Pathologic features of colorectal inflammatory polyps in Miniature Dachshunds. *Veterinary Pathology* **53** (4): 833-839

Vandevelde, M. and Fatzer, R. (1980) Neuronal ceroid-lipofuscinosis in older Dachshunds. *Veterinary Pathology* **17**: 686-692

Wood, F.D., Pollard, R.E., Uerling, M.R. and Feldman, E.C. (2007) Diagnostic imaging findings and endocrine test results in dogs with pituitary-dependent hyperadrenocorticism that did or did not have neurologic abnormalities: 157 cases (1989-2005). *Journal of the American Veterinary Medical Association* **231**: 1081-1085

Yamagishi, C., Momoi, Y., Kobayashi, T., Ide, K., Ohno, K., Tsujimoto, H. and Iwasaki, T. (2007) A retrospective study and gene analysis of canine sterile panniculitis. *Journal of Veterinary Medical Science* **69** (9): 915-924

Zatloukal, J., Lorenzová, J., Tichý, F., Nečas, A., Kecová, H. and Kohout, P. (2005) Breed and age as risk factors for canine mammary tumours. *Acta Veterinaria Brno* **74**: 103-109