Canine dystocia in 50 UK first-opinion emergency-care veterinary practices: Prevalence and risk factors

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Abstract

Dystocia can represent a major welfare issue for dogs of certain breeds and morphologies. First opinion emergency-care veterinary caseloads represent a useful data resource for epidemiological research because dystocia can often result in emergency veterinary care.

The study analysed a merged database of clinical records from 50 first opinion emergency-care veterinary practices participating in the VetCompass Programme. Multivariable logistic regression modelling was used for risk factors analysis. There were 701 dystocia cases recorded among 18,758 entire female dogs, resulting in a dystocia prevalence of 3.7% (95% CI: 3.5-4.0%). Breeds with the highest odds of dystocia compared with crossbred bitches were French Bulldog (OR: 15.9, 95% CI 9.3-27.2, $P < 0.001$), Boston Terrier (OR: 12.9, 95% CI 5.6-29.3, $P < 0.001$), Chihuahua (OR: 10.4, 95% CI 7.0-15.7, $P < 0.001$) and Pug (OR: 11.3, 95% CI 7.1-17.9, $P < 0.001$). Bitches aged between 3.0 and 5.9 years had 3.1 (95% CI 2.6-3.7, $P < 0.001$) times the odds of dystocia compared with bitches aged under 3.0 years.

Certain breeds, including some brachycephalic and toy breeds, appeared at high risk of dystocia. Opportunities to improve this situation are discussed.

Abbreviations

ABS - Assured Breeder Scheme

KC – Kennel Club

IQR - interquartile range

EPR – electronic patient records

OR – odds ratio

CI – confidence interval

Key Words

out-of-hours, whelp, canine, parturition, birth, VetCompass

Introduction

Dystocia is defined as a difficult birth or the inability to expel the foetus through the birth canal without assistance (Linde-Forsberg 2009). Dystocia requiring veterinary assistance has been estimated to occur in approximately 5% of all parturitions in domestic dogs (Linde-Forsberg 2009) and represents 2% of all female insurance claims in dogs in Sweden (Bergstrom and others 2006). Dystocia can represent a major welfare issue for certain subsets of the domestic dog population and carries an estimated mortality rate of over 20% for puppies and of 1% for dams (Gendler and others 2007). The Kennel Club (KC) Assured Breeder Scheme (ABS) is designed to monitor breeding data on pedigree dogs in the UK with the aim of improving the welfare of puppies and breeding bitches. However, not all breeding bitches are included under this scheme and the completeness of breeding data returned to the scheme is severely limited (Anon. 2016; Llewellyn 2013). Improved understanding of the epidemiology of dystocia in the general population of bitches in the UK could highlight those breeds and subgroups of dogs at highest risk and help veterinary surgeons to improve breed and breeding advice provided for this disorder (Adams and Frankel 2007).

Breed, body size and age have all been reported as risk factors for dystocia but often with conflicting results. Chihuahuas, Miniature Poodles, and Dachshunds were the most commonly presented breeds in a retrospective study of 128 dystocia cases from the US (Gaudet 1985b), whilst a review of insurance claim data for dystocia identified Scottish Terriers, Chihuahuas and Pomeranians as breeds with the highest risk for dystocia in Sweden (Bergstrom and others 2006). Several studies from countries such as Sweden, Germany and the USA, have reported a higher incidence of dystocia in miniature and toy breeds in patient populations derived from insurance, obstetric clinic and referral hospital databases (Bergstrom and others 2006; Gaudet 1985b; Münnich and Küchenmeister 2009). While age was not identified as a risk factor for dystocia in two studies based on referral data (Darvelid and Linde-Forsberg 1994; Gaudet 1985b), a survey of Boxer breeders reported increased risk of dystocia in bitches aged over four years (Linde Forsberg and Persson 2007). Improved clarity is required on risk factors for dystocia in the current general population of bitches in the UK.

Given that dystocia in dogs is often an emergency veterinary presentation (Smith 2007), first opinion emergency-care veterinary caseloads should offer a rich source of clinical case material for epidemiological research on canine dystocia but there are few published reports that have used data from this source. The current study aimed to analyse a merged VetCompass database of electronic patient records (EPRs) from 50 Vets Now first opinion emergency-care veterinary practices that cover over 1,000 primary-care practices to investigate the epidemiology of dystocia in dogs (VetCompass 2017; Vets Now 2015). Merging EPR data from multiple veterinary practices supports clinical research that can be reliably generalized to the overall dog population (Bateson 2010; McGreevy and Nicholas 1999).

Specific objectives of the current study were to report the prevalence of dystocia in the emergency-care caseload of entire bitches and to evaluate purebred status, breed, bodyweight and age as risk factors for dystocia. It was hypothesised that dogs weighing less than 10kg have greater risk of dystocia than dogs weighing 10kg or higher.

Materials and Methods

The VetCompass Programme at the Royal Veterinary College shares, analyses and disseminates veterinary clinical information from UK primary-care and emergency-care veterinary practices for epidemiological research that aims to develop an improved evidence base to support companion animal welfare initiatives (VetCompass 2017). Vets Now provides out-of-hours emergency-care services from multiple sites across the UK, annually treating over 100,000 emergency patients that are registered at over 1,000 primary-care practices (Vets Now 2015). Vets Now clinics use a bespoke standardised practice management system (Helix PMS) and Vets Now team members record presenting signs and diagnosis terms from VeNom standardised terminology during episodes of clinical care (The VeNom Coding Group 2017). A clinical query using structured query language was used to extract selected anonymized fields of EPR data from the Helix system before these fields were uploaded to the secure VetCompass relational database (O'Neill and others 2014b).

The sampling frame for the current study included all entire female dogs, with at least one EPR recorded within the VetCompass database, that attended Vets Now from September 1st, 2012 to February 28th, 2014 (Vets Now 2015). Data used in the current study included demographic (breed, date of birth, sex, neuter status and bodyweight) and clinical (clinical notes, treatment, presenting signs and diagnosis terms with relevant dates) information. Ethics approval was granted by the RVC Ethics and Welfare Committee (reference number 2014/S338). A cross-sectional study design was used to estimate prevalence and evaluate associations between risk factors and dystocia presentation. Sample size calculations estimated that a cross-sectional study would require a sample size of 18,647 entire bitches to provide a prevalence estimate with a 0.2% confidence limit for a disorder that occurs in 2.0% of overall population (assuming a UK population size 2,000,000 entire bitches and design effect 1.0) (Epi Info 7 CDC 2015).

Candidate dystocia cases were identified from the VetCompass database by searching across five data fields. The clinical notes free-text field was searched using the terms: *dyst, disto, labour, labor, cesa, caes, csec, c-sec, birth, partur, whelp, foet, fetal, contraction, litter, breach, breech, oxyto* (word stem for oxytocin), *neonat*. The client-reported presenting signs field was searched using the term for *trouble giving birth*. The clinic-reported presenting signs field was searched for *dystocia.* The VeNom diagnosis field was searched for any terms that included *dystocia* or *pregnancy* and the drug treatment fields were searched using the search terms; *oxyt* and *dopr* (word stem for Dopram-V [Zoetis]). The overall search results were aggregated and randomly ordered using the Rand function within Microsoft Excel (McCullough and Wilson 2005) to avoid temporal bias during the case-reading phase. The full clinical notes of all candidate dystocia cases were reviewed in detail to decide on case inclusion and to extract additional information on confirmed cases. The case definition for dystocia required presentation for clinical care related to whelping and that the bitch had at least part of one puppy retained internally at initial presentation. All entire bitches not meeting the dystocia case definition were included in the analysis as non-cases for dystocia.

Recognisable single breeds (Irion and others 2003) were grouped according to purebred/crossbred status, Kennel Club (KC) recognized-breed status (recognized/not recognized) and KC breed group (The Kennel Club 2017a). A *breed* variable included all individual breeds with eight or more dystocia cases, any remaining breeds among the 10 most common individual breeds overall, a grouping of all remaining pure breeds and a grouping of all crossbreds. *Age* (years) at dystocia diagnosis, for case animals, and at the mid-point between the first and final EPR, for the non-case animals, was categorised into five groups (< 3.0, 3.0-5.9, 6.0-8.9, ≥ 9.0 years, not recorded). *Bodyweight* described the maximum recorded value for each dog and was used to generate seven bodyweight categories: (0.0-9.9, 10.0-19.9, 20.0-29.9, 30.0-39.9, 40.0-49.9, ≥ 50.0 kg and no weight recorded).

Following data checking and cleaning in Excel (Microsoft Office Excel 2007, Microsoft Corp.), statistical analyses were conducted using Stata Version 13.0 (Stata Corporation). Prevalence values for dystocia with 95% confidence intervals (95% CI) were reported overall and for each of the common breeds. The 95% CI estimates were derived from standard errors, based on approximation to the normal distribution (Kirkwood and Sterne 2003). Descriptive statistics characterised purebred status, breeds, KC-recognized breed, KC breed group, age and bodyweight separately for dystocia cases and non-cases. Binary logistic regression modelling was used for univariable risk factor evaluation for association with dystocia occurrence. Purebred status, KC-recognized breed, KC breed group (highly correlated with breed) and bodyweight (defining characteristic of individual breeds) were excluded from multivariable modelling because breed was a factor of primary interest for the study.

Remaining factors with liberal associations in univariable modelling (P < 0.2) were taken forward for multivariable logistic regression modelling evaluation. Model development used manual backwards stepwise elimination. Clinic attended was entered as a random effect and pair-wise interaction effects were evaluated for the final model variables (Dohoo and others 2009). The Hosmer-Lemeshow test statistic (Hosmer and others 2013) and the area under the receiver operator curve (ROC) were used to evaluate model fit (non-random effect model) (Dohoo and others 2009). Statistical significance was set at $P < 0.05$.

Results

Descriptive results

The study population comprised of 18,758 entire female dogs attending 50 Vets Now clinics across the UK. There were 701 dystocia cases identified, resulting in a dystocia prevalence of 3.7% (95% CI: 3.5-4.0%) among emergency-case entire bitches.

Breed data were available for 668/701 (95.3%) of the dystocia bitches. Of these with data available, 628/668 (94%) were purebred and 561/668 (84.0%) were recorded as breeds recognized by the KC. Of the KC breed groups, the Toy group had the most case dogs: 172/668 (25.8%). The most common breeds diagnosed with dystocia cases were Chihuahua (n = 75, 10.7%), Staffordshire Bull Terrier (59, 8.4%), Pug (43, 6.1%), Jack Russell Terrier (43, 6.1%) and crossbred (40, 5.7%) (Table 1). Bodyweight data were available on 237/701 (33.8%) of dystocia bitches and the median bodyweight of these was 10.0 kg (interquartile range (IQR) 6.2-21.4, range 1.5-66.6). Age data were available on 659/701 (94.0%) dystocia bitches and the median age at dystocia was 3.0 years (IQR: 2.0 – 4.0, range: 0.7 – 14.0) (Figure 1).

Breed data were available for 16,757/18057 (92.8%) of the non-dystocia bitches. Of these with data available, 13,795/16,757 (82.3%) were purebred and 12,164/16,757 (72.6%) were recorded as breeds recognized by the KC. The Gundog group was the most common KC breed group: 3,509/12,164 (20.9%). Of the 16,757 non-cases with breed recorded, the most common breed types were crossbred (n = 2,961, 16.4%), Labrador Retriever (1,509, 8.4%), Staffordshire Bull Terrier (1,014, 5.6%) and Jack Russell Terrier (908, 5.0%) (Table 1). Bodyweight data were available on 6,040/18,057 (33.4%) of non-dystocic bitches and the median bodyweight of these was 12.1 kg (IQR 6.3-22.5, range 0.2-85.0). Age data were available on 15,292/18,057 (84.7%) non-dystocia bitches and the median age was 4.0 years (IQR: 1.0-9.0, range: 0.0-22.0) (Figure 1).

The prevalence of dystocia varied widely across the breeds. Breeds with the highest prevalence among the entire bitches treated at emergency care practices included French Bulldog (20.6% prevalence, 95% CI 14.1-28.4), Boston Terrier (18.8%, 95% CI 8.9-32.6), Pug (14.5%, 95% CI 10.9-19.4) and Chihuahua (14.2%, 95% CI 11.3-17.5). The prevalence of dystocia among entire crossbred bitches was 1.3% (1.0-1.8) (Table 2).

Risk Factor Analysis

Univariable logistic regression modelling identified six variables with liberally significant ($P < 0.20$) association with dystocia: purebred status, KC-recognised breed, KC Breed Group, breed, bodyweight and age. Although not included in multivariable modelling as explained above, the univariable results indicated that purebred dogs had 3.4 (95% CI 2.4-4.7, $P < 0.001$) times the odds of dystocia compared with crossbred dogs and that KC-recognized breeds had 2.0 (95% CI 1.6-2.4, $P < 0.001$) times the odds of dystocia compared with bitches of non-KC-recognized breeds. The Toy group had the highest odds of dystocia among the KC breed groups when compared with bitches of non-KC-recognized breeds: OR: 3.3, 95% CI 2.6-4.3, P < 0.001. Dystocia risk increased towards the extremes of the bodyweight range: bitches weighing < 10kg had 1.6 (95% CI 1.1-2.5, P = 0.016) times the odds and bitches weighing 40.0-49.9 kg had 3.5 (95% CI 1.8-6.8, P < 0.001) times the odds of dystocia compared with bitches weighing 20-29.9kg (Table 1).

The final multivariable model comprised two risk factors: breeds and age. The final model was improved by inclusion of the clinic attended as a random effect (rho: 0.03 indicating that 3% of the variability was accounted for by the clinic attended, P < 0.001) and these results were reported. No biologically significant interactions were identified. The final unclustered model showed acceptable model-fit (Hosmer-Lemeshow test statistic: P = 0.997) and good discrimination (area under the ROC curve: 0.801). Breeds with the highest odds of dystocia compared with crossbred bitches were French Bulldog (OR: 15.9, 95% CI 9.3-27.2, P < 0.001), Boston Terrier (OR: 12.9, 95% CI 5.6-29.3, P < 0.001), Pug (OR: 11.3, 95% CI 7.1-17.9, P < 0.001) and Chihuahua (OR: 10.4, 95% CI 7.0-15.7, P < 0.001). Bitches aged between 3.0 and 5.9 years had the highest odds of dystocia, showing 3.1 (95% CI 2.6-3.7, P < 0.001) times the odds compared with bitches aged under 3.0 years (Table 3).

Discussion

This study of over 18,000 entire bitches receiving first-opinion emergency veterinary care in the UK identified canine dystocia as a common emergency presentation (3.7% of all entire bitches presented). The study highlighted age and certain breeds as significant risk factors for dystocia. These results can enhance the overall evidence-base to assist breeders and veterinary surgeons to predict the breeds and ages associated with dystocia and therefore to improve dystocia-avoidance strategies at an overall dog population level.

The 3.7% prevalence for canine dystocia reported here is apparently higher than the results from a study of insured bitches in Sweden which reported a dystocia prevalence of 2%. However, the study designs are not directly comparable because the Swedish study included all bitches regardless of neuter status even though it was not possible for the neutered bitches to develop dystocia and so may have substantially under-estimated the true prevalence. In contrast, the current study included only entire bitches (Bergstrom and others 2006).

Although purebred status was assessed only at a univariable level in the current study because of co-linearity with the breed variable, purebred bitches showed 3.4 times the odds of presentation for dystocia compared with crossbred bitches. Previous studies have also reported that purebreds, and particularly brachycephalic types, have been associated with a higher risk of dystocia (Jackson 2004; Linde-Forsberg 2009). An over-representation of purebred dogs among the dystocia caseload could also reflect the higher financial value of purebred compared with crossbred puppies or other human behavioral drivers that may make owners of purebred bitches more inclined to seek emergency veterinary treatment. However, it is worth noting that so-called designer crossbred types now comprise an increasing proportion of crossbred dogs (Beverland and others 2008) and these designer dogs can have quite significant monetary values such that the historic distinctions between purebred and crossbred dogs are becoming increasingly blurred (Oliver and Gould 2012).

After accounting for the other factors assessed, the breeds with the highest odds of dystocia in the current study were the Boston Terrier, French Bulldog, Chihuahua and

Pug. None of the ten most common breeds in the overall study population showed lower odds of dystocia compared with crossbreds. Analysis of Swedish insurance data identified the Scottish Terrier, Chihuahua, Pomeranian and Pug as the breeds with the highest incidence rates for claims for dystocia (Bergstrom and others 2006). However, this insurance study was limited by the exclusion of three breeds (Boston Terrier, Bulldog and French Bulldog) that were not covered for caesarean section by the insurers in question (Agria insurance). So, owners of bitches of these breeds may have been less likely to take out insurance cover with that company. In addition, this insurance study included all bitches, regardless of neuter status, whose data may have confounded the results. A study of 128 bitches with dystocia identified Chihuahuas, Dachshunds, Pekingeses, Yorkshire Terriers, Miniature Poodles and Pomeranians as having significantly higher risk than a hospital population (Gaudet 1985b). In the current study, three of the four breeds with the highest odds of dystocia were breeds with extreme brachycephaly: Boston Terrier, French Bulldog and Pug. Such breeds have been previously reported to have dystocia rates approaching 100% (Gill 2002; Jackson 2004; Linde-Forsberg 2009). Recent increases in breed popularity of small-sized brachycephalic breeds such as the French Bulldog (KC registrations rose almost thirty-fold between 2005 and 2014) and the Pug (KC registrations rose four-fold between 2005 and 2014 (The Kennel Club 2017b) may also underlie the high frequency of these breeds among veterinary presentations for dystocia. The boom in demand for puppies of these popular breeds may encourage acceptance of breeding pairs without sufficient regard for self-whelping attributes. Furthermore, the high commercial value of the puppies means that veterinary costs can be easily passed on to the puppy purchasers (McGreevy and Nicholas 1999) and whelping bitches may be more likely to be presented for early emergency veterinary care if problems arise during the birthing process. Conversely, awareness among breeders of this high breed-related prevalence of dystocia combined with the high monetary value of their puppies means that these predisposed brachycephalic breeds may be more likely to present to routine day-care veterinary practices for planned elective caesarean than to present as out-of-hours emergency-care dystocia cases. So, despite the high odds ratios identified in the current study for brachycephalic breeds, it is possible that these results may still have substantially under-reported the true risk of dystocia in these brachycephalic breeds because an unknown but suspectedly high proportion of bitches from these breeds in the wider population undergo elective caesarean and therefore would be less likely to present for emergency-care whelping management (Evans and Adams 2010; Wydooghe and others 2013).

The current study provides strong evidence for pronounced breed predispositions, especially in brachycephalic breeds to dystocia, and highlights some opportunities for veterinary surgeons to become more involved. It has been suggested that there may be financial disincentives for veterinary surgeons to reduce the incidence of inherited diseases because they are paid to diagnose and treat them (McGreevy 2007). However, amid the broader debate about the ethics of breeding morphologically compromised dogs (McGreevy 2009; McGreevy and Bennett 2010), there is increasing evidence of multiple disorders affecting brachycephalic breeds (O'Neill and others 2015) and current veterinary interest in calling for changes to breed standards (Wedderburn 2016). So, it is timely to consider what general veterinary practitioners can do to reduce the welfare impacts of dystocia in high-risk breeds. One possibility for veterinary surgeon action is provided by the British Veterinary Association which has made it clear that it is ‘important for vets and breeders to report caesareans and any procedures that alter the natural conformation of a dog to the Kennel Club’ (British Veterinary Association

2016). However, although this recommendation for voluntary reporting by veterinary surgeons has been present for several years, the current veterinary reporting levels remain chronically low; just 2.7% of all caesareans reported to the KC during the first half of 2012 were submitted by veterinary surgeons (Llewellyn 2013). This suggests either poor awareness or simple non-compliance by the veterinary profession and it may be worth debating whether reporting of clinical dystocia and/or caesarean surgeries should become mandatory for the veterinary profession. Attending veterinary surgeons also have an ethical opportunity to counsel owners of dystocic bitches about the probability that further breeding may endanger the individual dams and their descendants. Veterinary practices could design their pricing policy to encourage owners of dystocic bitches to commit to neutering at the time of any caesarean surgery. In addition, breed clubs could encourage responsible breeding by requiring highly placed show dogs to be from self-whelping lines. Data from studies such as the current one could be used as evidence to promote the introduction of such initiatives.

The study hypothesised that dogs weighing under 10kg have greater risk of dystocia than dogs weighing 10kg or above. The univariable analysis did support an increased dystocia risk in smaller bitches but also revealed that a more complicated picture existed whereby bodyweights towards both extremes showed increased odds of dystocia. Bitches dogs weighing under 10 kg had 1.6 the odds of dystocia compared with dogs weighting 20.0-29.9 kg, whereas dogs weighing 40-49.9 kg had 3.5 times the odds. These findings are supported by previous reports that also reported higher incidence of dystocia in miniature and toy dogs (Bergström and others 2010; Gaudet 1985b; Münnich and Küchenmeister 2009) and in larger breeds (Münnich and Küchenmeister 2009). Small and miniature breeds often have single-pup pregnancies that can result in an oversized foetus and consequent dystocia (Darvelid and Linde-Forsberg 1994; Gaudet 1985a; Münnich and Küchenmeister 2009).

The current study reported that bitches aged 3.0-5.9 years old had over three times the odds of dystocia compared with bitches aged under three years. Previous studies have variously either reported no association with age (Darvelid and Linde-Forsberg 1994; Gaudet 1985b) or that older bitches were predisposed to dystocia (Bergström and others 2010; Linde Forsberg and Persson 2007). In a study of Boxer dogs, the incidence of uterine inertia was significantly higher in bitches that were four years or older compared with younger bitches and whelping complications other than uterine inertia were also higher in the older bitches (Linde Forsberg and Persson 2007). Older bitches are reported to have a higher incidence for single foetus pregnancies, uterine disorders and prolonged parturition which may contribute to their increased risk of dystocia (Münnich and Küchenmeister 2009).

There were some limitations to the current study. Some variables within the dataset had a high proportion of missing data (notably bodyweight) which limited the possible interpretations from the results. The study caseload represented emergency cases presented during out-of-hours periods (evenings, overnight and weekends) and therefore may vary from the routine caseloads recorded regular hours at primary-care practices. Conversely, this study also had several novel strengths. Although the optimal source of data would be the entire breeding bitch population in the UK, the current analysis of the overall population of entire bitches under veterinary care at a major UK first-opinion emergency-care provider benefits from a large sample size that enabled precise values to be reported for prevalence and high statistical power to detect important risk factors (O'Neill and others 2014a). The inclusion of clinical data from 50 Vets Now clinics covering over 1,000 primary-care practices spread across the UK should reduce geographical biases based on breed types or client expectations and promote good generalizability of the results.

In conclusion, this study revealed increased odds of dystocia among 3-6 year old bitches compared with those aged under three years and for brachycephalic breeds that included three of the four breeds with the highest odds of dystocia: Boston Terrier, French Bulldog and Pug. Application of this knowledge may help to inform veterinary surgeons when offering advice on breed choice for new owners or compiling breeding recommendations for breeder clients. Kennel clubs may use these results to focus their resources on strategies to reduce dystocia in high-risk breeds.

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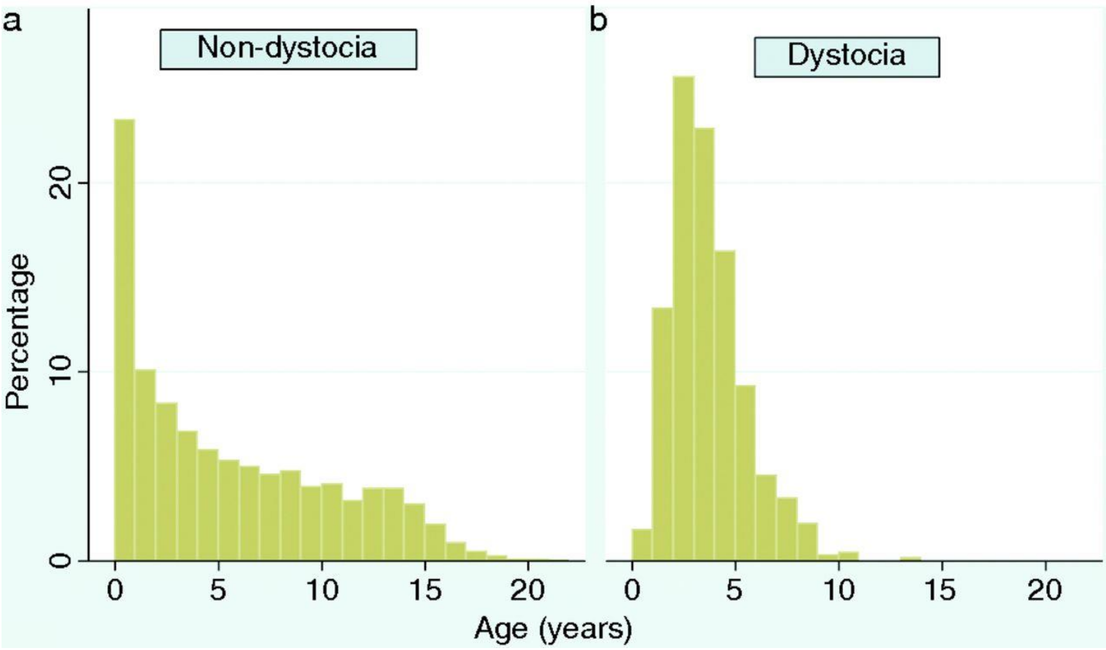
Competing Interests

Dan O'Neill is funded at the Royal Veterinary College by an award from the Kennel Club Charitable Trust. Aoife M O'Sullivan and Amanda K Boag are employed by Vets Now Ltd.

Figures

Figure 1. Ages of A. non-dystocia (n = 18,057) and B. dystocia (n = 701) entire bitches treated at 50 first-opinion emergency-care veterinary practices in the UK



Tables

Table 1: Descriptive and univariable logistic regression results (95% confidence intervals (CI)) for risk factors associated with dystocia in entire bitches attending first opinion emergency-care veterinary practices in the UK. The results shown are based on animals with data available.

Variable	Category	Case No. (%)	Non-case No. (%)	Odds ratio	95% CI	P-Value
Purebred status	Crossbred	40 (6.0)	2,962 (17.7)	Base		< 0.001
	Purebred	628 (94.0)	13,795 (82.3)	3.4	2.4-4.7	
KC-recognised breed	Not KC-recognised breed	107 (16.0)	4,593 (27.4)	Base		
	KC-recognised breed	561 (84.0)	12,164 (72.6)	2.0	1.6-2.4	< 0.001
KC Breed Group	Not_KC_Recognised	107 (16.0)	7,854 (28.3)	Base		
	Gundog	77 (11.5)	3,509 (20.9)	0.9	0.7-1.3	0.691
	Hound	45 (6.7)	793 (4.7)	2.4	1.7-3.5	< 0.001
	Pastoral	23 (3.4)	786 (4.7)	1.3	0.8-2.0	0.328
	Terrier	103 (15.4)	1,967 (11.7)	2.2	1.7-3.0	< 0.001
	Toy	172 (25.8)	2,213 (13.2)	3.3	2.6-4.3	< 0.001
	Utility	99 (14.8)	1,666 (9.9)	2.6	1.9-3.4	< 0.001
	Working	42 (6.3)	1,231 (7.4)	1.5	1.0-2.1	0.039
Breeds	Crossbreed	40 (5.7)	2,961 (16.4)	Base		
	Boston Terrier	9 (1.3)	39 (0.2)	17.1	7.8-37.6	< 0.001
	French Bulldog	28 (4.0)	108 (0.6)	19.2	11.4-32.3	< 0.001
	Chihuahua	75 (10.7)	453 (2.5)	12.3	8.2-18.2	< 0.001
	Pug	43 (6.1)	248 (1.4)	12.8	8.2-20.1	< 0.001
	Miniature Dachshund	12 (1.7)	113 (0.6)	7.9	4.0-15.4	< 0.001
	Bulldog	15 (2.1)	194 (1.1)	5.7	3.1-10.5	< 0.001
	Staffordshire Bull Terrier	59 (8.4)	1,014 (5.6)	4.3	2.9-6.5	< 0.001
	Golden Retriever	13 (1.9)	251(1.4)	3.8	2.0-7.3	< 0.001
	Jack Russell Terrier	43 (6.1)	908 (5.0)	3.5	2.3-5.4	< 0.001
	Border Terrier	10 (1.4)	178 (1.0)	4.2	2.0-8.5	< 0.001
	Yorkshire Terrier	22 (3.1)	621 (3.4)	2.6	1.5-4.4	< 0.001
	Springer Spaniel	14 (2.0)	524 (2.9)	2.0	1.1-3.7	0.030
	Boxer	12 (1.7)	355 (2.0)	2.5	1.3-4.8	0.006
	West Highland White Terrier	12 (1.7)	433 (2.5)	2.0	1.0-3.9	0.037
	Shih-tzu	15 (2.1)	469 (2.6)	2.4	1.3-4.3	0.005
	Cavalier King Charles Spaniel	12 (1.7)	437 (2.4)	2.0	1.1-3.9	0.033

	Cocker Spaniel	17 (2.4)	667 (3.7)	1.9	1.1-3.3	0.030
	Border Collie	8 (1.1)	427 (2.4)	1.4	0.6-3.0	0.403
	German Shepherd Dog	8 (1.1)	438 (2.4)	1.4	0.6-2.9	0.440
	Labrador Retriever	20 (2.9)	1,509 (8.4)	1.0	0.6-1.7	0.945
	Other purebred dogs	181 (25.8)	4,400 (24.4)	3.0	2.2-4.3	< 0.001
Bodyweight overall (kg)	< 10.0	115 (16.4)	2,624 (14.5)	1.6	1.1-2.5	0.016
	10.0-19.9	56 (8.0)	1,522 (8.4)	1.4	0.9-2.1	0.161
	20.0-20.9	31 (4.4)	1,159 (6.4)	Base		
	30.0-30.9	19 (2.7)	523 (2.9)	1.4	0.8-2.4	0.301
	40.0-49.9	13 (1.9)	140 (0.8)	3.5	1.8-6.8	< 0.001
	≥ 50.0	3 (0.4)	72 (0.4)	1.6	0.5-5.2	0.472
	No recorded bodyweight	464 (66.2)	12,017 (66.6)	1.4	1.0-2.1	0.051
Age category (years)	< 3.0	268 (38.2)	6,397 (35.4)	Base		
	3.0 - 5.9	320 (45.7)	2,771 (15.4)	2.8	2.3-3.3	< 0.001
	6.0 - 8.9	65 (9.3)	2,198 (12.2)	0.7	0.5-0.9	0.013
	≥ 9.0	6 (0.9)	3,926 (21.7)	0.0	0.0-0.1	< 0.001
	No age data available	42 (6.0)	2,765 (15.3)	0.4	0.4-0.5	< 0.001

Table 2: Breed prevalence (%) (95% confidence intervals (CI)) of dystocia in entire bitches treated at first opinion emergency-care veterinary practices in the UK

Breed type	Total no. dogs	No. dystocia cases	% dystocia	95% CI
Crossbreed	3,001	40	1.3	1.0-1.8
Boston Terrier	48	9	18.8	8.9-32.6
French Bulldog	136	28	20.6	14.1-28.4
Chihuahua	528	75	14.2	11.3-17.5
Pug	291	43	14.5	10.9-19.4
Miniature Dachshund	125	12	9.6	5.1-16.2
Bulldog	209	15	7.2	4.1-11.6
Staffordshire Bull Terrier	1,073	59	5.5	4.2-7.0
Golden Retriever	264	13	4.9	2.6-8.3
Jack Russell Terrier	951	43	4.5	3.3-6.0
Border Terrier	188	10	5.3	2.6-9.6
Yorkshire Terrier	643	22	3.4	2.2-5.1
Springer Spaniel	538	14	2.6	1.4-4.3
Boxer	367	12	3.3	1.7-5.6
West Highland White Terrier	455	12	2.6	1.4-4.6
Shih-tzu	484	15	3.1	1.7-5.1
Cavalier King Charles Spaniel	449	12	2.7	1.4-4.6
Cocker Spaniel	684	17	2.5	1.6-3.9
Border Collie	435	8	1.8	0.8-3.6
German Shepherd Dog	446	8	1.8	0.8-3.5
Labrador Retriever	1,529	20	1.3	0.8-2.0
Breed not recorded	1,333	33	2.5	1.7-3.5
Other pure breeds	4,581	181	4.0	3.4-4.6

Table 3: Final random-effects multivariable logistic regression model (95% confidence intervals (CI)) for risk factors associated with dystocia in entire bitches attending first opinion emergency-care veterinary practices in the UK (n = 18,758).

Variable	Category	Odds ratio	95% CI	P-Value
Breeds	Crossbreed	Base		
	Boston Terrier	12.9	5.6-29.3	< 0.001
	French Bulldog	15.9	9.3-27.2	< 0.001
	Chihuahua	10.4	7.0-15.7	< 0.001
	Pug	11.3	7.1-17.9	< 0.001
	Miniature Dachshund	6.0	3.0-12.0	< 0.001
	Bulldog	4.5	2.4-8.4	< 0.001
	Staffordshire Bull Terrier	4.1	2.7-6.2	< 0.001
	Golden Retriever	3.6	1.9-7.0	< 0.001
	Jack Russell Terrier	3.4	2.2-5.4	< 0.001
	Border Terrier	3.6	1.7-7.4	0.001
	Yorkshire Terrier	2.7	1.6-4.6	< 0.001
	Springer Spaniel	1.7	0.9-3.2	0.093
	Boxer	2.4	1.2-4.6	0.011
	West Highland White Terrier	2.5	1.3-4.9	0.007
	Shih-tzu	2.1	1.1-3.8	0.020
	Cavalier King Charles Spaniel	1.8	0.9-3.5	0.083
	Cocker Spaniel	1.5	0.9-2.7	0.146
	Border Collie	1.7	0.8-3.7	0.182
	German Shepherd Dog	1.4	0.7-3.1	0.370
	Labrador Retriever	0.8	0.5-1.4	0.523
	Other purebred dogs	2.6	1.8-3.7	< 0.001
Age category (years)	< 3.0	Base		
	3.0 - 5.9	3.1	2.6-3.7	< 0.001
	6.0 - 8.9	0.9	0.7-1.1	0.318
	≥ 9.0	0.0	0.0-0.1	< 0.001
	No age data available	0.4	0.3-0.5	< 0.001

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