Risk factors for tail injuries in dogs in Great Britain

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Summary

Tail injuries in dogs are an important welfare problem and it has been argued that prophylactic tail docking reduces the risk of injury in high risk animals. However, others argue that tail docking is not justified and is an unnecessary intervention that compromises animal welfare. A previous study conducted in the UK in 1985 showed that tail injuries were rare with the estimated prevalence being 0.39% (Darke et al 1985) and no significant association was found between tail docking and tail injuries. In contrast, a more recent study focusing on working dogs, found a significant reduction in tail injuries in docked spaniels (Houlton 2008). However, Houlton's study consisted of only working dogs, while Darke's study focused on a subset of the UK dog population and therefore they may not provide a representative perspective of the risks of injury or major risk factors for the UK dog population in general. A ban on non-therapeutic tail docking was introduced in Great Britain (GB) in early 2007, making the re-evaluation of tail injuries and the role of docking increasingly relevant. Therefore, the aim of the current study was to quantify the risk of tail injury, to identify major risk factors for tail injury and to evaluate the extent to which docking reduces the risk of tail injury in dogs in GB.

A nested case-control study was conducted during 2008 and 2009. Data were obtained from a stratified random sample of veterinary practices throughout GB and questionnaires were sent to owners of dogs with tail injuries (cases) and a randomly selected sample of dogs without tail injuries (controls). Risks of injury were reported adjusting for the sampling approach and mixed effects logistic regression was used to develop a multivariable model for risk factors associated with tail injury ($P < 0.05$).

Two hundred and eighty-one tail injuries were recorded from a population of 138,212 dogs attending 52 participating practices between March 2008 and March 2009. The weighted risk of tail injuries was 0.23% (95% CI 0.20 – 0.25). Thirty-six percent of injuries were related to in house injuries, 17.5% were outdoor related injuries, 14.4% were due to being caught in a door, for 16.5% the cause was unknown and the remainder were due to other causes. Dogs with a wide angle of wag and dogs kept in kennels were at significantly higher risk of sustaining a tail injury. Dogs with docked tails were significantly less likely to sustain a tail injury as expected. Approximately 500 dogs would need to be docked in order to prevent one tail injury. Springer spaniels, Cockers spaniels, Greyhounds, Lurchers and Whippets were all at significantly higher risk when compared to Labradors and other Retrievers. Differences between countries and between rural and urban environments were not significant (p=0.566 and p=0.468 respectively).

The current study suggests that the risk of tail injury was rare, though working dogs appeared to have a greater risk of injury than other dogs on univariable analysis. Specific breeds including spaniels were at substantially higher odds of injury and docking appeared to have a protective effect against injury. Being a working dog was not a major risk factor, suggesting that though working dogs were more likely to injure their tails (based on the risks of injury), other factors including breed characteristics and levels of activity of dogs were more important than work per se in practice attending dogs in general. Additional studies focusing on the high risk groups would be merited to allow further evaluation of risk factors in these specific groups.

Introduction

The docking of dogs' tails remains controversial and centres on whether non-therapeutic docking reduces the risk of tail injury sufficiently to justify the ethical concerns of a prophylactic intervention (Bennett and Perini 2003). A ban on non-therapeutic tail docking was introduced in Great Britain (GB) in early 2007. In Scotland, a complete ban was introduced, in Wales the ban was introduced with specific working breed exemptions and in England with specific working breed-type exemptions (2006; 2007). The exemptions include dogs involved in law enforcement, armed forces, emergency rescue, lawful pest control and lawful shooting of animals. These variations in legislation provided a unique opportunity to evaluate the association between docking and tail injuries in a population of dogs including substantial numbers of docked and undocked animals and assess whether or not country and rural or urban location are risk factors in themselves.

A previous study conducted in Edinburgh, UK in 1985 showed that tail injuries were rare with the estimated prevalence being 0.39% (Darke and others 1985). They estimated that not docking a dog's tail increased the risk of a tail injury 1.28 times, but this was found to be not significant (95%CI 0.61–2.69). A more recent survey, which recorded the types of injuries and causes of lameness in dogs involved in game shooting, showed a highly significant association between tail injuries and being undocked amongst Springer (p=0.008) and Cocker Spaniels (p=0.004) (Houlton 2008). Both these studies represented a subset of the GB dog population and were conducted prior to when the restrictions on docking were implemented. Additionally, the working dog study by Houlton (2008) relied on a convenience sample and the study by Darke and others (1985) is more than twenty years old, therefore further work to evaluate tail injuries in GB is required. The aim of the current study was to evaluate tail injuries in dogs in GB, to quantify the risk of tail injuries, to ascertain the extent to which docking reduces the risk of tail injury and identify other major risk factors for tail injury in dogs attending veterinary practices in GB.

Materials and Methods

A case-control study design was used nested within a cohort of veterinary attending dogs between March 2008 and March 2009. Pre-study power calculations estimated that approximately 250 dogs with tail injuries would be required. However, these calculations were revised based on the prevalence of dogs with docked tails amongst the dogs recruited into the study. The revised sample size calculations estimated that approximately 90-120 cases of tail injury would be required based on the detection of an odds ratio (OR) of 0.3-0.5, assuming that the prevalence of docking amongst dogs was approximately 12-14% (95% confidence level, 80% power, case: control ratio of 1:4, Win Episcope 2.0).

A list of mixed and companion animal veterinary practices were taken from the RCVS practice register (2008a). This list was stratified by country; England, Scotland and Wales, and then the list for each country was stratified by location; rural and urban based on the post code classification of the practice location (National Statistics Postcode Directory). A sample of veterinary practices were then randomly selected, using random number generation, from each of these lists, after which they were approached to determine if they were using one of the specified computerised practice management systems; Vetsolutions, Premvet, Midshires, Ventana, Teleos, VetOne and RxWorks, and if they were willing to participate in the study. Data were then extracted from their practice database giving the list of all dogs that attended the veterinary practice in the previous 12 month period and their clinical histories. A free text search was used to identify all dogs which had sustained a tail injury by searching for the word “tail”. The search detected all words containing “tail” whether there was a space or not before or after the word.

Cases were defined as any dog presented to the veterinary practice within the previous 12 months for treatment of a tail injury including fractures, dislocations, lacerations, contusions, self-trauma and neoplasia. Tail problems relating to neoplasia and self-trauma were included as it is anecdotally thought that in some of these cases there is an underlying chronic traumatic injury eventually leading to the development of a tumour or a self-traumatic injury. For every case, approximately 4 control dogs were randomly selected from the list of dogs attending the participating practices within the same time period. Dogs selected as controls that had sustained a tail injury within the past 12 months but had not been treated by a veterinarian, were excluded as controls. Dogs suffering from water tail / limber tail were excluded from the study as these injuries are not well understood and it is thought that they are due to muscle fatigue. It was also thought that by including these as cases this would result in a weakening of the power of the study and the possibility of examining associations between risk factors and typical tail injuries.

The owners of the selected cases and controls were sent a questionnaire during 2008 and 2009. The questionnaire was designed and pre-tested prior to the study. The questionnaire was reviewed by 5 epidemiologists and 8 clinicians. It was then pre-tested on 5 dog owners to ensure it was clear and easy to follow. The questionnaire was also translated into Welsh. A pre-paid reply envelope was supplied with the questionnaire in addition to a disposable tape measure enabling owners to measure the length and height of their dog. The questionnaire investigated aspects relating to the size, temperament and breed of the dog, the home environment, whether the dog was used as a working dog and the nature of any tail injuries (Table 1, questionnaire available on request from the first author). Those dog owners who returned their questionnaire were entered into a monthly prize draw (food hamper) in order to increase the response rate. A second questionnaire and reminder letter were sent to all owners if no response was received within four weeks.

Table 1: Risk factors evaluated in case-control study

Factor	
Dog characteristics	age, sex, neutering status, breed, weight, height, tail length, body length, coat length, coat type, body condition, docked before injury, tail shape, tail hair, temperament, tail wag angle, tail wag in circles, bottom wag, style of tail wag
Owner details / Type of activity	Country, urban/rural, veterinary practice, uses dog for work, shows dog, where is dog kept, type of property, how many other dogs owned, frequency of exercise, exercise hours, exercise environment, type of work, frequency of work, work hours, work environment

All data were entered into a pre-designed database with data entry validation rules (Access 2003, Microsoft Corporation). The data were checked, cleaned and then exported to Stata version 9 (Stata Corp, College Station, TX, USA) for analysis. The weighted risk estimates were calculated accounting for the sampling strategy by using the Stata ‘survey’ commands. Additional risk approximations were calculated for working and non-working dogs, for docked and non-docked dogs and for individual breeds or breed types based on estimated denominator data. This was calculated by using the proportion calculated from the data relating to the control dogs enrolled in the study. ‘Attributable risk’, ‘number needed to treat’ and ‘population attributable risk fraction’ were calculated where appropriate.

The analysis assessing risk factors initially involved univariable screening. This was done using chi squared tests of association and univariable logistic regression. The ‘ xtlogit’ command (with country and urban/rural as fixed effects and veterinary practice id as a random effect) was used in order to account for the clustering in the dataset. All variables were assessed for collinearity using a correlation matrix, and where two variables were found to be highly collinear a decision was made to exclude one variable from the model based on considerations including *a priori* importance of the risk factors, strength of associations and missing values (Dohoo and others 2003). All continuous variables were assessed graphically for normality. All variables which had a p-value less than 0.2 on univariable screening were put forward for mulitvariable analysis. Manual forward and backward stepwise multivariable mixed-effects logistic regression models were developed assessing the addition or removal of individual variables using the likelihood ratio test. Statistical significance was set at the 5% level. If the likelihood ratio test was not significant, it was also checked whether the variable had a confounding effect by assessing changes in the coefficients and significance of other variables in the model before being removed. All final model variables were assessed for interactions. The fit of the model was assessed using Hosmer-Lemeshow goodness-of-fit test on the basic logistic regression model. As the ‘xt’ commands in Stata version 9 do not support goodness-of-fit tests, further diagnostics, including the calculation of leverage and delta-betas, were used to identify any outliers or highly influential observations. The ‘quadchk’ command was used on the final ‘xtlogit’ model to assess the sensitivity of the quadrature approximation. The change in coefficients was less than 0.01% and therefore it can be assumed that the choice of quadrature did not significantly affect the results. Due to the *a priori* interest in working dogs, the variable ‘work’ was forced into all models to assess its significance. Several multivariable models were developed in order to assess various aspects of the data. A model was developed for all dogs in the study using different breed classifications, for spaniels only and for working dogs only.

The breed, sex and age of the non-responders amongst the cases and controls were compared to those that did respond in order to assess the representativeness of cases and controls. Additionally, the types of injuries recorded amongst the non-responding cases were compared to those of the cases that did respond.

Results

A total of 314 veterinary practices were initially contacted. Of these practices, 198 either immediately refused to participate or did not have a suitable computer system to be eligible to be included in the study. The remaining 116 practices were then sent a letter requesting their participation in the study, of which 52 agreed to participate. Those practices which did not agree to participate stated one of the following reasons: they did not want to participate in a study looking at such a topical issue, did not have the time or they were uncomfortable contacting their clients with questionnaires. The 52 participating veterinary practices provided clinical records for 138,212 dogs which had attended the practices within the previous 12 month period. A total of 281 cases were identified in the clinical records but questionnaires could not be sent to all cases at the request of some practices. Three practices withdrew from participating in the study after their database had been queried, meaning data were available on the number of cases and number of practice attending dogs but the cases could not be sent questionnaires. Additionally, there were some cases which had recently died or been euthanized, in which case the veterinary practice requested a questionnaire not be sent to those particular cases. A total of 224 questionnaires were sent out to cases and 799 to controls. Of all the cases 97 responded (response rate 43.3%), and 227 of the controls responded (response rate 28.4%). Five controls were excluded due to these dogs having sustained a tail injury in the previous 12 month period but not been seen or treated by a veterinarian. Of these five controls, two injuries occurred in working dogs whilst working and the other three were household injuries. One of these dogs had a docked tail prior to sustaining an injury.

There was no significant difference between the proportions of specific breeds amongst the cases that responded and the cases which did not respond (p=0.351). Additionally, there was no significant difference in the ages (p=0.985) or sex (p=0.686) between the case responders or non-responders. Similar results were found when comparing the responders and non-responders amongst the controls (breeds p=0.974; age p=0.974; sex p=0.561). There was no significant difference in the type of tail injuries recorded in the clinical data between the case responders and case non-responders (p=0.873).

Tables 2 and 3 show some descriptive results of the number of dogs docked, number used for work and the number of dogs of specific breeds amongst the cases and controls enrolled in the study.

Table 2: Number of dogs docked and used for work amongst the cases and controls

	Cases			**Controls**		
	Working	**Not working**	**Total**	**Working**	**Not working**	**Total**
Docked	0	2	2	9	26	35
Not docked	12	83	95	8	177	185
Total	12	85	97	17	203	220*

* 2 owners did not state whether or not their dog’s tail was docked.

Table 3: Number of dogs in specific breeds and used for work amongst cases and controls

	Cases			**Controls**		
	Working	**Not working**	**Total**	**Working**	**Not working**	**Total**
Labradors & other retrievers	3	16	19	4	34	38
English Springer spaniels	4	13	17	7	9	16
Cocker spaniels	1	3	4	1	4	5
Border collies, Rough collies	1	5	6	2	30	32
Jack Russell Terriers	0	1	1	1	14	15
Lurchers, Greyhounds, Whippets	2	14	16	0	6	6
Other	1	33	34	2	108	110
Total	12	85	97	17	205	222

Amongst the 29 working dogs, all were used for game shooting except for five dogs. One of these was a racing greyhound, one was a police dog (German Shepherd) and three were herding collies.

Risk of tail injury

Of the 138,212 dogs for which clinical records were obtained, 281 were identified as having had a tail injury within the previous 12 months. The weighted risk of tail injuries across all regions was 0.23% per year (95% CI 0.20 to 0.25). The risks of tail injury in each country and location are given in table 4.

Table 4: Risk estimates for countries and locations (no significant difference was found between any countries or locations)

Category	**No. cases**	**No. dogs at risk**	**Risk estimate %**	**95% CI**
England			**0.17**	**0.13 – 0.21**
Urban	65	36 509	0.18	0.14 – 0.22
Rural	22	13 442	0.16	0.09 – 0.23
Scotland			**0.22**	**0.18 – 0.26**

Urban	48	25 816	0.19	0.14 – 0.24
Rural	72	29 679	0.24	0.18 – 0.30
Wales			**0.23**	**0.18 – 0.28**
Urban	72	31 646	0.23	0.18 – 0.28
Rural	2	1 120	0.18	0.00 – 0.43
Weighted risk for GB	**281**	**138 212**	**0.23**	**0.20 – 0.25**

Based on the proportion of working and non-working dogs amongst cases and controls, the approximated risk amongst working dogs was 0.29% (32 injuries/10,974 dogs, 95%CI 0.21 to 0.43%) whilst the approximated risk amongst non-working dogs was 0.19% (249 injuries /127,238 dogs, 95%CI 0.17 to 0.22%) (29 working dogs was the number of working dogs amongst those that did respond while 32 working dogs is the approximated number of working dog injuries expected had all owners responded to the questionnaire out of the 10,974 clinical records). There was a statistically significant difference in risk between the two groups of dogs (p=0.032). The approximated risk for docked dogs was 0.03% (6 injuries / 21,285 dogs, 95% CI 0.01 to 0.06%) and for undocked dogs was 0.23% (275 injuries / 116,927 dogs, 95% CI 0.21% to 0.27%). This was a statistically significant difference in the risk (p<0.001). The attributable risk was calculated from these risk approximations and was found to be 0.2% for docking and therefore the 'number needed to treat' is 500 dogs. The population attributable risk fraction for docking was a decrease of 11.9%.

Risk approximations were also calculated for breeds and these results are given in table 5.

Table 5: Risk approximations for breeds and breed types.

Breed	**No. cases**	**Approximate no. dogs at risk**	**Risk estimate (%)**	**95% CI**
Labradors & other retrievers	56	23911	0.23	0.18 – 0.30
English Springer spaniels	47	10366	0.45	0.34 – 0.60
Cocker spaniels	12	3179	0.37	0.22 – 0.66
Border collies, rough collies	18	20732	0.08	0.06 – 0.14
Jack Russell Terriers	3	9675	0.03	0.01 – 0.09
Lurchers, greyhounds, whippets	47	3870	1.22	0.90 – 1.61
Other	98	66479	0.15	0.12 – 0.18

Types of tail injury

Of the 97 cases that completed a questionnaire; 70.1% (68 cases) were lacerations and bleeding; 20.6% (20 cases) were fractures or dislocations and the rest (9.3%, 9 cases) were self-trauma and neoplasia (6 cases and 3 cases respectively). The questionnaires showed that 44.3% (43 cases) were recurrent tail injuries (based on the owners' assessments), 53.6% (52 cases) were not recurrent injuries and 2 cases did not state if the injury was recurrent. According to owners' assessments, 36.1% (35 cases) of the injuries were caused by the dog knocking its tail against the wall, kennel wall and other household objects, 17.5% (17 cases) were from undergrowth or fences during exercise or work, 14.4% (14 cases) were due to their tail being caught in a door, 15.5% (15 cases) were due to other various causes and 16.5% (16 cases) did not know the cause. The majority of injuries were treated conservatively (57.7%, 56 cases) with antibiotics, anti-inflammatories and dressings, 30.9% (30 cases) resulted in tail amputation and 11.4% (11) did not require any specific treatment.

Risk factors for tail injuries

The major risk factors for tail injuries identified in the final multivariable model are shown in table 6. Breed was an important factor with English Springer spaniels having 5.97 times the odds and Greyhounds, Lurchers and whippets having 6.85 times the odds of sustaining an injury compared to Labradors and other retrievers. Dogs with docked tails had 0.03 times the odds of an injury compared to those dogs which were undocked. Dogs kept in kennels during the day, night or both had 3.60 times the odds of sustaining a tail injury when compared to those that are not kept in a kennel. Also, those dogs which wagged their tails in a very wide angle had 3.72 times the odds, whilst those that wag their tail in a moderately wide angle had 2.91 times the odds of sustaining an injury compared to those dogs which only wagged their tails in a narrow angle.

Other factors, height of the dog, weight of the dog, body length, coat type and type of tail hair were also shown to be significant factors. However, these factors were not included in the final model as there was strong collinearity with the variable breed, which increased the standard errors of the estimates for breed and made the model unstable.

The variable 'work' was forced into the model due to the *a priori* interest in work as a risk factor despite this variable not being significant. A variable classifying dogs into game shooting, other type of work or no work was also assessed and found to be not significant. There were no interactions found and the fit of the model was good (Hosmer Lemeshow model fit statistic P value=0.733). The area under the ROC curve for the logistic regression model was 0.7854 and there were no particularly high leverage or delta-beta values (defined as delta-beta>1.0, leverage >2k/n, where k=no. variables, n=no. observations) (Hosmer and Lemeshow 2000) which indicated no highly influential observations and supports good model fit.

Table 6: Results of multivariable mixed-effects logistic regression model (number of observations used in final model was 309 out of 319)

Variable category	No. cases	No. controls	β	se β	Odds ratio	95% CI	p-value
Breed							
Labradors / retrievers	19	37			1.00		
English Springer spaniels	16	16	1.786	0.655	5.97	1.65 – 21.52	0.006
Cocker spaniels	4	5	1.558	0.989	4.75	0.68 – 33.03	0.115
Border / rough collie	6	32	-0.753	0.546	0.47	0.16 – 1.37	0.168
Jack Russell terriers	1	15	-1.492	1.096	0.22	0.03 – 1.93	0.173
Greyhounds / lurchers / Whippets	16	6	1.924	0.604	6.85	2.10 – 22.39	0.001
Other breeds	33	103	-0.152	0.365	0.86	0.42 – 1.76	0.677
Missing	2	8					
Tail docked before injury							
No	93	181			1.00		
Yes	2	33	-3.467	0.913	0.03	0.01 – 0.19	<0.001
Tail wagging angle							
Narrow angle	10	61			1.00		
Moderately wide	28	62	1.066	0.464	2.91	1.17 – 7.21	0.021
Very wide	57	91	1.315	0.433	3.72	1.59 – 8.70	0.002
Is the dog kept in kennels (during night, day or both)							
No	78	201			1		
Yes	17	13	1.281	0.508	3.60	1.33 – 9.75	0.012
Work use*							
No	84	197			1		
Yes	11	17	-0.339	0.656	0.71	0.20 – 2.58	0.605
Intercept	-	-	-1.906	0.493	-	-	-
Random effect of practice id (ρ)	-	-	0.009	0.013	-	-	0.350

* Forced into model due to *a priori* interest in working dogs

Due to the high level of collinearity of many variables with breed and the increased odds in spaniels, the model was repeated restricting the analysis to only spaniels (Cocker and Springer spaniels). The results of this model are shown in table 7. This shows that whether a dog's tail was docked or not was the most important factor, with docked dogs having 0.008 times the odds of sustaining a tail injury compared to those dogs with undocked tails. The dog's sex was included in the model as it had a confounding effect on docking. 'Work' was forced into the model but was found to be non-significant. The fit of the model was good and the area under the ROC curve was 0.930. The model development was repeated using the different classifications of breeds, according to the current English and Welsh legislation for tail docking and the results are shown in Appendix 1 and 2 respectively. The results of these models showed similar results to the model shown in table 6. A model was also developed restricting the analysis to just working dogs. In this case, docked dogs were at significantly lower risk of sustaining a tail injury compared to those with intact tails and dogs kept in kennels were at a significantly higher risk (Appendix 3).

Table 7: Results of multivariable mixed-effects logistic regression model restricted to only spaniel breeds (number of observation used in final model was 41)

Variable category	No. cases	No. controls	β	se β	Odds ratio	95% CI	p-value
Tail docked before injury							
No	19	4			1		
Yes	1	17	-4.885	1.390	0.008	0.0004 – 0.12	<0.001
Dogs sex							
Male	14	8			1		
Female	6	13	-2.108	1.214	0.121	0.01 – 1.31	0.082
Work use*							
No	15	13			1		
Yes	5	8	-0.068	1.144	0.934	0.10 – 8.81	0.953
Intercept	-	-	2.758	1.073	-	-	-
Random effect of practice id (ρ)	-	-	0.012	0.030	-	-	0.426

* Forced into model due to *a priori* interest in working dogs

Discussion

This study has been able to estimate the risk of tail injuries in GB and identify major factors associated with a tail injury occurring in a large population of practice attending dogs. The overall risk of injury was low and the absolute number of working dogs sustaining injuries was small in relation to the total number of injuries reported, reflecting the small proportion of working dogs that attended the practices during the study period. Non-working trauma accounted for the majority of injuries seen by participating veterinary practices. Work in itself was not a major risk factor and animal characteristics such as breed, levels of tail activity and docking status were more important factors associated with tail injury in practice attending dogs. That there was an increased risk in working dogs on univariable analysis, but in the multivariable model this factor was not significant, may be related to the high correlation between breed and work use and the limited power to evaluate minor risk factors and factors present in a small proportion of the population (8% of the control population were classified as working). Further studies evaluating in greater detail risk factors in working dogs would be merited.

Risk of tail injury

The overall weighted risk of tail injuries in dogs in GB was estimated to be 0.23% per year; which was lower than the prevalence found by Darke and others (1985). This suggests that tail injuries requiring treatment in the general dog population of GB could be even rarer than originally thought. The difference in results between the studies may be due to differences in the population studied. In the study by Darke and others, the study population was predominantly urban, and restricted to those dogs attending the University of Edinburgh small animal clinic. In the current study, the dogs sampled were selected from veterinary practices throughout GB, both urban and rural, and therefore, were more representative of the general dog population of GB. The study in Edinburgh included dogs with tail lacerations, contusions, fractures dislocations, self-trauma, neoplasia and dermatoses, however, the current study only included dogs with lacerations, contusions, fractures, dislocations, self-trauma and neoplasia. Dogs with tail dermatoses were not considered as cases for the current study as there are many potential causes of this condition, such as allergies, flea infestation or even impacted anal glands. Additionally, the current study risk estimate is based on a population of 138,212 dogs, whereas the study by Darke and others based their risk estimate on a population of 12,129 dogs.

It is important to bear in mind that the current study has estimated the risk of tail injuries seen by a veterinarian amongst a veterinary attending dog population and therefore does not account for any tail injuries not seen by a veterinarian. The risk of tail injuries at 0.23% in the current study indicates that tail injuries are very rare and the approximated risk of tail injuries in working dogs was only slightly higher at 0.29%. In the study by Houlton (2008), 38 dogs out of 668 (5.68%) sustained a group 1 injury (injuries of the pads, nails or webbing of the feet), 74 dogs (11.08%) sustained a group 2 injury (wounds excluding the feet and tail), 21 dogs (3.14%) sustained group 3 injuries (articular pathology, fractures and muscular injuries) and 12 dogs (1.79%) sustained group 4 injuries (ocular injuries and miscellaneous conditions). However, direct comparison of these risks cannot be made due to the differences in populations of dogs studied, the Houlton studied focused only on working dogs but the current study included all practice attending dogs with working dogs representing a small proportion of them (9.1%), and also the risk estimated by Houlton related to many different types of injury. It would be useful to find other studies to compare the risk of injury; however, very few papers have looked at this.

The current study found no significant difference in risk between England, Scotland and Wales, or between urban and rural areas. This is information which may be considered for policy formation as the current tail docking legislation varies by country. This could indicate that there are no differences at all and the rate of tail injury is so low that minor policy differences have no practical consequences, or that these differences have yet to have a significant impact on the likelihood of tail injuries. The current study was conducted soon after the introduction of the new legislation and therefore it may be too soon to detect differences in risks of tail injury due to the differences in legislation. Dogs born after the ban on tail docking would only be at most 18 to 24 months of age at the time of the study. Additionally, the current legislation does not prevent docked or undocked dogs from being moved between countries. A further study could be done when the effects of the tail docking ban are fully felt and there is a much lower proportion of docked dogs in the population to fully assess the impact of the variations in legislation.

A significant difference was found between the risk approximations for working and non-working dogs, with working dogs being at significantly higher risk of sustaining a tail injury. However, this difference was not detected in the final multivariable model of risk factors. This suggests that work per se was not a major risk factor after adjusting for other major factors (especially breed). Further, ‘work’ was highly correlated with breed making it difficult to evaluate separately from this factor in the multivariable risk factor model. .

Nonetheless, there was also a significantly higher risk of tail injury amongst non-docked dogs compared to dogs which had been docked and this was indentified in the final model. This suggests that in general tail docking appeared protective. This is to be expected; as if a dog does not have a tail, or has a tail of reduced length, it is much less likely to injure it. The important factor to examine is the level of protection that docking provides and how much more likely a dog is to sustain a tail injury given that it is not docked. The population attributable risk fraction estimate indicates, assuming a causal association, that tail docking in the dog population studied is responsible for a 12% reduction in tail injuries, which could be considered to be a large and significant decrease. However, in absolute terms, the attributable risk is small at 0.2% and the ‘number needed to treat’ (which is the number of dogs needed to be docked in order to prevent one tail injury) is very large at 500 dogs. This can be explained by the fact that tail injuries are rare and this estimate is for the general dog population and not adjusted to specific breeds.

The risk approximations for breeds or breed-types showed that Lurchers, Greyhounds and Whippets, English Springer spaniels and Cocker spaniels are all at much higher level of risk of sustaining a tail injury. In Lurchers, Greyhounds and Whippets it is anecdotally thought that this may be due to their long, whip-like tails with very little hair cover for protection (2008b). For Springer and Cocker spaniels, it is thought that this may be due to their exuberant characters. However, it should be emphasised that in the current study the number of dogs representing each individual breed was low and therefore caution is needed in interpreting these findings. Additionally, it is important to keep in mind, that despite these breeds been shown to be the highest risk groups, the overall risk of tail injuries is still very low. It is interesting to note, that although greyhounds, lurchers and whippets were shown to be one of the groups at highest risk, these breeds are not and have never been customarily docked.

One of the factors of interest at the start of the study was the length of the dog's tail and not just whether or not it had been docked. Some breeds of dog have their tails docked to two thirds the normal length, others to half the length and other breeds have virtually the entire tail removed. Unfortunately, in the current study due to the small numbers of dogs recruited into the study, categorising dogs into these different groups was not possible in the multivariable model. By not being able to classify dogs in this way, this may have artificially inflated the relative risk of tail injury in undocked dogs. In the questionnaire, the owners were also asked to measure the exact length of their dog's tails using a measuring tape. Unfortunately, all these measurements were post-injury measurements and due to some dogs having had their tails amputated in the treatment of their tail injuries, this made this variable unsuitable for analysis as a risk factor.

Types of tail injury

The most common type of tail injury recorded in the current study was lacerations and bleeding. This is similar to the findings of Houlton (2008) where tail tip injuries were the most frequently reported tail injury. It was also interesting to note that 44.3% of the tail injuries were recurrent injuries. This shows an agreement with anecdotal evidence which suggests that tail injuries are very difficult to treat often resulting in many treatment attempts before finally having to amputate the tail. The current study has shown that almost one third of tail injuries requiring veterinary treatment resulted in tail amputation. However, it should also be noted that there were five control dogs which had to be excluded as they had sustained a tail injury but had not been seen by a veterinarian. This gives an indication that there may be tail injuries which occur but are treated by their owners. Further work assessing the severity of injuries would be a useful addition to the current study to help evaluate if any exemptions should be allowed and if managemental changes could prevent a large number of the current injuries.

Risk factors for tail injuries

The risk factor analysis identified several important risk factors. Firstly, an association was found between the breed of the dog and the likelihood of sustaining a tail injury. English Springer spaniels and Cocker spaniels were both at much higher risk when compared to Labradors and other retrievers. This finding supports that of Houlton (2008) who found that tail injuries were much more common amongst these breeds than Labradors or pointers. Additionally it was found that the Greyhound, Lurchers and Whippets breed category were at a significantly higher risk than Labradors and higher than both English Springer and Cocker spaniels. Anecdotally, and as mentioned before, it has been suggested that these breeds are at higher risk due to their long whip-like tails with very little hair coverage. Factors such as height, weight, body length, coat type and tail hair were found to be significant factors on univariable analysis. However, they could not be included in the final model due them being highly collinear with breed. For height, weight and body length, it was found that the larger dogs were more at risk of sustaining a tail injury – which supports the finding that Lurchers and Greyhounds appeared to have the highest risk of sustaining an injury.

The type of tail hair was also an interesting factor on univariable analysis. Dogs with bushy tails were found to have the lowest risk of sustaining an injury. This could suggest that the bushy hair provides some protection to the tail, padding it and reducing the likelihood of an injury. It was found that dogs with smooth hair were at highest risk which supports the finding that Greyhounds, Whippets and Lurchers were at higher risk and dogs with feathering on their tail had 2.3 times the odds of a tail injury compared to those with bushy tails. Some people suggest that dogs with tail feathering are more at risk as their tail hair catches on the undergrowth predisposing them to injury.

In the final model tail wag angle was found to be a risk factor with dogs which generally wag their tails very wide being more at risk. This intuitively makes sense, as the wider a dog wags its tail the more likely it is to knock its tail against things in its surroundings in comparison to dogs which wag their tails in a narrow angle, and the force with which they wag their tail may be greater. The questionnaire included a basic diagram to assist owners in estimating their dog's tail wag angle, however, it is important to be aware that owner subjectivity could still be present.

A dog being kept in kennels was found to be an important risk factor for a tail injury. This could possibly be due to the size of the kennels being too small in relation to the size of the dogs thereby increasing the chances of the dog knocking their tail against the kennel wall. This could also be closely linked to working dogs. In the current study 58.6% of working dogs lived in kennels, whilst the same was true for only 5.2% of non-working dogs. However, the variable ‘work’ was found to be non-significant whether or not the kennel variable was included in the model. It may be argued that this was because breed and ‘work’ are closely associated and therefore breed was masking the effect of work. However, when the analysis was run just for spaniels alone, thereby removing the effect of breed, work was still found to be non-significant. This also suggests that the risk approximations, previously calculated in the current study, which showed that working dogs were at higher risk than non-working dogs, were confounded by breed. This is also supported by the descriptive numbers shown in tables 2 and 3. Therefore work may not have been identified as a major risk factor in the model, despite the risk estimates showing working dogs to be at significantly higher risk; due to the high correlation with breed and the low power of the study (only 8% of the control population were working dogs). There are currently limited data available on the number of dogs in the UK and what proportion of the UK dog population are working dogs. Therefore it is not possible to assess how representative the sample of dogs recruited into the current study was.

The results of the current study suggest that dogs which are docked are less likely to sustain a tail injury. This supports the findings of the study conducted by Houlton (2008) which showed that there was a strong association between tail injuries and undocked Springer and Cocker spaniels. However, it contradicts the findings of Darke and others (1985) which found no significant association. This could be explained by the difference in data and analysis used between the Darke study and the current work. They compared the risk of tail injuries between dogs which were customarily docked and those which were customarily undocked, as information relating to the actual docking status of each dog in their study was not available. This could have introduced a bias resulting in them not detecting a significant association between tail injuries and being undocked. Additionally, they only used data extracted from the University of Edinburgh small animal practice teaching unit which may have biased the study population to a particular type of client and towards dogs kept in predominantly urban areas. Their estimates were also not adjusted for any other confounding factors and their study had less power due to a smaller sample size.

The results of the additional models for Spaniels only, and for working dogs only, also showed tail docking to be a very important factor in reducing the likelihood of a dog sustaining a tail injury. However, it is important to be aware that this would be expected and the difference between statistical significance and clinical significance should also be considered in interpreting the results. The level of difference in risk should be assessed to determine whether this justifies docking.

Additionally, when considering these results, due to the low number of docked dogs amongst the cases extrapolating the results to the general dog population should be interpreted cautiously.

Tail docking remains a controversial issue as can be seen by recent letters to the Veterinary Record (Davidson 2006; King 2007) and the number of submissions received by parliament in the drafting of the Animal Welfare Bill (2002). The debate is centred on whether non-therapeutic tail docking reduces the risk of tail injuries sufficiently to justify the ethical concerns of this prophylactic intervention (Bennett and Perini 2003; Bower and Anderson 1992; Morton 1992). A study conducted in Sweden reported that after a tail docking ban was put in place the incidence of tail injuries in German shorthaired pointers had increased (Strejffert 1992). However, this study also had several weaknesses. It followed a limited number of litters (53), did not make comparisons between docked and undocked dogs, did not compare animals before and after the ban and did not make any statistical comparisons to support their conclusions. Therefore, conclusions based on this study should be examined cautiously.

It has been reported that between 1992 and 2002, after a ban on tail docking had been introduced, 0.04% of all dogs presenting to the Department of Small Animal Clinical Sciences in Norway (a first opinion and referral outpatient, medical and surgical unit) required tail amputation due to tail injury (Bjerkas 2007). Despite these data not comparing the risk before and after the ban on tail docking it suggests that the number of injuries in undocked dogs was small. This suggests that tail injuries are rare whether or not docking is practiced.

It is important to be aware of the limitations of the current study. Due to the random sampling and selection of veterinary practices, only a small number of working dogs were included in the study. This could potentially decrease the chance of finding any significant association between work and tail injuries. Additionally, many of the variables in this dataset were highly collinear forcing decisions to be made as to which variables to include and which variables to exclude from the final model. This too may have resulted in the presence of residual confounding, thereby weakening any associations or potentially masking others. One of the potential biases could be the representativeness of the sample selected. The numbers of veterinary practices selected in each region were not sampled by probability proportional to size. This is because there are a very high proportion of practices in England, such that if this approach was used, virtually no practices would have been selected in Wales and Scotland, making it impossible to estimate the risk of tail injuries in these regions with any confidence. Additionally, only those practices using specific software packages were included in the study and this could be argued makes the sample not representative of the general population of dogs in Great Britain. However, the cooperation of the some of the biggest software companies was obtained and seven different practice management systems were included. An additional possibility for the sample selected to not be representative could be due to the possibility that not all dogs or cases would be seen by a vet. This bias was also highlighted by Houlton (2008). Some dogs which had sustained a tail injury may not have been examined by a veterinarian and may have been treated by their owner, or in the case of working dogs, by their trainer. In the latter case, the tail injuries seen in this study may be slightly biased towards tail injuries of non-working dogs therefore potentially masking any potential association with work, or biased more towards major injuries as the more minor injuries may not be treated by a veterinarian. In the current study five control dogs had to be excluded due to them having sustained a tail injury in the previous 12 month period but not been seen by a veterinarian. This may indicate that the prevalence of all tail injuries could be higher than estimated in this study, however, these injuries are likely to be less severe as they have not been seen by a veterinarian, and therefore less likely to raise welfare concerns.

The response rate of practices was low and the average response rate of dog owners was 35%. This may be due to the controversial nature of the topic meaning some people were not willing to participate. It was attempted to compare those that did and did not respond to check for any response bias, however, only a few basic characteristics were known and able to be compared. It was not possible to compare the proportion of working dogs amongst the responders and non responders. Additionally, some groups of dogs were not represented in the current study, such as police and army dogs. Therefore further studies should be carried out to assess the risk and risk factors for tail injuries in these dogs.

The main strength of the current study is that it was large and it is the first study assessing tail injury risk and risk factors for dogs from all parts of GB allowing objective assessment of frequency of injuries and risk factors associated with them. Additionally, there appeared to be no response bias as there were no significant differences between the cases that responded and those that did not and the controls that responded and those that did not. Further work would now be merited to build on this study, now that the full effects of the tail docking ban are beginning to be felt and there is a lower proportion of docked dogs in the population. Additionally, work assessing the severity of injuries would be a useful follow on to the current study to help evaluate if any exemptions should be allowed and if managemental changes could prevent a large number of the current injuries.

The current study has suggested that the overall risk of tail injuries is low, though specific breeds including spaniels, greyhounds and lurchers were at substantially higher odds of injury. The final risk factor model showed that being a working dog was not a major risk factor, and other factors including breed characteristics and levels of activity of dogs were more important than work per se in the practice attending population. Docking appeared to have a protective effect against injury as expected, however, it was calculated that 500 dogs would need to be docked in order to prevent one tail injury. Further studies focusing on what appear to be the highest risk groups of dogs would be valuable, in order to assess their specific risks in further detail.

Acknowledgement

We would like to thank the Welsh Assembly, the Scottish Government and Defra for funding this study. We would particularly like to thank the practice management companies: Vetone, Teleos, Midshires, Vetsolutions and RxWorks for assisting us with the data querying. We would like to take this opportunity to thank all the veterinary practices and owners who participated in the current study, without their cooperation this study would not have been possible.

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Appendix 1

Table 8: Results of multivariable mixed-effects logistic regression model using England legislation breed-type classification (number of observations used in final model was 309 out of 319)

Variable category	No. cases	No. controls	β	se β	Odds ratio	95% CI	p-value
Breed							
Not docked	69	168			1		
Spaniel types	22	22	1.967	0.544	7.16	2.46 – 20.79	<0.001
Terrier types	1	21	-1.936	1.049	0.14	0.02 – 1.13	0.065
Point-retrieve types	3	3	2.031	1.111	7.62	0.86 – 67.34	0.068
Tail docked before injury							
No	93	181			1.00		
Yes	2	33	-3.073	0.917	0.02	0.004 – 0.15	<0.001
Tail wagging angle							
Narrow angle	10	61			1.00		
Moderately wide	28	62	0.990	0.446	2.69	1.12 – 6.45	0.026
Very wide	57	91	1.249	0.415	3.49	1.54 – 7.87	0.003
Is the dog kept in kennels							
No	78	201			1		
Yes	17	13	1.529	0.537	4.62	1.61 – 13.22	0.004
Work use*							
No	84	197			1		
Yes	11	17	-0.316	0.617	0.73	0.22 – 2.45	0.609
Intercept	-	-	-1.871	0.376	-	-	-
Random effect of practice id (ρ)	-	-	0.012	0.036	-	-	0.433

Appendix 2

Table 9: Results of multivariable mixed-effects logistic regression model using Welsh legislation breed classification (number of observations used in final model was 309 out of 319)

Variable category	No. cases	No. controls	β	se β	Odds ratio	95% CI	p-value
Breed							
Not docked	74	174			1		
Spaniels	17	22	1.469	0.527	4.35	1.55 – 12.21	0.005
Terriers	1	16	-1.506	1.059	0.22	0.03 – 1.77	0.155
Point-retrieve	3	2	3.257	1.394	26.00	1.69 – 400.0	0.019
Tail docked before injury							
No	93	181			1.00		
Yes	2	33	-3.449	0.902	0.03	0.005 – 0.19	<0.001
Tail wagging angle							
Narrow angle	10	61			1.00		
Moderately wide	28	62	1.011	0.442	2.75	1.16 – 6.54	0.022
Very wide	57	91	1.350	0.416	3.86	1.71 – 8.71	0.001
Is the dog kept in kennels							
No	78	201			1		
Yes	17	13	1.613	0.525	5.02	1.79 – 14.04	0.002
Work use*							
No	84	197			1		
Yes	11	17	-0.214	0.608	0.81	0.25 – 2.66	0.724
Intercept	-	-	-1.901	0.376	-	-	-
Random effect of practice id (ρ)	-	-	0.003	0.002	-	-	0.357

Appendix 3

Table 10: Results of multivariable mixed-effects logistic regression model restricted to just those dogs in the study which were working dogs. Due to no dogs being docked and sustaining an injury, one dog was recoded to prevent a zero-value and therefore being dropped from the model (number of observations used in final model was 28 out of 29)

Variable category	No. cases	No. controls	β	se β	Odds ratio	95% CI	p-value
Tail docked before injury							
No	10	8			1		
Yes	1*	9	-3.932	1.502	0.02	0.001 – 0.37	0.009
Is the dog kept in kennels							
No	2	10			1		
Yes	9	7	3.385	1.325	29.52	2.20 – 396.4	0.011
Intercept	-	-	-1.276	0.807	-	-	-
Random effect of practice id (ρ)	-	-	0.011	0.018	-	-	0.382

*recoded to yes (was not docked) to prevent having a zero value in table

Glossary of terms

Attributable risk	The difference in the risk between an exposed population and an unexposed population. It represents the increase in the probability of disease in an exposed group, beyond the baseline risk, that results from the exposure.
Chi squared test	A test to assess the presence of association between two categorical variables
Clustering in data	This indicates a situation when each observation in the dataset did not have an equal probability of selection.
Cohort	A group which are followed over time
Collinearity	Where two variables are correlated in the same direction but not the cause of each other
Confounding	An extraneous variable that is correlated with both the dependent and independent variables, thus affecting their apparent relationship
Continuous variables	A variable measured on a continuous scale, i.e. can have decimal measurements, e.g. weight, height
Contusion	A bruise, usually a blunt injury resulting in the release of blood into surrounding tissues
Convenience sample	When the study participants are selected at the convenience on the researcher, where no or a limited attempt is made to ensure the sample is representative of the target population
Correlation matrix	A table indicating the strength and direction of association between pair-wise groupings of variables
Delta-betas	Is a measure of change that would occur in the regression coefficients if a particular observation was deleted, and is therefore a measure of the influence of observations
Dislocation	When bones in a joint become displaced or misaligned
Fixed effect	Is the way in which a coefficient is treated in a model, it indicated that the observations are related to the independent variables
Fracture	When a bone is broken into two or more pieces
Free text search	A search of all text or a part of the text which matches a specific piece of text.
Game shooting dogs	Any dog involved in flushing, pointing or retrieving
Goodness-of-fit	A measure of how well the model describes the outcome variable, there are different types: Chi2 or Hosmer Lemeshow
Interaction	This is a situation when the effect of two variables is not additive. The effect of the one variable is dependent on the value of the other variable.
Laceration	A wound where the skin is torn, cut or punctured
Leverage	A measure of the influence that a particular observation has

	on the regression coefficients
Likelihood ratio test	A statistical test used for making a decision between two hypotheses based on the ratio of the maximum probability of the result under the two different hypotheses.
Logistic regression	Used for the prediction of the probability of occurrence of an event by fitting data to a logistic curve
Mixed effects	A model which includes both random and fixed effects
Multivariable	An analysis which includes more than one explanatory variable
Neoplasia	Abnormal or uncoordinated proliferation of cells resulting in an abnormal mass
Nested case-control study	A type of study design where cases and controls are selected from a cohort / group of individuals which are being observed over time
Number needed to treat	The number which would need to have the exposure / be treated in order to prevent one event of the outcome
Odds ratio	Is the ratio of the odds of an event occurring in one group compared to another group and is therefore a measure of effect
Population attributable risk	Is a measure of the reduction in incidence of the outcome if the population was entirely unexposed to the variable of interest
Population attributable risk fraction	Is a measure of the proportion of the outcome that would be expected to not occur if the exposure was removed entirely from the population
Prevalence	Is the total number of cases in a population divided by the population at risk. It is therefore the proportion of the population affected by the outcome at that particular time.
Quadchk	This is a command used in the statistical software package “Stata” to assess the sensitivity of the quadrature approximation
Random effect	Is the way in which a coefficient is treated in a model, it indicated that the observations are not related to the independent variables
Risk	Is measure of occurrence of a disease, the number of cases divided by the number of the population at risk
Risk factor	A variable or factor which alters the likelihood of the outcome occurring
Self-trauma	A self-inflicted injury
Stratified random sample	A method of selecting participants for a study where the population is divided into groups or strata, and then from within each of these strata participants are randomly selected
Survey commands	This is a command used in the statistical software package

	"Stata" which is used to account for the sampling design, the way in which the study participants were selected
Univariable	An analysis involving only one independent and one dependent variable
Water tail / limber tail	A condition affecting dogs tails where the tail remains limp and painful for a few days. The cause of this condition is not well understood but is thought to be associated with muscle fatigue in the tail.
Weighted risk	When the risk estimate is adjusted to account for the sampling strategy, the way in which the study participants were selected. This is because not all study participants would have had the same probability of being selected.
Xtlogit	This is a command used in the statistical software package "Stata" which is used to conduct a logistic regression model where fixed or random effects may be included.