The Old School, Brewhouse Hill, Wheathampstead,
Hertfordshire AL4 8AN, UK

Animal Welfare 2012, 21(S1): 81-93
doi: 10.7120/09627281 2X13345905673809
ISSN 0962-7286

Do dog owners perceive the clinical signs related to conformational inherited disorders as 'normal' for the breed? A potential constraint to improving canine welfare

RMA Packer, A Hendricks and CC Burn*

Centre for Animal Welfare, Royal Veterinary College, Hawkshead Lane, North Mymms, Hatfield, Hertfordshire AL9 7TA, UK
* Contact for correspondence and requests for reprints: rpacker@rvc.ac.uk

Abstract

Selection for brachycephalic (foreshortened muzzle) phenotypes in dogs is a major risk factor for brachycephalic obstructive airway syndrome (BOAS). Clinical signs include respiratory distress, exercise intolerance, upper respiratory noise and collapse. Efforts to combat BOAS may be constrained by a perception that it is 'normal' in brachycephalic dogs. This study aimed to quantify owner-perception of the clinical signs of BOAS as a veterinary problem. A questionnaire-based study was carried out over five months on the owners of dogs referred to the Queen Mother Hospital for Animals (QMHA) for all clinical services, except for Emergency and Critical Care. Owners reported the frequency of respiratory difficulty and characteristics of respiratory noise in their dogs in four scenarios, summarised as an 'owner-reported breathing' (ORB) score. Owners then reported whether their dog currently has, or has a history of, 'breathing problems'. Dogs (n = 285) representing 68 breeds were included, 31 of which were classed as 'affected' by BOAS either following diagnostics, or by fitting case criteria based on their ORB score, skull morphology and presence of stenotic nares. The median ORB score given by affected dogs' owners was 20/40 (range 8–30). Over half (58%) of owners of affected dogs reported that their dog did not *have a breathing problem. This marked disparity between owners' reports of frequent, severe clinical signs and their perceived lack of a 'breathing problem' in their dogs is of concern. Without appreciation of the welfare implications of BOAS, affected but undiagnosed dogs may be negatively affected indefinitely through lack of treatment. Furthermore, affected dogs may continue to be selected in breeding programmes, perpetuating this disorder.*

Keywords: *animal welfare, brachycephalic, conformation, dog, owner perception, pedigree*

Introduction

Recognition of the clinical signs of disease by companion animal owners is an important initial step in the process of perceiving a 'problem', and deciding to seek veterinary attention for the investigation and potential treatment of any disease that may be present. Lack of recognition of clinical signs as indicative of disease, and instead considered 'normal' for certain demographics, was recently demonstrated in geriatric horses, with regard to owner-perceived 'benign' age-related changes (Ireland *et al* 2012). Lack of recognition of clinical signs of disease, or lack of perception that these signs indicate a 'problem' that requires veterinary attention, are potential constraints to improving the welfare of clinically affected animals. The resulting lack of treatment may lead to the continuation of clinical signs that may negatively affect an animal's welfare.

A duty of care is imposed upon the owners of all companion animals through the Animal Welfare Act 2006 (S9[2]) and the Welfare of Animals Act (Northern Ireland) 2011 (S9[2]), where one of the five 'needs' of animals protected under the Act is "Protection from pain, suffering, injury and disease". This 'need' potentially conflicts with practices employed in the breeding of companion animals of several species, whereby selection for extreme morphological characteristics to conform to breed standards has led to a variety of associated disorders (eg in dogs: Peyer 1997; McGreevy & Nicholas 1999, cats: Wegner 1995; Steiger 2005). In these cases, breeding may put animals bred for certain conformational traits at an increased risk of pain, suffering, injury and/or disease, and as noted by Serpell (2002), many companion animal breeds have effectively become handicapped by selection for traits that appeal to our anthropomorphic perceptions.

Table 1 Caseload breed demographics of six recent studies of BOAS (2005–2010) breeds reported highlighted for each study.

	Breed representation in BOAS case series' (%)					
Breed/Study	**Riecks (2007) 62 dogs, USA**	**De Lorenzi *et al* (2009) 40 dogs, Italy**	**Poncet *et al* (2005) 73 dogs, France**	**Torrez and Hunt (2006) 73 dogs, Australia**	**Ginn *et al* (2008) 53 dogs, USA**	**Njikam *et al* (2009) 39 dogs, Belgium**
Bulldog	43.6	32.5	17.8	19.2	18.0	30.8
Pug	21.0	50.0	6.8	26.0	32.0	38.5
Cavalier King Charles Spaniel	0	0	0	20.6	0	2.6
Staffordshire Bull Terrier	0	0	0	5.5	0	0
French Bulldog	3.2	17.5	67.0	2.7	6.0	17.9
Boxer	0	0	1.4	1.4	9.0	0
Shih Tzu	0	0	0	1.4	11.0	5.1
Boston Terrier	12.9	0	1.4	0	6.0	0
Pekingese	6.5	0	2.8	2.7	3.0	0
Shar Pei	1.6	0	1.4	1.4	0	0
Rottweiler	0	0	0	1.4	0	0
Chow Chow	1.6	0	0	0	0	0
Pomeranian	3.2	0	0	0	0	0
Bullmastiff	3.2	0	0	1.4	0	0
Lhasa Apso	0	0	1.4	0	3.0	2.6

Brachycephalic Obstructive Airway Syndrome (BOAS)

Sixty-three disorders were recently identified as directly related to conformational traits in the top 50 UK Kennel Club breeds (Asher *et al* 2009). Within that review, one of the disorders identified as most severe according to the Generic Illness Severity Index for Dogs was Brachycephalic Obstructive Airway Syndrome (BOAS). BOAS describes a syndrome of the upper airway that leads to restricted breathing, characterised by clinical signs such as dyspnoea (shortness of breath), stertor (snoring), stridor (wheezing), exercise intolerance, gagging, regurgitation and vomiting. Episodes of severe dyspnoea can also occur, leading to cyanosis (blueish skin/mucous membranes), hyperthermia and syncope (fainting) (Riecks *et al* 2007). Clinical signs are often severe by 12 months of age (Knecht 1979) and are life-long thereafter. These signs arise as a result of obstruction of the upper airways caused by anatomical abnormalities often seen in brachycephalic dogs (those with foreshortened muzzles), and have been reported in over ten brachycephalic breeds internationally (Table 1). A recent risk factor analysis found brachycephalic dogs to be 38 times more likely to have BOAS than non-brachycephalic dogs (Njikam *et al* 2009).

Brachycephaly is a discrete skeletal mutation (Pollinger *et al* 2005), where altered growth of the basioccipital and basisphenoid bones manifests in a shortening of the basicranial axis (Stockard 1941). Shortening of the skeletal muzzle appears not to be accompanied by corresponding soft tissue shortening, leading to a mismatch in proportion. This creates a cramming effect within the skull, with too much tissue in the available space (Harvey 1989), which partially blocks the larynx and interferes with the passage of air during inspiration and expiration. Additionally, the nares (nostrils) of brachycephalic dogs are often stenotic (narrowed), due to poor development (Wykes 1991), causing the wing of the nostril to obstruct the airway and collapse on inspiration, exacerbating the obstruction (Leonard 1956). These abnormalities encourage collapse of the airways due to significant, negative intra-airway pressures created in an effort to overcome the increased resistance to airflow (Wykes 1991). This can lead to secondary changes to the airway, the most common being the first stage of laryngeal collapse, everted laryngeal saccules, causing yet further obstruction (Koch *et al* 2003).

Increased airway resistance is often manifested in altered respiratory noise, with the nature and magnitude associated with the site and severity of obstruction. In animals with minimal obstruction, slightly 'stertorous' or 'stridorous' noises are often the only easily detectable abnormality (Holt 2004). Stertor is described as similar to snoring in humans (Holt 2004) or 'a snorting noise' (Hunt *et al* 2002), and is thought to be associated with excessive tissue in the upper portion of the airway (Riecks *et al* 2007). Stertor has been reported in brachycephalic dogs while awake and asleep, and alongside episodes of sleep apnoea (Hendricks 1987). Stridor, described as audible

wheezing, is often associated with restricted airflow at the level of the larynx, and is a common manifestation of laryngeal collapse (Riecks *et al* 2007).

To diagnose palate and laryngeal abnormalities, pharyngoscopic and laryngoscopic examinations are performed on induction of general anaesthesia prior to surgery, as visualisation of the oropharynx in the conscious animal is difficult and can induce extreme distress (Hendricks 1992). Diagnosis under general anaesthesia is often followed immediately by surgical 'correction' to relieve obstructions (Hedlund 1998), as anaesthesia is high risk in brachycephalic breeds (Riecks *et al* 2007). Surgical treatment includes the resection of the soft palate (staphylectomy: Schlotthauer 1929) and reshaping of the nares (rhinoplasty: Trader 1949). If these features are left untreated, changes to the larynx can progress to laryngeal collapse, where the cartilages collapse and cause further obstruction (Leonard 1960). Laryngeal collapse carries a guarded prognosis (Aron & Crowe 1985) and represents the most severe and hardest to treat stage of BOAS, with permanent tracheostomy required in severe cases to bypass the upper airways (Monnet 2003). A recent case series of seven immature brachycephalic dogs found that puppies aged under six months already exhibited these severe secondary changes (Pink *et al* 2006), highlighting the importance of early surgical intervention where indicated.

Prognosis and owner perception

To reduce the welfare impact of this condition, with regard to the severity and duration of clinical signs, treatment to improve the welfare of affected animals is desirable. It has been noted that the owners of brachycephalic dogs may be more tolerant of clinical signs of airway obstruction than non-brachycephalic dog owners, so may be prepared to tolerate a greater degree of respiratory compromise in their pets before seeking help (Torrez & Hunt 2006). Due to the chronic and prevalent nature of clinical signs, they may be 'accepted' by owners and not perceived as abnormal. As noted by Stafford and Martin (2008), due to owners' acceptance of ongoing dyspnoea, it may require a particularly acute or severe attack for owners to perceive a problem and present their dog to a veterinarian. This is problematic, as it may mean that many brachycephalic dogs are experiencing chronic negative effects on their welfare without serious appreciation of their clinical signs by their owners.

The aim of this study was to quantify owner recognition of clinical signs of BOAS, and whether these signs are perceived as a problem.

Materials and methods

Recruitment of owners and study dogs

Between December 2010 and May 2011, dogs referred to the Queen Mother Hospital for Animals (QMHA) were recruited for inclusion in the study. Owners of dogs referred to the orthopaedic, soft tissue surgery, neurology and neurosurgery, internal medicine, oncology, cardiology, dermatology and hydrotherapy services were approached. As appointments were booked in advance, all dogs were considered for recruitment prior to their arrival at the hospital and were excluded on a case-by-case basis if they were: (i) being presented for a disorder that would make them unsuited to leaving wards/nursing care during their stay in the hospital, or too painful/uncomfortable to be handled (clinicians were sought in these cases prior to the appointments to advise their suitability); (ii) known to be aggressive (either through previous experience at the study hospital, or through information provided by their referring veterinarian), and therefore not suitable for the handling aspect of the study; (iii) isolated from the general hospital population due to risk of disease transmission; and (iv) already recruited to a separate clinical trial/study within the study hospital.

Dogs referred to the emergency and critical care service, or presented to the out-of-hours first opinion service were not approached, due to the emergency nature of these cases meaning that they would be excluded under criteria (i). The owners of the remaining dogs deemed suitable were approached in the waiting room prior to their consultation, to request consent for their involvement in a broader research project investigating conformational inherited disorders in domestic dogs. Questionnaires were given to owners, with regard to their dog's behaviour, health and lifestyle. For newly referred cases, owners were requested to answer with regard to their dog's current state, and for cases presented for re-examination, owners were requested to answer with regard to their dog's state prior to treatment.

Questionnaire design

Prior to the study, the questionnaire was approved by the RVC's Ethical Review Committee (reference number: URN 2010 1054) and piloted on dog-owning members of staff and students at the RVC with both a clinical and non-clinical veterinary background, to check suitability and understanding for lay persons, and appropriate use of terminology.

The questionnaire contained several sections relevant to the current study (as well as information relevant to the wider project, not reported here), with information most pertinent to BOAS in the 'breathing difficulty' and 'breathing sounds' sections. The frequency of breathing difficulties and the severity of breathing sounds were requested in four activity scenarios (Tables 2[a] and [b]). With regard to BOAS-affected dogs, to capture the spectrum of severity of respiratory-noise abnormalities, options from 'slight' through to 'almost continuous' stertor and stridor were offered. To use non-technical terminology for owners, stertor was described as 'snoring or snorting', and stridor as 'wheezing'.

The degree of owner-reported respiratory difficulty and respiratory noise in the four scenarios was later quantified into a composite score, the 'owner-reported breathing' (ORB) score. The total score was out of 40, with scores out of five for each scenario, for both respiratory difficulty (Table 2[a]) and respiratory noise (Table 2[b]). A score of 0 would indicate respiratory difficulty had never been experienced and breathing sounds were 'very quiet' in all four

Table 2 Summary of questions regarding respiratory signs in dogs. Questions concerning signs of (a) breathing difficulties and (b) breathing sounds while at rest, gently walking, activity/exercising, and asleep are shown. Owners were indicated to tick the appropriate boxes, and designated scores (not present on the questionnaire) were used to calculate the owner-reported breathing (ORB) score. While (c) summarises a section later in the questionnaire where data were gathered on whether the owner perceived their dog to have a breathing problem and, if so, relevant clinical details.

(a)

BREATHING DIFFICULTY – How often does your dog show difficulty breathing in the following situations? Difficulty breathing could include your dog appearing very short of breath (more so than gentle panting), appearing unable to keep up with you or engage in physical activity, may appear anxious. During sleep this may include episodes where your dog stops breathing.						
	Never (Score = 0)	**Rarely (Score = 1)**	**Monthly (Score = 2)**	**Weekly (Score = 3)**	**Daily (Score = 4)**	**More than once per day (Score = 5)**
At rest, eg while lying down awake						
Gently walking eg walking around the house						
Activity/exercising, eg on a walk, while playing						
Asleep						

(b)

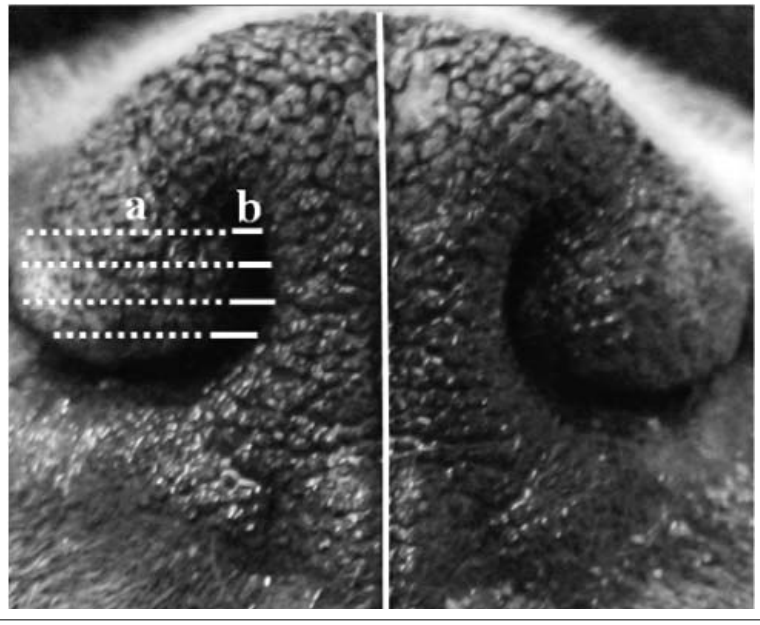
BREATHING SOUNDS – What does your dog's breathing sound like in the following circumstances?						
	Very quiet (Score = 0)	**Panting but no snoring/ snorting/ wheezing (Score = 1)**	**Slight snoring/ snorting/ wheezing (Score = 2)**	**Some snoring/ snorting/ wheezing (Score = 3)**	**Frequent snoring/ snorting/ wheezing (Score = 4)**	**Almost continuous snoring/ snorting/ wheezing (Score = 5)**
At rest, eg while lying down awake						
Gently walking, eg walking around the house						
Activity/exercising eg on a walk, while playing						
Asleep						

(c)

Does your dog currently have, or have a history of BREATHING PROBLEMS?				**YES**	**NO**
IF YES, PLEASE ANSWER THE FOLLOWING QUESTIONS:					
If known, what was your dog diagnosed with?					
What treatment (IF ANY) has your dog received for this condition? (PLEASE TICK AND FILL IN ANY ADDITIONAL INFORMATION)			Surgery		
			Medication		
At what age did you first notice this condition?			Years		Months
What first made you notice this condition? eg change in behaviour, collapse (PLEASE STATE)					
How quickly did these signs appear? (PLEASE CIRCLE)	Suddenly over a few hours	Over a few days	Gradually over a few weeks	Gradually over several months	Gradually over longer than 1 year
Do you believe this condition is: (PLEASE CIRCLE)	Resolved	Getting better	Getting worse	Staying the same	Comes and goes (but always there)	Episodic, sometimes free of problem
If episodic, how many episodes have occurred:					
If your dog has previously been treated for this condition, for how long were they 'improved'?					

Figure 1

Photograph of the external nares, used to quantify the degree of narrowing of the transverse diameter of the nares. Dotted lines (a) indicate the width of the alae nasi, while the solid lines (b) indicate the width of the adjacent external airway. The central line indicates the philtrum, delineating the left and right sides of the nasal planum.



scenarios. By contrast, a score of 40 would indicate respiratory difficulty more than once per day in all four scenarios, with corresponding respiratory noise classed as 'almost continuous snoring/snorting/wheezing'.

A 'breathing problem'?

In the final section of the questionnaire, 'Medical history', owners were asked to report whether their dog has, or has a history of 'breathing problems' (Table 2[c]). This terminology was chosen rather than 'respiratory disease', for example, both to use lay terms and to imply it did not have to be a diagnosed disease, rather a problem with breathing that they had noticed in their dog. Further details were then requested if the dog had been formally diagnosed for the purpose of the broader study.

Morphological data

Stenotic nares

All study dogs were examined for stenotic nares. This external abnormality is comparatively simple to diagnose compared with the invasive diagnosis of internal airway abnormalities; however, the severity of stenosis normally involves a subjective visual assessment (Brown & Gregory 2005). In some dogs, stenosis may be mild, while in others can result in the necessity to almost continually breathe with the mouth open (Hendricks 1992). To make this assessment more objective, a novel quantification of the degree of superficial stenosis of the external nares was carried out. Photographs of the nares were taken using a digital camera (Canon EOS 500D, Taiwan), with the nasal planum perpendicular to the field of view, and nares central to the photograph. To quantify the degree of narrowing of the external nares, four transverse measures of the width of the *alae nasi* (Figure 1[a]) were taken from a single photograph of each nare (using ImageJ© [Imaging Process and Analysis in Java, http://rbsweb.nih.gov/ij/]), along with the transverse width of the adjacent airspace (Figure 1[b]). An overall ratio of *alae nasi* to airway diameter ('nares ratio') was calculated for each dog from these measures.

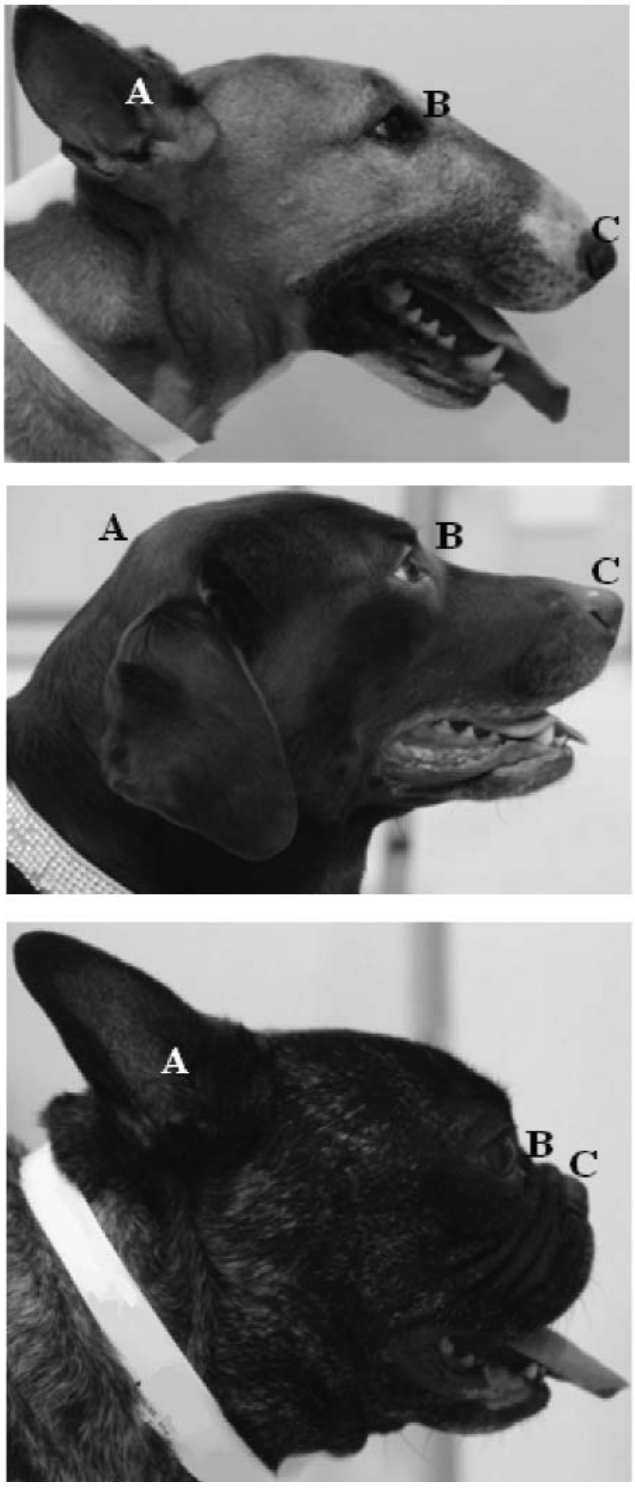
Skull conformation

Morphometric data were collected for each dog as part of the larger research project investigating conformational inherited disorders using measuring protocols from Sutter *et al* (2008). These measurements included cranial length and muzzle length, used to calculate the craniofacial index, a potential risk factor for BOAS, as it reflects the degree of skeletal shortening of the muzzle. Cranial length was measured 'From just between the eyes (Figure 2[b]) up the face, between the ears, to the back of the head where the bony process projects out' (Figure 2[a]). Muzzle length was measured 'From the tip of nose (Figure 2[c]) to just between the eyes where the inside corners of the eyes meet (Figure 2[b])'. Both measures were taken using a standard 1 m soft measuring tape. The craniofacial ratio was then calculated for each dog by dividing the muzzle length by the cranial length, to provide an objective measure of relative muzzle length.

Clinical classification

Dogs received a formal BOAS 'affected' status if they underwent internal airway assessment by soft tissue surgeons at the QMHA, and stenotic nares, elongation of the soft palate or everted laryngeal saccules were detected. Because of the invasive nature of formal BOAS diagnosis, brachycephalic dogs presented for problems other than BOAS would not routinely undergo airway assessment, but may still be affected by this condition. As such, dogs were also assigned as affected if they met the following criteria: i) Craniofacial ratio within or lower than the 95% confidence interval of

Figure 2



Three points on the canine skull used to measure cranial length (A to B) and muzzle length (B to C). Cranial and muzzle length, along with muzzle width, have been used to define terms for certain head shapes, with three terms commonly used: 'doliocephalic', meaning long and narrow headed (as demonstrated in the English Bull Terrier), 'mesaticephalic' or 'mesocephalic', meaning a head of medium proportions (as demonstrated in the Labrador Retriever), and 'brachycephalic', meaning short, wide-headed (as demonstrated in the French Bulldog) (Evans 1993).

formally diagnosed affected dogs; (ii) ORB score within the range or higher than that of formally diagnosed affected dogs; and iii) nares ratio within or lower than the 95% confidence interval of formally diagnosed affected dogs.

Dogs matching two of these criteria, that may represent possible BOAS cases, were classed as 'ambiguous' due to the uncertainty of their status as affected or unaffected, and were thus excluded from the analyses. Dogs meeting only one or none of the criteria were classed as unaffected.

Statistical analysis

ORB scores, craniofacial ratios and nares ratios were calculated as described above for all study dogs. Summary statistics for these parameters were calculated for the affected and unaffected groups, along with detailed descriptives of each clinical class's reports for individual clinical signs. Proportions of owners in each class reporting a 'breathing problem' in their dog were calculated. All statistics were carried out in PASW Statistics 18 (SPSS).

Results

Demographics

During the study period, of the dogs deemed suitable and subsequently approached, 285/290 (98.3%) agreed to participate. The five owners that declined were all of different breeds, with three of whom indicating their dog was not comfortable being handled by strangers, and the remaining two citing lack of time to fill out the questionnaire. A total of 285 owners completed the questionnaires on 48 crossbred and 237 purebred dogs of 68 breeds. The study population consisted of 172 males and 113 females, of which 72% were neutered. Dogs exhibited a wide variety of morphologies, with craniofacial ratios from 0.03 to 0.93 (mean [± SEM] = 0.50 [± 0.01]). This represents the most extreme end of brachycephaly where, in some cases, the overnose wrinkle extends more cranially than the length of the muzzle (Figure 3) through to doliocephalic dogs, where the muzzle length approaches the cranial length.

Clinical classification

A total of 17 dogs of the study population were referred to the QMH for investigation of suspected BOAS, and subsequently all received a formal diagnosis. These dogs represented six breeds, and a cross of one of these breeds (Table 3). From these dogs, inclusion criteria for the affected group were set as: i) craniofacial ratio 95% confidence interval: 0.12 – 0.23 (or below); ii) ORB score range: 8–27 (or above); and iii) nares ratio 95% confidence interval: 0.19–0.33 (or below).

A further 14 dogs of the study population that were referred for disorders other than BOAS met these criteria, resulting in a total of 31 dogs being classed as affected. Eleven dogs met two of the three criteria, and were classed as ambiguous, and 243 met either one (16) or none (227) of the criteria and were classed as unaffected.

Figure 3

Over-nose wrinkle (ONW) extending more cranially than the tip of the muzzle and obscuring the nares (N) in the Pug. NB This feature is discouraged in the Pug breed standards (Kennel Club 2009): "Eyes or nose never adversely affected or obscured by over nose wrinkle. Pinched nostrils and heavy over nose wrinkle is unacceptable and should be heavily penalised".

Table 3 Breed representation of 'affected' and 'ambiguous' BOAS cases, breed representation in the whole study population (including unaffected dogs of the listed breeds), and the mean craniofacial index of these breeds.

Breed	'Affected' cases (n)	'Ambiguous' cases (n)	Study population (n)	Craniofacial index (mean ± SEM)
Pug	11	1	13	0.08 (± 0.01)
French Bulldog	8	0	8	0.19 (± 0.02)
Bulldog	4	3	9	0.22 (± 0.02)
Boston Terrier	4	0	4	0.15 (± 0.02)
Dogue de Bordeaux	1	2	5	0.36 (± 0.01)
Cavalier King Charles Spaniel	1	0	9	0.38 (± 0.02)
'Victorian' Bulldog (Bulldog x Boxer)	1	1	4	0.34 (± 0.06)
Pekingese	1	0	1	0.10
Boxer	0	2	6	0.31 (± 0.01)
Shih Tzu	0	1	7	0.20 (± 0.02)
'Jug' (Jack Russell x Pug)	0	1	2	0.25 (± 0.04)

Morphometrics

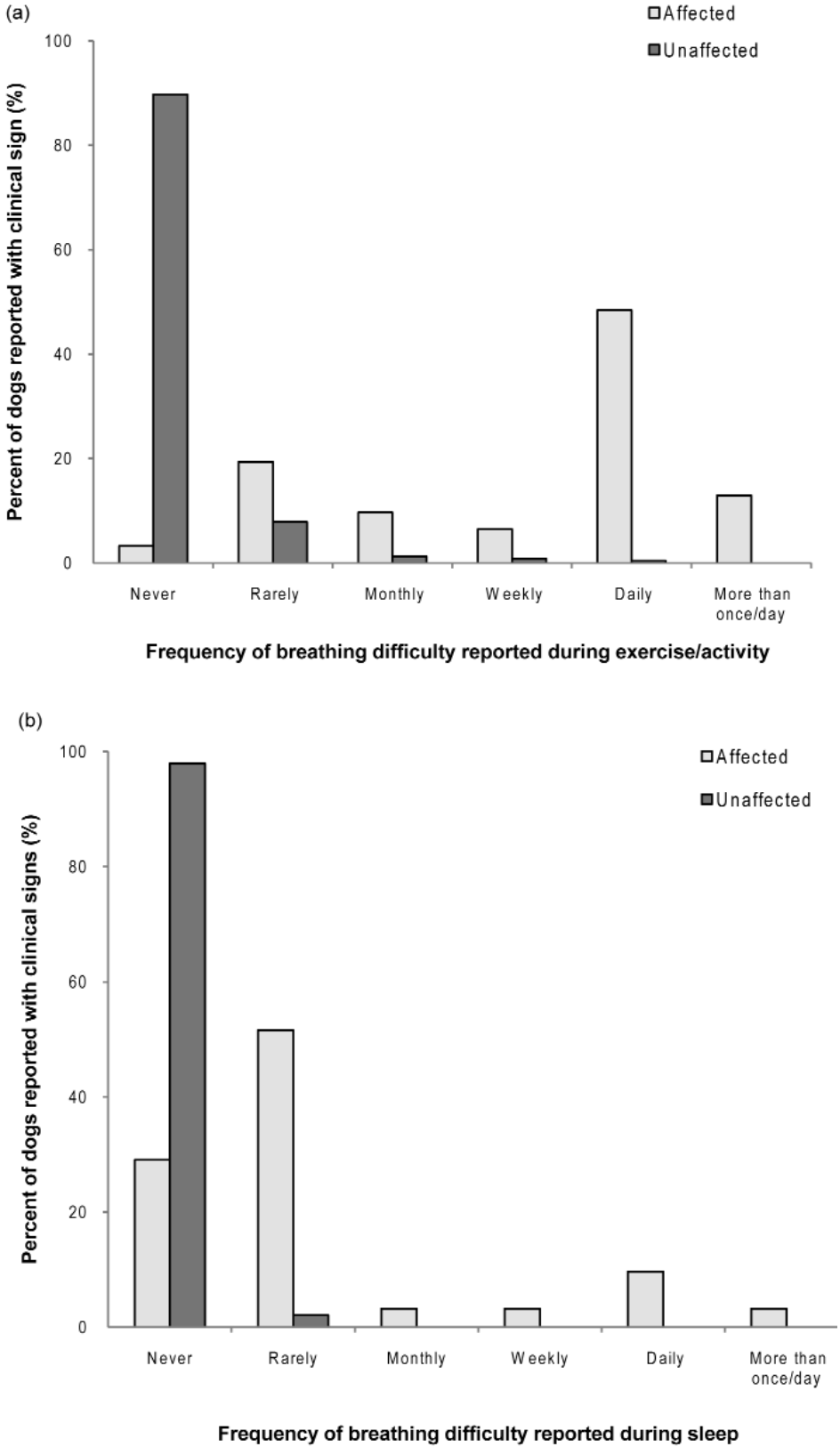
The affected class was represented by seven breeds, and a cross of one of these breeds (mean craniofacial ratio 0.15). Five of these breeds were also represented in the 'ambiguous' class (mean craniofacial ratio 0.26), along with a cross of one of these breeds, and a further two breeds (Table 3). The unaffected class (mean craniofacial ratio 0.56) was represented by 67 purebreeds and their crosses.

Of the 31 affected cases, nares-ratio data were available for 30 dogs (one case underwent emergency airway surgery so photographs were not possible). The mean nares ratio of the affected group was 0.24, in comparison to 0.81 in the unaffected group.

Owner-reported breathing (ORB) score

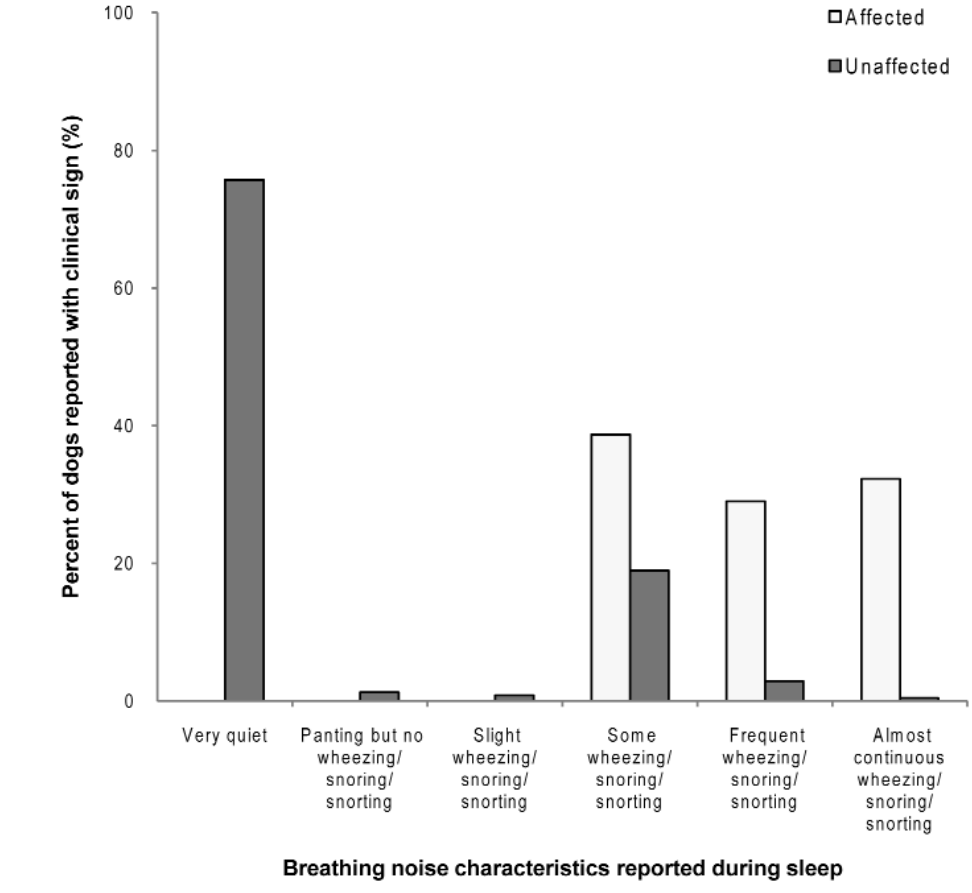
The median ORB score was 20/40 (range 8–30) for affected dogs, and 1/40 (range 0–13) for unaffected dogs. Examining

Figure 4

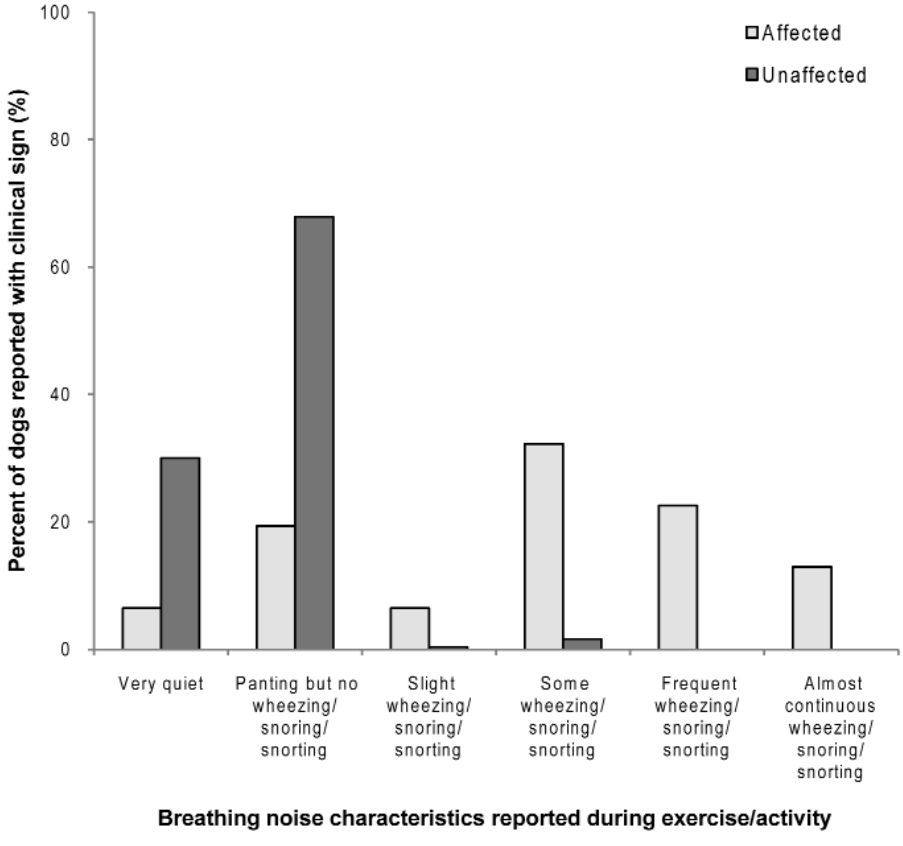


Owner-reported frequencies of breathing difficulties and breathing sounds in BOAS affected and unaffected dogs for (a) owner-reported frequency of breathing difficulties during activity/exercise, (b) owner-reported frequency of breathing difficulties while asleep, (c) owner-reported breathing sound characteristics during activity/exercise and (d) owner-reported breathing sound characteristics reported while asleep.

Figure 4 (cont)



(d)



owner reports of constituent clinical signs of the ORB score revealed marked differences between the affected and unaffected groups (Figure 4 [a]-[d]). Over 60% of affected cases (19/31) displayed breathing difficulties during activity/exercise either daily or more than once per day, in contrast to unaffected dogs, of which 90% had never experienced this clinical sign. Also, in this scenario, 68% of affected dogs were described as 'snoring, snorting or wheezing', in comparison to < 2% of unaffected dogs. The majority of unaffected dogs (68%) were reported to exhibit panting during activity/exercise, but with no accompanying abnormal respiratory noises. One hundred percent of affected cases were reported to snore while asleep, with nearly one-third (32.3%) reported to snore almost continuously. In contrast, three-quarters (75.7%) of unaffected dogs were reported to be 'very quiet' while asleep, with snoring reported in just 21%.

A 'breathing problem'?

Despite reports of high frequency and severe clinical signs of BOAS, 58% (18/31) of the owners of BOAS-Affected dogs reported that their dog did *not* currently have, or have a history of, breathing problems. This even included 7/17 of the owners of formally affected dogs referred for this disorder, who reported no breathing problem despite the official diagnosis. This was yet more pronounced in the 14 affected dogs that were not referred for BOAS, of which only three owners perceived a breathing problem in their dog. Additional spontaneous comments were provided by eight of the owners, in explanation of their answer 'No', to the question of the presence of breathing problems. These comments comprised: "No to breathing problem — other than being a Bulldog" and "(No,) but he is a Pug!", with six other owners simply stating the breed name (two Pugs, two Bulldogs, one Pekingese and one French Bulldog) in parentheses next to this question when answering 'No'.

Discussion

The aim of this study was to quantify owner recognition of clinical signs of BOAS, and investigate whether the owners of dogs exhibiting these signs perceive them as a 'problem'. We have demonstrated a disparity in recognition and perception, with well over half of affected dog owners reporting a high frequency and severity of clinical signs in their dogs, without perceiving them as a problem. Spontaneous comments indicate that this may be due to a perception of such signs being 'normal' in these breeds, and are consequently accepted as having no immediate need for veterinary intervention (Torrez & Hunt 2006). In a recent study of geriatric horses, a similar under-recognition of disease — especially respiratory disease — was attributed to owners either mistakenly regarding changes observed in their animals as normal, benign signs of ageing, rather than diseases requiring intervention, or being unaware of the significance of clinical signs, and therefore not seeking appropriate veterinary attention (Ireland *et al* 2012). The concept of age-related 'normality' of certain disorders has similarly been discussed in dogs, in relation to osteoarthritic disease (Lascelles & Main, 2002). Here, the authors highlighted that the presence of this painful disorder in older animals is often seen as 'something they have to live with', leading to under-recognition of the problem, and under-treatment of the pain. Human misinterpretation of the clinical signs of disorders affecting companion animals is not limited to physical health. A recent study revealed that dogs exhibiting tail-chasing behaviours at clinical intensities were over six times more frequently described as 'stupid' or 'funny' than other dogs, so despite tail-chasing sometimes being a pathological behaviour, it can remain untreated, or even be encouraged, because of an assumption that it is 'normal' dog behaviour (Burn 2011).

'Normal for the breed'

The concept of disorders being 'normal' for certain demographics is a likely constraint to improving the welfare of clinically affected animals, because if something is considered 'normal' then there may be a perception of no requirement to change it. The phrase 'normal for the breed', used by veterinarians, pet owners and breeders alike, indicates a culture of acceptance of certain problems in certain types of dog. The following statement, found on several Bulldog breeding websites internationally as part of a 'puppy guarantee', explicitly demonstrates this acceptance of certain diseases, including BOAS, as 'normal':

> English Bulldogs are only covered for a period of one (1) year from original purchase date. During which time, this guarantee does not cover what in Bulldog breeds we consider normal: 'cherry eye', entropion, 'loose hips', skin allergies, elongated soft palate, small trachea, stenotic nares (eg Purebred Breeders 2011).

Although some disorders are potentially high prevalence within certain breeds, the acceptance of them not being a problem due to their high frequency is detrimental to animal welfare, and as recently stated by Laurence (2009):

> I don't think it's acceptable for us to ignore the fact that every peke and pug has noisy breathing because it has upper respiratory obstruction. And, I think — and I include myself in this — we have become immune to the consequences of these conformations because they are 'normal' for the breed.

The nature of change — at breed and individual dog level

The gradual nature of changes brought about by selective breeding has been suggested as a factor contributing to what we perceive as 'normal' (The Boyd Group 1999), as part of a phenomenon coined by Temple Grandin: "bad becomes normal" (Grandin & Johnson 2005). Breathing problems within certain breeds have led to practices to ameliorate these signs, compensating for physically compromised animals, with reports over two decades ago illustrating such practices. Harvey (1989) noted that breeders of Bulldogs and other brachycephalic breeds carry oxygen cylinders to shows, and routinely arrange for Caesarean-section birth of puppies so as not to cause asphyxiation of the whelping bitch. Such extreme measures may again be viewed as 'normal' to those involved.

The temporal aspect of change may also act as a contributing factor to the perception of normality, not just at breed level, but at the individual dog level. BOAS is a chronic condition, with early onset of clinical signs, and severe secondary airway changes observed in immature dogs aged < 6 months (Pink *et al* 2006). For owners of dogs exhibiting signs from such a young age, a truly 'normal' or healthy reference point for their dog may not be present, and the gradual deterioration of clinical signs associated with progressive airway changes may not be perceived. Behavioural changes, such as continual open-mouth breathing (Hendricks 1992), or extending their head and neck to keep the airway open (Forrester *et al* 2001) may not be perceived as abnormal by owners, as many brachycephalic dogs exhibit these behaviours for the majority of the time while they are awake. There have previously been comments that clinical signs such as respiratory noise and snoring are thought of as 'cute' by owners (Milne 2007), and that other clinical signs such as exercise intolerance may just be perceived as an 'inconvenience', with only collapse classed as 'alarming' to the owner (Singleton 1962). A situation in which clinical signs of a disorder that has the potential to negatively impact upon affected animals' welfare, are perceived by owners as a positive aspect of their dog, is of particular concern.

The way forward

Due to the welfare implications of BOAS, efforts to reduce the prevalence of this disorder are needed. Brachycephalic dogs are increasing in popularity, with registrations of the Pug alone increasing from 3,500 to nearly 6,000 per year between 2007 and 2010 (Kennel Club 2007, 2010b). In terms of the demand for predisposed breeds, although the strict criteria dictated by breed standards for show animals may not be required by potential pedigree dog purchasers, aesthetics are still likely to play an important role in what type of dogs are in demand, with pet breeding strongly linked to fashion (Ott 1996). Raising awareness of the potential problems associated with such breeds and conformations may play an important role here, to ensure informed decisions are made when selecting puppies; encouraging selection to be based upon health and not solely on the aesthetics of their chosen breed. This could be carried out through educational resources (eg UFAW 2011) and through individual veterinarian-to-client communications.

Changes to the conformation and subsequent health of future dogs lies primarily with breeders, as the stakeholders who make individual breeding decisions. Breeders of brachycephalic dogs intended for the show ring are motivated to select animals to maintain breed standards; however, some standards are inherently putting dogs at risk of BOAS. BOAS has long been thought of as a consequence to pedigree breeding practices and breed standards, with reports from the 1960s stating that:

> Present day trends in the breeding of brachycephalic dogs produce specimens which suffer from dyspnoea to an ever-increasing degree" (eg Singleton 1962).

Breed standards have recently been updated to help avoid exaggeration, although there is still room for continued improvement, as standards still encourage at-risk brachycephalic conformations, eg 'Muzzle short' (Japanese Chin: Kennel Club 2009a), 'Muzzle relatively short' (Pug: Kennel Club 2009a), and 'Muzzle short, broad, turned upwards' (Bulldog: Kennel Club 2010a). Research to quantify the risk of BOAS across the spectrum of craniofacial indices, and the creation of quantitative 'limits' to these extreme conformations, is required to help refine breed standards in line with health and welfare.

Following recent criticisms of pedigree dogs, the UK Kennel Club has responded with several initiatives that have made reference to BOAS, raising awareness of this problem to breeders. For example, 'Fit For Function: Fit For Life' states that "every dog… should be able to breathe freely" (Kennel Club 2008). This sentiment is again echoed in Breed Watch, where obvious breathing difficulty is cited as an example of poor health and welfare to be avoided, and 'pinched nostrils' are classed as undesirable in several breeds, such as the Pekingese (Kennel Club 2011). As such, we may be less likely to attribute lack of information as a reason for the continued breeding of dogs exhibiting clinical signs and at-risk conformations.

Animal welfare implications

BOAS has potentially severe welfare implications, and if considered in line with the Companion Animal Welfare Council's (CAWC) (2006) assessment of inherited disorders it can be seen that BOAS:

- Has the potential to affect large numbers of animals; all brachycephalic dogs may be respiratory compromised to some degree, with > 10 breeds reported with this disorder in case series internationally (Table 1);
- Has the potential to continue to do so generation after generation into the future due to its inherent link with the brachycephalic conformation — if dogs with at-risk conformations continue to be bred then this problem will be perpetuated;
- Can have a severe adverse impact on animals' feelings; affected dogs are reported to be in chronic respiratory distress, thermal and physical discomfort, and experience behavioural restriction due to their impaired physical capabilities; and
- These effects can be of long duration, potentially affecting the dog for a large part of, or throughout, its life.

Our results show that 58% of the owners of affected animals claim their dogs have no breathing problem. This suggests that most dogs with BOAS are not referred for veterinary advice to help ameliorate the welfare problems associated with their condition. Without serious appreciation of the welfare implications of BOAS and effective recognition of its clinical signs, efforts to reduce the number of affected animals may be hampered, affected dogs may continue to be used in breeding programmes, and they may be left untreated to experience the chronic negative effects of BOAS for the rest of their lives.

Acknowledgements

We thank the owners and dogs involved in the study for their time and co-operation, elective student Joy Axe for assistance in data collection, the staff of the Clinical Investigations Centre and the Queen Mother Hospital for Animals for their ongoing support, UFAW for the Research and Project Awards funding this work and the RVC/BBRSC for the Quota Studentship funding RMAP. The paper was approved for submission (Manuscript ID number VCS_00256).

References

Aron DN and Crowe DT 1985 Upper airway obstruction: general principles and selected conditions in the dog and cat. *Veterinary Clinics of North America Small Animal Practice 15*: 891-917

Asher L, Diesel G, Summers JF, McGreevy PD and Collins LM 2009 Inherited defects in pedigree dogs. Part 1: disorders related to breed standards. *The Veterinary Journal 182*: 402-411. http://dx.doi.org/10.1016/j.tvjl.2009.08.033

Brown D and Gregory S 2005 Brachycephalic airway disease. In: Brockman D and Holt D (eds) *BSAVA Manual of Canine and Feline Head, Neck and Thoracic Surgery* pp 84. BSAVA: Cheltenham, UK

Burn CC 2011 A vicious cycle: a cross-sectional study of canine tail-chasing and human responses to it, using a free video-sharing website. *PLoS ONE 6*: e26553. http://dx.doi.org/10.1371/journal.pone.0026553

CAWC 2006 Breeding and welfare in companion Animals. *The Companion Animal Welfare Council's Report on Welfare Aspects of Modifications, through Selective Breeding or Biotechnological Methods, to the Form, Function, or Behaviour of Companion Animals.* CAWC: London, UK

De Lorenzi D, Bertoncello D and Drigo M 2009 Bronchial abnormalities found in a consecutive series of 40 brachycephalic dogs. *Journal of the American Veterinary Medical Association 235*: 835-840

Evans HE 1993 *Miller's Anatomy of the Dog*. WB Saunders: Philadelphia, USA

Forrester SD, Moon ML and Jacobson JD 2001 Diagnostic evaluation of dogs and cats with respiratory distress. *Compendium on Continuing Education for the Practicing Veterinarian 23*: 56

Ginn JA, Kumar MSA, McKiernan BC and Powers BE 2008 Nasopharyngeal turbinates in brachycephalic dogs and cats. *Journal of the American Animal Hospital Association 44*: 243-249

Grandin T and Johnson C 2005 *Animals in Translation: Using the Mysteries of Autism to Decode Animal Behaviour*. Scribner: New York, USA

Harvey CE 1989 Inherited and congenital airway conditions. *Journal of Small Animal Practice 30:* 184-187. http://dx.doi.org/10.1111/j.1748-5827.1989.tb01531.x

Hedlund CS 1998 Brachycephalic syndrome. In: Bojrab MJ, Ellison GW and Slocum (eds) *Current Techniques in Small Animal Surgery*. Williams & Wilkins: Baltimore, USA

Hendricks JC 1992 Brachycephalic airway syndrome. *Veterinary Clinics of North America Small Animal Practice 22*: 1145-53

Hendricks JC, Kline LR, Kovalski RJ, O'Brien JA, Morrison AR and Pack AI 1987 The English bulldog: a natural model of sleep-disordered breathing. *Journal of Applied Physiology 63*: 1344-1350

Holt DE 2004 Upper airway obstruction, stertor, and stridor. In: King LG (ed) *Textbook of Respiratory Disease in Dogs and Cats* pp 35-42. Elsevier: St Louis, USA. http://dx.doi.org/10.1016/B978-0-7216-8706-3.50009-8

Hunt GB, Perkins MC, Foster SF, Barrs VR, Swinney GR and Malik R 2002 Nasopharyngeal disorders of dogs and cats: a review and retrospective study. *Compendium on Continuing Education for the Practicing Veterinarian 24(3)*: 184-200

Ireland JL, Clegg PD, McGowan CM, McKane SA, Chandler KJ and Pinchbeck GL 2012 Comparison of owner-reported health problems with veterinary assessment of geriatric horses in the United Kingdom. *Equine Veterinary Journal 44:* 94-100. http://dx.doi.org/10.1111/j.2042-3306.2011.00394.x

Kennel Club 2007 *Top twenty breeds in registration order for the years 2007 and 2008.* Available at http://www.thekennelclub. org.uk/download/5675/2007-2008-Top-20.pdf. (Accessed 1 June 2011)

Kennel Club 2008 *Fit for Function Fit for Life*. Available at http://www.fitforfunction.org.uk/. (Accessed 1 June 2011)

Kennel Club 2009a *Pug Breed Standard*. Available at http://www.thekennelclub.org.uk/item/198. (Accessed 1 June 2011)

Kennel Club 2009b *Japanese Chin Breed Standard***.** Available at http://www.thekennelclub.org.uk/item/190. (Accessed 1 June 2011)

Kennel Club 2010a *Bulldog Breed Standard.* Available at http://www.thekennelclub.org.uk/item/155. (Accessed 1 June 2011)

Kennel Club 2010b *Top twenty breeds in registration order for the years 2009 and 2010*. Available at http://www.thekennelclub.org.uk/download/7748/Top-20.pdf. (Accessed 1 June 2011)

Kennel Club 2011 *Breed Watch: Pekingese*. Available at http://www.the-kennel-club.org.uk/services/public/breed/watch/display.aspx?breed=Pekingese. (Accessed 1 June 2011)

Knecht CD 1979 Upper airway obstruction in brachycephalic dogs. *Compendium on Continuing Education for the Practicing Veterinarian 1*: 25-30

Koch DA, Arnold S, Hubler M and Montavon PM 2003 Brachycephalic syndrome in dogs. *Compendium on Continuing Education for the Practicing Veterinarian 25*: 48

Lascelles BDX and Main CJ 2002 Surgical trauma and chronically painful conditions: within our comfort level but beyond theirs? *Journal of the American Veterinary Medical Association 221*: 215-222. http://dx.doi.org/10.2460/javma.2002.221.215

Laurence C 2009 Balancing pedigree dog breed standards and animal welfare — is it possible? *Veterinary Record 164*: 481-482

Leonard HC 1956 Surgical relief for stenotic nares in a dog. *Journal of the American Veterinary Medical Association 128*: 530

Leonard HC 1960 Collapse of the larynx and adjacent structures in the dog. *Journal of the American Veterinary Medical Association 137*: 360-363

McGreevy PD and Nicholas FW 1999 Some practical solutions to welfare problems in dog breeding. *Animal Welfare 8*: 329-341

Milne E 2007 *The Truth About Cats and Dogs*. Book Guild Publishing: Brighton, UK

Monnet E 2003 Brachycephalic airway syndrome. In: Slatter D (ed) *Textbook of Small Animal Surgery*. WB Saunders: Philadelphia, USA

Njikam IN, Huault M, Pirson V and Detilleux J 2009 The influence of phylogenic origin on the occurrence of brachycephalic airway obstruction syndrome in a large retrospective study. *The International Journal of Applied Research in Veterinary Medicine 7*: 138-143

Ott RS 1996 Animal selection and breeding techniques that create diseased populations and compromise welfare. *Journal of the American Veterinary Medical Association 208*: 1969-1974

Peyer N 1997 *Die Beurteilung zuchtbedingter Defekte bei Rassehunden in tierschutzerischer Hinsicht.* Dissertation of Veterinary Medicine, University of Bern, Switzerland. [Title translation: Assessing breeding-related defects in purebred dogs for their relevance in animal protection]

Pink JJ, Doyle RS, Hughes JML, Tobin E and Bellenger CR 2006 Laryngeal collapse in seven brachycephalic puppies. *Journal of Small Animal Practice 47*: 131-135

Pollinger JP, Bustamante CD, Fledel-Alon A, Schmutz S, Gray MM and Wayne RK 2005 Selective sweep mapping of genes with large phenotypic effects. *Genome Research 15*: 1809-1819

Poncet CM, Dupre GP, Freiche VG, Estrada MM, Poubanne YA and Bouvy BM 2005 Prevalence of gastrointestinal tract lesions in 73 brachycephalic dogs with upper respiratory syndrome. *Journal of Small Animal Practice 46*: 273-279

Purebred Breeders 2011 *Lifetime Guarantee: Terms and Conditions of Sale.* Available at http://www.purebredbreeders.com/puppypaperwork.pdf. (Accessed 1 June 2011)

Riecks TW, Birchard SJ and Stephens JA 2007 Surgical correction of brachycephalic syndrome in dogs: 62 cases (1991-2004). *Journal of the American Veterinary Medical Association 230*: 1324-1328. http://dx.doi.org/10.2460/javma.230.9.1324

Schlotthauer CF 1929 Congenital defects in the stomach of a dog. *Journal of the American Veterinary Medical Association 75*: 370-371

Serpell JA 2002 Anthropomorphism and anthropomorphic selection beyond the 'Cute Response'. *Society and Animals 10*: 437-454. http://dx.doi.org/10.1163/156853002320936926

Singleton WB 1962 Partial velum palatiectomy for relief of dyspnea in brachycephalic breeds. *Journal of Small Animal Practice 3*: 215-216. http://dx.doi.org/10.1111/j.1748-5827.1962.tb04190.x

Stafford MS and Martin M 2008 Investigation of dyspnoea in dogs. *In Practice 30*: 558-666. http://dx.doi.org/10.1136/inpract.30.10.558

Steiger A 2005 Breeding and welfare of cats. In: Rochlitz I (ed) *The Welfare of Cats.* Springer: Heidelberg, Germany. http://dx.doi.org/10.1007/978-1-4020-3227-1_10

Stockard CR 1941 The genetic and endocrinic basis for differences in form and behavior: as elucidated by studies of contrasted pure-line dog breeds and their hybrids. *Animal Anatomical Memoirs No 19*. The Wistar Institute of Anatomy and Biology: Philadelphia, USA

Sutter N, Mosher D, Gray M and Ostrander E 2008 Morphometrics within dog breeds are highly reproducible and dispute Rensch's rule. *Mammalian Genome 19*: 713-723. http://dx.doi.org/10.1007/s00335-008-9153-6

The Boyd Group 1999 *Genetic engineering: animal welfare and ethics. A discussion paper from the Boyd Group.* Available at http://www.boyd-group.demon.co.uk/genmod.htm. (Accessed 1 June 2011)

Torrez CV and Hunt GB 2006 Results of surgical correction of abnormalities associated with brachycephalic airway obstruction syndrome in dogs in Australia. *Journal of Small Animal Practice 47*: 150-154. http://dx.doi.org/10.1111/j.1748-5827.2006.00059.x

Trader RL 1949 Nose operation. *Journal of the American Veterinary Medical Association 114*: 210-211

UFAW 2011 *Genetic welfare problems of companion animals: an information resource for prospective pet owners and breeders.* Available at http://www.ufaw.org.uk/geneticwelfareproblems.php. (Accessed 1 June 2011)

Wegner W 1993 Tierschutzrelevante Misstande in der Kleintierzucht- der 11b des Tierschutzgesetzes greift nicht. *Tierarzliche Umschau 48*: 213-222. [Title translation: Relevant animal welfare abuses in small animal breeding]

Wykes PM 1991 Brachycephalic airway obstructive syndrome. *Problems in Veterinary Medicine 3*: 188-197