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| Institution: University of Cambridge | | |
| Unit of Assessment: 6 | | |
| Title of case study: Improving the health of flat-faced dog breeds | | |
| Period when the underpinning research was undertaken: 2015 – present | | |
| Details of staff conducting the underpinning research from the submitting unit: | | |
| Name(s): | Role(s) (e.g. job title): | Period(s) employed by submitting HEI: |
| Jane Ladlow David Sargan Nai Chieh Liu | Senior lecturer Senior lecturer Research Associate | 2006-2019 1994 – present 2016 – present |
| Period when the claimed impact occurred: 2015 - present | | |
| Is this case study continued from a case study submitted in 2014? N | | |
| <p>1. Summary of the impact (indicative maximum 100 words)</p> <p>Flat-faced dogs such as pugs, bulldogs and French bulldogs have increased in popularity in the past decade, with French bulldog registrations reaching 36,785 in the UK 2018. However, the flat-faced features they are known for has led to Brachycephalic obstructive airway syndrome (BOAS) being a common respiratory condition within flat-faced breeds; medical or surgical intervention is required by 65% of pugs.</p> <p>Research at the University of Cambridge led to the development of the world's first objective testing criteria for BOAS. The low-cost Functional Grading Scheme provides a standardised method for veterinarians to improve diagnosis and treatment outcomes for affected dogs, where there previously was no such method for quantitative assessment. Within the UK 40 vets are trained in the technique, which was endorsed by the Kennel Club in 2019 and the <i>Fédération Cynologique Internationale</i>, which represents pedigree dog organisations in 99 countries, in 2020.</p> <p>Stakeholder and media engagement by the researchers has raised public awareness of BOAS. This has led to a revision of pedigree dog health certification standards, changed how Disney advertised their recent film featuring a pug and contributed to a 38% reduction in the number of flat-faced dog purchases within the UK from 2018 to 2019.</p> | | |
| <p>2. Underpinning research (indicative maximum 500 words)</p> <p>In recent decades, breeding selection for extreme brachycephalic features (typically short noses) has resulted in dogs that are predisposed to upper airway tract obstruction due to an excess of soft tissues in that region, causing respiratory distress. This condition, known as brachycephalic obstructive airway syndrome (BOAS), is typical in pugs, French bulldogs and bulldogs.</p> <p>This serious and life-limiting condition has a range of clinical signs, including snoring, exercise intolerance and syncope (passing out). A range of surgical interventions are used to treat the condition, reducing symptoms. Affected breeds are increasingly popular, with the Kennel Club reporting 10,783 pug registrations in 2017, 10,665 bulldog registrations in 2018 and 36,785 French Bulldog registrations in 2018 (Kennel Club ten-yearly breed statistics). The French Bulldog is the UK's second most registered dog in the UK in 2019, and the British Veterinary Association (BVA) recording a 3,488% increase in registrations in the previous decade.</p> <p>Previously, BOAS was diagnosed through physical examination, a subjective process in which different vets employed different definitions of 'normal', and lesion assessment under general anaesthesia, which could be risky for the animals because of their respiratory inadequacy. In</p> | | |

2015, the BOAS research group at the Department of Veterinary Medicine, University of Cambridge determined and defined objective parameters to diagnose BOAS in common brachycephalic dog breeds by pioneering the use of whole-body barometric plethysmography (WBBP) chambers to record the breathing flow of un-sedated dogs. Using a WBBP chamber, the researchers quantified respiratory parameters of French bulldogs before and after exercise. The team developed an objective method to classify respiratory health by grading breathing changes invoked by exercise into four categories (0 – III, with 0 showing no signs of breathing abnormality and III as the most severe) [R1]. At the same time, they undertook a study comparing owner perception of BOAS and functional grading and found that 60% of owners failed to recognise BOAS in dogs graded II and III, i.e. those experiencing the most severe symptoms [R1].

Their method was subsequently tested on pugs and bulldogs as well as French bulldogs in 2016. The team found that methodology predicted BOAS status in each breed with 94-97% accuracy [R2]. Subsequent research has helped to assess the prevalence of BOAS among affected breeds and to validate the clinical efficacy of surgical techniques and their suitability for clinical intervention.

In 2017, the team determined prognostic indicators for surgical treatment. Age, body condition, laryngeal collapse and surgical techniques were associated with postoperative prognosis. Median BOAS indices decreased after surgery from 76% to 63%, although dogs with indices in this range are still considered clinically affected [R3]. Further research in 2017 analysed data collected on detailed external conformation and body condition score (BCS) within breeds who are affected by BOAS. They showed the importance of conformational measurements such as craniofacial ratio (CFR), eye width ratio (EWR), skull index (SI), neck girth ratio (NGR), and neck length ratio (NLR) as additional diagnostic criteria [R4]. The identification of conformational risk factors for BOAS is essential in breeding out this inherited disease. The team also identified that moderate and severe BOAS, requiring medical or surgical intervention, was experienced in 64.6% of pugs, 58.9% of French bulldogs and 51.2% of bulldogs [R4].

In the same year, the team sought to validate their grading of BOAS. They found that sensitivity increased from 57% pre-exercise to 93% after a three-minute trot test, and sensitivity of laryngeal stridor as a predictor of laryngeal collapse increased from 60% to 70% after exercise [R5]. The inclusion of these aspects with their grading highlights the high accuracy the scheme has for detecting BOAS.

The development of an effective grading scheme for BOAS has helped researchers to accurately determine the prevalence of the disease in affected breeds for the first time. Their increased knowledge of indicators and treatment options put the team in an exceptional position to raise awareness of the condition and improve the quality of life for brachycephalic dogs.

3. References to the research (indicative maximum of six references)

R1: Liu NC, Sargan DR, Adams VJ, Ladlow JF. Characterisation of Brachycephalic Obstructive Airway Syndrome in French Bulldogs Using Whole-Body Barometric Plethysmography. PLoS One. 2015 Jun 16;10(6):e0130741. doi: 10.1371/journal.pone.0130741. eCollection 2015. PubMed PMID: 26079684; PubMed Central PMCID: PMC4469695.

R2: Liu NC, Adams VJ, Kalmar L, Ladlow JF, Sargan DR. Whole-Body Barometric Plethysmography Characterizes Upper Airway Obstruction in 3 Brachycephalic Breeds of Dogs. J Vet Intern Med. 2016 May;30(3):853-65. doi: 10.1111/jvim.13933. Epub 2016 May 9. PubMed PMID: 27159898; PubMed Central PMCID: PMC4913582.

R3: Liu NC, Oechtering GU, Adams VJ, Kalmar L, Sargan DR, Ladlow JF. Outcomes and prognostic factors of surgical treatments for brachycephalic obstructive airway syndrome in 3 breeds. *Vet Surg.* 2017 Feb; 46(2):271-280. doi: 10.1111/vsu.12608. PubMed PMID: 28146288.

R4: Liu NC, Troconis EL, Kalmar L, Price DJ, Wright HE, Adams VJ, Sargan DR, Ladlow JF. Conformational risk factors for brachycephalic obstructive airway syndrome (BOAS) in pugs, French bulldogs, and bulldogs. *PLoS One.* 2017 Aug 1;12(8):e0181928. doi: 10.1371/journal.pone.0181928. eCollection 2017. PubMed PMID: 28763490; PubMed Central PMCID: PMC5538678.

R5: Riggs J, Liu NC, Sutton DR, Sargan D, Ladlow JF. Validation of exercise testing and laryngeal auscultation for grading brachycephalic obstructive airway syndrome in pugs, French bulldogs, and English bulldogs by using whole-body barometric plethysmography. *Vet Surg.* 2019 May;48(4):488-496. doi: 10.1111/vsu.13159. Epub 2019 Jan 21. PubMed PMID: 30666670.

All research outputs have been published in peer-review journals.

Competitive funding secured

Kennel Club Charitable Trust

- Objective characterisation of the respiratory cycle of brachycephalic dogs and its relationship to skull, skeletal and soft tissue characteristics, GBP19,145
- Identifying the associations between respiratory flow waveforms and the individual airway lesions causing brachycephalic obstructive airway syndrome (BOAS) GBP40,829
- Funding to support the Cambridge BOAS Research group, GBP50,000

Dog Welfare Trust:

- Small Grant, GBP3,250

Isaac Newton Trust:

- A genetic approach to causation of Brachycephalic Obstructive Airway Syndrome in dogs, GBP162,487

Waltham Foundation:

- Investigation of gene expression of positional candidate genes causing brachycephalic obstructive airway syndrome (BOAS), GBP15,874

4. Details of the impact (indicative maximum 750 words)

BOAS presents a significant health and welfare issue to flat-faced dog breeds: the 2017 British Veterinary Association's ([BVA](#)) Veterinary Profession survey found that 56% of brachycephalic dogs required treatment for breed-related health issues. A study published in 2020, examined 22,333 dogs under UK veterinary care; it cites [R1] and [R3], and strongly shows that brachycephalic breeds are generally less healthy than their non-brachycephalic counterparts [E1]. The increasing popularity of these breeds means that improving breed health by identifying dogs that are not affected by BOAS is essential to improve health and welfare of these dogs. The BOAS research group at the University of Cambridge has transformed the diagnosis and treatment of BOAS, improving animal welfare and health outcomes for pet dogs and their significant public engagement work has had a demonstrable impact in the reduction of pedigree breed registrations.

Changes to professional practice

A new respiratory functional grading scheme

The objective and non-invasive Functional Grading Scheme created by Ladlow, Liu and Sargan, launched in 2019, and is the world's first objective testing criteria for BOAS, improving diagnosis, treatment and outcomes for affected breeds. It is the only scheme recommended by the UK Kennel Club. The Kennel Club said: "*The Respiratory Function Grading Scheme is the*

strongest mechanism we have to show a commitment to tackling BOAS within these breeds” [E2]. Within the UK, 40 vets are currently recommended by the Kennel Club for regional referrals [E2], ensuring that brachycephalic breed owners across the UK can now access specialist care for their pets. In 2019, 396 dogs were graded under the scheme [E2].

Global roll out of the scheme

In June 2020, the President of the FCI (Fédération Cynologique Internationale, representing 99 countries’ pedigree dog organisations) endorsed the functional grading system, making it available to all FCI member countries via license agreements, and pledged to cooperate with Dr Ladlow to develop guidelines for national organisations [E3]. This represents a key change in practice. The Irish and New Zealand Kennel Clubs have already agreed to license the scheme [E5]. The president of the New Zealand Kennel Club said: *“The RFG scheme will be immediately designated as a mandatory test for all three breeds under the Accredited Breeders Scheme”* [E4].

As well as being supported by the Kennel Club and FCI, the functional grading scheme has been adopted as part of a health certification scheme run by each of the three UK breed councils representing brachycephalic breeds (Bulldog, French Bulldog and Pug). These certificates are issued to dogs that represent the healthiest examples of these breeds, and hence increase demand to breed only from the healthiest dogs [E5].

Whole-body barometric plethysmography (WBBP) chambers

Following the research into respiratory grading methods, WBBP chambers, which provide objective criteria to validate the test protocol on introduction and to allow further BOAS research, have been installed in leading veterinary hospitals including the Royal Veterinary College in London and the Royal (Dick) School of Veterinary Sciences, Edinburgh [E6], impacting professional practice.

Improving awareness, reducing demand

Ladlow and Sargan are founding members of the Brachycephalic Working Group (BWG), an organisation dedicated to improving the health and welfare of brachycephalic dogs and reducing consumer demand for the breeds [E7]. Established in 2016, the BWG was instrumental in the development of the 2018 BVA and British Small Animal Veterinary Association’s (BSAVA) *Breed to Breathe* campaign on brachycephaly in pedigree dogs. Vets have been issued a ten-point practice plan to improve the health and welfare of brachycephalic dogs and promote responsible pet ownership; this includes the use of the functional grading scheme. All vets are strongly encouraged to advise against breeding if a dog is suffering from BOAS [E8].

The Senior Vice-President of the BVA said, *“Flat-faced dogs have seen a rapid rise in popularity in recent years, which has been fuelled by their prominence in the media, but many people are unaware that their ‘cute’ looks mask serious and often life-limiting health problems”* [E9]. To counteract this, Sargan, Ladlow and the BWG have worked hard to reduce exposure of flat-faced dogs in the media whilst raising awareness of their health issues to prospective owners. In 2017, as a result of this, Halifax bank removed a marketing campaign that featured a pug: *“Since being made aware of the health issues associated with flat-faced dogs, we have reviewed our marketing and advertising materials and will be removing any use of these breeds from our imagery at the earliest opportunity.”* [E10].

Sargan and Ladlow appeared in *Saving the British Bulldog*, a prime-time 2018 BBC1 documentary that documented the fight against harmful breeding practices and was viewed by almost two million people [E11], [E12]. Presenter Catherine Tate said *“I just don’t think there is a level of awareness yet that has infiltrated the public, because clearly the dogs are suffering. We as humans have to start putting the dogs first, and I don’t think we are”*. [E11]. The documentary sparked debate on social media, with comments including *“Nice to see the Bulldog breeders advocating health testing! Shame it’s not mandatory!”*

#savingthebritishbulldog” and *“#SavingTheBritishBulldog is the most amazing thing I’ve watched. Get rid of these bad breeders and keep them a healthy British icon”* [E12].

When Disney announced the film *Patrick* (released June 2018) about the life of a pug, concerns were raised by the BWG and veterinary community that the high profile film could increase demand for the breed, as had happened in previous films featuring animals. Sargan, Ladlow and Liu and the BWG worked closely with the director and producer of the film (private communication) to ensure it was released in a responsible way. Disney UK agreed numerous actions including: they would create no pug-related merchandise to support the film, a welfare message would be included in the credits explaining health issues, and leaflets would be distributed to the public and journalists at cinemas describing pug health issues [E9]. Rather than the anticipated increase in pug registrations previously observed with dog-focussed films, after the film was released the Kennel Club noted a 38% decrease in pug registrations from 10,783 in 2017 to 6,751 in 2019. [E9]. Whilst it is too early to predict long term trends, the Senior Health and Welfare Manager at the Kennel Club said *“We hope the new figures are a sign of our message getting through and that there are now fewer, better-informed owners buying from responsible breeders”* [E9].

The work of Ladlow, Liu and Sargan has been fundamental to the development of an objective and non-invasive assessment of airway function in flat-faced dogs. Their work enables practitioners and pet owners to identify risk factors for BOAS and improve clinical diagnosis. Public awareness of the animal welfare problems of BOAS have reduced consumer demand, with 2019 compared to 2018 registrations reduced by 31% in pugs, 8% in French bulldogs and 7% in bulldogs [E9]. This marks the first time in a decade these breeds have seen a decrease in numbers [E9].

5. Sources to corroborate the impact (indicative maximum of 10 references)

- E1. O'Neill, D.G., Pegram, C., Crocker, P. et al. Unravelling the health status of brachycephalic dogs in the UK using multivariable analysis. *Sci Rep* 10, 17251 (2020) doi: 10.1038/s41598-020-73088-y (R1, R3 cited on page 7)
- E2. Collated information from The Kennel Club: statement on the Respiratory Function Grading Scheme; list of recommended vets for the Respiratory Function Grading Scheme; Respiratory Function Grading Scheme 2019 results
- E3. FCI article endorsing the Respiratory Function Grading Scheme and signed cooperation agreement between Dr Ladlow and the president of the FCI
- E4. Articles relating to Irish Kennel Club and New Zealand Kennel Club endorsement of the Respiratory Function Grading Scheme
- E5. Health Scheme guidelines for the French Bulldog Club of England, the Pug Breed Council and the Bulldog Breed Council
- E6. Royal Veterinary College and Royal (Dick) School of Veterinary Science webpages stating they have WBBP unit facilities
- E7. BWG members list
- E8. Breed to breathe 10-point plan
- E9. Combined articles including: (i) BVA article detailing the actions Disney agreed to take following the release of film *Patrick* (page 1); (ii) Kennel club registration data 2010 – 2019 (page 3); (iii) Pets4homes article describing the decline in pugs (page 4); (iv) Kennel club article describing decline in flat faced dog popularity (page 15)
- E10. Article including statement from Halifax bank agreeing to remove advertisements using flat-faced dogs
- E11. BBC Documentary ‘Saving the British Bulldog’
- E12. Articles showing viewer numbers of *Saving the British Bulldog* and the debate this led to on social media.