In the know about noses: Burrowing into brachycephalic dog breeds (Part 2)

Brachycephalic dogs, with their significantly shortened faces and muzzles, are known to be at increased risk for a range of serious diseases. The Nationwide® Pet Health Analytics and Insights Team analyzed data representing more than 450,000 dog years of canine claims from their database of dogs protected by Nationwide insurance. This report on Part 2 of the analysis reveals further insights into the risks faced by dogs with the extreme brachycephalic conformation and brachycephalic obstructive airway syndrome (BOAS) and outlines opportunities for clinical intervention for these dogs. February 2023

Executive summary

This white paper is an analysis powered by claims submitted on behalf of over 50,000 Nationwide-insured brachycephalic dogs. The data reveal additional significant health problems in dogs with extreme brachycephalic conformation (French Bulldogs, English Bulldogs, and Pugs) and that have had claims submitted for brachycephalic obstructive airway syndrome (BOAS). Our large data set adds previously unavailable context and reveals new insights into this population.

Part 1 of the analysis quantified the risk of diseases found in brachycephalic breeds compared to non-brachycephalic breeds. This report, Part 2 of the analysis, reveals insights into the dramatic increase in the risk of certain respiratory, gastrointestinal, and spinal disease comorbidities in extreme brachycephalic dogs with BOAS. Together, the two parts of the analysis shed new light on the increased health risks faced by these popular breeds.

This analysis shows:

- **BOAS further increases risks for "extreme brachycephalic" dogs –** Not only do the subset of extreme brachycephalic dogs (French Bulldogs, English Bulldogs, and Pugs) face increased risks of certain diseases, but those that also suffer from BOAS are even more dramatically at risk to have claims for other conditions – twice as likely for spinal disease, 4.5 times more likely for pneumonia, and 5 times for esophageal disease.
- **Early education is essential –** The first claim for most extreme brachycephalic dogs with BOAS is submitted early in life, with the majority of affected French and English Bulldogs receiving the diagnosis before their second birthday, and Pugs by age four. Education of the veterinary healthcare team and the pet family will increase opportunities for early intervention and optimal outcomes.
- **Nationwide comorbidity data creates new opportunities for interventions –** While understanding the risk of comorbidities is incredibly helpful, being able to predict the sequence of disease creates the opportunity for early diagnosis or even prevention. For example, in extreme brachycephalic dogs affected by pneumonia as an initial disease, other comorbidities might be avoided or mitigated by early BOAS surgery.

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Introduction

Increasingly popular companions, brachycephalic dogs appeal to many different owners, from the family next door to world-famous celebrities. Their somewhat "infantile" appearance, with large eyes, large foreheads, and bulging cheeks, and their reputation for family-friendliness and outgoing personalities, may all contribute to their popularity.[1] Unfortunately, along with these characteristics comes a list of related health conditions. As noted in Part 1 of this report, veterinary researchers have investigated many of these issues. Most of these are single-site evaluations, often including groups of fewer than 100 dogs. Our large data set provides a major advantage in identifying relative risks.

This analysis complements Part 1, incorporating data from more than 450,000 purebred dog years at risk (DYAR) and more than 50,000 individual brachycephalic dogs. Unless otherwise noted, all relative risk calculations achieved a statistical significance of $p<0.01$ (Bonferroni-adjusted). A comprehensive review of the analytical methodology can be found in a separate methodology document at the link below:

www.petinsurance.com/petdata

While Part 1 primarily described the relative disease risks between brachycephalic and non-brachycephalic dogs and extreme and non-extreme brachycephalic dogs, Part 2 delves into the risks surrounding comorbidities in extreme brachycephalic dogs with brachycephalic obstructive airway syndrome (BOAS) compared with extreme brachycephalic dogs without BOAS. In particular, we evaluated these risks at the breed level, comparing extreme brachycephalic dogs with BOAS with their non-BOAS breed cohorts. Because BOAS is primarily a disease of extreme brachycephalic dogs, comparisons to extreme brachycephalic dogs without BOAS are most relevant, although we have included comparisons to the non-brachycephalic, non-BOAS dog population where they provide useful context. We conclude with evidence-based recommendations for veterinary healthcare teams and pet families to optimize management for these conditions. We encourage reading both parts of the analysis for the most complete picture.

A note on relative risk

Readers have varying levels of comfort with statistics, so we've worked to make the information here as easy to understand as possible for everyone. We have therefore provided risk ratios ("half as likely," "three times as likely") with the combined claims relative risk data. Where appropriate, we included the relative percentages. For example, if breed A has a 163.5% risk of having a pneumonia claim submitted when compared to the mean (average) rate for other dogs, this is equivalent to noting that breed A is 1.63 times more likely to have had a pneumonia claim submitted than the average dog, or that breed A had a 63.5% greater risk of a pneumonia claim.

In the know about noses: Burrowing into brachycephalic dog breeds (Part 2)

Study population

Table 1 - Brachycephalic dogs by Nationwide purebred breed rank

Breed	Breed Rank
French Bulldog	3
Shih Tzu	6
English Bulldog	7
Boxer	8
Pug	16
Boston Terrier	20
Cavalier King Charles Spaniel	21
Lhasa Apso	61
Bull Mastiff	74
Chinese Shar-Pei*	76
Pekingnese	79
Chow Chow	87
Brussels Griffon	97
Dogue De Bordeaux	108
Japanese Chin	123

This analysis uses data from the same purebred dog population described in Part 1: 15 brachycephalic dog breeds, and a subgroup of three extreme brachycephalic breeds (Pugs, French Bulldogs, and English Bulldogs).

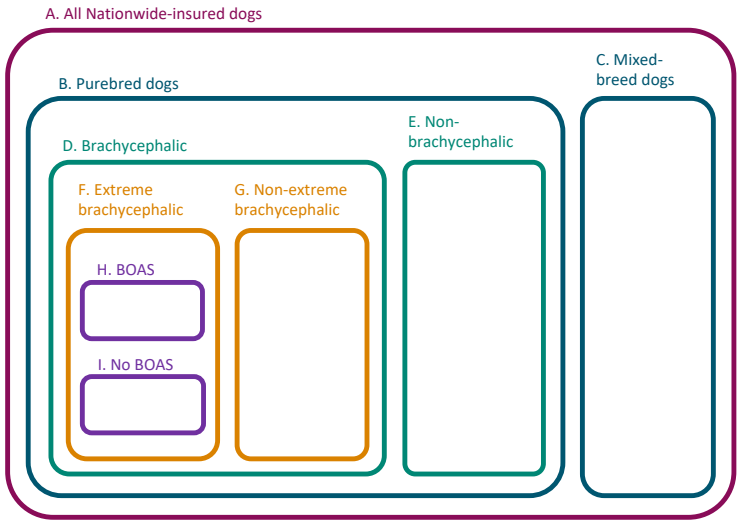
Inclusion in the two groups was determined by identification of the breed as brachycephalic or extreme brachycephalic in at least three peer-reviewed papers. Extreme brachycephaly has been defined in these resources as breeds with the most severe morphological changes to the features distinctive to brachycephalic dogs (e.g., shortened muzzle and skull, underbite, and wide-set eyes). A complete description of the inclusion criteria is available in the methodology document.

Table 1 shows the breeds included in the analysis and their relative rank among Nationwide-insured purebred dogs, as of October 2022.[2] Brachycephalic breeds currently account for 21.6% of purebred dogs insured by Nationwide, and extreme brachycephalic breeds account for more than half of these dogs.[2]

Demographics are described in greater detail in Part 1 of this report.

Figure 1 describes the various subsets of dogs used in the analysis. Part 1 evaluated the relative disease risks between dogs with and without brachycephaly (groups D and E), and extreme vs. non-extreme brachycephaly (groups F and G). Part 2 evaluates the relative risk of comorbidities in dogs with extreme brachycephalic morphology and BOAS (group H) compared to dogs with extreme brachycephaly but without BOAS (group I).

Figure 1 - Schematic of dog populations as grouped for analysis
(size of boxes is not representative of population sizes)



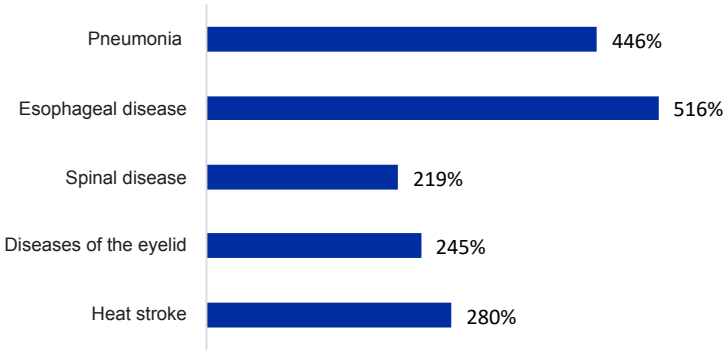
In the know about noses: Burrowing into brachycephalic dog breeds (Part 2)

Brachycephalic obstructive airway syndrome (BOAS) and comorbidities

Of all BOAS claims received by Nationwide from 2016 to 2021, 93% are from policies for extreme brachycephalic breeds. Dogs from this group are almost 15 times more likely to have a claim submitted for BOAS than non-extreme brachycephalic dogs; French Bulldogs are almost 17 times more likely to have a claim submitted for BOAS, English Bulldogs nearly 12 times more likely, and Pugs almost 10 times more likely than non-extreme brachycephalic dogs.[3]

While published studies have shown relationships between BOAS and other conditions before, to the authors' knowledge, this analysis represents the largest single-study cohort of brachycephalic dogs.[4, 5, 6] Accordingly, this white paper can create comorbidity analyses that have not been possible with other populations. Our results show that diagnosis with BOAS in extreme brachycephalic dogs is correlated with a dramatically higher risk of many other serious health concerns (Figure 2).

Figure 2 - Relative disease risk in extreme brachycephalic dogs with BOAS vs without BOAS



According to these data, BOAS may be considered an effective sentinel disease for other conditions (e.g., pneumonia, spinal disease, esophageal and gastrointestinal disease) that are exacerbated by extreme brachycephalic morphology. The progressive nature of BOAS and association with respiratory and esophageal disease has been documented as caused at least in part by dramatic changes in airflow and airway pressure from the abnormally long soft palate, stenotic nares, undersized nasal chambers, and other structural alterations. These pressure changes lead to secondary respiratory and digestive system disorders that worsen with time.[7] Extreme brachycephalic dogs are also at risk of vertebral malformations, from hemivertebrae to kyphosis and scoliosis, although they are not consistently linked with clinical signs of spinal disease.[8] The correlation this analysis reveals with spinal disease and extreme brachycephalic conformation warrants additional investigation for the underlying cause.

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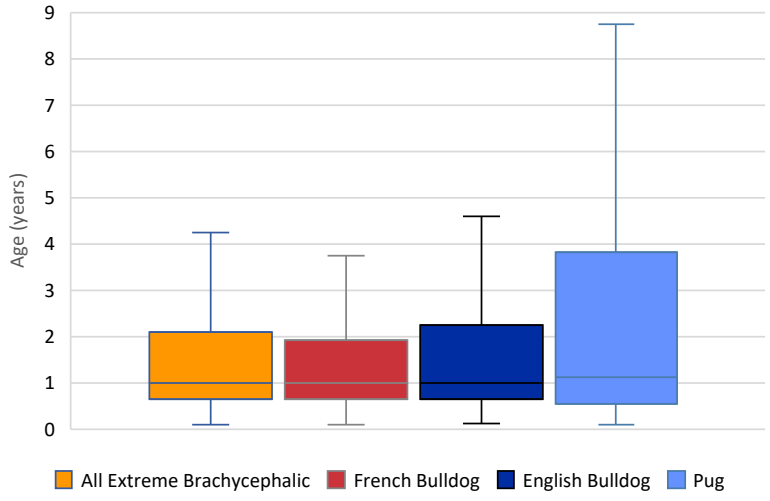
Age at diagnosis with BOAS

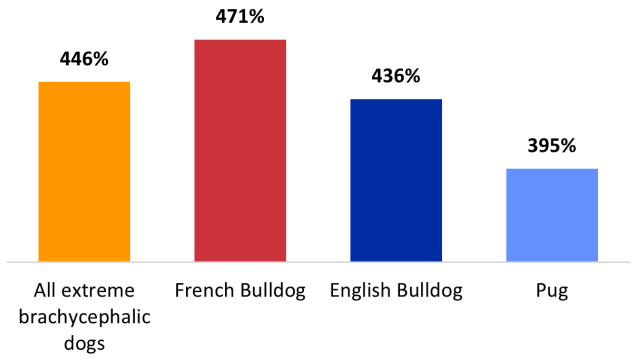
Dogs with BOAS begin showing clinical signs early in life. In our study population, in almost 75% of dogs with BOAS the initial claim is submitted before 2 years of age. This is particularly true of French Bulldogs and English Bulldogs, while 75% of Pugs have their first BOAS claim submitted prior to age 4. (Figure 3). One explanation might be that Pugs experience less severe forms of disease compared to the two other breeds, but further investigation is needed.

Figure 3 - Box and whisker chart showing age distribution for first claim for brachycephalic obstructive airway syndrome (BOAS)



Claims for BOAS may be accompanied by claims for related diseases, or shortly precede them. Amongst dogs with claims submitted for BOAS and pneumonia, 26% of first-time pneumonia claims are made at the same time as the initial BOAS claim, 50% are submitted within 3 months, and the remainder of first-time pneumonia claims are almost all submitted within 1 year of the initial BOAS claim. This early development of comorbidities supports the studies recommending early intervention with corrective surgery for dogs with BOAS. The exact timing remains a topic of investigation.[9, 10]

Figure 4: Relative risk of claims for pneumonia among extreme brachycephalic dogs with BOAS vs without BOAS



Pneumonia in extreme brachycephalic dogs with BOAS

The impact of extreme conformation and BOAS claim submission on the risk of pneumonia is dramatic. Extreme brachycephalic dogs with BOAS are 4.46 times more likely to submit a claim for pneumonia than extreme brachycephalic dogs without BOAS (Figure 4). For context, extreme brachycephalic dogs with BOAS are 12 times more likely to submit a claim for pneumonia than all other purebred dogs without BOAS.

Comparing the relative risks at the breed level, French Bulldogs (471%) English Bulldogs (436%), and Pugs (395%) with BOAS are at significantly greater risk. Thus, if one of these three extreme brachycephalic breed dogs has a claim submitted for BOAS, they are 4-5 times more likely than a dog of the same breed without BOAS to also submit a claim for pneumonia.

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Gastrointestinal comorbidities in extreme brachycephalic dogs with BOAS

BOAS predisposes dogs to concomitant gastrointestinal disease. In one report, endoscopy of brachycephalic dogs referred for BOAS surgery identified esophageal, gastric, or duodenal abnormalities in 97.3% of cases.[11] Another study determined that French Bulldogs are at increased risk of esophageal, gastric, and intestinal diseases, even as compared to other extreme brachycephalic breeds.[12]

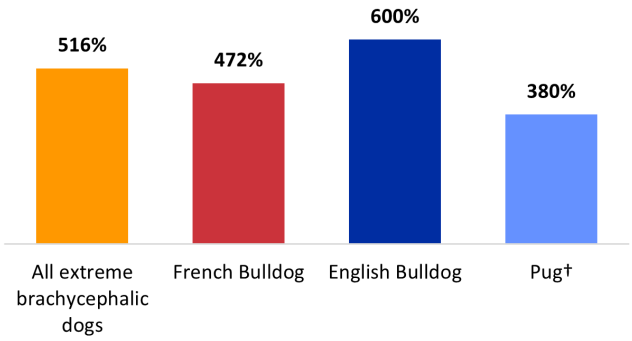
Our analysis combines the two factors, considering the risk of different esophageal and gastrointestinal diseases in BOAS-affected dogs from the three extreme brachycephalic breeds.

Extreme brachycephalic dogs with BOAS were at double the relative risk of submitting a claim for any esophageal or gastrointestinal disease as compared to extreme brachycephalic dogs without BOAS.

Esophageal disease

The correlation between BOAS and esophageal disease is also dramatic. In our cohort, extreme brachycephalic dogs with BOAS were 5.16 times more likely to have a claim submitted for esophageal disease (e.g., megaesophagus, esophagitis) than extreme brachycephalic dogs without BOAS (Figure 5).

Figure 5: Relative risk of claims for esophageal disease among extreme brachycephalic dogs with BOAS vs without BOAS



Compared to other purebred dogs without BOAS, extreme brachycephalic dogs with BOAS are at 8.86 times the risk for esophageal disease.

At the breed level, French Bulldogs with BOAS (472%) and English Bulldogs with BOAS (600%) are both at increased relative risk for esophageal disease as compared to their breed counterparts without BOAS. Although Pugs with BOAS were at 380% relative risk for esophageal disease as compared to Pugs without BOAS, this difference did not meet this analysis' standards for statistical significance

Other gastrointestinal diseases

Extreme brachycephalic dogs with BOAS are more likely to suffer from other gastrointestinal conditions as well. They were 2.17 times more likely than extreme brachycephalic dogs without BOAS to submit a claim for gastroenteritis, and 4.46 times more likely to submit a claim for inflammatory bowel disease (IBD).

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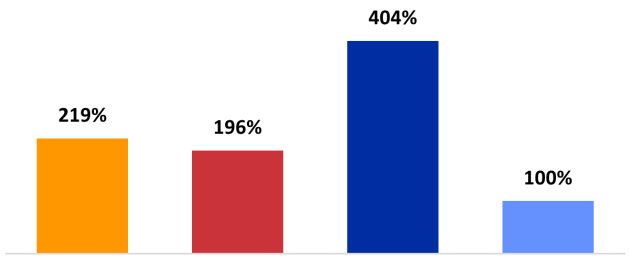
Spinal disease in extreme brachycephalic dogs with BOAS

While many veterinarians consider the Dachshund to be the classic dog at risk for developing intervertebral disc disease (IVDD), studies have shown that French Bulldogs are at increased risk as well. According to one study, 43% of French Bulldogs may develop IVDD, and those with kyphosis are significantly more likely to be diagnosed with it.[13] Among French Bulldogs with clinical signs of neurologic disease (defined as encephalopathy, myelopathy, peripheral nervous system disorder, muscular disorder, and unclassified neurologic disorder), nearly half (45.5%) had IVDD in one study.[14] Our analysis reveals an even greater risk of claims submission for spinal disease (that includes IVDD, myelopathy, and paresis) for extreme brachycephalic dogs with BOAS.

Figure 6: Relative risk of claims for spinal disease among extreme brachycephalic dogs with BOAS vs without BOAS

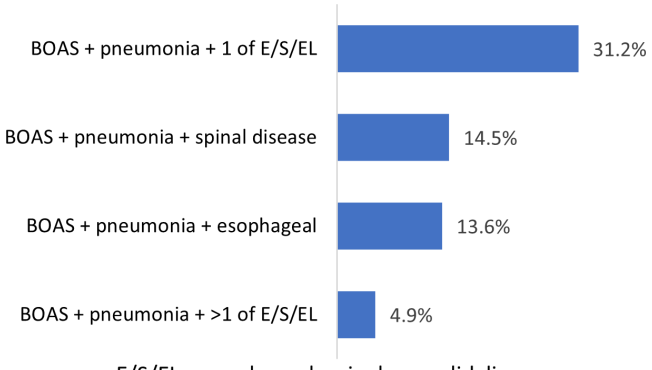


In our analysis, extreme brachycephalic dogs with BOAS were 2.19 times more likely to submit a claim for spinal disease as compared to extreme brachycephalic dogs without BOAS, and 6.69 times more likely than other purebred dogs without BOAS.

As expected, French Bulldogs had the highest relative risk of submitting a claim for spinal disease compared to the general purebred population. However, English Bulldogs with BOAS were at the highest relative risk as compared to their non-BOAS breed-mates, being more than 4 times as likely to submit a claim for spinal disease (Figure 6). French Bulldogs with BOAS were nearly twice as likely as their non-BOAS counterparts to submit a claim for spinal disease. Although this difference is less than one might expect, it may reflect the high baseline of spinal disease (mostly IVDD) in French Bulldogs noted above.

Intervertebral disc disease will be explored in greater depth in the upcoming white paper "*Aging Well Part 2*" to be published in 2023.

Figure 7: Frequency of additional comorbidities in extreme brachycephalic dogs with BOAS and pneumonia



E/S/EL = esophageal, spinal or eyelid disease

Multiple comorbidities with BOAS

While this analysis has thus far focused on the risk of BOAS with another single disease, it is not a great leap to recognize that multiple comorbidities with BOAS also occur. Among extreme brachycephalic dogs with BOAS and pneumonia, 31.2% also submitted claims for one of either esophageal, spinal, or eyelid diseases; claims for spinal disease (14.5%) and esophageal disease (13.6%) were the most common. One in 20 of these dogs (5%) had claims submitted for two or more of these additional conditions (Figure 7).

† Does not meet study's goal of statistical significance (Bonferroni-adjusted p<0.01 = p<=0.0000625)

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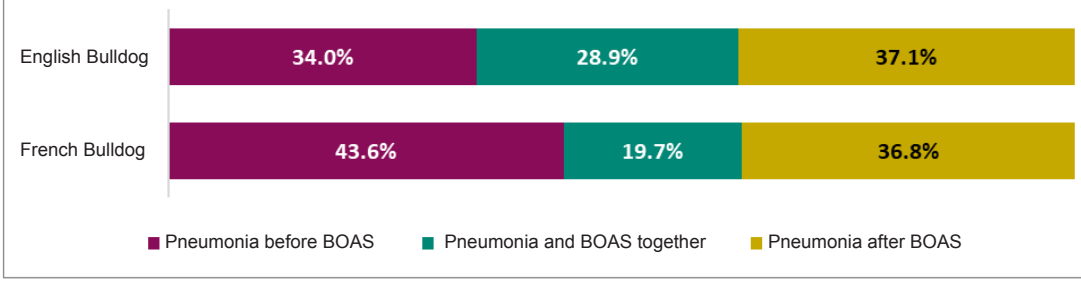
Dogs with BOAS and esophageal disease were also likely to submit claims for additional diseases. Among extreme brachycephalic dogs with esophageal disease, nearly half (48%) submitted claims for one of either pneumonia, spinal, or eyelid diseases; nearly one-third (29%) of these claims were for pneumonia.

When treating extreme brachycephalic dogs with BOAS, veterinary healthcare teams would do well to counsel owners on their increased risk for multiple other diseases. Owner awareness and vigilance can lead to timely intervention.

Sequences of claims for BOAS and comorbidities

The path dictated by extreme brachycephaly and BOAS leads to a maze of additional health problems. These additional diseases tend to appear early in the dog's life, with somewhat predictable patterns. We have already noted that extreme brachycephalic dogs with BOAS are 4.5 times more likely to submit claims for pneumonia. Of these dogs, French Bulldogs are more likely to submit claims for pneumonia before their BOAS is diagnosed, while English Bulldogs are almost equally likely to submit claims for pneumonia after being diagnosed with BOAS as before (Figure 8).

Figure 8: Sequence of pneumonia comorbidity in extreme brachycephalic breeds with BOAS



Pneumonia may thus be a leading indicator for BOAS in these breeds, especially in French Bulldogs. Veterinarians treating them for pneumonia would be well-advised to discuss BOAS, its risks, and appropriate actions with their owners.

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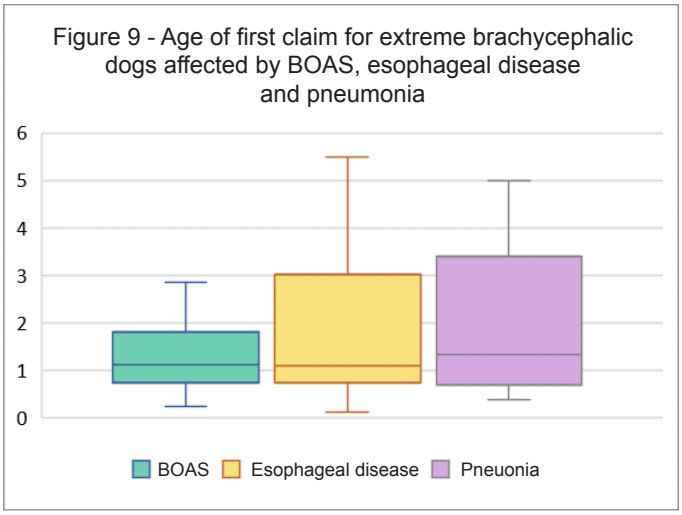
In the most complex of the cases we considered (all of which were French Bulldogs and English Bulldogs), the extreme brachycephalic dogs with BOAS, pneumonia, and esophageal disease, the BOAS claim often comes earliest, with the esophageal disease and pneumonia claims following. (Figure 9). For these dogs, not only does their path lead to multiple diseases, it leads them to the revolving door at the entrance to their veterinarian's clinic.



Overall, our results indicate that extreme brachycephalic dogs, particularly those with BOAS, are at significantly higher risk of developing additional diseases requiring intense veterinary care from early in life. Owners and prospective owners of these dogs should be made aware of these risks. In the next section, we offer suggestions for discussing BOAS and its implications with owners.

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Clinical recommendations for extreme brachycephalic dogs*

Clinicians' everyday experience that French Bulldogs, English Bulldogs, and Pugs are often sicker than the average dog is reinforced by the data in this analysis.[15] This reality leads to an increased burden of medical responsibility for families that choose extreme brachycephalic dogs as pets. Helping to educate current and prospective pet families about the increased risk of serious diseases in these dogs (and the financial, emotional, and welfare concerns that may arise) is time well-spent.

Advice to give pet families concerning BOAS:

- **A disease of young adults:** French and English Bulldogs are typically diagnosed with BOAS by 2 years of age, Pugs by 4 years of age
- **Clinical signs of BOAS:** Severity varies from mild to moderate (e.g., snoring, snorting, gagging, restlessness) to severe (e.g., exercise intolerance, collapse, cyanosis)
  - Recording clinical signs while the dog is at home may help veterinary teams tailor recommendations based on an individual dog's response to exercise, stress, or heat[16]
- **Early surgical intervention:** Because of the increased risk of developing multiple comorbidities in French and English Bulldogs, and Pugs with BOAS, this analysis supports recommendations for considering corrective surgery close to the time of diagnosis[9, 10]
- **Lifestyle recommendations:**
  - **Weight management:** As discussed in Part 1 of our analysis on brachycephalic dogs, the evidence base that obesity is a risk factor for development and severity of multiple conditions in extreme brachycephalic dogs (BOAS, IVDD, esophageal disease in BOAS dogs) warrants strong recommendation for nutrition counseling to maintain a healthy (4-5/9) body condition score.[3]
  - **Intervertebral disc disease:** English and French bulldogs with BOAS are at significantly greater risk of submitting claims for IVDD
    - **Prevention:** Low-impact exercise programs to maintain muscle tone, use ramps or low stairs rather than jumping onto furniture, weight management[17]
    - **Monitor for:** Limping, back or neck pain, wobbly gait, or difficulty walking
- **Sequenced comorbidities:** Our sequencing analysis shows that extreme brachycephalic dogs tend to submit claims in a sequence of BOAS and pneumonia, then esophageal disease. Evaluation by a veterinarian is recommended when clinical signs for these conditions are noted, especially in dogs with a BOAS diagnosis.
  - **Pneumonia:**
    - **Monitor for:** Coughing, rapid or labored breathing, poor appetite, weakness, or exercise intolerance
    - **High risk levels:** Nearly one in three (31%) extreme brachycephalic dogs with BOAS and pneumonia in this analysis developed esophageal, spinal, or eyelid disease
  - **Esophageal disease:**
    - **Monitor for:** Vomiting or regurgitation of food (especially after meals), or frequent swallowing

* Additional recommendations are included in Part 1 of this analysis

Conclusions

This white paper represents the second exploration of pet health insurance data from tens of thousands of individual brachycephalic dogs, totaling hundreds of thousands of dog years at risk.

While Part 1 of our analysis revealed risks experienced by extreme brachycephalic dogs, Part 2 reveals additional risks faced by extreme brachycephalic dogs with BOAS, including pneumonia, esophageal disease, and intervertebral disc disease. Our results highlight the need for careful counseling of dog owners, and close collaboration between pet families and their veterinary healthcare teams throughout the dog's life.

Our two-part analysis has revealed new, actionable information regarding common diseases of brachycephalic dogs, including the more familiar respiratory and ocular syndromes, gastrointestinal diseases, heatstroke and pregnancy complications, and some surprises, including systemic allergic reactions and spinal disease. Furthermore, it emphasizes the threat of BOAS to the overall health of extreme brachycephalic dogs. We encourage readers, whether veterinary professionals or dog owners, to consider the information in both parts of the analysis.

The goal of these Nationwide analyses is to provide pet families and veterinary healthcare teams with objective, data-informed personalized pet health guidance. We hope to facilitate early disease recognition, appropriate interventions, and better health outcomes for pets.

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About Nationwide's Pet Health Analytics and Insights Team

In 2021, Nationwide's pet insurance division created a dedicated Pet Health Analytics and Insights Team comprised of veterinarians, data scientists, and breed experts working in collaboration with Nationwide actuaries, analytics experts, and technology partners. The goal: providing pet families, veterinary healthcare teams, and the animal health industry with personalized pet insights that contribute.

Previous white papers from Nationwide

Canine Cancer Series

- "**Oodles of Doodles: Popularity and Health**," on the popularity of poodle crosses and their lower rates of cancer claims compared to their contributing breeds – Poodles, Golden Retrievers, and Labrador Retrievers.
- "**Diversity of Risk: Purebred Dogs and Cancer**," on the relative risk of claims for common cancers in popular purebred dogs.
- "**About the Size of It: Scaling Canine Cancer Risk**," on the effect dog size has on the relative risk of cancer, how it differs across body systems, and what effect size and body system has on age of initial cancer claim.

Senior Pets

- "**Aging Well: Old Dogs, New Data (Part 1)**," on common conditions in aging canines, and how risk changes by breed and dog type.

These white papers are available at www.petinsurance.com/petdata, along with expanded explanations of analytical methodology. The publication of white papers based on the analysis of Nationwide pet data is part of a larger effort by Nationwide in pioneering positive change in veterinary medicine. We support the greater use of "big data" by industry players, shared for the benefit of all.

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