



Mapping of initiatives to prevent inherited diseases and exaggerated phenotypes in dogs

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Publication date:
2023

Document version
Publisher's PDF, also known as Version of record

Citation for published version (APA):
Bruun, C. S., Fredholm, M., Proschowsky, H. F., & Sandøe, P. (2023). *Mapping of initiatives to prevent inherited diseases and exaggerated phenotypes in dogs*. Department of Veterinary and Animal Sciences, University of Copenhagen.



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Frederiksberg, January 2023

Photo on front page: Levgeniia, Colourbox.

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Funding: The project was funded by Videncenter for Dyrevelfærd, Danish Veterinary and Food Administration

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English summary

Background

Over the past few decades there has been a growing awareness that the breeding of certain dog breeds has a number of seriously negative consequences for the dogs' health, and thus also for their welfare. Some of these consequences are due to the numerically small breeding populations, while others seem to be a direct consequence of the breeding goals themselves, which have in some cases become exaggerated in comparison with the breed standards. However, in many respects, increased public awareness of these issues has not led to the problems being resolved. For example, a Danish study published in 2019 showed that more than 40% of French Bulldogs – which, in 2022, was the fifth most popular dog breed in Denmark – have serious breathing problems.

Focus and methods

Following a brief introduction to the historical background of the problems that we are still seeing in some breeds, in this report we describe and examine the effect of the following types of initiative designed to curb the negative consequences of dog breeding: research initiatives, initiatives within the dog breeding community, initiatives to inform and influence the prospective dog owners and legislative initiatives. We cover a number of western countries.

This report is based on 1) legal documents; 2) documents from Fédération Cynologique Internationale (FCI), and also from the Danish and other national kennel clubs, Animal Welfare organizations and other relevant stakeholders links to which are typically found on the organizations' webpages; and 3) the scientific literature. Moreover, interviews were also conducted with stakeholders in Norway and the Netherlands.

Main findings

The historical background of the problem

Organized dog breeding involving closed-breed populations has existed since the nineteenth century. In most countries, the national kennel club organizes the breeding and maintains the studbooks. Most of the national kennel clubs are associated with FCI.

The organizational work has to a large extent been driven by volunteers and enthusiasts. The dogs have therefore been selected by individual dog owners and generally in great loyalty to the traditions and culture prevailing in each breed and show community.

An important, negative consequence of breeding within closed-breed populations is inherited disease. Moreover, exaggerated phenotypes have become a problem. The most problematic of these is seen in the brachycephalic breeds such as the Pugs and the Bulldogs. Dogs of these breeds can have excessively flattened muzzles/skulls, which may result in "brachycephalic obstructive airway syndrome" (BOAS) as well as a number of other secondary problems with eyes, ears, skin and so on. Over the past few decades the number of dogs with a studbook has declined. This development is seen especially in popular breeds. Thus, in breeds such as the Chihuahua and the French Bulldog the proportion of Danish dogs with a studbook is now below 15%. At the same time, there is an ever-increasing trade of purebred dogs across national borders.

Research initiatives

Research is crucial in order to generate knowledge about all aspects of breeding-related impaired health, including inherited diseases, clinical signs and the validity of DNA tests. The traditional Nordic collaboration between the kennel clubs and the universities provides valuable, applicable information that is used to improve breeding programs, and to improve our understanding of the nature of inherited diseases, and so on. Moreover, epidemiological studies are important in tracking the prevalence and distribution of diseases in each breed. In order to undertake epidemiological studies, sufficient and reliable data on the prevalence and distribution of the various diseases is required. Some studies have been performed on some diseases, but they are limited to specific samples taken at particular time points. In view of this a common, central registry of health data from veterinarians is needed in order to create an overview of the health status of various dog breeds – both pedigree dogs, non-pedigree dogs and crossbred dogs. This would also allow the effect of breeding programs and other health improving initiatives to be assessed.

In Denmark, a registry of this kind has been in development for more than 10 years. One obstacle is that, if it is to be useful, the veterinarians need to implement a new diagnostic system from which the necessary data can be harvested. However, the veterinarians' duty is to promote animal health and welfare, relieve pain, treat diseases, and the like – not only at an individual level but also in a broader population perspective. The Danish Veterinary Association has recently taken steps towards establishing such a diagnostic registry.

Initiatives taken by the breeding organizations

It has become clear that if we are to respond to the challenge presented by inherited diseases effectively, additional health-focused selection criteria will be necessary in several breeds. However, stringent breeding rules focusing on health are not always welcome in the breeding communities – maybe due to a lack of insight into the scientific background of the recommendations. Thus, in the breeding community, traditions like coat color, skin folds and specific conformation measures seem to be at least as important as the dogs' health and welfare. Another limitation on imposing stringent health criteria is the lack of genetic variation in the breeds. In some breeds various breed-related diseases are so prevalent that selecting only the healthiest dogs for breeding would jeopardize genetic variation even more and create problems with inbreeding and new inherited diseases.

It should be acknowledged that the breed clubs and kennel clubs have taken some effective initiatives against several inherited diseases in their breeding programs. In numerically large breeds with only a small number of inherited diseases this strategy does not cause problems. This is, however, a balancing act, because breeders who see no need to abide by the breed club's requirements may choose to produce puppies without a studbook.

Although the kennel clubs have developed breeding restrictions in an attempt to contain several inherited diseases they have not reacted sufficiently vigorously to the problems created by exaggerated phenotypes. Both FCI and the kennel clubs have taken various initiatives to discourage unhealthy conformation. However, in most cases – e.g. in the short-muzzled breeds – no notable improvement has been achieved.

Breeders of short-muzzled breeds are in general aware of the risk of breathing problems created by BOAS, but some signs of BOAS such as conspicuously loud breathing and snoring are perceived as

normal for the breed. Therefore, exaggerated phenotypes persist. They continue to be a serious problem.

The breed standards must be approved by FCI. Therefore, FCI plays an important role in this matter. Statements drawing attention to what is required for healthy conformation have been added to some breed standards by FCI. However, a more thorough reformulation of the most critical breed standards with some clear limitations seems to be necessary.

A BOAS grading program developed at Cambridge University is being implemented in several countries. However, the brachycephalic dogs are burdened with other inherited diseases in addition to BOAS, including spinal diseases, gastro-intestinal problems and skin diseases. Were these to be factored in as criteria for breeding, the remaining healthy population to be used in breeding would become far too small – at least, unless the studbooks are opened.

Opening the studbook – i.e. allowing non-pedigree individuals of a desired phenotype to be enrolled in the breeding population – is an effective way to increase genetic variation and at the same time preserve the key characteristics of a breed. An open studbook strategy has been adopted in connection with the Danish-Swedish Farmdog, and it appears it would be effective in other breeds, including those burdened by several inherited diseases and/or exaggerated phenotypes. A higher number of dogs in the breeding population allows for selection against inherited diseases without jeopardizing genetic variation.

It should be underlined that initiatives taken within the organized breeding sector can only benefit registered dogs. Some form of accompanying action would need to be taken to extend the benefits to unregistered dogs as well.

Initiatives to inform and influence dog buyers

As long as there is demand, there will also be supply. Therefore, initiatives to make dog buyers aware of the health and welfare issues in several breeds, and care about them, are of great importance.

The campaigns run by animal welfare organizations with, among other things, flyers, You Tube videos, information on web pages and social media, have so far not had a major effect. The commitment made by veterinarians to speak up and inform owners about their dogs' health issues has probably not had any real effect either. At any rate, the breed-related health problems have remained largely unchanged.

As already mentioned, many prospective dog owners are aware of the health issues seen in, for example, the brachycephalic dog breeds. Still, the dogs' health is not always given first priority. Thus, the vast amount of information on the significant risk of disease in some breeds seems to have had minimal or no effect. Instead societal influence, trends and fashion appear to affect buying decisions powerfully. Therefore, more complex instruments based on social marketing should be used to steer the way dog buyers think and act when choosing a dog.

Legislative initiatives

In most countries, general legislative instruments have been developed in an effort to ensure healthy breeding in dogs. In Denmark, however, the minister has so far chosen not to use the authority given by the Animal Welfare Act 2013 to introduce such regulations. A legal framework

would, however, be an important lever with which to implement and enforce initiatives to prevent unhealthy dog breeding.

The legislative initiatives taken in Germany and the Netherlands to improve dog breeding illustrate very well the difficulties of enforcement. In general, enforcement is easier with registered dogs, because the legislation can be incorporated into the existing rules and breeding programs. However, a side-effect of the legislation in the Netherlands has been that people have left the kennel club. Any legislation aiming at improving breeding-related health and welfare should therefore be equally enforceable in relation to dogs with and without pedigree.

The Norwegian lawsuits detailed in this report brought against breeders of Cavalier King Charles Spaniels and English Bulldogs signal the very limited success so far in improving the situation in pedigree breeding. Even if the English Bulldog breeders have won their case, a strong signal has been sent that the limit has been reached.

In light of this, it would be a good start if all countries in which there is organized pedigree dog breeding – including Denmark – had clear, general, pieces of legislation stating that unethical breeding causing discomfort, pain and/or disease is illegal.

The advantage of using legislative initiatives to move us towards healthier breeding is that they can be drafted so as to apply to all dogs, not just those registered with a kennel club. Still, it is difficult to administer and enforce such rules with such wide scope. Legislation should not, therefore, be relied upon alone. It must be mobilized together with the other initiatives presented here.

Recommendations

Recommendations on research initiatives

A considerable amount of research into dog health is being conducted. It is, however, characterized by a focus on specific problems. Only to a limited extent does it offer a more general overview of the disease or health condition in our dog breeds.

We recommend one tool that would be very beneficial for future research in this area:

- 1) Establish a health registry recording diagnoses made by veterinarians (both for pedigree and non-pedigree dogs).

Data collected in this registry would provide a solid basis for epidemiological research. The studies issuing from this research could deliver an overview of disease and health in our dog breeds and allow breeding programs and other health-improving initiatives to be evaluated.

Recommendations regarding the organized breeding

The breeding of certain dog breeds has without doubt had some seriously negative impacts on the dogs' health and welfare.

We recommend three specific tools that would move dog breeding in a healthier direction:

- 1) More consistent enforcement of the health-oriented guidelines that have already been added to the breed standards.
- 2) Changes to the standards of those breeds burdened with exaggerated conformations.

- 3) The opening of the studbooks for breeds with numerically small populations and breeds with several breed-related health problems.

In relation to 2), we would like to stress that, since FCI is an independent international organization, and that the owner country of each dog breed proposes the breed standards to FCI, it is difficult to influence this process unless it is addressed at EU level. In relation to 3), we note that only the respective owner countries can open the studbooks.

Recommendations on initiatives to inform and influence dog buyers

The initiatives taken by animal welfare organizations and veterinarians do not seem to have had any noticeable effect on the way people act and think when buying a dog. We therefore recommend that more complex instruments based on social marketing are used to steer the way dog buyers act when choosing a dog.

Recommendations on legislative initiatives

The legislative initiatives in the Netherlands and Germany show that it is difficult to devise and accurately formulate relevant legislative criteria, and equally difficult to administer and enforce those criteria. We recommend that:

- 1) As has happened in other countries, general legislative instruments are developed in Denmark in an effort to ensure healthy dog breeding.
- 2) The effect of the legislative initiatives in the Netherlands and Germany are monitored closely.

Dansk sammendrag

Baggrund

Der er gennem de seneste årtier kommet øget fokus på, at avlen inden for visse hunderacer har en række alvorlige negative konsekvenser for hundenes sundhed og dermed også for deres velfærd. Nogle af disse konsekvenser skyldes avl i for små populationer, mens andre synes at være en direkte følge af de mål, man avler efter, som i nogle tilfælde er en overdrivelse af racestandarderne. Den store offentlige bevågenhed har dog ikke nødvendigvis ført til, at problemerne er blevet mindre. Fx viste en dansk undersøgelse, som blev publiceret i 2019, at over 40 % af franske bulldogs, der i 2022 var den femte mest populære hunderace i Danmark, har alvorlige åndedrætsproblemer.

Fokus og metoder

I projektet har vi, på tværs af en række vestlige lande, efter kort at have beskrevet den historiske baggrund for problemstillingen, beskrevet og undersøgt effekten af flg. typer af initiativer til at modvirke negative konsekvenser af hundeavl: forskningsmæssige initiativer, initiativer inden for den etablerede hundeavl, initiativer til at oplyse og påvirke holdninger hos kommende hundeejere og lovgivningsinitiativer.

Rapporten er baseret på 1) lovgivningstekster, 2) dokumenter fra Fédération Cynologique Internationale (FCI), den danske og andre kennelklubber, dyreværnsorganisationer og andre relevante stakeholdere typisk fundet på hjemmesider og 3) videnskabelig litteratur. Desuden er der gennemført to interviews med centrale aktører fra Norge og Nederlandene.

Væsentligste fund

Den historiske baggrund for problemstillingen

Organiseret hundeavl i lukkede populationer har eksisteret siden 1800-tallet. I de fleste lande, er det en national kennelklub, der organiserer avlen, og som er det stambogsførende organ. De fleste af de nationale kennelklubber er tilknyttet Fédération Cynologique Internationale (FCI).

Arbejdet inden for den organiserede avl har i vid udstrækning været drevet af frivillige og entusiaster. Udvælgelsen af hunde bliver foretaget af individuelle hundeejere i stor loyalitet over for kulturen og de traditioner, som dominerer i de respektive opdrætter- og udstillingsmiljøer.

En væsentlig negativ konsekvens af en sådan avl inden for lukkede populationer har været arvelige sygdomme. Endvidere er der opstået en problemstilling med overdrevne fænotyper. Den mest problematiske af disse ses hos de brachycephale racer som mops og bulldog. Hunde inden for disse racer kan have alt for fladtrykte næser/kranier, hvilket resulterer i 'brachycephalic obstructive airway syndrome' (BOAS) samt en række andre afledte problemer med øjne, ører, hud mm. I de seneste årtier er dele af den etablerede hundeavl gået tilbage, således at færre hunde har en stambog. Denne udvikling ses især for populære racer, og inden for hunderacer som chihuahua og fransk bulldog er andelen af danske hunde med stambog således på under 15%. Samtidig sker der en stadigt stigende handel med racehunde på tværs af grænser.

Forskningsinitiativer

Forskning er af afgørende betydning for at generere viden om alle aspekter af avlsrelaterede sundhedsspørgsmål, f.eks. arvelige sygdomme, kliniske problemstillinger og validering af DNA-tests. Det traditionelle nordiske samarbejde mellem kennelklubberne og universiteterne giver værdifuld,

anvendelig information, der bruges til at forbedre avlsprogrammer, forstå karakteren af arvelige sygdomme mv.

Endvidere er der behov for epidemiologiske undersøgelser, hvor forekomst af sygdomme, dødelighed m.m. følges inden for de forskellige racer. For at kunne gennemføre en sådan forskning er det nødvendigt med tilstrækkelige og pålidelige data om udbredelsen af de forskellige sygdomme. En række undersøgelser er allerede foretaget, men de er begrænset til specifikke sygdomme og racer. Et fælles, centralt register over sundhedsdata fra dyrlæger, et såkaldt diagnoseregister, er nødvendigt for at skaffe overblik over sundhedstilstanden for forskellige hunderacer – både stambogsførte og ikke-stambogsførte hunde. Dette vil også give mulighed for at vurdere effekten af avlsprogrammer og andre sundhedsforbedrende tiltag.

I Danmark har et sådant register været undervejs i mere end 10 år. En hindring er, at dyrlæger skal implementere et nyt elektronisk diagnosesystem, hvorfra data kan høstes. Det er imidlertid dyrlægers opgave at fremme dyresundhed og -velfærd, smertelindring, behandle sygdomme m.m. – ikke kun på individniveau, men også i et bredere perspektiv. Baseret på et forudgående samarbejde mellem en række relevante interessenter, har Den Danske Dyrlægeforening nu taget skridt til at igangsætte etableringen af et sådant diagnoseregister.

Initiativer inden for den etablerede hundeavl

For at håndtere udfordringerne med arvelige sygdomme er det blevet nødvendigt at indføre sundhedskrav i forbindelse med udvælgelse af dyr til avl i mange racer. Strenge avlsregler med fokus på sundhed er dog ikke altid velkomne blandt opdrætterne – måske på grund af manglende indsigt i den videnskabelige baggrund for nødvendigheden af disse.

Inden for dele af den organiserede avl er ydre karakteristika som pelsfarve, hovedform og kropsbygning mindst lige så vigtige som hundenes sundhed og velfærd. Da der i forvejen er begrænset genetisk variation inden for de enkelte racer, er det vanskeligt at lægge strenge sundhedskriterier ind i forbindelse med udvælgelse af hunde til avl.

I nogle racer er diverse racerelaterede sundhedsproblemer så udbredte, at avl baseret udelukkende på de sundeste hunde vil formindske den genetiske variation markant. Det vil skabe problemer med indavl og nye arvelige sygdomme.

Kennelklubberne har taget en række effektive initiativer mod flere arvelige sygdomme i avlsprogrammer for flere racer. I antalsmæssigt store racer med få sygdomme giver dette ikke anledning til problemer. Der er dog tale om en balancegang, fordi opdrættere, der ikke ønsker at honorere kennelklubbens krav, blot kan producere hvalpe uden stambog. Selvom kennelklubberne har implementeret avlskrav for flere arvelige sygdomme, har de ikke i tilstrækkelig grad reageret på problemstillingen med overdrevne fænotyper. Således er der, fx inden for de fladsnude racer, ikke sket mærkbare forbedringer selvom der er taget forskellige initiativer både af FCI og nationale kennelklubber. Opdrættere af de berørte racer er opmærksomme på risikoen for vejtrækningsproblemer i forbindelse med BOAS, men nogle tegn på BOAS, såsom tydelige vejtrækningslyde eller snorken, opfattes ofte som normale for racen. Derfor er overdrevne fænotyper stadig et alvorligt problem.

Da FCI er det organ, der godkender racestandarder, spiller FCI en vigtig rolle i denne sag. Bemærkninger, der gør opmærksom på sund kropsbygning, er blevet tilføjet nogle racestandarder.

Imidlertid synes en mere omfattende omformulering af de mest kritiske racestandarder med nogle klare begrænsninger at være påkrævet.

Et BOAS gradueringsprogram udviklet ved Cambridge University er ved at blive implementeret i flere lande. Men da de brachycephale hunde er belastede med andre arvelige sygdomme ud over BOAS, f.eks. rygssygdomme, mave-tarmproblemer og hudsygdomme, kan det blive vanskeligt at finde tilstrækkeligt mange sunde hunde til opretholdelse af racerne, medmindre man åbner stambøgerne.

At åbne stambogen, dvs. at inkludere ikke-stambogsførte hunde med lignende udseende i avlspopulationen, er en effektiv måde at øge den genetiske variation og samtidig bevare en races egenskaber. Denne strategi er blevet brugt - og bruges stadig - inden for avlen af dansk-svensk gårdhund. Dette ville være en effektiv strategi i racer belastet med et stort antal arvelige sygdomme og/eller overdrevne fænotyper. Et øget antal avlshunde vil give mulighed for selektion mod arvelige sygdomme uden at gå på kompromis med den genetiske variation.

Det skal understreges, at initiativer taget i den organiserede avl alene gavner stambogsførte hunde. Der skal tages parallelle tiltag for også at inkludere ikke-stambogsførte hunde.

Initiativer til at informere og påvirke købere af hunde

Så længe der er en efterspørgsel, vil der også være et udbud. Derfor er initiativer til at gøre hundekøbere opmærksomme på sundheds- og velfærdsproblematikken i flere racer af stor betydning.

Kampagner fra dyreværnsorganisationer og dyrlæger med flyers, YouTube-videoer, information på websider og sociale medier m.m. har indtil videre ikke haft den store effekt. Dyrlægenes indbyrdes aftaler om at sige fra og informere ejerne om deres hundes helbred har tilsyneladende heller ikke haft nogen effekt. I det mindste har en del af de racerelaterede sundhedsproblemer ikke ændret sig nævneværdigt.

Som allerede nævnt er mange fremtidige hundeejere opmærksomme på de sundhedsmæssige problemer, der ses i fx brachycephale hunderacer. Alligevel har hundenes helbred ikke altid første prioritet. Den store mængde information om den betydelige risiko for sygdom hos nogle racer ser således foreløbigt ud til at have haft en begrænset effekt hos hvalpekøbere. I stedet synes samfundsmæssig indflydelse, trends og mode at påvirke beslutningen om valg af race stærkt. Derfor bør mere komplekse instrumenter baseret på social marketing, bruges til at påvirke den måde, hundekøbere tænker og handler på, når de skal vælge hund.

Lovgivningsmæssige initiativer

I de fleste lande er der lavet generelle lovgivningsmæssige krav for at sikre avl af sunde hunde. I Danmark har fødevareministeren indtil videre dog valgt ikke at udnytte den bemyndigelse, som dyrevelfærdsloven giver til at indsætte sådanne krav. En lovgivningsmæssig ramme ville være en vigtig løftestang til at implementere og håndhæve initiativer til at forhindre usundt opdræt af hunde.

De lovgivningsinitiativer, der er taget i Tyskland og Nederlandene, illustrerer meget godt, at det ikke er ligetil at ændre hundeaflen via lovgivning. Der er bl.a. vanskeligheder med hensyn til håndhævelse. Generelt er håndhævelsen nemmere med registrerede hunde, fordi lovgivningen kan indarbejdes i de eksisterende regler og avlsprogrammer. Derfor har en bivirkning af lovgivningen i Nederlandene været, at folk har forladt kennelklubben. Enhver lovgivning, der sigter mod at

forbedre avlsrelateret sundhed og velfærd, bør derfor kunne håndhæves lige godt for hunde med og uden stambog.

Retssagerne i Norge mod kennelklubben og navngivne opdrættere af cavalier king charles spaniel og engelsk bulldog er tilsyneladende en reaktion på den manglende succes inden for den etablerede hundeavl for at forbedre sundheden hos disse hunde. Selv om de engelske bulldog-opdrættere vandt deres sag, er der sendt et stærkt signal om, at grænsen er nået. Det ville i lyset af dette også være en god start, hvis alle lande – inklusive Danmark – havde klare, generelle formuleringer om, at uetisk avl, der forårsager, ubehag, smerte og/eller sygdom er ulovligt.

Lovgivningsmæssige initiativer som retter sig mod sundere avl har den fordel, at et sådant initiativ vil gælde for alle hunde og ikke kun dem, der er registreret i en kennelklub.

Som nævnt er det dog vanskeligt at identificere og formulere relevante kriterier og lige så vanskeligt at administrere og håndhæve sådanne regler. Lovgivningen kan derfor ikke stå alene, men må fungere i samspil med de andre initiativer, som er præsenteret her.

Anbefalinger

Anbefalinger vedrørende forskningsinitiativer

Forskningsaktiviteter i relation til sundhed hos hunde er omfattende. De bærer imidlertid præg af mest at være fokuseret på specifikke problemstillinger snarere end at skaffe et overblik over den samlede sygdoms-/sundhedstilstand hos vores hunderacer.

Vi kan pege på et enkelt redskab, der ville være til stor gavn for den fremtidige forskning:

- 1) Etablering af et diagnoseregister baseret på indrapportering fra dyrlæger (både for stambogsførte- og ikke-stambogsførte hunde)

Data indsamlet i et sådant register vil i sammenhæng med epidemiologisk forskning kunne skabe et overblik over den samlede sygdoms-/sundhedstilstand hos vores hunderacer og gøre det muligt at vurdere effekten af avlsprogrammer og andre sundhedsforbedrende tiltag.

Anbefalinger vedrørende den organiserede avl

Der er ingen tvivl om, at avlen inden for visse hunderacer har haft en række alvorlige negative konsekvenser for hundenes sundhed og velfærd.

Vi kan pege på tre specifikke redskaber, som vil kunne bringe avlen i en sundere retning:

- 1) Bedre håndhævelse af de sundhedsmæssige retningslinjer angivet i racestandarderne
- 2) Ændring af racestandarden hos racer belastet med overtypning
- 3) Åbning af stambøger hos antalsmæssigt små racer med mange sundhedsproblemer

I relation til 2) skal det understreges, at FCI er en uafhængig international organisation, og at det er de lande, der har ejerskab til de respektive hunderacer, som indstiller racestandarderne til FCI. Det er således vanskeligt at påvirke en proces, der kan føre til ændringer medmindre det løftes til EU niveau. I relation til 3) er det kun de respektive racers ejer-lande, der har lov til at åbne stambøgerne.

Anbefalinger vedrørende initiativer til at informere og påvirke købere af hunde

Kampagnerne, som dyreværnsorganisationer og dyrlæger har iværksat, ser ikke ud til at have haft en mærkbar effekt. Vi må derfor konkludere, at mere komplekse instrumenter baseret på social marketing bør anvendes til at påvirke den måde, hundekøbere tænker og handler på, når de skal vælge hund.

Anbefalinger vedrørende lovgivningsmæssige initiativer

De lovgivningsmæssige tiltag der er taget i andre lande viser, at det er vanskeligt at identificere og formulere relevante kriterier og lige så vanskeligt at administrere og håndhæve sådanne regler. Vi anbefaler at:

- 1) Der i lighed med i andre lande laves generelle lovgivningsmæssige formuleringer i Danmark for at sikre sund avl af hunde
- 2) Effekterne af de lovmæssige tiltag der er foretaget i Nederlandene og Tyskland følges fremadrettet

The organization of dog breeding

Establishment of modern dog breeds and the challenges to which they give rise

The wolf is the wild ancestor of all of the dogs we know today. The time and place of the domestication of dogs has been intensively studied. Several estimates have been made but the consensus seems to be that the first steps in the domestication process that has taken place over a significant length of time took place at several locations shortly before the advent of agriculture 10,000 years ago and probably even earlier (Vilà et al., 1997, Galibert et al., 2011, Freedman et al., 2014). A saluki-like type of dog existed already 6,000-7,000 years ago, and several types of dogs were serving various purposes in ancient Egypt 3000 years ago. There has been a significant increase in the number of breeds since the medieval period, especially over the last two centuries (Galibert et al., 2011).

Inspired by the improvements which had been obtained in production animals, a similar systematic approach to the breeding of dogs began in the 19th century. Efforts were made to improve the hunting, herding and guarding abilities of different dog breeds and to adjust dogs' phenotypic appearance. In many breeds, the dogs had studbooks documenting their family trees and tracing their ancestry back to particular popular dogs on which the breed was based. The studbooks were closed, meaning that only descendants of these specific animals could obtain a studbook. Kennel clubs emerged which managed the studbooks – first in England (1873) and later in the USA (1884) and other places in Europe (Sandøe et al., 2015a). More than 400 breeds have been established worldwide, each with its own characteristics. Today, in the Western world, nearly all dogs are purebred dogs or crosses of these. Purebred companion dogs are found all over the world, but it should be stressed that in the global south there is a huge population of outbred dogs that live as village or street dogs.

As mentioned above, many breeds have been established based on just a small number of individuals (known as founders) that were considered to represent the best dogs of the breed. The subsequent mutual and repeated (in)breeding of these relatively few individuals allowed certain traits and characteristics to be fixed in the breed, so that the phenotype was kept uniform from generation to generation. However, this strategy has also caused varying degrees of inbreeding and reduced genetic variation (Sutter and Ostrander, 2004, Sandøe et al., 2015b). The advantage of the many different and stable breed profiles is that in addition to conformation traits (e.g. size and hair coat type) utility traits like hunting, herding and guarding, can, to a large extent, be predicted for a dog of a certain breed, and thus the choice of breed fitting the buyer's lifestyle is made easier. Utility traits related to specific breed types (herding types, pointing dogs, etc.) have a background in genetics (Dutrow et al., 2022), but whether more general behavioral traits like aggressiveness, fear, trainability, etc. are associated with specific breeds as a result of their heritage is controversial (MacLean et al., 2019, Morrill et al., 2022).

Dog breeding organizations

In Denmark, the largest pedigree registry for dogs is the Danish Kennel Club, and in many other countries equivalent national kennel clubs exist. The kennel clubs issue pedigrees to purebred dogs of the many different breeds.

Most European kennel clubs are recognized by Fédération Cynologique Internationale (FCI). FCI is a global association with member kennel clubs all over the world, but only one kennel club per country is associated with it. The kennel clubs in the UK and USA are not members but they nevertheless collaborate with FCI (The Danish Kennel Club (a)).

FCI recognizes 356 breeds, and each breed is “owned” by a country. The country in question is typically assumed to be the country of origin of the specific breed, making it the “native breed” of that country. For example, Denmark is the owner country of the Broholmer and Germany is the owner country of the German Shepherd. It is the owner country that has formulated the breed standard, which is a description of the “ideal type of the breed” (FCI (a), 2022); (The Danish Kennel Club (b)). The breed standards provide a quite detailed description of how the dog should ideally look, including: the size and general appearance of the dog, the quality and characteristics of its fur, the shape of the skull, the size and shape of the jaws, the shape and carriage of the tail and ears, and so on. In addition, the way the dog moves, its behavior and approved coat colors are described. Specific unwanted traits that may be seen in the breed such as aggressiveness, breathing problems or impaired hearing are also listed (The Danish Kennel Club (b)). The breed standard is binding for all kennel clubs under FCI, and it cannot be changed except by FCI and the owner country.

In Denmark all pedigree dogs are associated with a breed club. Together with the kennel club, the breed club looks after the interests of the breed. Some breeds have their own breed club (e.g. The Danish Dalmatian Club) but in some cases two or more related breeds share the same club (e.g. The Danish Retriever Club) (The Danish Kennel Club (d)).

The first dog shows (focusing on appearance) and field trials (focusing on practical tasks) took place in England in the 19th century (Sandøe et al., 2015a). Shows and trails are initiated and maintained by the kennel clubs. At the shows each dog is evaluated by judges against the breed standard. The “best” dogs are awarded titles and will typically become popular breeding dogs. The show results therefore have a significant impact on the way the breed develops – especially in terms of conformation.

In addition to conforming to the breed standard, in many breeds specific demands have to be met by the parents if their offspring are to be issued a studbook. This could be an X-ray examination showing that the hip joints are healthy, DNA testing for breed-specific inherited diseases, or an optical examination for inherited eye diseases. In some cases, additional recommendations on health, the animal’s exterior or show awards are listed, but typically these are not mandatory (The Danish Kennel Club (c)).

National legislation requires all dogs in Denmark to be chip marked and registered with the Danish dog registry. A comparison of the numbers from the Danish Kennel Club and the Danish dog registry reveals that approximately one third of all Danish dogs are registered in the Danish Kennel Club. However, the registration percentage varies from breed to breed. For example, 70% of German Shepherds, 54% of Cavalier King Charles Spaniels (CKCS) and 53% of Golden Retrievers are registered, whereas for several of the other popular breeds it is much lower: 5% of Maltese, 12% of French Bulldogs and 42% English Bulldogs (Sandøe et al., 2022). Some of the dogs that do not have a Danish kennel Club studbook are pure bred or at least listed in the dog registry as purebred. Others are crossbred and thus a mix of two or more breeds. A relatively recent category of crossbred dogs are the so-called “designer breeds”, which are becoming increasingly popular – e.g. labradoodle

(Labrador x Poodle) or Maltipoo (Maltese x Poodle). Over the past ten years, annual registrations of Labradoodle in Denmark have increased from six to 458 (Danish Dog Registry).

Inherited diseases and extreme conformation

There is, however, a downside to the way our dog breeds have been established and bred. As mentioned above, the significant contribution to the genetic make-up of a breed by a limited number of founder dogs results in limited genetic variation in the individual breeds. On top of that, popular sires/champions that have been extensively used in breeding have transmitted their genetic material – including recessive, deleterious variants/mutations – to a large part of the population. Dogs of the same breed are therefore to some extent related, and inbreeding cannot be avoided. This increases the risk of certain inherited diseases in each breed (Sutter and Ostrander, 2004). A few examples are the eye disease “progressive rod-cone degeneration” seen in several breeds (Zangerl et al., 2006), disc herniation in dachshunds (Jensen and Christensen, 2000) and heart disease in CKCS (Summers et al., 2015).

In addition, the breed standards are a source of many of the problematic phenotypes seen in our dog breeds. For example, Basset Hounds are required to have long ears, Bulldogs to have a short muzzle and Shar Pei to have skin folds. In some instances, problematic phenotypes tend to be exaggerated – not because the breed standards change, but because the interpretation of them tends to drift. For example, in the French Bulldog breed standard, the muzzle is described as being “very short and broad”. Moreover, it is highlighted that the nose should be 1/6 of the total length of the head. Thus, it can be measured whether the dog complies with the standard. Still, the standard is interpreted differently – and over the years the muzzle of the breed has become shorter and shorter. The downward slope of the back of a German Shepherd is described as “slightly downwards”, but over time it has become steeper. The skin folds of the English Bulldog have become more pronounced and so on. When exploring the internet for comparisons of old and new pictures of the same breed, it is evident that in many breeds the exterior characteristics have become more extreme (Sandøe et al., 2015b). The way the shows are being judged seems to be trend-setting – not only among the pedigree dogs but also for the breeds as such.

Many of these exaggerated traits have come with a price: the short muzzled (brachycephalic) breeds like French and English Bulldog and Pug have breathing difficulties, the short, rounded skull of the CKCS has caused neurological diseases due to compression of the brain tissue, the excessive skin in several breeds causes skin fold infections, and so on. Research efforts and measures to alleviate some of these problems are described in the section on research initiatives.

Aim

The aim of this report is to describe initiatives – and when possible also the effects of these initiatives - to prevent inherited diseases and extreme phenotypes in dogs: research-based initiatives, initiatives taken by the breeding organizations, initiatives to inform and influence dog buyers, and legislative initiatives.

The report is based on the scientific literature, interviews kindly provided by stakeholders involved in the various initiatives or relevant organizations, legislative documents and other information available on the internet.

Research-based initiatives to investigate breed-specific diseases

Knowledge about inherited diseases in our dogs is important in improving their health and welfare. (Gough et al., 2018) give an overview of breed-specific inherited diseases and pre-dispositions and provide useful information for, among others, the breeders of specific breeds. However, in order to choose the most effective breeding strategies, prioritize efforts, or find the best treatment, more specific and nuanced knowledge is required about, for example, the prevalence, pathophysiology, distribution and severity of the diseases in question.

Research of this kind generating applicable results will be presented in this section. A huge number of studies have contributed to the knowledge we have at present, and an exhaustive review would lie outside of the scope of this report. In what follows, examples from three categories of research in breed-related diseases are described: epidemiological studies, studies on complex inherited diseases and studies on monogenic inherited diseases.

Epidemiological studies

To identify the most effective initiatives for improving the health of our companion animals it is important to know the etiology, risk factors, prevalence, severity and distribution of the problems. This also applies to problems related to breeding in dogs. Epidemiological studies can answer some of these questions, but only when sufficient, reliable and relevant data on the health issues are available. Veterinary clinical journals are a valuable source of such data, and when they are collated in a single, common registry they provide an important foundation for these investigations. At the Royal Veterinary College, University of London, a registry of this sort – VetCompass – has been established (The Royal Veterinary College). More than 1800 veterinary practices deliver anonymized data to VetCompass. Valuable research has been conducted using the data.

One group of studies has investigated which disorders are the most prevalent in certain breeds, together with breed mortality and life span. A sampling of results is listed in Table 1.

Table 1: Prevalent disorders, life span and cause of death in five breeds.

Breed	Most common disorders	Median life span (years)	Most common cause of death	Reference
Rottweiler	Aggression, obesity, ear infection, arthritis	9.0	Cancer, inability to stand	(O'Neill et al., 2017b)
Greyhound	Dental disease, overgrown nails, wound, osteoarthritis, claw injury	11.4	Cancer, collapse, arthritis	(O'Neill et al., 2019a)
English Bulldog	Ear infection, skin infection, obesity, cherry eye (prolapsed gland of third eye lid)	-	Heart disease, cancer, brain disorder, respiratory tract disorders	(O'Neill et al., 2019b)

Pug	Obesity, eye ulceration, ear infection	-	-	(O'Neill et al., 2016)
German Shepherd	Ear infection, arthritis/joint disease, diarrhea, obesity, aggression.	10.3	Joint disorders, inability to stand	(O'Neill et al., 2017a)

Such studies provide an overview of the disease predispositions of the breeds, which in most cases are inherited, and in some cases extreme body conformation is implied. One example is the high prevalence of eye ulceration in Pugs, which is due to their protruding eyes (resulting from the anatomy of the skull). In general, the results should, however, be interpreted carefully. The high prevalence of osteoarthritis and claw injury seen in Greyhounds may very well arise because they are used as racing dogs.

One may wonder why respiratory disorders are not among the most prevalent disorders in Pugs and English Bulldogs. Many of the short-muzzled (brachycephalic) dog breeds, including Pugs, and French and English Bulldogs, have impaired breathing as a result of their skull conformation and their short muzzles. The syndrome is called Brachycephalic Obstructive Airway Syndrome (BOAS). BOAS is without any doubt a common disorder in these breeds, but it may not be a common reason to take the dog to the veterinarian. Many owners (and veterinarians too) may not recognize this problem because the symptoms of BOAS are considered “normal” for the breed (O'Neill et al., 2019b, Kenny et al., 2022). One study has shown that 58% of the owners of BOAS-affected dogs did not recognize that their dog had a breathing problem (Packer et al., 2012).

In other studies, the general health of breeds and the frequency of individual diagnoses have been compared. One study has shown that, in comparison with other breeds, French Bulldogs have a significantly higher risk of stenotic nostrils, BOAS, ear and skin fold infection, and difficulties giving birth (O'Neill et al., 2021). Pugs also have a higher risk of BOAS and stenotic nostrils, and of eye ulcerations due to their protruding eyeballs (O'Neill et al., 2022a). Another investigation has shown that the overall risk of being diagnosed with disease is much higher in English Bulldogs than it is in other breeds, suggesting that the Bulldogs have substantially poorer health and presumably lower quality of life (O'Neill et al., 2022b). The VetCompass data has also provided the basis for studying longevity and cause of death in different breeds. For example, life expectancy (in years) has been found to be 4.5 for French Bulldogs, 7.9 for Chihuahuas and 7.4 for English Bulldogs, whereas it is 11.8 years for crossbred dogs and 12.7 for a Jack Russell Terrier (Teng et al., 2022).

The huge amount of data in VetCompass can provide reliable answers to many questions about the health and predispositions to disease in different dog breeds. It offers an opportunity to follow and validate the effect of the breeding decisions that have been taken.

Studies on complex inherited diseases

Some of the most prevalent diseases affecting several breeds are complex inherited diseases like disc herniation, heart valve diseases and hip dysplasia. Each of these diseases is caused by many mutations/DNA variants in several genes and is also influenced by environmental factors.

Several genetic studies have been performed in order to identify one or more “major genes” involved in complex inherited diseases (e.g. (Mogensen et al., 2011, Marschall and Distl, 2007,

Madsen et al., 2011)). It is assumed that some of the genes (major genes) involved in complex inherited diseases have a more significant impact than the others. By identifying one or more major genes, a DNA test can be provided allowing the more favorable variant of the gene to be selected, thus improving of the animals' health status. This, however, is a difficult task, and it is only seldom that such genes are identified.

Some of the complex inherited diseases are highly hereditary, some less so. "Heritability" is a measure indicating the degree to which the presence of a disease/trait is explained by genetic factors. Heritability is estimated as values between 0 and 1. For a disease or trait with a heritability of 0.4 approximately 40% of the phenotypic variation is determined by genetics. The higher the heritability, the larger the expected improvement in the breed's health in a breeding program based on selection of animals with the best health status.

Research into clinical manifestations, age of onset, breed dispositions, diagnosis, treatment and heritability has been important in establishing effective strategies to control complex inherited diseases. The following examples, in which research has provided knowledge and tools to control such diseases, illustrate this.

Disc herniation

The short-legged (chondrodystrophic) dog breeds like Dachshunds, Beagles, French Bulldogs and Pekingese are prone to early onset disc herniation. The highest frequency is seen in Dachshunds, and therefore most research has focused on this breed. Disc herniation is a painful and debilitating condition often treated with surgery or – in the worst case – euthanasia. The disease process starts with minor degenerative changes in the intervertebral discs leading to tissue death and calcifications. The connective tissue weakens, and as a result the disc may protrude or even herniate (Bray and Burbidge, 1998, Smolders et al., 2013, Bergknut et al., 2012). Disc herniation is almost always preceded by disc calcification. The greater the number of calcified discs, the higher the risk of disc herniation. Therefore, by counting the calcified discs after an X-ray examination of the back, the dog's risk of developing disc herniation can be predicted. The number of calcifications reach a maximum at around the age of 2-2½ years, and thereafter they may dissolve (Jensen and Arnbjerg, 2001). It has been shown that dogs with ≥ 5 calcifications have a 14 times greater risk of developing disc herniation than dogs with fewer than 5 calcifications (Bruun et al., 2020). The tendency of disc degeneration and calcification is highly heritable, with a heritability estimate at 0.6-0.87 (Jensen and Christensen, 2000). Due to this high heritability X-ray examination of the back has become part of the Dachshund breeding program in several countries (Jensen and Christensen, 2000). The breeding program in the Danish Dachshund Club is based on X-ray examination at the age of 2-4 years. Only dogs with 0-4 calcifications are recommended for breeding (The Danish Kennel Club (h)). This program has improved the back health of, especially, wire-haired Dachshunds significantly. Coton de Tulear dogs are also predisposed to disc herniation and back examination has recently been added to the breeding program for this breed.

In a study to identify one or more genes with an impact on disc herniation in several short-legged dog breeds, a research group from the University of California found a mutation in the gene *FGF4* which they claim is a risk factor for disc herniation. Based on this result, a DNA test has now been established (Brown et al., 2017). The test was later evaluated in the Danish Dachshund population (Bruun et al., 2020). The evaluation showed that the mutation is associated with disc calcification (and thus disc herniation) in wire-haired Dachshunds, but almost all long-haired and smooth-haired

Dachshunds have two copies of the mutation, irrespective of their back status. Thus, if the DNA test were used in the breeding program for dachshunds almost no dogs would be allowed to breed.

Mitral (heart) Valve Disease

Another disease that is quite prevalent in dogs is mitral valve disease. The mitral valve is positioned on the left side of the heart, between the anterior chamber and the heart chamber. When the blood is pumped from the left heart chamber into the aorta it closes the aperture to the left atrium, thus preventing the blood from returning to the lung circuit from where it just came. Mitral valve disease is caused by degenerative changes in the valve tissue resulting in thickened and nodular valves. In this state, such valves are unable to close the aperture during heart contraction, allowing the blood to reflux into the left atrium (Menciotti and Borgarelli, 2017). Typical clinical signs are coughing, exercise intolerance and labored breathing (Coffman et al., 2021). The disease is age-dependent and is seen in 90% of small breed dogs > 8 years. However, Cavalier King Charles Spaniels tend to develop it at a younger age and at higher frequency (Borgarelli and Buchanon 2012; Fox 2012). Mitral valve disease is highly heritable in this breed. The tendency to develop heart murmur has a heritability of 0.33, and the severity has a heritability of 0.67 (Lewis et al., 2011). The diagnosis is made by auscultation and echocardiography, and although the disease cannot be cured, medical treatment can prolong the dog's life (Menciotti and Borgarelli, 2017). Since 2001 heart examination has been a mandatory part of the breeding program of Danish Cavalier King Charles Spaniels (The Danish Kennel Club (h)). In 2016, the effect of this feature of the breeding program was evaluated. Among dogs that were products of the program, the risk of mitral valve disease had been reduced by 73% over a ten-year period. Among dogs that were not products of the program, the risk had not reduced in the same period (Birkegård et al., 2016).

Hip dysplasia (HD)

Hip dysplasia is another complex inherited disease. It occurs in most breeds, but the highest prevalence is seen in larger, fast-growing breeds such as Newfoundland, Rottweiler, Labrador Retriever, German Shepherd and Golden Retriever (Rettenmaier et al., 2002, LaFond et al., 2002). Dogs with HD are born with normal hips but develop laxity of the hip joint and later a partial dislocation, joint deformity and consequently arthritis. The latter is painful, and in dogs with HD osteoarthritis may be present under two years of age. The heritability of HD has been estimated in several studies, with values ranging from 0.1 to 0.6 depending on the evaluation system and breed. Most estimates, however, are close to 0.3, indicating that HD is less heritable than mitral valve disease and disc herniation (Soo and Worth, 2015). The disease is diagnosed by X-ray examination of the hips. It is graded for severity, and in most countries the FCI scoring scheme is used: A (excellent), B (borderline), C (mild), D (moderate) and E (severe) (FCI, Ginja et al., 2015)). In order to reduce the prevalence of HD, breeding schemes based on X-ray examination of the hips have been implemented by many kennel clubs. In the Danish Kennel Club hip examination is mandatory for several breeds prior to breeding, including Rottweiler, German Shepherd, Golden Retriever, Labrador Retriever, Saint Bernard and Schnauzer (The Danish Kennel Club (h)). For all breeds, grades A, B and C are permitted for breeding. However, for most breeds it is recommended that only A and B graded dogs be used for breeding. Thus, selection is based on the scoring of the individual dog. There is evidence showing that improvement of general hip health can be achieved more rapidly when estimated breeding values (EBV) are used (Ginja et al., 2015). EBV is calculated using combined hip score information from the dog itself and its relatives, and it is therefore more indicative of the dog's genetic merits than phenotype alone. In addition, a population mean is calculated, and each

individual dog's EBV is related to this mean, which is set to 100. A dog with an EBV higher than 100 is expected to improve the hip health of the population and a dog with an EBV below 100 is expected to reduce the hip health of the population. Calculation of accurate EBVs requires a minimum number of data, and the Danish Kennel Club has set a limit of 50 new X-rays per year. Thus, EBVs are calculated for 19 breeds in the Danish Kennel Club. Several breeds have breeding recommendations based on EBVs, but there are no mandatory EBV-based breeding programs (The Danish Kennel Club (i)).

Research into HD has enabled breeding schemes used in the breeding programs of several breeds to be developed, and for some breeds, the schemes have brought about a reduction in both the severity and the prevalence of HD (James et al., 2019, Hedhammar, 2020, Ohlerth et al., 2019). However, conflicting interests are at play, and not all breed clubs have used the available knowledge to achieve the best possible improvements to hip health.

Brachycephalic obstructive airway syndrome (BOAS)

Brachycephalic dog breeds have a short muzzle and skull. Examples include the English and French Bulldogs, Pugs, Shih Tzus, Boxers, Boston Terriers, Bull Mastiffs and Pekingese. Over time, there has been a tendency to select dogs for breeding with increasingly short muzzles and skulls. This has resulted in a cranial conformation leaving too little space for the internal soft tissue such as the soft palate and the tongue, which leads to obstruction of the airway. Moreover, the dogs suffer from narrow trachea and narrow or closed nostrils, forcing them to breathe through their mouth. In some dogs, the small mucosal pouches on each side of the larynx are everted and sucked into the airway because of the increased respiratory effort. As a result of all these features brachycephalic dogs are predisposed to breathing difficulties and exercise intolerance. Moreover, their ability to cool their body down in warm weather by panting is poor. Together these problems form the syndrome BOAS. The only possible treatment is surgery, which typically involves widening the nostrils or shortening the soft palate (Packer et al., 2015, Dupre and Heidenreich, 2016).

Unlike HD, mitral valve disease and disc herniation, the brachycephalic dog breeds have deliberately been selected for their skull conformation, including the short muzzle – but, as is now realized, to the point that their health and welfare are threatened. Not all dogs belonging to the brachycephalic breeds are affected by BOAS. Some are free of it, some severely affected, and others fall somewhere between these outcomes. Therefore, several studies have been conducted to identify easily measured parameters that can be used as “BOAS markers” in selection for healthier dogs. There seems to be a consensus that neck girth, overweight and degree of nostril stenosis are associated with the degree of BOAS (Packer et al., 2015, Liu et al., 2017, Ravn-Mølby et al., 2019).

Precise BOAS grading of the individual dogs is vital for accurate diagnosis. It is also important in deciding whether surgery is needed, evaluating the effect of surgery and, not least, in making advantageous breeding decisions. A precise assessment of respiratory function can be made using advanced equipment like the whole-body barometric plethysmographic (WBBP) chamber. In most clinics, however, this is not standard equipment, and as an alternative, various models for exercise tests have been developed. Finland uses a 1,000 m walking test (The Finnish Kennel Club, Lilja-Maula et al., 2017). There are also tests based on three or six minutes of brisk walking. A widely adopted test has been developed by researchers at the University of Cambridge. It has been shown that this assigns the dogs with the same BOAS grades as the WBBP examination (Liu et al., 2017, Riggs et al., 2019). The test consists of a physical examination, including the grading of nostril stenosis,

auscultation of the respiratory sounds, a 3-minute exercise test, and further auscultation. The dog is then assigned one of four grades: 0 (free), 1 (mild BOAS), 2 (moderate BOAS) or 3 (severe BOAS) (Cambridge BOAS Research Group, University of Cambridge, 2022). This grading system has been developed for three breeds so far: English and French Bulldog and Pug. It is already used in the British Kennel Club, and in 2019 the Norwegian Kennel Club implemented this method of BOAS grading as a voluntary examination (The Norwegian Kennel Club). The Danish Kennel Club will soon accept BOAS grading too (The Danish Kennel Club, 2020). The Cambridge grading system has also been adopted in Mexico, the first country outside Europe (The Norwegian Kennel Club (c), 2022). To date, its effect has not yet been tested. It will be evaluated in an upcoming Danish project.

Studies on monogenic inherited diseases

The database Online Mendelian Inheritance in Animals (OMIA) (Online Mendelian Inheritance in Animals) provides an overview of known inherited diseases (and other traits) in animals. From the front page of the website it is evident that among domesticated animal species the dog has the highest number of recorded inherited diseases. The reason for this is the way purebred dogs are bred: small populations with extensive use of the same breeding animals results in reduced genetic variation and inbreeding. Recent advances in molecular genetics and DNA technological methods have accelerated the discovery and identification mutations behind many known monogenetic disorders in dogs. Two examples are described in the following.

Polyneuropathy in the Alaskan Malamute

Polyneuropathy in the Alaskan Malamute is caused by the substitution of a single base in the gene *NDRG1* resulting in substitution of an amino acid in the NDRG1 protein. The disease is an autosomal, recessively inherited neurological disease that causes progressive paresis in the young dog and always ends with euthanasia. It was first observed in the 1970s in Norway. Efforts were made in Scandinavia to eradicate it through breeding programs (Moe et al., 1982, Moe and Bjerkås, 1992), but in 2009 a new case was observed in Denmark, revealing that the mutation was still in the population. Another quite similar neurological disease caused by a mutation in the *NDRG1* gene is known in Greyhounds (Drögemüller et al., 2010), and this gene was therefore a good candidate gene for the comparable disease in the Alaskan Malamute. By sequencing the gene in healthy and sick dogs, and comparing the DNA sequences, the mutation was identified. This allowed a DNA test to be developed (Bruun et al., 2013). The DNA test has been used in the breeding program since 2013, and no more disease cases are now being seen. Breeders are encouraged to use healthy carriers (which carry one copy of the mutation) as long as they are mated with dogs that are free of the mutation. This strategy prevents sick puppies from being born without reducing genetic diversity in the breed. A limited number of carriers are still present in the population as a result.

Congenital myasthenic syndrome (CMS) in the Old Danish Pointing Dog

Another example of a monogenetic disorder for which the mutation has been identified is the autosomal, recessively inherited disease CMS. This has been observed in Old Danish Pointing Dogs since 1977. Affected dogs can run for 5-30 minutes, after which their endurance seems to wane. Eventually they fall down and rest for some minutes, and thereafter they are able to run again for a period (Flagstad, 1982). Investigations pointed towards a defect in the gene *CHAT*. In 2007 the gene was sequenced in affected and healthy dogs, and the two sequences were compared. A single base substitution in the gene resulting in the substitution of an amino acid was identified as the causative

mutation (Proschowsky et al., 2007). A DNA test was then devised that has now been used in the breeding program for this breed for some years. The mutation has been eradicated.

As exemplified above, several reliable and valuable DNA tests for monogenic disorders have been established and are used to prevent sick puppies from being born. However, DNA tests that have not been sufficiently validated are unfortunately also offered by commercial laboratories. For example, the tested variant may not be responsible for the disease, or the test may be advertised for all breeds even if only one, or few of them, harbor the variant. Many dog owners and breeders are eager to use DNA tests, both because they care about their dogs' health and because a DNA test delivers a simple, binary answer. However, if the DNA test is not validated, or is irrelevant for the breed, then it is at best useless. At its worst, the use of such a test can lead to unfortunate breeding decisions while other important health issues in the breed are overseen. Thus, DNA tests may draw attention to what is measurable instead of what is important.

Summarizing discussion and comments

Research-based initiatives are extremely important in ensuring that the health of dog populations is monitored. They provide a foundation on which breeding recommendations for individual breeds can be based and ensure that monogenic diseases can be eradicated without detrimental effects on genetic variation.

The British veterinary disease registry VetCompass has proven its worth – many useful studies have been conducted with its data. The prevalence of diseases, causes of death, and longevity, in various breeds provide a valuable map of breed-specific problems. In the Netherlands, Norway and Denmark efforts have been made to establish similar registries, but so far they have not come into being.

The complex inherited diseases are by far the most common in dogs. Information about traits or disease markers that can be used in a selection program (e.g. calcifications in relation to disc herniation) plays an important role in strategies to improve dog health. This process is, however, very slow, and if the disease is painful, has a high prevalence, or reduces life quality in other ways, this may not be the best way to go.

In the Danish Kennel Club, EBVs are being calculated for both HD and disc calcification. The kennel clubs of Sweden and Finland calculate EBVs for HD and elbow dysplasia (ED) but not for disc calcification. In Norway, only EBVs for HD are calculated. If EBVs were used as selection criteria instead of the individual dog's grading results, health improvement would be achieved more rapidly, especially for diseases with low to middle heritabilities.

It is important to validate DNA tests before they are used in a breeding program. Does the test have a reliable predictive value? Is it negative in healthy dogs? Is it relevant to one, or several, or all breeds? Was the test validated in dog populations other than the one in which it was developed? How high is the frequency of the deleterious DNA variant/mutation, and what will the impact be if all carriers are excluded from the breeding population? If these matters are not clear, the test may be useless. It may even be harmful to the breed or population, because it may exclude healthy animals from breeding.

The International Partnership for Dogs is a global organization for stakeholders around the world working to improve the health and welfare of dogs (International Partnership For Dogs). On their homepage, known DNA tests for inherited diseases in dogs can be scrutinized. For each DNA test

there is a color-based breed rating indicating the test's relevance to the breed (International Partnership For Dogs (a)). The ratings can be used as a form of rough but helpful guidance by veterinarians, breeders and others trying to navigate through the growing jungle of DNA tests of varying validity.

Initiatives taken by breeding organizations to promote healthy breeding

Attention points in the breed standards addressing unhealthy conformation

The breed standards provide a detailed description of how the ideal dog should look. As some of these traits have become more and more pronounced in some breeds, descriptions of unwanted exaggerations and unhealthy conformations have over time been added to the breed standards.

Examples of such formulations are:

Shar Pei:

“Function of eyeball or lid in no way disturbed by surrounding skin, folds or hair. Any sign of irritation of eyeball, conjunctiva or eyelids highly undesirable. Free from entropion.” (FCI, 1999).

French Bulldog:

“The length of muzzle is about 1/6 of the total length of the head.”

Nose: Black, broad, snubbed, with symmetrical and well opened nostrils, slanting towards the rear. The slope of the nostrils as well as the upturned nose must, however, allow normal nasal breathing.

SEVERE FAULTS: Overtyped, exaggerated breed characteristics.” (FCI, 2015).

Pug:

“Pinched nostrils and heavy over nose wrinkle is unacceptable and should be heavily penalised.” (FCI, 2011).

Thus, it is well-known in the organized breeding community that several breeds are burdened with diseases due to exaggerated conformation, and the added descriptions of unwanted traits is an attempt to limit the negative effects.

Breeding programs

As mentioned previously, the national breed clubs and the kennel clubs decide the breeding programs for pedigree dogs within each breed. Decisions about which health criteria the breeding dogs will be required to comply with are based on research and current knowledge of the causes, prevalence and severity of individual diseases. The size of the breed population is also taken into consideration. If too many criteria are included in a breeding program, the consequence will be that many dogs are excluded from breeding, causing a reduction of genetic variation, and inbreeding and the appearance of new diseases. Another consideration is the economic load for the dog breeders. The number of tests and examinations should be both manageable and affordable. Otherwise, breeders may be inclined to leave the breed clubs. Altogether, the breeding programs reflect a balanced consideration of many aspects related to the breed, its health and the breeders – even though there is of course, case by case, room for discussion about whether the right balance has been struck.

A few examples of initiatives taken via the breeding programs will be mentioned here.

Episodic falling syndrome (EFS) is a recessively inherited neurological disease seen in CKCS. In homozygous animals, episodes are triggered by exercise, stress or excitement. During an episode, the dog stays conscious, all four legs stiffen, the back arches and eventually the dog falls over. Between episodes, the dog is normal. In 2012, the mutation causing the syndrome was identified and DNA testing became a possibility (Gill et al., 2012). In Denmark, testing of the parents before breeding has been mandatory since 2012, and this has eliminated the disease in the registered CKCS population.

A second example is mitral valve disease. This form of heart disease is commonly seen in old dogs, but among CKCS it has a particularly high prevalence and earlier onset. Its genetics are more complex than those of EFS, but – as mentioned above - a screening program based on ultrasound examination before breeding has improved the general heart health of the CKCS breed (Birkegård et al., 2016).

Third, assuming that several behavioral traits, including aggressiveness, trainability, attachment and fear of strangers, are hereditary to some degree (MacLean et al., 2019), a formalized mentality assessment is required for some breeds. During the test, the dog is exposed to different situations like contact, surprise, hunting, playing, and noise. Thus, the test is a tool that is used to describe the dog's mental strengths and weaknesses (The Danish Kennel Club (e)). For many breeds a "best profile" is also described (The Danish Kennel Club (f)). In Denmark, a mentality description is a part of the breeding program for, among other breeds, Broholmer and Rottweiler, and in some breeds there are specific requirements regarding the result.

Breeding strategies

On the FCI homepage a document listing the organization's "international breeding strategies" can be found (FCI (b), 2022). Here it is underlined that only healthy dogs should be used in breeding, that any exaggerations and inbreeding should be avoided, that dogs unable to mate and give birth naturally should be excluded from breeding, and that inherited diseases should be handled by means of DNA tests or in screening programs.

In order to address BOAS, which is common in the brachycephalic breeds, FCI have published a dedicated strategy "*Brachycephalic breeds and Brachycephalic Obstructive Airway Syndrome (BOAS). Report, Strategy and Recommendations of the FCI Scientific Commission*" with general breeding recommendations around this syndrome (FCI Scientific Commission, 2020). They recommend that morphologic and/or functional evaluation of brachycephalic dogs should be introduced, and that only healthy dogs should be used for breeding. In 2019, they signed an agreement with Jane Ladlow from the BOAS research group at the University of Cambridge under which they will cooperate on the development of guidelines for breeders in order to improve the health of the brachycephalic breeds (FCI, 2019). The BOAS grading program developed by the BOAS research group with Jane Ladlow is described below.

In the Nordic countries "breed-specific breeding strategies" have been formulated for most breeds (e.g. (The Swedish Kennel Club, 2021); (The Norwegian Kennel Club (a), 2022). Each strategy, or in Danish Racespecific Avls-Strategi (RAS), is set out in a document describing the breed's history and development, its disease predispositions, and other health-related issues, together with an explanation of the breeding program, past and present, and current breed goals. An example of a RAS can be viewed here (Broholmerselskabet, 2019).

A comparable system exists in the Kennel Club (UK), which has issued advice on how to prepare a “breed health improvement strategy” (Seath, 2022). The guidance states that the strategy should have four themes:

- Improving breed health
- Engaging with breeders and owners to implement health plans
- Developing plans for health improvement
- Leading and setting the breed's direction for health improvement

The UK Kennel Club has also implemented “Breed Watch” (The Kennel Club, 2022). Breed Watch serves as a “warning system” for some breeds with certain breed-specific, visible health concerns. It addresses show judges in particular but it is relevant to breeders and exhibitors too. For each breed on the list, specific points of concern are described. “Category 3 breeds” are *“susceptible to developing specific health conditions associated with exaggerated conformation”* and include, for example the Pug, German Shepherd and English Bulldog. “Category 2 breeds” have *“visual points of concern that can cause pain or discomfort”*. They include the Basset, Chihuahua and Dachshund.

A similar initiative has been taken by the Nordic kennel clubs (Denmark, Norway, Sweden, Finland and Iceland), which have prepared “Breed specific instructions” (BSI). These describe various unhealthy exaggerations of breed characteristics – both for groups of dogs, such as brachycephalic dogs, and specific breeds. They were put together with input from show judges, veterinarians and breed clubs and are intended to remind show judges to be watchful for exaggerated phenotypes (The Nordic Kennel Union, 2018).

A more comprehensive list of breeding resources provided by the World Small Animal Veterinary Association (WSAVA) inherited disease committee can be found in the Appendix.

BOAS screening program

One of the most severely exaggerated breed characteristics is the short muzzle in breeds such as the Pug, French and English Bulldog. Dogs of these breeds are at risk of developing BOAS.

To reduce the frequency of BOAS in the three brachycephalic breeds: Pugs, French Bulldogs and English Bulldogs, several kennel clubs have introduced the grading system developed by researchers at Cambridge University (described in this report’s section about research based initiatives). At present, in the Norwegian Kennel Club, BOAS grading of the parent dogs is required for English Bulldog puppies to be registered, and so far grade 3 dogs’ offspring cannot be registered. BOAS grading is voluntary for the other two breeds. Only veterinarians who have completed the associated BOAS grading course are authorized to grade. The course ensures that veterinarians are able to grade with consistent precision across all dogs. To secure a critical mass of gradings, only a certain number of veterinarians in each country are trained to perform the grading. The same BOAS grading program will be implemented in Denmark and Sweden in spring 2023.

A simpler functional test is used by the French kennel club (Centrale Canine, 2020). Finland has also implemented functional tests that differ slightly from the test developed at Cambridge University.

Open studbooks

Denmark has six native breeds (Broholmer, Danish Spitz, Black Spitz, Danish-Swedish Farmdog, Old Danish Pointing Dog and Greenland Dog). A number of these had been extinct in their original form and were later reconstructed using non-pedigree dogs with suitable phenotypic resemblance. In most breeds (e.g. the Broholmer) the studbook was closed as soon as the desired breed type was achieved while others kept it open. An example of the latter is the Danish-Swedish Farmdog. The reconstruction of this breed began in the 1980s in a cooperative program involving Denmark and Sweden, and the breed obtained its international FCI-recognition in 2019. Throughout these years the studbook was kept open, as it remains today. Thus, new dogs can be introduced to the breed following careful evaluation by an appointed panel of judges. The process is still active, and since FCI recognition six new non-pedigree dogs have been approved in Denmark. Only the two countries of origin (Denmark and Sweden) can approve new dogs in the breed. The dogs are assigned an FCI studbook, but naturally this is one without ancestral information. They have an equal right to be used for breeding – the only limitation lies in their ability to win certain titles at international dog shows. However, once their offspring have a full three-generation pedigree they gain the right to win any title at an international show.

This strategy has contributed to the general health and genetic variation of the breed, but it has also resulted in a less uniform breed type.

Collaboration between kennel clubs and universities

In the Nordic countries there is ongoing research collaboration between the kennel clubs and the universities. At least one animal genetics professor/associate professor is a member of the Health Board, or is otherwise associated with it, in order to advise on health-related issues and breeding programs. In addition, several collaborative research projects designed to provide guidelines for specific diseases are being conducted. The Danish Kennel Club co-funds the projects, provides health data (among other things), and facilitates collaboration with the relevant breed clubs. The projects are typically undertaken as Master's projects for veterinary or animal science students. The aims include, for example: identifying the frequency of a specific mutation in a breed, finding the mutation causing a hereditary disease in a candidate gene, and validating an already established DNA test. A few examples will be mentioned here:

“Osteogenesis imperfecta in Danish wire-haired Dachshunds”: Here the objective was to investigate whether the mutation causing the disease was present in the Danish population and at what frequency. The mutation was found to have a relatively high frequency, and consequently it was suggested that the corresponding DNA test should be included in the breeding program.

“Validation of a hip dysplasia DNA test for Labrador retrievers”: This project investigated whether the DNA test could be used to predict the risk of hip dysplasia for individual Danish Labradors. There was no correlation between the test result and hip status, suggesting that the test should not be adopted in the breeding program (The Danish Kennel Club (g)).

In addition to these smaller projects, PhD projects providing basic information on inherited diseases are conducted, typically in close collaboration with a specific breed club. Such projects have led to the breeding programs that have helped to reduce both back problems in Dachshunds and heart problems in CKCS (described later).

Summarizing discussion and comments

In general, the initiatives undertaken by the breeding organizations target dogs registered with the organizations themselves. However, initiatives and trends within the organized breeding community seem to influence the general dog breeding community, at least to some extent. Some dogs that are not registered are probably also being DNA-tested. However, they are not participating in any overall strategy, and how these breeders administer the results probably varies greatly.

The breeding programs have been, and continue to be, important and successful in improving the health of dogs of many breeds – especially with respect to monogenic inherited diseases. As explained above, many diseases have been controlled much more successfully through the use of DNA tests in the breeding programs. Still, the way our dog breeds have been established and the way the dogs are being bred generates limited genetic variation. Selective breeding will always result in loss of genetic variation over time, and unavoidably, inherited diseases emerge on a regular basis in small, closed populations. If this ongoing challenge is to be curbed effectively in a long-term manner, the aim should be to increase the sizes of the breeding populations and thus the genetic variation in individual breeds. This can be done by, for example, opening the studbooks as has been done with the Danish-Swedish Farmdog. This creates more genetic variation, and it is an effective way to secure a numerically small breed and limit the risk of its inherited diseases.

Breeding programs targeting complex inherited diseases like disc herniation and heart disease have been successful in improving overall health in breeds susceptible to these diseases. However, because many genes and environment influence these traits, this has been a rather long, and still ongoing, process, and one that is complicated by the fact that not all breeders comply with the recommendations.

The collaboration between universities and kennel clubs is valuable at many levels. For one thing, it contributes to veterinary education and gives students insights into the challenges of dog breeding. It is also effective in delivering answers to well-defined questions, providing insight in the health situation and allowing the kennel clubs to make informed decisions.

The effectiveness of the strategies published by FCI and the kennel clubs to promote healthy breeding and avoid exaggerated phenotypes is difficult to evaluate. First, it is questionable whether the instructions are being followed by the show judges and breeders. The requirement that for example Pugs and French Bulldogs should have open nostrils is emphasized both in the breed standards and in the BSI. Still, at least 75% of French Bulldogs have been shown to have moderately to severely closed nostrils (Ravn-Mølby et al., 2019, Liu et al., 2017). The corresponding percentages are also considerable for Pugs (57 %) and English Bulldogs (45%) (Liu et al., 2017). Thus, even if not all of these dogs are registered in kennel clubs, this is a strong indication, that for at least some health traits neither the attention points in the breed standards nor the BSI have been effective in reversing the trend.

Second, initiatives to improve health by selecting the most healthy dogs for breeding represent a very slow process. Measurable results may not be seen in the near future. This is supported by the fact that for example many brachycephalic dogs still require surgery in order to be able to breathe. Another solution would be to open the studbooks, as was done with the Danish-Swedish Farmdog, to increase the number of dogs and phenotypic diversity in the population, or to cross in other breeds to counteract the extreme phenotypes. The latter strategy would, however, “destroy” years

of selective breeding and the “refinement” of the dog breeds, and the organized breeding community would without doubt perceive it as a radical and unacceptable solution – at least, initially.

The BOAS screening program developed by researchers at University of Cambridge is now being implemented in an increasing number of national kennel clubs. It is also recommended by FCI. The core of the BOAS selection program is to use only those dogs with acceptable breathing function. However, any improvements brought about by such a program will be very slow in coming.

Initiatives to inform and influence buyers of dogs

With all the available information on the breed-related health issues connected with extreme conformation, and on life-threatening inherited diseases with a particularly high frequency, one may wonder why several of the breeds in question have become increasingly popular.

In Table 2, the 12 most popular breeds (2022) in Denmark are listed (Danish Dog Registry).

Table 2: The 12 most popular breeds in Denmark (2022).

Popular breeds in Denmark (2022)
1 Labrador Retriever
2 Bichon Havanais
3 Golden Retriever
4 English Cocker Spaniel
5 French Bulldog
6 German Shepherd
7 Shih Tzu
8 Coton de Tulear
9 Maltese
10 Dachshund
11 Poodle
12 Cavalier King Charles Spaniel

For example, French Bulldog is the 5th most popular breed and number 7 on the list is Shih Tzu - another brachycephalic breed. In the UK, the French Bulldog became the most popular breed in 2018, with a 3000% increase in numbers since 2008 (British Veterinary Association), and in Australia the registration of brachycephalic dog breeds has also increased steadily (Teng et al., 2016).

In general, people are aware that, for example, a very short muzzle is an extreme conformation, and they would probably infer that the breeding goals do not counteract this phenotype. In spite of this knowledge, people acquire such dogs (Steinert et al., 2019). A Danish study has shown that owners of French Bulldogs and Chihuahuas tend not to be concerned about health issues before they obtain the dog. Instead, this group of dog owners place more emphasis on availability or the dog's personality (Sandøe et al., 2017). Owners of French Bulldogs, Pugs and English Bulldogs are aware of the health problems of the breeds, but still they report that their dog is in good health – even that it is healthier than is average for the breed (Packer et al., 2019). They also tend to re-acquire animals of these breeds and recommend them to others, mainly because they are perceived as suitable for a sedentary lifestyle and a life with children, and because of their personality (Packer et al., 2020). However, owners of French Bulldogs with experience of health issues in their dogs tend not to re-acquire dogs of that breed (Sandøe et al., 2017, Packer et al., 2020).

The tendency to choose breeds with associated challenges is not restricted to health traits. When it comes to behavioral traits, it has been shown that some of the most popular dog breeds tend to be difficult to train and have separation problems or fear of other dogs. Thus, fashion and societal

influence rather than traits like behavior, health or longevity seem to determine the choice of breed (Ghirlanda et al., 2013).

Efforts have been made to inform dog buyers about the problems associated with exaggerated phenotypes. In 2008, the BBC broadcasted the documentary “Pedigree dogs exposed” showcasing, among other things, Bulldogs with severe breathing problems and a CKCS screaming with pain caused by the disease syringomyelia. The program received considerable attention and kick-started various campaigns against extreme conformation in dogs.

In the following, initiatives adopted in different contexts are exemplified.

Initiatives taken by veterinarians

During the WSAVA congress in Copenhagen in 2017 the health issues in brachycephalic dog breeds were the theme of a panel discussion (World Small Animal Veterinary Association, 2017). More than 200 delegates attended the discussion. The veterinarians reported that surgery procedures – from opening the nostrils, shortening the soft palate, correcting the dog’s bite to performing Caesarean sections – in the brachycephalic breeds have become the norm instead of an exception. The overall message of the discussion was that veterinarians should dare to speak out, and that the education of owners and breeders is important. Since then, a video with experts explaining (and dogs displaying) BOAS has been produced. It can be found on the WSAVA homepage, together with additional resources and links related to BOAS (World Small Animal Veterinary Association).

The British Veterinary Association (BVA) launched the campaign “Breed to Breathe” in January 2018 (British Veterinary Association). It had developed a “10-point plan” for veterinary practices which advises veterinarians to, for example, offer pre-purchase consultations, participate in health schemes and surveillance programs, and to develop a communication strategy related to these health issues. The BVA has also created a toolbox with resources for veterinarians in order to raise awareness of the problems.

The Danish Veterinary Association has also initiated a campaign: “Stop bad breeding”. This is designed to inform veterinarians, breeders and owners about the health issues of the brachycephalic breeds. A campaign video was also produced in 2020 (Danish Veterinary Association).

In a Swedish campaign, more than 700 veterinarians have signed the statement “Stop unhealthy dog ideals”, which focuses on the exaggerated brachycephalic ideal. The campaign was mentioned in 2015 in a Swedish television program, in which a veterinarian and two owners of French Bulldogs were interviewed about the problems (Swedish TV4, 2015).

Animal welfare organizations

UK

In March 2022, the Royal Society for the Prevention of Cruelty to Animals (RSPCA) launched the campaign #SaveOurBreath with the aim of drawing attention to the suffering and health problems associated with the brachycephalic phenotype – not only in dogs, but also in cats, rabbits and horses (Royal Society for the Prevention of Cruelty to Animals, 2022). On their homepage they ask the public to report if they see brachycephalic animals in advertisements, films or elsewhere. The use of such pets in commercials is assumed to encourage people to buy these breeds, and therefore the RSPCA is working to stop such use. They also ask owners of brachycephalic animals to report their

own experience with their pets. Moreover, they provide various kinds of information and material about brachycephalic animals.

In addition to their specific focus on brachycephalic animals, the RSPCA website has a page with information about health problems in purebred dogs (Royal Society for the Prevention of Cruelty to Animals). Here, the most prevalent unhealthy conformation characteristics are described, and the related health problems are explained. They also provide a guide on how to find a responsible breeder – not least, through their quite humorous video “What is a good breeder?”, which goes through the dos and don’ts of puppy buying (Royal Society for the Prevention of Cruelty to Animals, 2018). Some of the advice given here addresses the problem with online puppy dealers selling farmed, and often imported, puppies from unscrupulous breeders or puppy mills. Such puppies are often cheaper and could be less likely to have had breed-based health examinations than puppies from kennel club breeders (Voris et al., 2011). They may also suffer from further problems connected with early weaning, lack of proper socialization, infectious diseases, and the like.

The organization Blue Cross also campaigns against using brachycephalic pets in advertisements in their petition #EndTheTrend (Blue Cross).

The Dog Breeding Reform Group (Dog Breeding Reform Group) raises public awareness about unhealthy dog breeding. On their web page, information relevant to puppy buyers and breeders is made available. Information on breed health is also included, as well as an elaborate guide to unhealthy dog conformation (Canine & Feline Sector Group).

The Netherlands

The organization FairDog in the Netherlands – not to be confused with the similarly named Fairdog in Denmark – is a collaboration between veterinarians, scientists, breeders, rehoming organizations, pet shops, and others advocating for the healthy breeding and selling of dogs (Fairdog). Their aim is to provide a platform for reliable dog selling. The Dutch Kennel Club used to be associated with FairDog, but it left the organization in 2020. The Kennel Club explained that it felt it was increasingly being held responsible for unhealthy breeding, while it saw as a problem mainly with unregistered dogs and breeders (The Dutch Kennel Club, 2021).

Norway

The Norwegian Society for Protection of Animals (NSPA, Dyrebeskyttelsen Norge) explicitly states that its aim is to curb unhealthy breeding in dogs. For this purpose the Society started the campaign “Honestly”, which incorporates many different activities designed to publicize information about unhealthy breeding. Some examples of this are:

The Society has produced campaign videos (The Norwegian Society for Protection of Animals (a), 2018, The Norwegian Society for Protection of Animals, 2021).

It has also published articles, such as (The Norwegian Society for Protection of Animals (b), 2018).

At the Oslo Marathon, it allowed members of the public to try out oxygen-limiting face masks simulating what it is like to move/run with obstructed airways.

It has participated in debates and delivered talks (The Norwegian Society for Protection of Animals (b)).

It has published the information folder “Advice for puppy buyers” (The Norwegian Society for Protection of Animals, 2020).

In spite of these efforts, the Society concludes on its website that current efforts to inform the public about unethical breeding and breed-related health issues is inadequate. It notes that dog breeds with a high frequency of severe inherited diseases and extreme conformation are still very popular. It has therefore initiated a lawsuit against some breeders of both CKCS and the English Bulldog (this is described in the section below on legislative initiatives).

Summarizing discussion and comments

In view of the popularity of dogs such as those in the brachycephalic breeds, campaigning for cautiousness when buying dogs of these breeds has so far not had any measurable effect. Instead, societal influence, as suggested by Ghirlanda and colleagues (Ghirlanda et al., 2013), seems to be a powerful factor. When other cultural phenomena, like hairstyle and clothing, are considered it comes as no surprise that we are all subject to the fluctuations of fashion, and that choice of dog breed is no exception. A so-called “Paris Hilton effect” on the popularity of the Chihuahua breed has been observed. The appearance of dogs in movies also influences breed popularity. The movie “101 Dalmatians” caused an uplift in the number of Dalmatian registrations at the British Kennel Club, and the same happened with Collie registrations after “Lassie” was shown in cinemas (Ghirlanda et al., 2014).

The role of veterinarians is important. They have professional insight into disease mechanisms, and usually dog owners trust their veterinarian. However, pointing out that a client’s dog is suffering as a result of its conformation, or that it should not be used for breeding given its risk of passing on an inherited disease, may be a difficult task. This may affect the owner’s confidence in the veterinarian. It may even mean the clinic loses clients. However, if all veterinarians advised in accordance with the same standards and principles, things might be easier.

The BBC television program “Pedigree exposed” aired in 2008 caught a lot of people’s attention and triggered activism, especially in animal rights organizations. Still, some of the breeds exposed in the program (e.g. French Bulldog and CKCS) are still among the most popular

There is a growing awareness, also witnessed in a number of the initiatives described above, that traditional information campaigns will not by themselves solve the problems. The appearance of dogs in some breeds – with their fascinating phenotypes, their association with celebrities and various media, and their fashionableness – is a very strong driver. To counter this, it is marketing that must be put the work, or more specifically “social marketing”. This has been defined as “the application of marketing principles to enable individual and collective ideas and actions in the pursuit of effective, efficient, equitable, fair and sustained social transformation” (Roy, 2016). This kind of approach seems to underlie the RSPCA initiative mentioned above and the initiatives of a number of Dutch stakeholders promoted on the website “Veterinarians and animal welfare organizations” (Veterinarians and animal welfare organizations). To move forward in this direction, however, collaboration with experts in marketing and other aspects of social science will be required.

Legislative initiatives to prevent unhealthy dog breeding

In many European countries, and in parts of Australia and New Zealand, legislation aimed at protecting animal welfare contains requirements limiting the breeding of dogs (or all animals) “with traits, defects, or serious abnormalities that can be expected to cause suffering either to the animal itself or to its offspring” (Andersen et al., 2021). Denmark’s animal welfare law, however, does not contain any general statutory requirements concerning the breeding of dogs and other companion animals, even though a provision enables the responsible minister to make such requirements. Commercial dog breeders (defined as breeders with two or more bitches who produce two or more litters per year) are required to have a permit from The Danish Food Agency, which issues happy or sad smileys according to their observations at their yearly visit. However, only the rearing conditions and training of staff, not breeding decisions, are evaluated (The Danish Food Agency).

In a couple of countries, rather general legal initiatives have been followed up by more specific implementation rules.

In the Netherlands, a list of criteria that breeding dogs must meet in order to prevent BOAS has been formulated.

In Germany, breeding goals in various dog breeds that do not comply with the general formulations in the Animal Welfare Act are described, and suggestions for improvements are worked out, and these should act as binding guidelines for breeding organizations, individual breeders and responsible authorities (Herzog et al., 2005).

In Norway the general formulations have not been followed by more specific rules, but § 25 of the Norwegian Animal Welfare Act, on animal breeding, has been interpreted in a lawsuit against the Norwegian Kennel Club and specific breeders of the English Bulldog and CKCS.

In the sections below the initiatives taken to enforce general animal welfare legislation in the Netherlands, Germany and Norway are described and commented on.

Legislative initiatives to prevent unhealthy dog breeding in the Netherlands

In the 2014 Dutch Animal Keepers Decree, general regulations governing the keeping and breeding of pets are formulated in Article 3.4 (The Dutch government, 2014). Article 3.4 outlaws the breeding of companion animals in ways that have negative effect on their welfare and health. Serious hereditary defects and external, conformational traits or appearance features with negative effects on the animal’s welfare and health should be avoided, for example. Moreover, passing on behavioral abnormalities to offspring should be avoided, and mating should occur in a natural way.

Animal protection organizations have been active in highlighting the impaired welfare of purebred dogs with extreme phenotypes. This contributed to the government’s decision to enforce the decree. To make the decree operational, the Dutch minister of Agriculture, Nature and Food Quality, Carola Schouten, requested the Expertise Center Genetics of Companion Animals at Utrecht University to provide guidelines to be used in the enforcement of the decree. The decree covers several species, breeds and types of challenges. However, it was decided that the initial effort would target brachycephalic dogs, many of which have serious welfare issues.

As described in this report's section on research initiatives, the brachycephalic phenotype is characterized by a short muzzle leaving too little space for the internal soft tissue, narrow or closed nostrils, a short and convex skull, protruding eyes and nasal skin folds. Due to these features brachycephalic dogs are predisposed to breathing difficulties, exercise intolerance, and eye and skin problems, among other things (O'Neill et al., 2022, O'Neill et al., 2021, Dupre and Heidenreich, 2016).

Based on inputs from specialists, and on scientific literature on the brachycephalic phenotype and its clinical problems, the working group from Utrecht University formulated a list of criteria and standards that the brachycephalic dogs should meet in order to be accepted for breeding (van Hagen M., 2019). Since March 2019, the decree has been enforced vis-à-vis breeders of brachycephalic dogs (Ministry of Agriculture Nature and Food Quality (a), 2019).

It is recognized that in some breeds probably all of the dogs will exceed the limits of the standard. Given this, less strict criteria are temporarily allowed for some of the measurements until selection towards a healthier phenotype has had some impact in the population.

The main criteria are listed in Table 3, where the key phenotypic descriptions are highlighted in red, yellow or green. The ideal phenotype is in green, unacceptable traits are in red, and phenotypes that are accepted during a transition period are in yellow.

Table 3: Criteria published by the Expertise Center Genetics of Companion Animals at Utrecht University (van Hagen M., 2019)

Criterion	Aim considering the risk of eye problems and BOAS	Enforcement standard	Consequences of exceeding the limits of the standard
Abnormal breathing sound (stridor)	Absent	The dog makes loud sniffing, snoring or sawing sounds when at rest (not asleep) or a nasal, pharyngeal and/or laryngeal stridor can be heard when the dog is at rest	Exceeds the limits of the standard, irrespective of other criteria
Nostrils	Open nostrils	Mild to moderate stenosis = mild to moderate narrowing of the nostrils	Meets the standard for now, provided none of the limits of the other criteria is exceeded
		Severe stenosis = severe narrowing of the nostrils	Exceeds the limits of the standard, irrespective of other criteria
Relative muzzle length (or craniofacial ratio =	Equal to or greater than 0.5	Greater than 0.3 but less than 0.5	Meets the standard for now, provided none of the limits of the other criteria is exceeded

CFR = muzzle length/cranial length)		Less than or equal to 0.3	Exceeds the limits of the standard, irrespective of other criteria
Nasal fold	No nasal fold present	Nasal fold present but no visible contact between the hairs of the nasal fold and the conjunctiva or cornea of the eye, no wet nasal fold hairs adjacent to the cornea, no signs of ocular inflammation adjacent to the nasal fold	Meets the standard for now, provided any inflammation/dermatitis related to intertrigo is treated in accordance with the provisions of the Welfare Act and none of the limits of the other criteria is exceeded
		Nasal fold present and hairs from the nasal fold are in contact with or could come into contact with the cornea or conjunctiva (wet nasal fold hairs)	Exceeds the limits of the standard, irrespective of other criteria
Exposed sclera (white of the eye)	White of the eye not exposed or at most very slightly exposed near the lateral canthus (in the outermost corner of the eye) only	White of the eye exposed in two or more quadrants -> shallow orbit and/or an excessively wide eyelid aperture, with a poorly protected eyeball and increased risk of corneal ulcers developing	Exceeds the limits of the standard, irrespective of other criteria
Extent of eyelid closure when the eyelid reflex is elicited	Eyelid reflex present and eyelids close fully	Eyelids cannot be closed fully	Exceeds the limits of the standard, irrespective of other criteria

Relative muzzle length, or CFR, is the ratio between two measurements: cranial length and muzzle length. Cranial length is measured along the midline of the skull from the bony protrusion at the top back of the skull to the point between the medial corners of the eyes. Muzzle length is measured from the point between the medial corners of the eyes to the tip of the nose (see Figure 1).

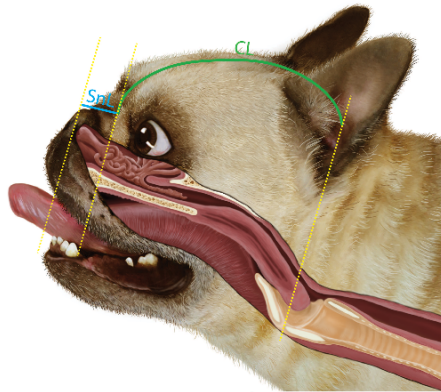


Figure 1. CRF = Muzzle (or snout) length (SnL) shown in blue divided by cranial length (CL) shown in green (Liu et al., 2017).

The “CFR > 0.3” criterion, according to the researchers behind the scheme, is essential. However, very few dogs of the brachycephalic breeds comply with it. For example, an average French Bulldog has a CFR of approx. 0.2 or lower (Packer et al., 2015). The argument for including the CFR criterion is that exaggerated brachycephalic skull conformation contributes substantially to the development of a number of disorders, including BOAS, protruding eyes, inner ear problems and dental crowding. Allowing only those dogs with a less extreme brachycephalic skull to breed will in time eliminate the problems.

The other major bottle-neck for breeders is the “open nostrils” criterion. A Danish study has shown that 80% of French Bulldogs have moderate or severe nostril stenosis (Ravn-Mølby et al., 2019), so in this breed only 20% of dogs would pass the test based on nostrils alone. Thus very few French Bulldogs would be allowed to breed.

The Dutch scheme recommends owners who want to use their dog for breeding to take it to the veterinarian, who will take the measurements. At present, approximately 500 veterinarians in the Netherlands have a free registration system where information about the animals seen by the veterinarian is recorded: sex, breed, consultation date, diagnosis, etc. The six criteria are implemented on one page of the system, where they can be filled out. To date, at least 200 dogs have been examined (Hille Fieten and Marjan AE van Hagen, personal communication).

The criteria are chosen and formulated in such a way that they can easily be used by both veterinarians and non-veterinarians in the evaluation of the dogs. Staff from Netherlands Food and Consumer Product Safety Authority (NVWA) are tasked with ensuring that dogs comply with the criteria. They have been trained to take the relevant measurements. It is unknown to us how many dogs have been evaluated by the authorities.

An additional set of criteria has been formulated for veterinary surgeons or specialists. These criteria are to be used when doubts about the potential of the dog to be bred from arise, or as evidence in legal procedures.

So far, it has remained legal to own, import or sell a dog that does not comply with the criteria. What is outlawed is its use for breeding. An import ban was suggested by various stakeholder, but this has so far not been implemented by the government.

The enforcement rules are set out and communicated on the Ministry of Agriculture, Nature and Food Quality homepage (Ministry of Agriculture Nature and Food Quality (a), 2019) and at the Dutch Kennel Club homepage (Ministry of Agriculture Nature and Food Quality (b), 2019).

In August 2019, in response to the criteria formulated by the Expertise Center, The Dutch Kennel Club published in an alternative list of criteria, which they suggested would be an improvement (see Table 4) (The Dutch Kennel Club, 2019).

The phenotypic criteria suggested by the Expertise Center are listed in the “Enforcement standard” column. Again, phenotype descriptions in red are unacceptable traits, and those in yellow are to be accepted during a transition period. The Dutch Kennel Club’s comments and suggested adjustments to the Expertise Center’s criteria are listed in the last column, where it is also stated whether or not the criteria are the same.

Table 4: Criteria suggested by The Dutch Kennel Club (The Dutch Kennel Club, 2019)

Criterion	Enforcement standard	Proposal of the Dutch Kennel Club on the breeding of brachycephalic dogs
Abnormal breathing sound (stridor)	At rest (not asleep) the dog makes strong sniffing, snoring or sawing noises, or there is a nasal, pharyngeal and / or laryngeal stridor at rest	Dogs are assessed both at rest and during exercise by a veterinarian when taking an exercise tolerance test. Same standard.
Nose opening	Mild stenosis = moderate narrowing of the nostrils.	Assessment of the nostrils by a veterinarian during a clinical examination.
	Severe stenosis = severe narrowing of the nostrils.	Same standards.
Relative muzzle length (or craniofacial ratio = CFR =muzzle length/cranial length)	Greater than 0.3 but less than 0.5	Use criterion to determine risk dogs that must meet additional measures.
	Less than or equal to 0.3	
Nasal fold	Nasal fold present but no visible contact of the hair with the conjunctiva or cornea of the eye, wet nasal fold hair or signs of inflammation	Evaluation of the nasal fold by a veterinarian during a clinical examination. Same standards.
	Nasal fold present and hair that from the nasal fold (may) touch the cornea or conjunctiva (wet nasal fold hair)	

Visibility of the whites of the eyes (the sclera) in the dog looking straight ahead	White of the eye visible in 2 or more quadrants-> shallow eye socket and / or large eyelids, with a poorly protected eyeball and an increased risk of developing corneal ulcers	Assessment of the eyes by a veterinarian specialist during an ECVO eye examination. Same standard.
Eyelid reflex: test whether the eyes can be closed	Eyelids cannot be closed completely	Assessment of the eyes by a veterinarian specialist during an ECVO eye examination. Same standard.
Body Condition Score (BCS)	Not specified in government criteria.	Assessment of the BCS by a veterinarian during a clinical examination. Dogs may not be obese (BCS > 7/9). Extra criterion.
Exercise tolerance test	Not stated in this form in government criteria.	Assessment by veterinarian in accordance with report. Extra criterion.
Neck and chest circumference	Not listed as an enforcement criterion.	Assessment by veterinarian Extra criterion.

Several of the criteria are identical with those suggested by the Expertise Center, but there are several important differences between the two strategies. The Dutch Kennel Club adds:

- Exercise tolerance test (6 minute and 1000 m walk test) for all dogs and hence more focus on functionality.
- Neck and chest circumference, which has been associated with BOAS (Liu et al., 2017).
- Body condition score, which has been associated with BOAS (Liu et al., 2017).

Further, in the Kennel Club criteria:

- Craniofacial ratio (CFR) is omitted 1) because its prognostic value as regards brachycephalic obstructive airway syndrome (BOAS) is ambiguous, and 2) because several brachycephalic breeds are unable to satisfy this criterion $CFR \geq 0.3$.
- The dogs should be assessed by veterinarians.
- Imported dogs should comply with the criteria in order to be registered in The Dutch Kennel Club.
- Crossbred dogs and lookalikes may be registered with a studbook (not an FCI studbook) with the relevant breed.

The Kennel Club also emphasizes that dogs outside the breed clubs should also abide to the criteria, and they suggest extensive training of dog show judges to ensure that no dogs with exaggerated

characteristics are awarded prizes. Also, only judges from the Netherlands (or Scandinavia where equally strict rules exist) with relevant training should be allowed to judge in the Netherlands.

The minister of Agriculture, Nature and Food Quality has rejected The Dutch Kennel Club's suggestions but temporarily allowed only one parent dog to satisfy the $CFR \geq 0.3$ requirement (The Dutch Kennel Club, 2020).

The CFR criterion has not been adopted by The Dutch Kennel Club: in their suggested criteria in their suggested criteria, CFR should be used to identify dogs at risk, and there are no requirements on skull or nose conformation. Instead, they include a functional exercise test. Thus, their suggestion is that extremely brachycephalic dogs may be allowed to breed if they are functionally acceptable and can tolerate some exercise.

The Dutch Kennel Club's response to the Expertise Center criteria has created a conflict between it and FCI. FCI is very protective of the breed standards formulated by the official owner countries. It states that the suggestion to allow crossbred dogs in the registry is undermining hundreds of years of breeding history. FCI would have preferred to implement the BOAS screening program developed by Jane Ladlow at Cambridge University (Riggs et al., 2019, Cambridge BOAS Research Group), but moves in this direction have been delayed by the covid pandemic (Jakkel T., 2020).

The enforcement of the Dutch legislation has created public awareness of the welfare problems of extreme brachycephalic dogs. Several breeders of brachycephalic dogs have left The Dutch Kennel Club (Hille Fieten and Marjan AE van Hagen, personal communication). The new regulations are included in the breeding program for the brachycephalic breeds (e.g. (The Dutch Kennel Club)). As already mentioned, not many of the brachycephalic dogs comply with the criteria decided on by the government, and their offspring are therefore unable to obtain an FCI studbook. Whether the enforcement has yet had any effect in moving towards a less extreme phenotype among brachycephalic dogs in the Netherlands is as yet unknown.

Summarizing discussion and comments

The main characteristic of brachycephalic dog breeds is the short snout. For example, in the breed standard for French Bulldogs the nose is described as "very short". However, over time the noses in several brachycephalic dog breeds have become shorter and shorter, reflecting the fact that interpretation of the breed standard has been drifting towards an extreme skull and nose conformation that causes the breathing problems seen in these breeds. The breed standard states that the breathing should be unhindered. This part of the standard has obviously not been given enough attention.

The initiatives taken by the national kennel clubs (including The Dutch Kennel Club) and FCI have not been effective in preventing the emergence of the extreme brachycephalic phenotype and the various disorders linked with it. Now, the Dutch government has acted to prevent dogs with extreme brachycephaly from breeding.

One important difference between the criteria in Dutch government policy and those suggested by The Dutch Kennel Club is the CFR. CFR score is strongly correlated with the risk of BOAS. In a study of dogs representing 97 breeds it has been found that BOAS only occurs in dogs with $CFR < 0.5$ (Packer et al., 2015). In another study of the three breeds, Pug, French and English Bulldog, however, the correlation was not as evident. First, variation of CFR values within each breed was limited. Thus, the

CFR measurements overlapped considerably in the various BOAS categories. Second, the inter-observer reproducibility was generally poor, indicating that this measurement is not easy to perform consistently in brachycephalic dog breeds (Liu et al., 2017). However, it may be easier to tell whether the CFR of a dog is > 0.3 or < 0.3 than it is to measure exact CFR.

If only dogs with a $CFR > 0.3$ are acceptable for breeding purposes, highly brachycephalic dogs like the average Pug or French Bulldog will not be permitted to breed (unless it is mated with a dog with $CFR > 0.3$). Thus, the aim of the Dutch policy is to “phase out” dogs with extreme brachycephalic conformation and in that way prevent BOAS and other disorders caused by this conformation. This can be viewed as a breed ban, because practically all dogs of breeds like the Pug and the English Bulldog have a $CFR < 0.3$, so crossing with other breeds or crossbreeds will probably be necessary. Potentially, then, the initiative will be effective in solving the problems related to brachycephaly.

Still, it seems the initiative will be difficult to enforce. There is no formalized testing of the dogs. That task is left to the breeders. However, the criteria are added to the breeding programs (in The Dutch Kennel Club) for the relevant breeds, so they apply particularly to pedigree dogs. This seems to be the reason that many breeders have left The Dutch Kennel Club. Importing brachycephalic dogs is so far legal no matter if the dog is healthy or not.

Not all of the highly brachycephalic dogs are equally likely to develop BOAS. The approach taken by The Dutch Kennel Club is instead to allow the characteristic conformation but select only those dogs that are not too negatively affected by their phenotypic features for breeding. In this way, it is hoped, the various breeds’ characteristic conformations will be preserved while the general health of the breeds will improve. This may occur, but it will probably take a very long time, to the detriment of many dogs.

In the Netherlands, the law enforcement around canine brachycephaly has caused a lot of conflicts within and between the breed clubs, The Dutch Kennel Club, FCI and the breeders. This may have been inevitable, but potentially these conflicts will have undermined future collaboration on the development of healthier dog breeds in general.

One indisputable effect is that the new rules have drawn a lot of public attention to the health problems of these breeds. More people have become aware that the breeds are prone to breathing difficulties. Potentially, this will raise demand for healthier dogs with less extreme phenotypes.

Legislative initiatives to prevent unhealthy dog breeding in Germany

§ 11b of the German Animal Welfare Act outlaws the breeding of animals where it is expected that, due to heredity, the animals themselves, or their offspring, will lack body parts or organs for appropriate use, or have body parts that are unsuitable, or reshaped in such a way that pain, suffering or damage occur as a result. It is also forbidden to breed animals if it is expected that the offspring a) will develop hereditary behavioral disorders or aggressive behavior, b) be such that their contact with other specifics causes suffering or harm, or c) be such they can only be kept under conditions that cause them suffering or harm.

On the basis of § 11b two initiatives have been taken:

- 1.

In order to make the Animal Welfare Act clearer and operational, an expert group appointed by the Federal Ministry of Food and Agriculture has produced the document “Expert opinion on the interpretation of § 11b of the Animal Welfare Act (ban on torture breeding)” (Herzog et al., 2005). (The term “torture breeding” is a translation of the German word “qualzucht”. As well as “torture”, qual can also be translated as pain, anguish or agony.)

Breeding goals in various dog breeds that are not compliant with the Animal Welfare Act are described, and suggestions as to how to make improvements are worked out. The document should act as binding guidance for breeding organizations, breeders and for responsible authorities in order to prevent “torture breeding”.

For example, as mentioned above, some dog breeds with short legs are prone to intervertebral disc herniation. Therefore, breeding against this disease should be a breeding goal. It is acknowledged that more research is required to establish suitable selection criteria. In other cases, a breeding ban is recommended: e.g. for Rhodesian ridgebacks with dermoid sinus. The Rhodesian Ridgeback is characterized by a ridge on the back with hairs growing in the opposite direction. This creates a predisposition to dermoid sinus, which is an opening on the surface of the skin towards the spine (Mann and Stratton, 1966). A breeding ban is also recommended for the hairless dogs (Chinese and Mexican) in view of their very exposed and sensitive skin, and their lack of teeth and deficient immune system, and because the relevant allele is lethal in homozygous dogs.

There are no specific instructions on how this interpretation of the Animal Welfare Act should be executed, except that it should act as guidance.

2.

Via the “Animal Protection Dog Ordinance” § 10 (Federal Ministry of Justice, 2021) new, sharpened rules on dog shows entered into force in Germany in January 2022. It is now prohibited for dogs to participate in shows and field trials if, for hereditary reasons:

- parts of their body or organs are missing, unsuitable for normal function or altered, causing any suffering
- their behavior is affected, causing suffering
- their contact with other species living beings causes any suffering
- the keeping of the dog causes any suffering

This means that before a show or trial all dogs must undergo a general examination to check that they have no signs of “torture breeding” (“qualzucht”). Moreover, in 40 breeds additional examinations must be performed – some annually – before permission to appear at the show is granted. For example, once a year:

- some breeds must have their eyes examined for cataract
- dachshunds must have their back X-rayed for intervertebral disc disease
- some breeds must have their heart examined for mitral valve disease
- some of the brachycephalic breeds must undergo a respiratory function-grading scheme (until they reach 5 years of age) (Verband für das Deutsche Hundewesen (VDH) e.V., 2022)

The examinations must be performed by so-called “official” veterinarians in the relevant German state (Bundesland) before the show. These regional officials are private practitioners who also serve the ministry/ government in veterinary relevant matters. However, the law has been interpreted very differently in different German states. In some cases, dogs with the same phenotypic trait have been allowed access to a show in one state and denied it in another. In other cases, healthy carriers of recessive inherited diseases have also been excluded from a show, because of their potential to pass on this disease to their offspring. However, in general it is encouraged to use carriers of recessive inherited diseases in breeding in order to preserve genetic variation in the breed.

As a consequence of the new rules for dog shows, some breeds are not allowed at dog shows anymore. One example is the Chinese Crested Dog, which is excluded because it lacks hair on most parts of its body.

Where the dogs that are allowed to compete in the show are concerned, the judges will pay additional attention to a list of breed-specific criteria described in the Breed Specific Instructions (BSI) originally developed by the Nordic kennel clubs (Denmark, Norway, Sweden, Finland and Iceland) and now adopted by the German kennel club. For example, the brachycephalic breeds should not show signs of breathing difficulties like snoring sounds or unprovoked panting.

The German Kennel Club has stated that they agree with the terms of the Animal Welfare Act but not with the way it is enforced in relation to dog shows. They agree, for example, that a dog with breathing difficulties should not be allowed to be shown. However, in cases where the decisions have, in their opinion, been unfair or damaging to a healthy breeding practice they have sued the authorities (Lucin A, 2022). The results of these lawsuits are unknown to us.

Summarizing discussion and comments

A focus on dog shows would be expected to have some impact – at least, for breeds with a significant part of the population registered in a kennel club. Dogs awarded prizes at shows usually become popular breeding dogs. Therefore, their appearance has a strong impact on the general appearance of dogs from that breed. If shorter muzzles, more skin or longer ears are seen to be highly valued at conformation shows, the exterior of this dog breed will move in that direction – both for registered and not-registered dogs. Ensuring that dogs entering shows are healthy and do not have extreme body conformation will therefore influence the health of the following generations positively.

The guidelines on “torture breeding” prepared by the expert group gives a good overview of the major problems in several dog breeds. However, they are not operational, and they are difficult to enforce.

The requirements of the “Animal Protection Dog Ordinance” are based on the Animal Welfare Act, but they are enforced only in dog shows and exhibitions. They therefore chiefly target the organized dog breeding community – i.e. they directly affect dogs registered in the kennel club following the operation of a breeding program with various health-related criteria. The breeding organizations have been contributing to the extreme phenotypes of many dog breeds, but in some cases they have also contributed to the discovery of solutions that push breeding in a healthier direction. The exaggerated phenotypes are just as common among dogs without studbooks, but for this group no organized action (in fact, little or no action at all) is being taken to improve the health of the dogs. Breeding decisions are being made by individual breeders.

Another weakness of the way the German legislation is being enforced is that the interpretation of the relevant section is left with individual veterinarians examining the dogs and is therefore far from uniform. Taking a dog to a dog show in Germany has become more expensive and involves additional work, and the new (and in some cases unreasonable) rules may keep many dog owners from attending. At the same time, the enforcement of the law has no effect on dogs that are not entering the shows. The overall effect on the health of German dogs is therefore questionable.

The German initiative does, however, send a strong signal – both to the public and breeding organizations – that unhealthy breeding must be dealt with. The kennel club is therefore being pushed towards higher prioritization of canine health and wellbeing. At the same time, the public perception of what a “healthy dog” is may also change.

Legislative initiatives to prevent unhealthy dog breeding in Norway

Regulation of animal breeding in the Norwegian Animal Welfare Act appears in § 25 (Ministry of Agriculture and Food, 1997) (translated):

“§ 25. Breeding

Breeding shall encourage characteristics which give robust animals which function well and have good health.

Reproduction, including through methods of gene technology, shall not be carried out in such a way that it:

- a. changes genes in such a way that they influence the animals’ physical or mental functions in a negative way, or passes on such genes,*
- b. reduces the animals’ ability to practise natural behaviour, or*
- c. cause general ethical reactions.*

Animals with a genetic constitution as cited in the second article shall not be used for subsequent breeding.”

The Animal Welfare Act is enforced by the Norwegian Food Safety Authority (Mattilsynet).

In 2020 a controversial lawsuit took place in Norway: The Norwegian Society for Protection of Animals (NSPA) (in Norwegian, Dyrebeskyttelsen Norge)(The Norwegian Society for Protection of Animals (a)) sued the Norwegian Kennel Club (NKC) the Norwegian Bulldog Club, the Norwegian Cavalier Club, three breeders of CKCS and three breeders of English Bulldog for non-compliance with the Norwegian Animal Welfare Act § 25. The court found that § 25 does indeed outlaw the breeding of dogs of these breeds (The Norwegian Kennel Club (b), 2022).

“Ethical breeding” has been on the NSPA agenda since 2015, when they started working actively to draw attention to the health problems associated with purebred dogs (The Norwegian Society for Protection of Animals (b)). For example:

- In 2015 they commissioned a progress report from veterinary experts in the Norwegian University of Life Sciences (NMBU) on the health aspects of purebred dog breeding in Norway.
- In 2018 they launched the campaign “Honestly” (against unethical breeding of companion animals).

- They have published several articles on the subject in national newspapers and journals, and have been active on social media, in public meetings, etc.
- They have had meetings with the Veterinary Organization, the Norwegian Food Safety Authority and the NKC to discuss the problems of ethical breeding.
- They have informed the government about these problems
- They have encouraged the Norwegian Food Safety Authority to take firm action against unhealthy breeding.
- In 2018, after the dog show “Dogs4All” they informed the Norwegian Food Safety Authority that the Animal Welfare Act had been infringed in several cases.

However, their efforts have not had the desired effect. The NSPA believes that breeding, at least with CKCS and the English Bulldog, is banned by § 25 of the Animal Welfare Act, and it was to have this clarified that they went to court.

CKCS are burdened with several inherited diseases:

- Chiari-like malformation (CM) and syringomyelia (SM) are interconnected conditions seen in CKCS. CM is characterized by a malformation of the skull that may result in part of the brain (cerebellum) being displaced into the spinal canal. This changes the normal flow of cerebrospinal fluid, leading to an accumulation of fluid in cavities in the spinal canal, which is to say SM. Almost all CKCS have CM to a certain degree, and it is estimated that 70% also have SM. Approximately 15% of CKCS suffer from the associated clinical signs: hyper-sensitivity, pain, phantom scratching, vocalization and sleep disorder. The normal treatment is medical pain relief and pain-relieving surgery (Thøfner et al., 2015, Hechler and Moore, 2018).
- Heart valve disease (MMVD) causing an accumulation of fluid in the lungs and heart failure. This disease is seen in older dogs in many breeds, but in CKCS it develops at a young age. Approximately 50% of 8 year-old CKCS will have developed the disease, and 43% of this breed die from it (Swift et al., 2017).
- Two monogenic inherited diseases also occur in CKCS: curly coat syndrome and episodic falling syndrome. These, however, can be controlled with DNA testing.

Likewise, English Bulldogs are known to have several inherited diseases:

- Brachycephalic Obstructive Airway Syndromes (BOAS) as described above (Liu et al., 2017).
- Skin fold dermatitis, allergies, hip and elbow joint diseases, eye diseases and bladder stone. Their body conformation also hinders natural mating and birthing (Evans and Adams, 2010, O'Neill et al., 2021, O'Neill et al., 2022b, Koehler et al., 2009).

The NSPA has acknowledged that both of the two breed clubs, the NKC and the six breeders are concerned about the dogs' welfare and health, and that the clubs have undertaken health-improving initiatives. Moreover, the six breeders were selected for the lawsuit precisely because they illustrate “best practice”. Thus, one purpose of the lawsuit was to test whether the Animal Welfare Act is not complied with even when the clubs and the breeders do “their best” in terms of healthy breeding.

The NSPA emphasize the proposition accompanying the Animal Welfare Act (Ministry of Agriculture and Food, 2008) where § 25 is elaborated (translated):

“Breeding that affects the animal’s function negatively will be against the law, even if the intention is to breed away the negative effects over time. This also applies if the consequence is that the breed becomes extinct.

The need for routine medical or surgical treatment may be an indication that the breeding infringes the section [i.e. § 25].”

Thus, in their opinion a long-term breeding program designed to correct “negative effects” can still be in violation of the Animal Welfare Act. Instead, the NSPA suggest cross-breeding as a solution. The clubs and the breeders, on the other hand, claim that the majority of those dogs within these breeds live good lives, and that the share of healthy dogs constitutes a sufficiently large population on which future breeding can be based. They also stress that the Norwegian Food Safety Authority enforcing the law has not suggested any breeding ban.

The court’s finding, against the six breeders and The Norwegian Kennel Club, that the breeding of CKCS and the English Bulldog, and the registration of these breeds by the kennel club, is contrary to § 25 of the Animal Welfare Act (The Norwegian Kennel Club (b), 2022) was appealed. The court confirmed that it was against the Animal Welfare Act § 25 for the three CKCS breeders to breed CKCS and for the kennel club to register CKCS. The court emphasized the diseases CM and SM, and to a lesser extent mitral valve disease (The Norwegian Kennel Club (c), 2022). This verdict has since been appealed again (The Norwegian Kennel Club (d), 2022). For English Bulldogs, however, the opposite conclusion was reached. The three breeders and The Norwegian Kennel Club were acquitted. The fact that the breed club has implemented BOAS grading as a breeding restriction (excluding grade 3 animals from breeding) as well as a testimony from Jane Ladlow, who developed the grading system, was stressed (The Norwegian Kennel Club (c), 2022, The Norwegian Kennel Club (e), 2022).

According to the NKC, this case raises questions about the Norwegian Food Safety Authority’s general ability to enforce the law (not only with respect to dog breeding). If the present verdict is maintained, it will probably lead to a principal decision affecting other breeders of CKCS. The lack of reliable information about the prevalence of the various diseases is a general weakness in this case. A national common registry with data on diseases, or diagnoses from veterinarians, would be an invaluable resource (Nina Brogeland Laache and Hilde Engeland, NKC, personal communication).

After the case, the Norwegian Food Safety Authority started a process of writing a regulation on dog breeding (Norwegian Food Safety Authority, 2021). This will be based on the European “Responsible dog breeding guidelines” (The European Commission, 2020).

Summarizing discussion and comments

The decision to concentrate on the two breeds in the Norwegian lawsuit was probably strategic. CKCS is a very popular breed, and the verdict could therefore be expected to have a significant impact. However, if a breeding ban is decided for this breed it will be difficult to enforce for dogs with no pedigree, because these dogs’ owners may claim that their dogs are crossbred. This may, however, be determined with a DNA test.

Among the brachycephalic breeds the English Bulldog population is not the largest. Still, in this case it was probably treated as a representative of the brachycephalic breeds.

The NKC claims that there are sufficient numbers of healthy dogs of these two breeds upon which to base breeding to improve general health in the breeds. This depends very much on how intense the selection is. One study reports that approximately 50% of English Bulldogs, French Bulldogs and Pugs have clinically significant signs of BOAS (Liu et al., 2017). In another study of French Bulldogs 81% of the examined dogs had moderate or severe nostril stenosis (Ravn-Mølby et al., 2019). A study of English Bulldogs has revealed very low genetic diversity, raising questions about the real potential to reverse the breed's health problems through selective breeding (Pedersen et al., 2016). These dog breeds already have numerically small populations, and excluding, for example, half of a population from breeding would create a serious genetic bottleneck, resulting in inbreeding and the appearance of new hereditary diseases – especially if only pedigree dogs are bred. Besides, these breeds are burdened with other diseases that should also be considered. If less intense selection is pursued the risk of inbreeding is of course reduced, but progress towards a healthier phenotype and improved welfare will take several generations. Moreover, as long as the risk associated conformation is still there, breeding with only healthy individuals is no guarantee that the offspring will be healthy. This is why the NSPA suggest crossbreeding, which would probably have an instant effect on some of the problematic phenotypes.

Summarizing discussion

Research initiatives

Research is crucial in order to generate knowledge about all aspects of breeding-related health issues, including inherited diseases, clinical signs and the validity of DNA tests. The traditional Nordic collaboration between the kennel clubs and the universities provides valuable, applicable information that is used to improve breeding programs, understand the nature of inherited diseases, and so on. In order to undertake epidemiological studies, sufficient and reliable data on the prevalence and distribution of the various diseases is required. Some studies have been performed on some diseases, but they are limited to specific samples taken at particular time points. A common, central registry of health data from veterinarians is needed in order to create an overview of the health status of various dog breeds – both pedigree dogs, non-pedigree dogs and crossbred dogs. This would also allow us to assess the effect of breeding programs and other health improving initiatives.

In Denmark, the creation of such a registry has been underway for more than 10 years. One obstacle is that, if it is to be useful, the veterinarians need to use the same diagnoses and thus a common diagnostic registry must be developed and integrated in the electronic systems of the veterinary clinics. In addition, the system must satisfy GDPR-rules in a satisfactory way. However, the veterinarian's duty is to promote animal health and welfare, relieve pain, treat diseases, and the like – not only at an individual level but also in a broader population perspective. The Danish Veterinary Association has recently taken steps towards establishing such a diagnosis registry.

Initiatives taken by the breeding organizations

Organized dog breeding involving closed-breed populations and tracking of the pedigrees began in the nineteenth century. The organizational work has to a large extent been driven by volunteers and enthusiasts. The dogs have therefore been selected by individual dog owners and generally in great loyalty to the traditions and culture prevailing in each breed and show community. An important, negative consequence of breeding within closed-breed populations is a high prevalence of inherited diseases. In order to respond to this challenge, additional health-focused selection criteria such as hip scores and DNA tests have become necessary. However, stringent breeding rules focusing on health are not always welcome in the breeding communities – perhaps due to a lack of insight into the scientific background of the recommendations. Thus, in the breeding community, traditions like coat color, skin folds and specific conformation measures seem at least as important as the dogs' health and welfare. Another limitation on imposing stringent health criteria is the lack of genetic variation in the breeds. In some breeds the selection of only the healthiest dogs for breeding would jeopardize genetic variation even more and create problems with inbreeding and new inherited diseases.

It should be acknowledged that the breed clubs and kennel clubs have taken some effective initiatives against several inherited diseases in their breeding programs. However, due to the small breeding populations, new inherited diseases are likely to occur from time to time.

When it comes to exaggerated phenotypes, which in many cases have gone far beyond their physiological limits, various actions have been taken. However, the effect has been unsatisfactory.

Even if some breeders of brachycephalic breeds like the Pug, or the English or French Bulldog, are aware of the risk of BOAS, some signs of BOAS, like evident breathing sounds and snoring are often perceived as “normal for the breed.” Obviously, the majority of breeders must be aware that most of these dogs are unable to give birth in a natural manner.

Both FCI and the kennel clubs have reacted by developing recommendations and highlighting the importance of a healthy conformation. These initiatives have been directed at the breeding community in general, but also specifically at show judges. However, exaggerated phenotypes remain a serious issue, and therefore the initiatives have been ineffective in reversing the trends. If the kennel clubs are to continue issuing FCI studbooks, they must abide by FCI rules. Therefore, FCI plays an important role in this matter. Statements drawing attention to healthy conformation have been added to some breed standards by FCI. However, these initiatives may have been too late and thus unable to reverse the trend towards a more extreme conformation. Moreover, not all show judges have seemingly given them enough attention at conformation shows. A more thorough reformulation of the most critical breed standards with some clear limitations would be helpful together with initiatives to ensure their enforcement.

The BOAS grading program developed at Cambridge University is being implemented in several countries. However, the brachycephalic dogs are burdened with other inherited diseases in addition to BOAS such as spinal diseases, gastro-intestinal problems and skin diseases, and if the challenges presented by these are addressed as well, the remaining healthy population to be used for breeding would become far too small.

The most lenient way to improve a breed burdened with many inherited diseases, and with low genetic variation, appears to be an adaptation of the strategy with an open studbook used in the Danish-Swedish Farndog. That is, not by deliberately crossing two different breeds, but rather by allowing non-pedigreed individuals of a desired phenotype (with regard to both health and conformation) to be enrolled in the breeding population. This is an effective way to increase genetic variation and at the same time preserve the characteristics of a breed. A larger number of breeding dogs will allow for selection against hereditary diseases without compromising the genetic variation. It should be underlined that the initiatives taken within the organized breeding world benefit registered dogs alone. Parallel action must be taken to include unregistered dogs as well.

Initiatives to inform and influence buyers of dogs

As long as there is demand, there will also be supply. Therefore, initiatives to make dog buyers aware of the health and welfare issues in several breeds are of great importance.

The campaigns run by animal welfare organizations with, among other things, flyers, You Tube videos, information on web pages and social media, have so far not had any major effect. The commitment made by veterinarians to speak up and inform owners about their dogs' health has probably not had any real effect either. At any rate, the breed-related health problems have not changed.

As already mentioned, many prospective dog owners are aware of the health issues seen in, for example, brachycephalic dog breeds. Still, the dogs' health is not always given first priority. Thus, the

vast amount of information on the significant risk of disease in some breeds seems to have had minimal or no effect. Instead societal influence, trends and fashion appear to affect buying decisions powerfully. Therefore, more complex instruments based on social marketing should be used to steer the way dog buyers think and act when choosing a dog.

Legislative initiatives

In most countries, general legislative instruments have been developed in an effort to ensure healthy breeding in dogs. In Denmark, however, the minister has chosen not to go down this path (Andersen et al., 2021). A legal framework would be an important lever in implementing and enforcing initiatives to prevent unhealthy dog breeding.

The legislative initiatives taken in Germany and the Netherlands illustrate very well the difficulties with regard to enforcement. In general, enforcement is easier with registered dogs, because the legislation can be incorporated into the existing rules and breeding programs. But an unintended and unwanted side-effect of the legislation in the Netherlands has been that people have left the kennel club. Any legislation aiming at improving breeding-related health and welfare should therefore be equally enforceable in relation to dogs with and without pedigree.

The Norwegian lawsuits detailed in this report are a consequence of the lack of success in changing the situation. Even if the English Bulldog breeders have won their case, a strong signal has been sent by the NSPA that the limit has been reached.

In conclusion, it is an advantage of legislative initiatives designed to move us towards healthier breeding that they apply to all dogs, and not only those registered with a kennel club. Still, it is difficult to identify and formulate relevant criteria, and equally difficult to administer and enforce such rules. Moreover, it is important to first scrutinize the lessons learned in other countries who have embarked on legislative approaches.

If any legislative approach is to have a chance of success it must be based on cross-disciplinary knowledge, including veterinary, legal and psychological/social-scientific expertise, as well as input from the breeding associations and organizations.

Conclusion and recommendations

Recommendations on research initiatives

A considerable amount of research into dog health is being conducted. It is, however, characterized by a focus on specific problems. Only to a limited extent does it offer a more general overview of the disease or health condition in our dog breeds.

We recommend one tool that would be very beneficial for future research in this area:

- 1) Establish a health registry recording diagnoses made by veterinarians (both for pedigree and non-pedigree dogs).

Data collected in this registry would provide a solid basis for epidemiological research. The studies issuing from this research could deliver an overview of disease and health in our dog breeds and allow breeding programs and other health-improving initiatives to be evaluated.

Recommendations regarding the organized breeding

The breeding of certain dog breeds has without doubt had some seriously negative impacts on the dogs' health and welfare.

We recommend three specific tools that would move dog breeding in a healthier direction:

- 1) More consistent enforcement of the health-oriented guidelines that have already been added to the breed standards.
- 2) Changes to the standards of those breeds burdened with exaggerated conformations.
- 3) The opening of the studbooks for breeds with numerically small populations and breeds with several breed-related health problems.

In relation to 2), we would like to stress that, since FCI is an independent international organization, and that the owner country of each dog breed proposes the breed standards to FCI, it is difficult to influence this process unless it is addressed at EU level. In relation to 3), we note that only the respective owner countries can open the studbooks.

Recommendations on initiatives to inform and influence dog buyers

The initiatives taken by animal welfare organizations and veterinarians do not seem to have had any noticeable effect on the way people act and think when buying a dog. We therefore recommend that more complex instruments based on social marketing are used to steer the way dog buyers act when choosing a dog.

Recommendations on legislative initiatives

The legislative initiatives in the Netherlands and Germany show that it is difficult to devise and accurately formulate relevant legislative criteria, and equally difficult to administer and enforce those criteria. We recommend that:

- 1) As has happened in other countries, general legislative instruments are developed in Denmark in an effort to ensure healthy dog breeding.

- 2) The effect of the legislative initiatives in the Netherlands and Germany are monitored closely.

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Appendix

Links to various breeding resources (WSAVA hereditary disease committee)

SOURCE	Weblink
AKC responsible breeding guidelines	http://images.akc.org/pdf/breeders/resources/guide_to_breeding_your_dog.pdf
AKC guidelines on RPO	https://www.akc.org/expert-advice/lifestyle/responsible-dog-owner/
Functional dog collaborative	https://functionalbreeding.org/
ASPCA responsible breeding guidelines	https://www.asPCA.org/about-us/asPCA-policy-and-position-statements/position-statement-criteria-responsible-breeding#:~:text=Responsible%20breeders%20care%20about%20the,that%20the%20surgery%20is%20done
Wikipedia guidelines	https://www.wikihow.com/Create-a-Responsible-Dog-Breeding-Program
Good Dog standard	https://www.gooddog.com/standards-and-screening
European breeding guidelines	https://food.ec.europa.eu/system/files/2020-11/aw_platform_plat-conc_guide_dog-breeding.pdf
Australian breeding guidelines	https://www.dogsNSW.org.au/breeders/responsible-breeding/
Russian guidelines	http://rkf.org.ru/russian-cynological-federation/
European cat breeding guidelines	https://food.ec.europa.eu/system/files/2020-11/aw_platform_plat-conc_guide_cat-breeding.pdf
Swedish guidelines 1	https://www.slu.se/en/faculties/vh/research/forskningsprojekt/hund/hgen-international-breeding-program-to-improve-health-in-pedigree-dogs/
Swedish guidelines 2	https://dogwellnet.com/content/health-and-breeding/breeding/general-guidelines/cynological-organizations-more-on-ethics-and-breeding/breeding-dogs-in-sweden-skks-tools-and-efforts-to-improve-canine-health-r301/
European/UK resources	http://puppycontract.org.uk/
Dog welfare code (UK)	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/697953/pb13333-cop-dogs-091204.pdf
European/UK resources	https://www.thekennelclub.org.uk/dog-breeding/the-kennel-club-assured-breeders/
Guidance notes for conditions for breeding dogs (UK)	https://www.plymouth.gov.uk/sites/default/files/Guidance%20Notes%20for%20Breeding%20Dogs%202018.pdf
European responsible dog breeding guidelines	https://food.ec.europa.eu/system/files/2020-11/aw_platform_plat-conc_guide_dog-breeding.pdf

AVMA responsible breeding	https://www.avma.org/javma-news/2017-03-01/avma-passes-policy-responsible-pet-breeding
BVA	https://www.bva.co.uk/take-action/our-policies/extreme-conformation/
FVE	https://fve.org/publications/breeding-for-extreme-conformations-what-is-the-problem/
Canadian	https://www.canadianveterinarians.net/policy-and-outreach/priority-areas/extreme-conformations/
FCI guidelines	https://www.fci.be/en/Breeding-42.html