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Welfare concerns associated with pedigree dog breeding in the UK

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Abstract

In the UK, numerous pedigree dogs of many breeds experience compromised welfare due to the direct and indirect effects of selective breeding. Many breeds are selected to have physical conformations which, although perceived by some to be desirable, have direct negative effects upon their welfare. Dogs are regularly bred whose heads are too large and pelvises too small to birth naturally or whose faces are so flat that they are unable to breathe or exercise normally. There are also many indirect effects of selective breeding for appearance, including significantly elevated prevalence of specific diseases within particular breeds. Current breeding practices can therefore result in unnecessary suffering due to pain, disability, disease and behavioural problems. In this paper, we summarise and review the current scientific evidence for such suffering, and difficulties associated with assessing the impact of current breeding practices. Limited record-keeping, lack of transparency in the breeding and showing world, and the absence of sufficient research, mean that the full extent of the problem is difficult to assess. Furthermore, the collection of data is currently unsystematic, and although there are specific case studies of individual breeds and particular disorders, relatively few have been conducted in the UK. Individual breeds each suffer from their own array of problems, so each breed's survival and improvement (in terms of health and welfare) is likely to require a different specific course of action. With 209 breeds currently registered in the UK, this makes the situation complex. We collate and present a range of suggestions which may help to improve pedigree dog welfare significantly, and prioritise these based on expert opinion.

Keywords: *animal welfare, dog breeds, domestic dogs, exaggerated features, inbreeding, recommendations*

Background information

Many pedigree dogs in the UK and elsewhere remain healthy for much of their lives. However, numerous individuals of many breeds experience compromised welfare due to the direct and indirect effects of selective breeding (McGreevy & Nicholas 1999; Companion Animal Welfare Council 2006; Arman 2007).

Dogs of many breeds have significantly lower life expectancy than cross-breed dogs (eg Patronek *et al* 1997; Egenvall *et al* 2000). All objective studies which have compared average age at death have found that cross-breeds and, in particular, small cross-breeds (Patronek *et al* 1997), live longer than individuals of most of the pure-breeds. This is due in part to the inverse correlation between body size and life expectancy seen across all dogs, and of course, reduced longevity is not synonymous with reduced quality of life. However, there is also considerable evidence that cross-breed dogs have lower veterinary bills (data from Churchill Insurance company cited in *K9 Magazine* 2007) which suggests that they are ill less often and less likely to suffer compromised welfare as a consequence. There is an expectation that genetically isolated pure breeds will naturally show less vigour than out-bred dogs (associated with the phenomenon of heterosis in out-bred animals), but in many breeds, current selective breeding practices may have exaggerated this effect.

Most breeds of dog were originally selected for the performance of particular utilitarian functions, and humans chose breeding animals which were best suited for the various roles required of them (Miklósi 2007). Today, pedigree dogs appearing in conventional breed shows are required to conform to written breed standards, which in the UK are owned by the Kennel Club and derived in consultation with several hundred breed societies (The Kennel Club 1998). Although the vast majority of pedigree dogs never appear in a show, many are bred by breeders who aspire to produce show-quality animals and whose surplus dogs are sold as pets (Willis 1995). Therefore, trends in the show-dog breeding community have major implications for the domestic dog population at large, and decisions made by a minority of breeders have considerable repercussions for pets and the pet-owning public.

Over the past 130 years, specific physical attributes have been selected for preferentially in many breeds, largely for

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cosmetic reasons, and without sufficient attention to health, temperament, welfare and functionality (McGreevy & Nicholas 1999). This has resulted in two distinct but inter-related welfare issues: (i) exaggerated anatomical features — morphological and phenotypic extremes that result directly in reduced quality of life and (ii) increased prevalence of particular inherited disorders as a result of lack of genetic diversity, inbreeding, line breeding, ill-informed breeding choices, and selection of dogs that pays too much attention to external appearance.

We believe it is important to distinguish between these two issues since the first is a direct effect, and the second an indirect effect of specific breeding practices, and their remedy requires different approaches. When planning how best to improve health and welfare in a breed it is essential that both of these issues are taken into consideration.

In this paper, we begin by briefly describing each of these effects and the current challenges associated with their quantification, before going on to suggest plausible routes forward which we have prioritised using a focus panel. These suggestions are particularly timely given the recent media interest in pedigree dog welfare (BBC 2008), sparking wide public interest and the ongoing independent reviews being carried out, at the time of writing, by the Associate Parliamentary Group for Animal Welfare and The Dogs Trust/The Kennel Club.

Exaggerated anatomical features that reduce quality of life

Although there are few peer-reviewed papers documenting evidence that exaggerated anatomical features do reduce the quality of life, the veterinary literature describes a whole suite of palliative and surgical procedures developed explicitly to counteract such effects, which is in itself evidence that the problems are of significant welfare concern (Rooney & Sargan 2009). Examples include: large breeds suffering from problems associated with the overly rapid growth of bones and osteochondrosis, caused by the death of bone tissue growing too rapidly for its blood supply to keep up (Smith & Stowater 1975; Ekman & Carlson 1998); long-backed breeds suffering problems of vertebral degeneration (Breit & Kunzel 2004) and giant breeds with deep chest cavities being prone to gastric problems (Monnet 2003). Skeletal problems are associated with short limbs in the dwarf breeds (Demko & McLaughlin 2005) whilst incomplete formation of the cartilage rings can lead to collapse of the trachea in toy breeds (Johnson 2000; Fossum 2002). In brachycephalic breeds the skull has been selected to be shortened from front to back, which can restrict the flow of air through the nose; combined with a comparatively elongated soft palate (Monnet 2004), this can create breathing difficulties and render the dog unable to lead an active life without respiratory distress. New quantitative analysis suggests the brachycephalic and giant breeds suffer significantly increased mortality relative to other breeds, and giant breeds also experience quantifiable morbidity for several years prior to death (Sargan & Rooney, in prep). There are many further examples of exaggerated features including neotenous skull shape, long ears, excessive skin folds, screw tails and cosmetic hair ridges which can be accompanied by neural defects (Salmon Hillbertz *et al* 2007), as well as features which restrict the animals' ability to behave, signal and interact normally (Rooney 2009).

Increased prevalence of inherited disorders

The indirect effects of selective breeding for appearance include very significantly reduced genetic diversity unevenly spread across the genome (Jones *et al* 2008), resulting in elevated prevalence of specific diseases within particular breeds. Coupled with ill-conceived breeding practices (whereby breeders inadvertently select regions of the genome which contain a disorder as well as the trait they actually desire) and insufficient selection pressure on health and welfare, this has led to certain breeds becoming especially susceptible to a whole suite of disorders, many of which are acutely painful or chronically debilitating.

There are numerous examples of genetic disorders which have been thoroughly studied and shown to be over-represented in certain breeds, and for many of these the genetic basis of inheritance is known. For example, some diverse examples of rigorous studies include:

• Cardiac problems are common in Cavalier King Charles spaniels highlighted in a recent Kennel Club survey (The Kennel Club 2006) to be the commonest disease condition reported in the breed (25% of all conditions or a prevalence of 17%);

• A recessive eye disease called Collie Eye Anomaly which when severe can cause blindness, affected some 13.7% of the whole Lancashire Heeler breed (Bedford 1998), suggesting that 60% of the breed carried one or more copies of the mutation;

• Diabetes is very common in certain breeds and occurrence is elevated by three- to more than ten-fold in Australian, Cairn and Tibetan terriers, Samoyeds, Swedish Elkhounds, and Swedish Lapphunds (Kennedy *et al* 2006; Fall *et al* 2007);

• The prevalence of breed-specific glaucoma in North America was 5.52% in American Cocker spaniels and 5.44% in Bassett hounds. This is considerably higher than the prevalence of 0.89% in the general dog population (Gelatt & MacKay 2004) and;

• The relative risk of inheriting a specific heart problem (canine congenital sub-aortic stenosis which often leads to fatal heart attack), was found to be 88 times higher in the Newfoundland than in the general dog population (Kienle *et al* 1994).

Since breeds are by definition genetically restricted populations, they will naturally show some variation in levels of specific disorders, but when the prevalence of disorders is very high, as in the cases above, there is cause for particular concern. Selective breeding has contributed to this situation. Most dog breeds originated from a relatively small number of founder animals. Individuals showing desirable conformations (defined by 'fanciers' and later laid down in breed standards) were mated together within this small group to accentuate traits perceived to be desirable. A dog can only

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be registered with the UK Kennel Club if the sire and dam are registered in that breed's studbooks. Hence, dog breeds each represent a closed gene pool and the Kennel Club, breed societies, and the pedigree dog-showing community have, in effect, formally endorsed the inbreeding of dogs.

The link between inbreeding and increased disease risks in purebred dogs is well established (Brooks & Sargan 2001). In most (if not all) dog breeds, genetic diversity is low. There is, consequently, an increased chance of inherited disorders being manifest in offspring (Cruz *et al* 2008), and it is difficult to eliminate problems without crossing with individuals of other breeds (out-breeding) which is currently not permitted. Today, the problems continue. Recent research has shown that genetic diversity continues to be lost with each generation (Calboli *et al* 2008). Many breeders now understand the need to avoid inbreeding of very close relatives, but often do not look far enough up the pedigree for common ancestry. Unfortunately, some breeders still do inbreed as they strive for specific anatomical features as laid down in the breed standards. In addition, 'line breeding' (aimed at accentuating features expressed in that family) means that breeding partners are often selected from a sub-population of the entire breed. Furthermore, the over-use of very popular champion sires means that any deleterious alleles which they carry, can very rapidly become widely distributed in the breed. These practices exacerbate the problem of elevated disease incidence within specific breeds.

Difficulties in assessing the full extent of the problems

Collection of disease prevalence data is currently unsystematic, and relatively few specific case studies of individual breeds or particular disorders have been conducted in the UK. As has been highlighted previously (McGreevy 2007), the absence of systems for routine collection of morbidity and mortality data mean that true prevalence of genetic disorders are very difficult or impossible to ascertain or monitor. Although numerous, current studies are *ad hoc* and the methods of reporting disease frequency are inconsistent; some report prevalence (which is affected by disease duration), others incidence, some rely on insurance databases which are biased towards young and pedigree dogs and some use referral service data which may not be representative. Such factors can make it impossible to conclude which breeds are most affected by a given condition, which condition is the biggest problem in a given breed, or to establish with certainty whether a specific breed is unaffected.

It has been estimated that, on average, each breed has been reported to show an elevated prevalence for between four and eight disorders (Brooks & Sargan 2001), although some authors quote much higher figures, with Labrador Retrievers being listed as prone to 95 different disorders (Gough & Thomas 2004). There tend to be fewer reports of inherited diseases in breeds that are rare and/or poorly studied. In fact, there is a significant correlation between the number of Kennel Club registrations in 2007 and the number of entries for the breed in the IDID Database (Inherited Diseases in Dogs [IDID] Sargan 2004; Spearman's Rank correlation; $Rho = 0.716$, $P < 0.001$), strongly suggesting that current knowledge of genetic diseases in dog breeds is a function of the level of veterinary surveillance, and that lower figures are often underestimates.

In assessing and prioritising problems, it is important to consider the likely welfare impact of particular deleterious effects on individual animals. For instance, is a condition such as deafness more or less important to the well-being of a dog than loss of colour and day vision? Should a condition which involves a lifetime of morbidity but which may be relatively mild, or an anatomical feature which restricts behaviour to such a degree that a dog cannot run or play, be considered as more, or less, severe than an episodic, but severe disease such as epilepsy? Or, to take what would often be considered a more severe pairing, should an inherited complete blindness with early onset be considered more or less severe than a killing disease that has its entire impact later in life, such as a predisposition to late onset cancer? Currently, we do not have the objective data on which to base these judgements, which means it is difficult to advise prospective owners on the most 'healthy breed' . Therefore, we must rely on educated subjective estimates of the relative risk of the disorder, its likely duration and the extent to which it will compromise quality of life. Care must be taken to avoid anthropomorphism. For example, the sense of smell is considered to be at least as important to canine welfare as hearing (Bradshaw & Casey 2005) and, yet, as far as we are aware, no studies have been carried out that look for loss of sense of smell in relation to inherited disease in dogs, probably because it is a much less important sense for most humans. Disorders that restrict a dog's ability to behave normally should also be considered since lack of opportunity to engage in species-specific behaviour is also likely to impact significantly on quality of life.

The need for progress

The UK Kennel Club has recently emphasised the presence and danger of breeding for extreme morphology. They have a Health and Welfare Strategy Group (The Kennel Club 2009a), and numerous new (and welcome) initiatives intended to combat the problem. However, there are many breeds whose current anatomies raise serious welfare concerns, and a strong case can be made that as long as physical attributes continue to dominate the breed standards, with less emphasis on health, welfare and temperament, this is likely to continue. Therefore, the situation needs to be addressed as a matter of urgency.

The Kennel Club and many veterinary scientists have been aware of heritable disease problems and, as a result, have tried to develop programmes to assist breeders in identifying dogs at risk, and to reduce the incidence of inherited diseases. Clinically based surveillance schemes for joint and eye health have more recently been supplemented with DNA-based testing for particular mutant genes. The absence of transparent statistics make the success of the former difficult to assess (Rooney & Sargan 2009), whilst the latter remain too slow and costly to be of immediate universal benefit.

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However, in spite of these significant efforts, the problems associated with pedigree dog breeding remain serious. They affect large numbers of animals, estimates suggest there are four to six million purebred dogs in the UK (PFMA 2008), and the UK Kennel Club alone registers over 271,000 dogs per year (The Kennel Club 2009a). The effects perpetuate from generation-to-generation, and may be of long duration, potentially for a large proportion, or even the entirety, of an animal's life (CAWC 2006). Importantly, dogs of many breeds are born with a high likelihood that they will be denied at least one, and possibly more than one, of the five freedoms (FAWC 1992). Exaggerated anatomies mean that dogs may suffer discomfort and be prevented from behaving normally without likely injury, whilst having a high likelihood of developing a disease can lead to pain, fear and distress. Therefore, to safeguard the future of pedigree dogs, changes in breeding and selection practices are urgently required, and for some breeds more drastic measures will be needed.

How do we best optimise improvement in pedigree dog welfare in the future?

The situation is complex, with many interested parties, and numerous plausible courses of action. Simply abandoning pedigree breeding is neither a likely course in current society, nor necessarily a desirable one, since diverse breeds show a wide range of traits which are valuable to both companion and working dog roles (eg Rooney & Bradshaw 2004). Each breed has its own array of problems and so there is no single solution, hence, over the years, a wide range of possible measures have been suggested (eg McGreevy 1999; CAWC 2006). However, opinions vary, and authors with different areas of expertise or belonging to different stakeholder groups are likely to prioritise the value of specific actions differently. The approach we decided to take was, through examination of research findings and reports and discussions with prominent experts in the field, to compile a list of 36 actions (Table 1) which have been posed as possible routes forward. In December 2008, we presented these suggestions, via an email survey, to twenty prominent experts drawn from four disciplines: four dog welfare experts; five university-based veterinary experts; five geneticists and six practising veterinarians. The individuals were selected to cover a range of disciplines all integral to pedigree dog welfare with the aim of balancing attention to particular concerns. All had current knowledge and interest in the problems surrounding pedigree dog breeding.

This group was assembled opportunistically and cannot be viewed as fully representative of all potential stakeholders, but by polling the opinions of people from different disciplines a wider range of views was obtained than the authors' subjective opinions alone. Each respondent was asked to consider the 36 potential actions in turn, and state whether they supported, conditionally supported, or disagreed with each (or whether they had no opinion). They were then asked to rate each suggestion on a scale of 1–10 for its relative value to the pursuit of improving pedigree dog welfare. They were given the opportunity to comment on, and attach conditions to, each action. Finally, the respondents ranked the five actions that they viewed to be most crucial to improving pedigree dog welfare. The results are shown in Table 1 and based upon their average value ratings, and the proportion of respondents supporting, we prioritised our recommendations.

Many of the 36 suggested actions were widely considered useful; 32 were supported by at least 80% of respondents although, for some, specific conditions were raised by the respondents (see Rooney & Sargan 2009). We therefore categorised as priority recommendations the four actions which were supported by all or all but one respondent; rated on average greater than 7.5 (out of 10) for value; and listed by three or more respondents in their top five. We categorised as primary recommendations the remaining actions supported by at least 85% of respondents and rated an average of 7 (out of 10) or more for value. We summarise these fourteen recommendations below; however, many of the remaining 22 actions (Table 1) were strongly supported and may also be potentially valuable.

Recommendations

Many of the highly supported recommendations of the panel were in accordance with the suggestions of McGreevy (2007). The action rated most highly for improving welfare was 'Systematic collection of morbidity and mortality data from all registered dogs'. This action would provide reliable, representative data on the prevalence of different disorders in each breed in the domestic dog population, and when combined with 'Setting up systems to monitor the effectiveness of any interventions and changes in breeding strategies', would enable progress to be quantified and reviewed. The RSPCA is currently working with the University of Sydney and the Royal Veterinary College on a research project to create a new electronic system for collecting, analysing and reporting data on inherited disorders in both dogs and cats, which is hoped will ultimately receive universal uptake.

However, given the severity of current welfare problems, quantification is not enough; remedial action is also required. Hence, the other two priority actions were both aimed at increasing genetic diversity. The panel thought it important to conduct a 'Revision of registration rules to prevent the registration of the offspring of any mating between first-degree and second-degree relatives'. Subsequent to the survey's completion, the UK Kennel Club has banned first-degree matings (The Kennel Club 2009b); however, the survey respondents also supported the banning of second-degree matings. These are more than twice as common as first-degree relative matings in recent pedigrees (Sargan & Rooney, in prep) and so result in loss of genetic material at a greater rate. Hence, banning these matings should also be considered.

For many breeds, this must also be accompanied by other efforts to increase genetic diversity, such as to 'Opening stud books to allow more frequent introduction of new genetic material into established breeds' and 'Encouraging importation and inter-country matings'. Such actions

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Table 1 Mean importance ratings, and percentage of respondents supporting, and ranking in the top five actions, listed in order of value rating.

Potential action	Mean value rating	% of respondents of those expressing an opinion who supported the action	% of the supporters who detailed conditions	Number of respondents ranking action within the most important five
Systematic collection of morbidity and mortality date from all registered dogs†	8.72	100	38.9	8
Revision of registration rules to prevent the registration of offspring of matings between 1st degree & 2nd degree relatives†	8.33	94.7	0	5
Open studbooks to allow more frequent introduction of new genetic material into established breeds†	8.33	94.7	5.9	3
Conducting a full ethical review of current breeds‡	7.88	85.0	31.3	4
Setting up systems to monitor the effectiveness of any interventions and changes†	7.55	95.0	16.7	3
Development of detailed management plans for each breed‡	7.55	90.0	41.2	4
Refinement of diagnostic tests and DNA markers for inherited disorders‡	7.37	93.8	13.3	2
Increase genetic diversity by encouraging importation and inter-country matings‡	7.29	94.7	5.9	0
Exploration of methods by which to penalise unethical breeding	7.20	75.0	46.7	3
Make registration of pedigree dogs conditional upon both parents undergoing compulsory screening tests‡	7.17	94.4	25.0	4
Development and support for shows that are judged on temperament, health and welfare	7.1	80.0	31.3	0
Introduction of codes of practice that encourage breeders to consider health, temperament and welfare‡	7.06	94.1	25	4
Training and accreditation of judges to prioritise health, welfare and behaviour in the show ring‡	7.06	90.0	38.9	4
Creating and fostering the image of a happy and desirable dog being one that experiences high welfare‡	7.00	89.4	0	4
Formulation of an independent panel of experts from multiple disciplines‡	7.00	95.0	38.9	5
Development of schemes for calculating Estimated Breeding Values‡	7.00	86.7	15.4	1
Introduction of dog breeder warranties or contracts which commit breeders to paying compensation for avoidable inherited disorders	6.94	89.5	31.3	1
Placement of restrictions of the number of caesareans permitted per bitch	6.93	88.2	40	1
Provision of expert and accurate information to the public and potential buyers	6.89	100	31.6	
Review all and when appropriate, revise breed standards to prioritise health and welfare	6.89	100	41.2	
Conducting pedigree analyses on all UK breeds	6.88	94.1	5.9	2
Revision of registration rules limiting the number of offspring any one male can sire	6.82	77.8	0	2
Development of methods for enhanced communication between geneticists and breeders	6.82	94.7	23.5	1
Development of secondary legislation to control dog breeding	6.47	88.2	13.3	2
Encouragement for breeders to make responsible breeding choices	6.40	83.3	20	2
Production of neutered F1 hybrids	6.36	55.6	60	1
Set a minimum number for founder stock for new breeds	6.33	82.3	14.3	1
Development of methods to objectively measure quality of life	6.28	94.7	5.9	3
Campaign for revision and then sign and ratify the European Convention for the Protection of Pet Animals	6.00	87.5	21.4	0
Encouragement of future owners to fully research breeds	5.94	89.5	43.8	0
Measurement of real current homozygosity levels in breeds	5.93	100	13.3	1
Seek consistency and tranparency in test reporting, eg hip scores	5.88	94.4	17.6	0
Prioritisation of animal welfare over financial gain by veterinians	5.86	77.8	14.3	1
Development of an accreditation scheme for breeders, breed societies and veterinarians	5.67	94.7	47.1	1
Production of a safe, honest feedback mechanism to help empower potential pedigree dog buyers and breeders	5.24	78.9	53.3	0
Utilisation of temperament assessments to select dogs which are best suited to the environment in which they live	4.36	68.4	30.8	1

† Priority recommendations; ‡ Primary recommendations.
Non-integers are a result of incomplete sample sizes for specific questions which respondents omitted to answer.

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challenge traditional pedigree dog breeding conventions, but there are several examples of their success. In light of the ban on tail docking, a UK trial successfully produced a 'Bob-tailed Boxer' by crossing a Boxer to a Welsh Corgi, and then backcrossing to Boxer. A fourth-generation animal (3rd back-cross) was registered with the Kennel Club and won prizes (Cattanach 1996). Ironically, this introduction of non-pedigree genetic material into the line was permitted for purely aesthetic reasons, but it does demonstrate the potential value of out-crossing. Similar success has been obtained with a trial to overcome elevated uric acid levels in Dalmatians. It appears that selection for the spotting pattern of the coat inadvertently resulted in selection for a linked gene that results in high uric acid levels and may cause urinary stone and dermatological problems (Dalmatian Club of America 2007). These problems are thought to potentially affect all extant purebred Dalmatians, and cannot therefore be solved by selection within the breed. A trial, in which a Dalmatian was out-crossed to a Pointer, followed by selection against the defect during back-crossing to Dalmatians, was successful in eliminating the disorder, but only by the fifth generation of back-crosses were a small number of the dogs considered pure enough to be registered by the breed society. Such reluctance by breed societies provides a financial disincentive for breeders to out-cross, and this needs to be addressed.

The panel acknowledged that it is critical to have dedicated input from geneticists, and rated highly the recommendation of 'Refinement of diagnostic tests and DNA markers for inherited disorders'. DNA-based technologies have been developed for over 50 inherited disorders in dogs (Sargan 2004). These hold great potential for combating disorders (particularly genetically simple ones), and there are great success stories. For example, copper toxicosis had reached very high prevalence of 46% in the Dutch Bedlington population in the late 1970s and early 1980s. This figure has been dramatically reduced by careful breeding strategy and, later, facilitated by DNA screening, so that cases are now rare. However, although there are tests advised for many disorders, as yet in the UK, registration of animals has been made dependent on DNA tests in only two breeds (Irish Red Setters and Irish Red and White Setters) and for only one disease (Canine Leucocyte Adhesion Deficiency [CLAD]; The Kennel Club 2009a). Given the large number of breeds and the multiplicity of recognised breed predispositions, this is unsatisfactory. Therefore, the survey respondents recommended that, in the future, 'Registration of pedigree dogs should be conditional upon both parents undergoing compulsory screening tests for disorders prioritised from those known to be a problem in that breed'. In such prioritisation, account should be taken of the method of inheritance of each disorder, its relative prevalence, and its impact on welfare. It is important to realise that when many tests are available, breeders and breed societies will need to devise breeding strategies carefully in order to avoid further diminution of gene pools. A phased introduction of the tests listed may therefore need to be planned with input from independent veterinary and genetic experts.

A further primary recommendation was the 'Development of schemes for calculating Estimated Breeding Values (EBVs)' for multifactorial disorders. The EBV of an animal for any trait predicts the average performance of its progeny for that trait and initially would utilise phenotypic, heritability and pedigree data, and in the future, it is likely that DNA marker data could also be utilised. However, survey respondents raised the issue that development of these technologies is neither cheap nor rapid. Developing a single DNA test can cost in excess of one hundred thousand pounds and so whilst there is great potential value in the development of additional genetic markers, they cannot be viewed as the sole nor immediate solution. Hence, the panel agreed as vitally important, and rated as even higher than genetics input, the need to co-ordinate efforts of experts from multiple disciplines.

The fifth most valued action is to 'Conduct a full ethical review of current breeds'. For this, input from animal welfare science is vital. In the long term, decisions should be based on quantifying impact on quality of life and combining this with real data on the relative likelihood of each disorder developing. Although, currently, there are scarce objective data on which to base these judgements, a systematic approach is still needed. This should take each breed and each disorder in turn, considering both direct and indirect effects. It should make educated estimates of the relative risk of the disorder, its likely duration and the extent to which it will compromise quality of life. The cut-off point of what level is acceptable relies on ethical debate and indeed this could potentially arrive at conclusions to enforce rapid out-crossing in some breeds or even to phase out specific breeds that an expert panel considers cannot be saved without unacceptable suffering.

The sixth recommendation, consequential on the fifth, is the 'Development of detailed management plans for each breed to improve health and welfare', which must be constructed in conjunction with geneticists and epidemiologists, as well as breeders. Individual breed clubs and societies have an important role to play improving their own breed. However, in the UK, these number over 700, and it may be argued that there would be advantages in their working together rather than operating autonomously and the survey panel repeatedly stressed that there would be benefits of external input.

Survey respondents varied in their opinions as to whether external control or new legislation is necessary. More preferred the idea of 'Introduction of Codes of Practice that encourage breeders to consider health, temperament and welfare', like those recently developed, under the Animal Welfare Act (2006) for pet dogs and cats and for boarding establishments. They also supported the idea of the 'Formulation of an independent panel of experts from multiple disciplines' which could not only facilitate dialogue but meet at regular intervals to assess, monitor and direct future progress.

The 'Training and accreditation of judges to prioritise health, welfare and behaviour in the show ring' was also highly supported. Current Kennel Club initiatives are

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aiming to do this, as well as modifying breed standards (The Kennel Club 2009a). However, the problems are widespread, and the majority of breeds are affected to some degree. To tackle all these is likely to require more than simply modifying appearance-driven breed standards. Changes must be directed specifically at ensuring that judges understand and concentrate on breed health and welfare even, when necessary, to the exclusion of distinctive 'cosmetic' features of the breed.

The final primary recommendation was 'Creating and fostering the image of a happy dog being one that experiences high welfare'. Approximately 37% of dog owners base their selection choice predominantly on the breed's physical appearance (Taylor Nelson Sorfes, unpublished data). We suggest that this needs to be addressed. A catchy, appealing 'brand' could challenge cultural norms, as has happened in the successful 'happy chicken' campaign (eg reported in Channel Four 2009). This would encourage the general public to choose dogs on the basis of their quality of life and not just appearance, and to consider a range of breeds as well as cross breeds.

Conclusion

To improve the health and welfare of pedigree dogs, we have suggested actions aimed at tackling the tendency to exaggerate cosmetic traits and at reducing inbreeding that has become harmful to genetic diversity. These actions were evaluated by a panel of experts with a variety of expertise, but all sharing long-term professional experience of the effects of canine inherited disease on health and welfare. In spite of the wide range of opinions expressed by the survey respondents, there were many actions that were universally valued and this was a valuable way to prioritise recommendations. Our focus panel was relatively small and composed primarily of academics and veterinarians and it would now be very interesting to carry out a similar exercise with a more diverse array of stakeholder groups, for example including dog breeders.

Many of these recommendations are starting to be implemented by the Kennel Club and individual breed societies. The UK Kennel Club is in a unique position to be able to drive positive change. However, there are very many other interested parties which also have roles to play and a co-ordinated approach is required. In recent years and, in particular, since the publication of the dog genome by Lindblad-Toh *et al* (2005), there has been increasing collaboration among those in the fields of dog breeding, genetics and disease. We suggest that welfare charities, veterinary associations, dog breeders and all other stakeholders must continue to unite in using the latest advances in genetics and epidemiology to find a new model of dog-breeding practice. This should focus on both the direct effects of morphological extremes and also the indirect effects of inherited disease loads, and consider all breeds. It should seek to overcome current problems as well as ensuring that no further problems develop.

In the long-term, society should aim to only breed dogs whose anatomy, temperament and genetic predisposition for disease or disorder, make them likely to produce offspring which will experience a high quality of life, free from pain and suffering, and initiatives should be directed towards achieving this aim. Change will come about most quickly through a concerted approach, in which the actions support one another. The most important element, however, is to ensure that all stakeholder groups engage in the process and fully support the action(s) they need to take. This is the challenge that lies ahead.

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