Inconsistent identification of pit bull-type dogs by shelter staff

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ABSTRACT

Shelter staff and veterinarians routinely make subjective dog breed identification based on appearance, but their accuracy regarding pit bull-type breeds is unknown. The purpose of this study was to measure agreement among shelter staff in assigning pit bull-type breed designations to shelter dogs and to compare breed assignments with DNA breed signatures. In this prospective cross-sectional study, four staff members at each of four different shelters recorded their suspected breed(s) for 30 dogs; there was a total of 16 breed assessors and 120 dogs. The terms American pit bull terrier, American Staffordshire terrier, Staffordshire bull terrier, pit bull, and their mixes were included in the study definition of 'pit bull-type breeds.'

Using visual identification only, the median inter-observer agreements and kappa values in pairwise comparisons of each of the staff breed assignments for pit bull-type breed vs. not pit bull-type breed ranged from 76% to 83% and from 0.44 to 0.52 (moderate agreement), respectively. Whole blood was submitted to a commercial DNA testing laboratory for breed identification. Whereas DNA breed signatures identified only 25 dogs (21%) as pit bull-type, shelter staff collectively identified 62 (52%) dogs as pit bull-type. Agreement between visual and DNA-based breed assignments varied among individuals, with sensitivity for pit bull-type identification ranging from 33% to 75% and specificity ranging from 52% to 100%. The median kappa value for inter-observer agreement with DNA results at each shelter ranged from 0.1 to 0.48 (poor to moderate). Lack of consistency among shelter staff indicated that visual identification of pit bull-type dogs was unreliable.

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Introduction

As pet dog ownership in the United States passes 70 million, mixed breed dogs have nearly overtaken purebreds in the proportion of owned dogs (American Veterinary Medical Association, 2012). Even when purebred dogs are acquired, it is most commonly for companionship and not for the working roles for which they were historically developed. Despite the decreased focus on purpose-bred dogs, breed assignment continues to influence how dogs are viewed and managed (Simpson et al., 2012). This is true even when the actual breed of dog, if any, is unknown.

Guessed breed designations are often included in veterinary records, dog licenses, animal shelter records, pet adoption websites, lost-and-found notices, housing applications, and insurance policies (Voith et al., 2013). Visual breed assessments have been shown to be erroneous more frequently than not[1] (Voith et al., 2009, 2013). The past few decades have seen an increase in ownership restrictions applied to certain breeds of dogs and dogs that resemble them. The restrictions are based on the assumptions that certain breeds are inherently dangerous, that those breeds can be reliably identified, and that restricting these breeds would improve public safety.

When dogs bite people and other animals, the suspected breed of dog reported by witnesses is often listed in official bite reports filed by hospitals or animal control facilities.[1] Media coverage of dog

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[1] Croy, K.C., Levy, J.K., Olson, K.R., Crandall, M., Tucker, S.J., 2012. What kind of dog is that? Accuracy of dog breed assessment by canine stakeholders (Abstract). In: 5th Annual Maddie's Shelter Medicine Conference, Orlando, USA. http://sheltermedicine.vetmed.ufl.edu/education/research-studies/current-studies/dog-breeds/ (accessed 27 June 2015).

bite-related injuries has been shown to be more extensive and to report the suspected breed more frequently when witnesses report a pit bull or guard-line breed as involved.[2] The sources and reliability of this breed reporting have been questioned (Collier, 2006; Patronek and Slavinski, 2009; Voith et al., 2009, 2013; Patronek et al., 2010, 2013).

A study of all dog bite-related fatalities that occurred during the 10-year period 2000–2009 reported that 90% of the dogs involved were described in at least one media account with a single breed descriptor, potentially implying that the dog was purebred (Patronek et al., 2013). However, approximately 46% of the dogs in the US are mixed breed dogs (American Veterinary Medical Association, 2012), and it seemed unlikely to the authors that purebred dogs would be disproportionately represented among the dogs involved in these incidents. Further, in only 18% of the cases were the authors able to make a valid determination that the dog involved was a member of a distinct, recognized breed (Patronek et al., 2013). Nevertheless, unverified reports of the dog breeds involved in serious and fatal incidents have been used to develop opinions regarding perceived danger levels of different breeds[1] (Voith et al., 2009, 2013; Patronek et al., 2013).

These opinions have led to restrictions or outright bans on certain breeds by municipalities, insurance companies, homeowner associations, and animal shelters. It has been estimated that as of 2009, restrictions regarding ownership of dozens of breeds were in place in more than 300 jurisdictions in the US (Berkey, 2009). Most restrictions name 'pit bull' as a regulated 'breed,' but many also include Rottweilers, Doberman Pinschers, German shepherd dogs, and Chow Chows, among more than 30 others.

'Pit bull' is not a recognized breed, but a term applied to a heterogeneous group whose membership may include purebred dogs of various breeds, along with dogs presumed to be mixes of those breeds. Use of this descriptor varies according to the recognized breeds included and the opinions of the observers (Patronek et al., 2013). Nevertheless, dog owners, animal shelters, insurance companies, veterinarians, and the public frequently use the term 'pit bull' casually and in official documents, as though it describes a single, recognized breed. The lack of a universally accepted definition of 'pit bull' and reliance upon the opinion of observers complicate identification of dogs targeted for regulatory control by 'breed bans' (Hoffman et al., 2014). Most, but not all, breed-specific ordinances in the US include with the term 'pit bull' the American pit bull terrier, American Staffordshire terrier, and Staffordshire bull terrier, along with dogs that, based upon their appearance, are deemed to resemble these breeds.

Since actual pedigree information is not usually available, determining the likely breed of dogs that may fall under breed-based restrictions requires a subjective assessment of the dog's appearance. Recently, DNA analysis has been used to investigate the breed heritage of individual dogs targeted in breed restriction cases. However, the largest testing service does not offer a DNA test for identification of American pit bull terriers. Additionally, it does not provide a test for 'pit bulls', since the term variously refers to a loose collection of breeds and their mixes or to dogs with similar morphology rather than a group of dogs with a controlled gene pool.

Shelter staff members and veterinarians routinely make subjective breed assessments as part of daily shelter operations. They also may be tasked with providing expert opinions regarding the likely breed of individual dogs involved in breed regulation cases. Depending upon the regulatory environment and/or the beliefs of shelter managers, the stakes may be high for dogs identified as pit bulls and for their owners[3] (Voith et al., 2009).

The primary objective of this study was to determine the level of agreement among shelter workers in designating pit bull-type breeds for shelter dogs. A secondary objective was to compare shelter workers' breed assignments with DNA breed signatures.

Materials and methods

Study sites

Four Florida animal shelters were recruited. These shelters admitted 2520–10,154 dogs in the calendar year prior to the study. At each shelter, managers assigned three staff members and one shelter veterinarian whose regular duties included assignment of breed designations to newly admitted dogs to participate in the study as dog breed assessors. Each assessor completed a questionnaire regarding their shelter experience and previous training in dog breed identification. In addition to the veterinarians, assessor job titles included animal control officers, kennel staff, veterinary assistants/technicians, and customer service staff. The assessors might or might not have had previous knowledge of the dogs selected for the study.

Dogs

At each study site, 30 healthy dogs 2 months of age and older were selected by the research team to phenotypically represent a variety of age, body size, body types, coat length, and coat color. In the case of related dogs (dams and litters), only one dog from each family was selected. Only dogs that staff considered safe to handle were eligible for inclusion. The breed previously assigned to each dog at the time of shelter admission was recorded for comparison. The cage card for each dog was covered so that the breed previously assigned at intake was not visible to the dog breed assessors. The study protocol was approved by the Institutional Animal Care and Use Committee at the University of Florida on 7 March 2011.

Subjective breed assessment

At each shelter, the four dog breed assessors were given a list of the selected dogs and asked to assign a primary breed for each dog based on its physical appearance. Assessors could assign a secondary breed if they felt that it was indicated and could select 'mixed breed' if they felt there were no defining characteristics that allowed a specific breed identification. Assessors were allowed to list any breed and were not provided with a predetermined list of breeds to choose from. They were escorted as a group by a research team member to the front of each dog's kennel and did not move to the next dog until all assessors had recorded their breed designations. The assessors were not allowed to confer with anyone or to view any intake paperwork, cage cards, computer records, or references while the study was in progress.

For the purposes of this study, the terms American pit bull terrier, American Staffordshire terrier, Staffordshire bull terrier, pit bull, and their mixes were included in the study definition of 'pit bull-type breeds' because these terms are frequently included in laws regulating dog ownership based on breed or phenotype. For each dog, the breed assigned by the shelter prior to the study and the breeds assigned by each shelter staff member during the study were coded by the investigators as 'pit bull-type' if any of these breed terms were included as the primary or secondary breed identification. The breed identification was coded as 'not pit bull-type' if none of these breed terms was included.

Dog physical assessments

Following the shelter staff breed assessment, each dog was photographed, weighed, measured from the floor to the top of the shoulder, and assessed by the research veterinarian for body condition using three categories (underweight, ideal weight, overweight). Physical characteristics including coat length, coat type, coat color, ear type, tail type, age (juveniles ≤6 months, adults 6 months and older), sex, and reproductive status were recorded.

DNA assessment of dog breeds

Three milliliters of whole blood was collected from each dog into EDTA tubes for DNA analysis. Samples were shipped to a commercial DNA analysis laboratory (Wisdom Panel Professional Canine Genetic Analysis, Mars Veterinary)[3] at room temperature by overnight courier on the day of collection. DNA was extracted and typed

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[2] Delise, K., 2007. Pit bulls prohibited. In: The Pit Bull Placebo: The Media, Myths and Politics of Canine Aggression. Animals. Anubis Publishing, Denver, pp. 8–55. (Chapter 8) http://nationalcanineresearchcouncil.com/uploaded_files/publications/230603563_Pit%20Bull%20Placebo.pdf (accessed 27 June 2015).

[3] See: Mars Veterinary, 2014. Mars Wisdom Panel website. FAQs: I don't think my dog looks like the breeds detected in the Wisdom Panel analysis. Can you help me understand this? http://www.wisdompanel.com/why_test_your_dog/faqs/#35 (accessed 27 June 2015).

at 321 different single nucleotide polymorphisms (SNPs) across the genome using selective hybridization and PCR amplification, followed by a discriminatory single base-pair primer extension reaction. The SNP genotypes were detected by mass spectrometry. The laboratory then used a Bayesian generative model to infer the family tree of a dog from comparison of detected genotypes with 226 breed signatures developed previously from more than 9700 pure bred dogs. Inference was performed on 11 different family tree models, and the best-fit model was selected using the deviance information criterion (Martin et al., 2010).

Results from the DNA analysis laboratory included major breed composition percentages in increments of 12.5%. If breed compositions were identified in amounts <12.5%, these breeds were listed as 'minor breeds.' American pit bull terrier and pit bull were not included in the 226 breed signatures. Dogs were coded as 'pit bull-type' if the breed American Staffordshire terrier or Staffordshire bull terrier was identified to comprise at least 12.5% of the breed signature.

Statistical analysis

Agreement among shelter staff for identification of pit bull-type dogs and between shelter staff and DNA breed signatures was assessed with the kappa statistic according to the following criteria: $\kappa < 0.01$, poor agreement; 0.01–0.20, slight agreement; 0.21–0.40, fair agreement; 0.41–0.60, moderate agreement; 0.61–0.80, substantial agreement; 0.81–1.00, almost perfect agreement (Landis and Koch, 1977). Findings were considered to be significant when $P < 0.05$. The 95% confidence intervals (CI) for sensitivity and specificity estimates were calculated using the exact method. All analyses were performed with statistical software (Stata, StataCorp).

Results

Staff members and dogs selected for the study

A total of 16 shelter staff members, including four shelter veterinarians, participated in the study. All staff members had at least 3 years of shelter experience, but only one reported any formal training in dog breed identification (Table 1). The 120 dogs selected for the study comprised 20–25% of the dogs present in each of the four shelters on the day of the study visit and represented a range of ages, sexes, and phenotypes (Table 2). Juveniles included two puppies estimated to be 2 months of age, 12 estimated to be 3–4 months of age, and 12 estimated to be 5–6 months of age, based on dentition.

Inter-observer agreement for visual breed identification

Using visual identification only, the median inter-observer agreements and kappa values in pair-wise comparisons of each of the five staff breed assignments (one admission breed and four assessor breeds) for pit bull-type dog vs. not pit bull-type dog ranged from 76 to 83% and from 0.44 to 0.52, respectively (Table 3).

Table 1
Occupation and training of shelter staff members responsible for assigning breeds of dogs in four Florida animal shelters.

	n	%
Current job title		
Veterinarian	4	25
Veterinary technician	4	25
Animal control officer	2	13
Customer service	3	19
Animal care	3	19
Years of shelter experience		
<3	0	0
3–5	9	56
6–10	4	25
11–15	2	13
>15	1	6
Breed identification training[a]		
Formal training	1	6
Mentored on the job	14	88
Studied breed book	5	31
Other dog experience	12	75
No training	4	25

[a] Total responses >100% because respondents could select more than one item.

Table 2
Demographic features of 120 dogs selected for visual and DNA breed assignments in four Florida animal shelters.

Characteristic	*n*	%
Age		
Juveniles (≤6 months)	26	22
Adults (>6 months)	94	78
Sex		
Females	52	43
Males	68	57
Body weight (kg)		
<11	26	22
11–20	47	39
21–30	35	29
31–40	11	9
>40	1	1
Height (cm)		
≤20	1	1
21–30	13	11
31–40	17	14
41–50	48	40
51–60	34	28
>60	7	6
Body condition		
Underweight	8	7
Ideal weight	97	81
Overweight	15	12

DNA breed signatures

Using DNA identification, of the 120 dogs chosen for participation in this study, 25 (21%) were identified with pit bull-type heritage (comprising at least 12.5% American Staffordshire terrier or Staffordshire bull terrier) by DNA breed signatures. The breed signatures in these dogs belonged to American Staffordshire terrier in 19 dogs, Staffordshire bull terrier in four dogs, and both breeds in two dogs. According to the breed signatures, none of these 25 dogs were purebred or contained more than 50% contribution of either breed.

Agreement between visual and DNA-based breed assignments

The median inter-observer agreements and kappa values in pair-wise comparisons of each of the five staff breed assignments (one intake breed assignment and four breed assessor assignments) with the DNA breed signature for pit bull-type or not pit bull-type ranged from 67 to 78% and from 0.1 to 0.48, respectively (Table 3). Selected examples of breed identification by staff assessment and DNA analysis are provided (Table 4).

Of the 25 dogs identified as pit bull-type dogs by breed signature, 12 were identified by shelter staff as pit bull-type dogs at the time of admission to the shelter (prior to the study visit), including five labeled American Staffordshire terrier mix, four pit bull mix, two pit bull, and one American Staffordshire terrier. During the study, 20/25 dogs were identified by at least one of the four staff assessors as pit bull-type dogs, and five were not identified as pit bull-type dogs by any of the assessors. Overall, the mean sensitivity of visual identification of pit bull-type dogs was 50% (95% CI, 44–56%). The breeds assigned to these dogs by the four staff assessors included pit bull (67%), American pit bull terrier (8%), American Staffordshire terrier (25%), and their mixes.

Of the 95 dogs (79%) that lacked breed signatures for pit bull heritage breeds, six (6%) were identified by shelter staff as pit bull-type dogs at the time of shelter admission, and 36 (38%) were identified as pit bull-type dogs by at least one shelter staff assessor at the time of the study visit. Overall, the mean specificity of visual identification of non-pit bull-type dogs was 83% (95% CI, 78–89%).

Table 3
Inter-observer agreement for identification of pit bull-type dogs based on breed assignment by staff at the time of shelter admission, breed assignment made by four shelter staff assessors, and DNA breed signature.

	Median % agreement among staff members in visual identification of pit bull-type dogs (range)	Median κ (range)	Median % agreement between staff members and DNA breed signature for identification of pit bull-type dogs (range)	Median κ (range)
Shelter 1	80 (70–93)	0.44 (0.13–0.79)	77 (73–80)	0.38 (0.26–0.44)
Shelter 2	76 (59–90)	0.44 (0.19–0.61)	67 (53–77)	0.10 (0.07–0.22)
Shelter 3	83 (77–90)	0.52 (0.23–0.67)	75 (67–87)	0.24 (0.07–0.52)
Shelter 4	77 (70–93)	0.46 (0.23–0.82)	78 (77–87)	0.48 (0.38–0.60)

Table 4
Examples of staff member breed assessments and DNA breed signatures for several study dogs.

Dog	Photo	Intake breed	Staff 1	Staff 2	Staff 3	Veterinarian	Prominent DNA breeds (%)
Dog 7		Labrador retriever mix	American Staffordshire Labrador retriever	American Staffordshire Labrador retriever	American Staffordshire Labrador retriever	Pit bull Labrador retriever	Irish water spaniel (25) Siberian Husky (25) Boston terrier (25)
Dog 8		Boxer mix	Boxer Labrador retriever	American Staffordshire Chow Chow	Boxer Labrador retriever	American Staffordshire Greyhound	Boxer (25) Alaskan Malamute (25)
Dog 9		American Staffordshire mix	American Staffordshire	American Staffordshire mix	Pit bull	American pit bull terrier	American bulldog (50) American Staffordshire (50)
Dog 11		Australian cattle dog mix	Australian cattle dog Border collie	Catahoula Labrador retriever	Australian cattle dog Border collie	Australian cattle dog Border collie	Australian cattle dog (25) American Staffordshire (25)
Dog 59		Pit bull	Pit bull mix	Pit bull	American pit bull terrier mix	Pit bull mix	American bulldog (50) American Staffordshire (50)
Dog 62		Terrier mix	Jack Russell terrier Hound	Basenji Labrador retriever	Shar-Pei Rat terrier	Chihuahua mix	Chow Chow (25) American Staffordshire (25) Siberian Husky (25)

Accuracy in breed assignment as determined by sensitivity and specificity based on DNA breed signatures varied among individual staff assessors, with sensitivity for pit bull-type breed identification ranging from 33 to 75% and specificity ranging from 52 to 100% (Table 5). Veterinarians were not more likely than other shelter staff members to assign breeds that were consistent with the DNA breed signature.

Discussion

A key finding of this study was that agreement among different shelter staff members evaluating the breeds of the same shelter dogs at the same time was only moderate. Lack of consistency among shelter staff in breed assignment confirmed that visual identification of pit bull-type dogs was unreliable.

There is no standardized breed signature for the mixed breed dog known as the 'pit bull,' and the surrogate DNA breed signatures used in this study were for the American Staffordshire terrier and the Staffordshire bull terrier. One in five dogs genetically identified with pit bull heritage breeds were missed by all shelter staff at the time of the study. One in three dogs lacking DNA evidence for pit bull heritage breeds were labeled pit bull-type dogs by at least one shelter staff member.

These findings are consistent with previous reports of poor inter-observer agreement among individuals attempting to identify the predominant breeds of dogs. In a large Internet survey, a national sample of 5922 self-identified 'dog-experts,' including breeders, exhibitors, trainers, groomers, behaviorists, rescuers, shelter staff, veterinarians, and veterinary technicians, was recruited to complete an anonymous Internet survey in which they selected the most likely breed for dogs depicted in photographs.[1] One hundred dogs were included in the Internet survey, and each respondent was randomly shown photographs (front facial and lateral whole body) of 20 of these dogs. Based on the photographs and information about the height, weight, sex, and age of each dog, respondents selected from a drop-down menu of 181 breed options, including 'no predominate breed.' An average of 53 different breeds was selected for each dog, ranging from a low of 11 breeds selected for a purebred Beagle to a high of 84 different breeds for a single mixed-breed dog. In another study, 923 survey takers involved in dog-related professions and activities watched 1 minute color videos of 20 different dogs, and based on the images and information about age, weight, and sex, recorded one or two predominant breeds or 'mix' (Voith et al., 2013). Agreement among survey participants was poor, with at least half of respondents agreeing on the breed for only 7/20 dogs.

Our findings are also consistent with previous reports comparing visual breed identification with results of DNA breed profiles. In a study of 20 dogs adopted from 17 different agencies, the agency's breed designation matched DNA breed profiles in only four dogs (Voith et al., 2009). In the subsequent study using videos of the same dogs, visual breed identifications matched DNA results less than half of the time in 14/20 dogs in the study (Voith et al., 2013).

Table 5
Sensitivity for identification of 25 pit bull-type dogs and specificity for identification of 95 non-pit bull-type dogs as determined by DNA breed signature at the time of shelter admission and by four shelter staff members.

	Number identified by staff as pit bull-type	Sensitivity, % (95% CI)	Specificity, % (95% CI)
Shelter 1			
Admission breed	5	5/8, 63 (25–91)	22/22, 100 (85–100[a])
Assessor 1	8	4/8, 50 (16–84)	18/22, 82 (60–95)
Assessor 2	6	3/8, 38 (9–76)	19/22, 86 (65–97)
Assessor 3	6	4/8, 50 (16–84)	20/22, 91 (71–99)
Veterinarian	6	4/8, 50 (16–84)	20/22, 91 (71–99)
Shelter 2			
Admission breed	3	1/3, 33 (1–91)	25/27, 93 (76–99)
Assessor 1	6	1/3, 33 (1–91)	22/27, 81 (62–94)
Assessor 2	15	2/3, 67 (9–99)	14/27, 52 (32–71)
Assessor 3	13	2/3, 67 (9–99)	16/27, 59 (39–78)
Veterinarian	9	2/3, 67 (9–99)	20/27, 74 (54–89)
Shelter 3			
Admission breed	5	2/6, 33 (4–78)	21/24, 88 (68–97)
Assessor 1	4	3/6, 50 (12–88)	23/24, 96 (79–100[a])
Assessor 2	7	3/6, 50 (12–88)	20/24, 83 (63–95)
Assessor 3	6	2/6, 33 (4–78)	20/24, 83 (63–95)
Veterinarian	8	2/6, 33 (4–78)	18/24, 75 (53–90)
Shelter 4			
Admission breed	6	4/8, 50 (16–84)	20/22, 91 (71–99)
Assessor 1	4	4/8, 50 (16–84)	22/22, 100 (85–100[a])
Assessor 2	7	4/8, 50 (16–84)	19/22, 86 (65–97)
Assessor 3	8	5/8, 62.5 (24–91)	19/22, 86 (65–97)
Veterinarian	11	6/8, 75 (35–97)	17/22, 77 (55–92)

CI, 95% confidence interval by exact method.
[a] One-sided 97.5% confidence interval.

Dogs were selected for the Internet survey if they were reported to have at least one breed that comprised at least 25% of their DNA profile.[1] Visual identifications were considered correct if at least one named breed matched at least one breed in the DNA profile. On average, visual breed identifications matched DNA breed signatures for only 27% of dogs; 6% of dogs were never correctly identified. Although these previous studies included dogs with pit bull-type DNA breed signatures in 10% (Voith et al., 2009, 2013) and 23%[1] of the dogs tested, respectively, the topic of identification of pit bull-type dogs was not specifically discussed.

Participants in two of the studies overestimated their ability to correctly identify breeds visually. In the Internet survey, 68% of respondents predicted they would correctly identify breeds at least half of the time, but only 4% actually did.[1] In the study using videos, after the survey was completed, respondents attended an educational session in which the heredity of phenotypic attributes was discussed and images of breed crosses that looked nothing like their parents were displayed (Voith et al., 2013). Despite being presented with evidence of the poor correlation of physical appearance with breed composition in mixed breed dogs, some respondents clung to their opinions that the DNA results must be wrong; authors of the study called for the completion of similar studies to confirm the findings in additional dogs (Voith et al., 2013).

The commercial DNA testing laboratory used in this study reported an average accuracy of 84% in first-generation crossbred dogs of known parentage.[3] The breed distribution tested represented 45% of American Kennel Club registrations. The accuracy of the test in dogs with more than two breeds and in dogs lacking any purebred heritage is unknown.

Most shelter management software programs have pre-populated drop-down menus of dog breeds that staff members select from when dogs are admitted to the shelter. The two commercial shelter software programs used in the study shelters listed 200–250 dog breed terms, including pit bull terrier, pit bull mix, American pit bull terrier, American Staffordshire terrier, and Staffordshire bull terrier. Breed is a required field for the creation of new dog records, and staff do not have the option of leaving it blank if they are uncertain of the breed assignment.

As demonstrated in the current study, guessing breeds based on visual appearance is fraught with error. In a previous study, the offspring of a cross between a purebred Basenji and a purebred Cocker Spaniel did not physically resemble either parent (Scott and Fuller, 1965). When those offspring were backcrossed to either of the parental breeds, even more variability in physical phenotype occurred. This occurs because dog breeds contain a variety of genetic variants for specific traits and these are not reliably expressed in a 1:1 ratio when mixed with other breeds.[3]

Breed designations have been used in attempts to predict future behavior or personality, such as activity level, trainability, friendliness, or propensity for aggression, but recent studies have demonstrated that the behavior of individual dogs varies widely both within a breed and between breeds (Svartberg, 2006; Martinez et al., 2011; Casey et al., 2013, 2014). In addition, modern purebred dogs often lack the behaviors that were historically selected for when dogs were bred and used for specific functional tasks (Svartberg, 2006). There have been no reports correlating the behavior of crossbred dogs with that expected of the parental breeds. A pair of large studies examining patterns of aggression in dogs found no association between aggression and specific breeds (Casey et al., 2013, 2014). These reports found that aggression tended to occur in a single context, such as a strange person entering the house or encountering an unfamiliar dog on a walk, rather than being generalized over a wide variety of circumstances. There was a low association between inter-dog aggression and human-directed aggression. Together these findings suggest that dogs are more likely to show aggression in response to situational perceived 'threats' rather than to have a general trait of aggression.

The lack of a correlation between the appearance and behavior of individual dogs with that of their crossbred parents highlights the fact that inherited genes determine what could happen, and not necessarily what will happen. Pedigree analysis can explain the degree of relatedness but does not necessarily predict which morphological or behavioral traits are expressed in mixed-breed dogs. This is an important concept to consider when educating the public either in the areas of law or adoption. Mixing breeds is not like mixing paint.

The regulation of certain dog breeds is controversial, with little evidence that breed bans have resulted in decreased serious or fatal dog bite-related injuries (Klaassen et al., 1996; Rosado et al., 2007; Overall, 2010; Patronek et al., 2010). Regulation of particular breeds has been challenged in court, as has the breed identification of individual dogs[4] (Patronek and Slavinski, 2009). In 2011, the US Department of Justice ruled that the Federal Americans with Disabilities Act supersedes any local breed restrictions and allows disabled persons to keep service dogs of restricted breeds (VanKavage, 2011).

In many jurisdictions, animal shelter staff members and veterinarians are considered to be experts in breed identification and are asked to visually assess dogs to determine whether they should be categorized as pit bulls or other regulated 'breeds' based on their physical features alone[4–6] (Simpson et al., 2012). As more cases of

breed identification involve DNA analysis and are challenged in court, veterinarians could be called to testify or even be held liable should their breed identification opinions be found to be in error (Berkey, 2009; Simpson et al., 2012). The results of this study confirm that shelter staff members, including veterinarians, frequently disagree with each other on whether dogs fall into the pit bull-type category, and their assessments of whether or not a dog was a pit bull-type only moderately agree with DNA breed profiles.

Limitations of our study include unknown sensitivity and specificity of the DNA breed testing and lack of a DNA test for American pit bull terrier. There is also no DNA test for 'pit bull,' since this term refers to a phenotype, not a pedigree. The test for the Bayesian analysis used by providers of the DNA testing relied on breed signatures of purebred dogs selected for the database and not a representative randomized sample of all dogs, which might be a source of inaccuracy. In addition, relatively little information exists regarding the accuracy of the DNA test for identifying the breed composition of mixed breed dogs. Nonetheless, the key finding in this study was that the poor agreement among staff members in pit-bull type dog identification indicates that many errors in visual breed identification were made, even if it was not possible to determine with certainty which of those identifications were wrong.

Conclusions

The marked lack of agreement observed among shelter staff members in categorizing the breeds of shelter dogs illustrates that reliable inclusion or exclusion of dogs as 'pit bulls' is not possible, even by experts. This has special significance to the topic of restrictive breed regulations, since such regulations are based on the faulty assumptions that (1) certain breeds or phenotypes are inherently dangerous, and (2) that those breeds and their mixes can be identified by observation. Since injuries from dogs have not decreased following bans on particular breeds, public safety is better served by focusing on recognition and mitigation of risk factors for dog bites, such as supervising children, recognizing canine body language, avoiding approaching an unfamiliar dog in its territory, neutering dogs, and providing adequate socialization and companionship for dogs and identification and management of individual dangerous dogs and reckless dog owners.

Conflict of interest statement

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