

Escape rates and biting histories of dogs confined to their owner's property through the use of various containment methods

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OBJECTIVE

To determine escape rates for dogs confined to their owner's property by various containment methods and determine whether biting history was associated with containment method.

DESIGN

Cross-sectional survey.

SAMPLE

974 owners of 1,053 dogs.

PROCEDURES

Individuals patronizing pet stores in Columbus, Ohio, were recruited to complete a survey on the method they used to confine their dogs to their property and their dogs' behavior history.

RESULTS

Dogs were confined to their owner's property by a physical fence (821/1,053 [78.0%]), electronic fence (150/1,053 [14.2%]), or tether system (82/1,053 [7.8%]). Dogs confined by an electronic fence were more likely to have escaped (66/150 [44.0%]) than were dogs confined by a see-through fence (153/658 [23.3%]), privacy fence (38/163 [23.3%]), or tether (22/82 [26.8%]). Forty-eight (4.6%) dogs had reportedly bitten a person in the past, and 81 (7.7%) had reportedly bitten another dog, but containment method was not significantly associated with whether dogs had ever bitten a person or another dog. Greeting behavior (growling, snarling, or trying to bite) was significantly associated with a history of biting a person or another dog.

CONCLUSIONS AND CLINICAL RELEVANCE

Results suggested that escape rate, but not biting history, was associated with the method owners used to confine dogs to their properties. Greeting behavior was associated with biting history, suggesting that owners of dogs that growl, snarl, or attempt to bite when meeting an unfamiliar person or dog should seek assistance to prevent future bites. (*J Am Vet Med Assoc* 2017;250:297–302)

Safe containment of dogs is especially prudent given that most bites to people and other dogs are inflicted by owned dogs as opposed to strays.^{1–6} People are often bitten while passing by or entering an owned dog's immediate property, with most fatal and severe attacks occurring under such conditions.^{3,6–9} Entering a space occupied by and familiar to the dog has been implicated in most dog bites to unfamiliar children, even if the child was not interacting with the dog at the time of the incident.¹⁰ Most dog bites in public areas are inflicted by dogs that live in proximity to the victim.¹¹

Many dogs that bite on their own property likely do so because of an inability to escape unwanted interaction with people. The confined space of a yard on a familiar property may put dogs at greater risk for aggression in an outdoor containment system.

A variety of methods are used to confine dogs to their owner's property and prevent them from escap-

ing. In general, these confinement methods consist of physical fences, tethering systems, and electronic fences. Physical fences can be made of various materials (eg, chain link or wood) and, depending on their design, allow dogs to see people and animals on the other side of the fence (eg, chain-link fences) or prevent them from doing so (eg, wooden privacy fences). Tethering systems consist of a stake and cable or an aerial trolley and cable attached to the dog's harness or collar. Electronic fences are wired or wireless systems incorporating an electronic device affixed to a dog's collar that administers a shock when the dog reaches or crosses a predetermined boundary. Various training methods are used to teach the dog that approaching or crossing the boundary will result in a shock before the dog is left unsupervised.

These various containment systems offer different degrees of safety and security. Dogs confined by physical fences can escape by climbing or jumping

over or digging under the fence; dogs confined by tethering systems can escape as a result of breakage of the tether, collar, or harness; and dogs confined by electronic fences can escape if the incentive to leave the property (eg, to chase prey or perceived intruders) is greater than the dog's reluctance to receive a shock. Additionally, only physical fences (unlike electronic fences and tethering systems) afford dogs protection from outside intruders.

To our knowledge, no studies have been performed on the frequency with which dogs escape from various containment methods. The purpose of the study reported here, therefore, was to determine escape rates for dogs confined to their owner's property by means of physical fences, tethers, or electronic fences. In addition, we wanted to determine whether dogs with a history of biting a person or another dog were more likely to be confined to their owner's property with a particular containment method.

Materials and Methods

The study was conducted as a cross-sectional survey of dog owners patronizing 8 pet stores^{a,b} located in Columbus, Ohio, during June or July 2013. As they entered the stores, individuals were recruited to participate in the study by volunteer veterinary students who used a preestablished recruitment script. Recruiters had been trained on methods for screening and enrolling potential participants and had been provided information on how to answer participant questions about the survey without biasing or inadvertently influencing participant responses. Individuals were eligible to be included in the study if they were ≥ 18 years old, owned at least 1 dog that was ≥ 6 months old, had been living in their current home for ≥ 3 months, and had some means of confining their dogs to the property. Individuals who only owned dogs that were < 6 months old were excluded because the behavior of puppies does not reliably predict adult dog behavior.¹ Individuals who had lived in their current home for < 3 months were excluded because it was thought that this period of time was needed for owners to reliably assess their dog's response to the containment system. Individuals who allowed their dogs to roam the property freely without use of a containment system or who solely leash walked their dogs were also excluded from participation.

Individuals who agreed to participate in the study were asked to complete a 4-page survey.^c As an inducement, individuals who completed the survey were given a flying disc engraved with The Ohio State University College of Veterinary Medicine logo and slogan. The study protocol was approved by The Ohio State University Institutional Review Board. Consent for use of the survey locations was provided prior to study commencement by the corporate offices of the pet store chains and by the managers of the individual stores involved in the study.

The survey included questions regarding the number of dogs participants owned and the charac-

teristics (age, sex, neuter status, and breed) of each dog. Participants were then asked about the type and characteristics of the containment system they used on their properties. Owners who said that they had a physical fence on their properties were asked to indicate the type of fence (eg, chain link, slatted, iron, privacy, or other) and whether dogs were able to easily see through the fence (yes vs no). Participants who said that they used an electronic fence to contain their dogs were asked why they had chosen an electronic fence, how they had trained their dogs to be accustomed to the fence, and what areas the dogs had access to on the property. Respondents were allowed to specify ≥ 1 reason for choosing an electronic fence or method of training. All participants, regardless of the type of containment system reported, were asked to indicate how long during the day their dogs typically spent outside on the property, both supervised and unsupervised; whether their dogs were allowed outside when no one was home; and whether their dogs had ever escaped from the property. Participants were provided lists of potential options to describe their dog's behavior when greeting unfamiliar dogs (ignores, plays, sniffs, barks, and growls, snarls, or tries to bite) and unfamiliar people (avoids; plays; sniffs, licks, or rubs; jumps; barks; and growls, snarls, or tries to bite) and were instructed to select all that applied. Participants were also asked to report whether their dogs barked at unfamiliar dogs or people passing by the property and how often strangers passed through the property uninvited (never, occasionally, frequently, or daily). Finally, participants were asked whether each dog had ever bitten a person or another dog at any point in its life. Survey responses were anonymous, and no personal or contact information was collected from participants.

Statistical analysis

For statistical analyses, the unit of measurement was the individual dog, with each dog from households with multiple dogs considered separately. Dogs were grouped into the 8 breed groups (herding, hound, nonsporting, sporting, terrier, toy, working, and miscellaneous) recognized by the American Kennel Club,¹² with mixed-breed dogs considered as a separate group, and χ^2 analysis was used to test whether breed group, sex (male vs female), or neuter status (neutered vs sexually intact) was significantly associated with whether dogs had ever bitten a person (yes vs no) or had ever bitten another dog (yes vs no). In addition, χ^2 analyses were performed to test for associations between fence type (see-through fence [including responses for which dogs could see another person or dog], privacy fence [including responses for which dogs were unable to see another person or dog], electronic fence, or tether system) and whether the dog had ever bitten a person (yes vs no), between fence type and whether the dog had ever escaped from the property (yes vs no), between type of training for electronic fence and whether the dog had ever

escaped from the property, between whether the dog was allowed outside when no one was home (yes vs no) and whether the dog had ever bitten a person (yes vs no), between the dog's behavior when greeting unfamiliar people (avoids; plays; sniffs, licks, or rubs; jumps; barks; or growls, snarls, or tries to bite) and whether the dog had ever bitten a person (yes vs no), between the dog's behavior when greeting unfamiliar dogs (ignores, plays, sniffs, barks, or growls, snarls, or tries to bite) and whether the dog had ever bitten another dog (yes vs no), between whether the dog barked at unfamiliar people passing by the property (yes vs no) and whether the dog had ever bitten a person (yes vs no), and between how often strangers passed through the yard uninvited (never, occasionally, frequently, or daily) and whether the dog had ever bitten a person. The Fisher exact test was used when the expected value for any cell was < 5 . All analyses were performed with standard software.^d Values of $P < 0.05$ were considered significant.

Results

A total of 1,062 surveys were completed. However, 67 surveys were excluded because the owners did not meet the inclusion criteria and 21 were excluded because > 1 fence type was used on the property, making it impossible to determine which fence type had a primary influence on the dog's behavior. Surveys from the remaining 974 owners were included in the study.

The 974 individuals included in the study owned a total of 1,107 dogs. However, 54 of these dogs were excluded because they were < 6 months old or had been recently (< 3 months ago) acquired. Thus, information for a total of 1,053 dogs was used in the analyses.

Of the 1,053 dogs included in the study, 504 (47.9%) were castrated males, 51 (4.8%) were sexually intact males, 464 (44.1%) were spayed females, and 34 (3.2%) were sexually intact females. Dogs were predominantly of mixed breeding or unknown origin ($n = 453$ [43.0%]). There were 132 dogs in the sporting group, 103 dogs in the herding group, 97 dogs in the terrier group, 81 dogs in the toy group, 74 dogs in the nonsporting group, 57 dogs in the hound group, 54 dogs in the working group, and 2 dogs in the miscellaneous category.

Most dogs were confined to their owner's property by a physical fence (821/1,053 [78.0%]). Most physical fences were made of materials such as chain link, wood slats, or wrought iron that allowed dogs to see through the fence (658/821 [80.1%]); the remainder (163/821 [19.9%]) were privacy fences. One hundred fifty of the 1,053 (14.2%) dogs were confined to their owner's property with an electronic fence, and 82 (7.8%) were confined with a tether system.

Two hundred seventy-nine of the 1,053 (26.5%) dogs had reportedly escaped from the owner's property. A significant ($P < 0.001$) association between fence type and whether dogs had ever escaped was identified, with dogs confined by electronic fences more likely to have escaped (66/150 [44.0%]) than dogs con-

finied with a see-through fence (153/658 [23.3%]), privacy fence (38/163 [23.3%]), or tether (22/82 [26.8%]).

When owners of the 150 dogs contained by electronic fences were asked how they had trained their dogs to be accustomed to the fence, most (109 [72.7%]) reported using a trainer employed by the fencing company. Others reported that they followed the instruction manual (28 [18.7%]) or used a trainer not employed by the fencing company (3 [2.0%]). Owners of 4 (2.7%) dogs reported that the dogs needed no training to stay within the boundaries of the electronic fence, and owners of 11 (7.3%) dogs reported that dogs were trained by other methods not specified. For dogs contained by an electronic fence, method of training was not significantly associated with whether the dog had ever escaped from the property.

Of the 150 dogs contained by an electronic fence, 88 (58.7%) had access to both the front yard and backyard. Thirty-eight (25.3%) dogs were contained by separate electronic fences in the front yard and backyard that were not connected, 23 (15.3%) dogs had access to only the backyard, and 1 dog's information was not given. No dogs contained with an electronic fence had access only to the front yard.

Reasons owners gave for choosing an electronic fence included "appearance" (54 [36.0%]), "physical fencing not being allowed on their property" (52 [34.7%]), "to allow their dogs more freedom" (50 [33.3%]), and "the prohibitive cost of a physical fence" (47 [31.3%]; some owners gave ≥ 1 answer). Six owners reported other reasons for choosing an electronic fence.

Owners of 66 of the 1,053 (6.3%) dogs reported that their dogs typically never spent any time outside on the property while supervised by the owner (it is possible these dogs were always unsupervised while outside). Most dogs (443/1,053 [42.1%]) typically spent up to an hour outside on the property each day while supervised by the owner. Only 12 of the 1,503 (0.8%) dogs spent ≥ 7 hours outside on the property each day while supervised by the owner. In contrast, owners of 427 of the 1,503 (28.4%) dogs reported that their dogs never spent any time outside on the property unsupervised. Two hundred eighty-nine of the 1,053 (27.4%) dogs spent up to an hour unsupervised outside on the property each day, and 137 (13.0%) spent 1 to 2 hours unsupervised outside on the property each day. Thirty of the 1,053 (2.8%) dogs spent ≥ 7 hours unsupervised outside on the property each day.

Forty-eight of the 1,053 (4.6%) dogs had reportedly bitten a person in the past, and 81 (7.7%) had reportedly bitten another dog. Breed group, sex (male vs female), and neuter status (neutered vs sexually intact) were not significantly associated with whether dogs had ever bitten a person (yes vs no) or had ever bitten another dog (yes vs no). Similarly, containment type (see-through fence, privacy fence, electronic fence, or tether system) was not significantly associated with whether dogs had ever bitten a person (yes vs no) or had ever bitten another dog (yes vs no). Thirty-four of the 658 (5.2%) dogs contained by a see-through fence,

1 of the 163 (0.6%) dogs contained by a privacy fence, 6 of the 150 (4.0%) dogs contained by an electronic fence, and 7 of the 82 (8.5%) dogs contained by a tether system had reportedly bitten a person.

The most common response owners gave when asked to describe their dog's behavior when greeting unfamiliar dogs was "sniffs" (609/1,053 [57.8%]), followed by "plays" (461/1,053 [43.8%]), "barks" (345/1,053 [32.8%]), "ignores" (105/1,053 [10.0%]), and "growls, snarls, or tries to bite" (96/1,053 [9.1%]). There was a significant ($P < 0.001$) association between growling, snarling, or trying to bite when greeting unfamiliar dogs (yes vs no) and whether the dog had ever bitten another dog (yes vs no), with dogs that growled, snarled, or tried to bite when greeting other dogs more likely to have bitten another dog (36/96 [37.5%]) than dogs that did not (45/957 [4.7%]). Most (728/1,053 [69.1%]) owners reported that their dogs barked at unfamiliar dogs passing by the property.

The most common response when owners were asked to describe their dog's behavior when greeting unfamiliar people was "sniffs, licks, or rubs" (707/1,053 [67.1%]), followed by "jumps" (363/1,053 [34.5%]), "barks" (282/1,053 [26.8%]), "avoids" (98/1,053 [9.3%]), and "growls, snarls, or tries to bite" (36/1,053 [3.4%]). There was a significant ($P < 0.001$) association between growling, snarling, or trying to bite when greeting unfamiliar people (yes vs no) and whether the dog had ever bitten a person (yes vs no), with dogs that growled, snarled, or tried to bite when greeting unfamiliar people more likely to have bitten a person (10/36 [27.8%]) than dogs that did not (38/1,017 [3.7%]).

Most owners reported that their dogs barked at unfamiliar people passing by the property (687/1,053 [65.2%]), but only 45 of the 687 (6.6%) dogs that barked at unfamiliar people passing by the property had ever bitten a person. However, 45 of the 48 (94.0%) dogs that had reportedly bitten a person also barked at unfamiliar people passing by the property, whereas 642 of the 1,005 (63.9%) dogs that had reportedly never bitten a person barked at unfamiliar people passing by the property. These percentages were significantly ($P < 0.001$) different. Only 3 of the 366 (0.8%) dogs that reportedly did not bark at unfamiliar people passing by the property had ever bitten a person.

Five hundred thirty-four of the 1,053 (50.7%) owners reported that strangers never passed through their yard uninvited. The remainder reported that uninvited strangers passed through their yard occasionally (389/1,053 [36.9%]), frequently (83/1,053 [7.9%]), or daily (47/1,053 [4.5%]). Dogs were significantly ($P = 0.016$) more likely to have bitten a person if uninvited strangers passed through their yard on a daily basis (5/47 [10.6%]) than if uninvited strangers never passed through their yard (17/534 [3.2%]). One hundred twenty-six of the 1,053 (12.0%) owners allowed their dogs in the yard when no one was home, including through the use of a dog door. Dogs that were allowed to be in the yard when no one was home were significantly ($P = 0.017$) more likely to have bitten a person (11/126

[8.7%]) than were dogs that were not allowed to be in the yard when no one was home (37/927 [4.0%]).

Discussion

Results of the present study suggested that the method used to confine dogs to their owner's property was associated with the likelihood dogs would escape, with dogs confined by an electronic fence significantly more likely to have escaped (66/150 [44.0%]) than dogs confined with a see-through fence (153/658 [23.3%]), privacy fence (38/163 [23.3%]), or tether (22/82 [26.8%]). On the other hand, containment type (see-through fence, privacy fence, electronic fence, or tether system) was not significantly associated with whether dogs had ever bitten a person or had ever bitten another dog.

Dog owners in the present study used a wide variety of containment systems to confine dogs to their property, but systems that allowed people and other animals to freely access the property (ie, electronic fences and tether systems) were much less common (150/1,053 [14.2%] and 82/1,053 [7.8%], respectively) than physical fences (821/1,053 [78.0%]). Although dogs contained by an electronic fence were not more likely to have a history of having bitten a person or another dog, they were more likely to have escaped from the property. This was consistent with results of a study by Blackwell et al¹³ in the United Kingdom that suggested owners who used electronic fences reported less success than expected in keeping their dogs within the confines of their properties than when dogs were contained by other means. Contrary to manufacturer claims, therefore, it appears that electronic fences may not be a reliable means of confining dogs to their owner's property. This may be largely due to the fact that electronic fences rely on technology and training, whereas other means of confinement (ie, fences and tether systems) rely on physical barriers. Regardless of their level of training, dogs are never 100% consistent in their responses. An electric shock from an electronic fence system may be a sufficient deterrent to prevent a dog from escaping under normal circumstances, but may not be when the incentive to escape (eg, the chance to chase another dog or person) is particularly high. In addition, electronic fences are liable to fail because of power outages, battery depletion, or other technical problems, potentially leading to an increased rate of escape.

A prospective study by Patronek et al⁹ showed that 11.7% of dog bite-related fatalities over a 10-year period were related to owned dogs roaming the neighborhood. Intuitively, therefore, it seems that because they were more likely to escape the property, dogs contained by electronic fences would have been more likely to have bitten a person or another dog. However, this was not found to be the case in the present study.

Although containment system was not found in the present study to be associated with whether dogs had bitten a person or another dog, several factors were significantly associated with a history of

biting. For example, dogs that were allowed to be in the yard when no one was home were significantly ($P = 0.017$) more likely to have bitten a person (11/126 [8.7%]) than were dogs that were not allowed to be in the yard when no one was home (37/927 [4.0%]). It is possible that at least some of the dogs allowed in their yard when no one was home had been obtained specifically for a propensity to protect the property, rather than companionship. Potentially, these dogs may not have been well socialized to people and, therefore, may have been more likely to bite if they encountered a stranger on their property. Also, owners may encourage aggressive behaviors even when protection is not the primary reason for acquiring a dog,¹⁴ and dogs allowed in the yard when no one was home may have been more likely to have a history of biting in part because of more frequent exposure to unfamiliar people. A previous study⁸ attributed bites to a lack of intervention and supervision by owners. In future studies, it would be interesting to test for any differences in bite risk for outdoor dogs that were able to choose to escape threatening stimuli (eg, via a dog door) versus outdoor dogs that were unable to escape such stimuli.

We also found, in the present study, an association between the frequency with which uninvited strangers passed through the yard and a history of having bitten a person. Again, this was likely a result of greater exposure to strangers. It seems possible that some dogs that had uninvited strangers passing through their yard on a daily basis escalated their level of aggression to biting when more inhibited forms of aggression (eg, barking, growling, or lunging) were not effective at keeping strangers away.

Most (687/1,053 [65.2%]) owners in the present study reported that their dogs barked at unfamiliar people passing by the property. Dogs can bark for many reasons, including territorial aggression, as a form of attention-seeking behavior, during play, because of fear or distress, or as a manifestation of compulsive behavior, generalized anxiety, or separation anxiety.^{1,13} However, a recent study by Raglus et al¹⁵ suggested that dogs left outside in Australia barked more in response to environmental stimuli than because of boredom or separation anxiety. Interestingly, nearly all (45/48 [94.0%]) of the dogs in the present study that had reportedly bitten a person also barked at unfamiliar people passing by the property. Given its high prevalence, barking appeared to be a relatively normal behavior among dogs in the present study. However, it also appeared to reflect a broader problem in certain dogs prone to biting.

Most importantly, dogs in the present study that growled, snarled, or tried to bite when greeting unfamiliar people were more likely to have bitten a person (10/36 [27.8%]) than were dogs that did not engage in these behaviors with unfamiliar people (38/1,017 [3.7%]). Similarly, dogs that growled, snarled, or tried to bite when greeting other dogs were more likely to have bitten another dog (36/96 [37.5%]) than were dogs that did not (45/957 [4.7%]). Notably, dogs that were aggressive (ie, growled, snarled, or tried to bite)

when greeting other dogs were not necessarily aggressive when greeting unfamiliar people, a finding consistent with results of previous studies.^{2,14,16} Aggression in dogs appears to be contextual, and dogs typically show aggression in response to particular circumstances, as opposed to aggression being a personality characteristic of individual animals.¹⁷ Nevertheless, our findings suggested that owners who see signs of aggressive greeting behavior in their dogs should seek the guidance of an animal behavior professional (board-certified veterinary behaviorist or certified applied animal behaviorist) to reduce the risk of biting incidents in the future.

Previous authors^{6,7} have suggested that dogs confined by a tether system may be at greater risk for biting, and a prospective study⁹ from 2013 found that 28.9% of dog bite-related fatalities from 2000 through 2009 involved dogs that were chained. In contrast, we did not find that dogs confined by a tether system were more likely to have bitten a person or another dog.

Sexually intact male dogs have previously been reported to be the most prone to bite and may be at greater risk of exhibiting territorial aggression.^{1,6-8,10,18,19} This was not consistent with results of the present study, in which neither sex nor neuter status was significantly associated with a history of biting a person or another dog. We also did not find an association between bite history and breed group, whereas previous studies^{1,7-10,19-21} have reported mixed results on the potential association between breed and a propensity for biting. Most of the dogs in the present study were of mixed breeding, making it difficult to identify an association between breed group and biting history.

Importantly, because of the low number of dogs in the present study with a history of biting, identifying significant associations was difficult. We also did not have information pertaining to the environment where reported bites took place; therefore, the containment system may not have been relevant. Physical fencing was the most common means of confining dogs in our study, but this may have been related to the particular geographic area where the study was performed, and results may be different if the study were to be repeated in other areas. Owners were also not asked how long a containment system had been installed on their properties, possibly making it a less relevant factor in behavior.

Another important limitation of the study was that data collection relied on self-reported answers of dog owners. Survey studies are limited because there is always the possibility that owners will misinterpret questions or be untruthful in their answers. For example, the term "bite" was not defined for participants, and participating owners may have had differing perspectives on what constituted a bite. Some owners may not have considered a bite that did not break the skin as worthy of reporting in their responses. Furthermore, owners may have been reluctant to reveal a history of aggressive behavior in their dogs to veterinary professionals, making it possible that bites were

underreported. A study of dogs known to have bitten a person or another dog might have helped magnify some of our findings.

The present study was also limited by the fact that only pet owners who shopped at a pet supply store were included. Additionally, the demographics of study participants may have influenced our results related to percentages of dogs that were allowed to be in the yard when no one was home, reasons for choosing an electronic fence over a physical fence, or some other study questions. Despite this, we believe that significant associations found in the present study would be repeatable elsewhere.

In conclusion, although we did not find significant associations between containment type and a history of biting a person or another dog, we did find several factors significantly associated with a history of biting. We also found that dogs contained by electronic fences were more likely to have escaped from their property, putting themselves at risk of injury and putting them in greater contact with the surrounding public. Dogs allowed in the yard when no one was home and dogs living where uninvited strangers passed through the yard on a daily basis were more likely to have bitten a person. Aggressive greeting behavior was also significantly associated with a history of biting. Barking at unfamiliar people passing by the property was not significantly associated with a history of having bitten a person, but nearly all dogs that had bitten a person also barked at unfamiliar people passing by the property. To prevent bites to people, owners should consider keeping their dogs indoors when they are not home and unable to supervise their behavior in the yard and prevent frequent uninvited visitors from passing through the yard. Additionally, owners of dogs that display aggressive greeting behaviors should seek professional assistance because these dogs may be more likely to bite.

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Footnotes

- a. Pet People, Columbus, Ohio.
- b. Pet Supplies Plus, Columbus, Ohio.

- c. Copies of the survey are available from the corresponding author on request.
- d. Stata, version 9.1, StataCorp, College Station, Tex.

References

1. Overall KL, Love M. Dog bites to humans—demography, epidemiology, injury, and risk. *J Am Vet Med Assoc* 2001;218:1923–1934.
2. Rosado B, Garcia-Belenguer S, Leon M, et al. A comprehensive study of dog bites in Spain, 1995–2004. *Vet J* 2009;179:383–391.
3. Beck AM, Jones BA. Unreported dog bites in children. *Public Health Rep* 1985;100:315–321.
4. Reisner IR. Differential diagnosis and management of human-directed aggression in dogs. *Vet Clin North Am Small Anim Pract* 2003;33:303–320.
5. Cornelissen JM, Hopster H. Dog bites in The Netherlands: a study of victims, injuries, circumstances, and aggressors to support evaluation of breed specific legislation. *Vet J* 2010;186:292–298.
6. Wright JC. Severe attacks by dogs: characteristics of the dogs, the victims, and the attack settings. *Public Health Rep* 1985;100:55–61.
7. Gershman KA, Sacks JJ, Wright JC. Which dogs bite? A case-control study of risk factors. *Pediatrics* 1994;93:913–917.
8. Shuler CM, DeBess EE, Lapidus JA, et al. Canine and human factors related to dog bite injuries. *J Am Vet Med Assoc* 2008;232:542–546.
9. Patronek GJ, Sacks JJ, Delise KM, et al. Co-occurrence of potentially preventable factors in 256 dog bite-related fatalities in the United States (2000–2009). *J Am Vet Med Assoc* 2013;243:1726–1736.
10. Reisner IR, Shofer FS, Nance ML. Behavioral assessment of child-directed canine aggression. *Inj Prev* 2007;13:348–351.
11. Landsberg G, Hunthausen W, Ackerman L. *Handbook of behavior problems of the dog and cat*. Philadelphia: Elsevier Ltd, 2003.
12. American Kennel Club. Dog breeds. Available at: www.akc.org/breeds. Accessed Sep 2, 2014.
13. Blackwell EJ, Bolster C, Richards G, et al. The use of electronic collars for training domestic dogs: estimated prevalence, reasons and risk factors for use, and owner perceived success as compared to other training methods. *BMC Vet Res* 2012;8:93–104.
14. Sacks JJ, Kresnow M, Houston B. Dog bites: how big a problem? *Injury Prev* 1996;2:52–54.
15. Raglus TI, De Groef B, Mastron LC. Can bark counter collars and owner surveys help identify factors that relate to nuisance barking? A pilot study. *J Vet Behav* 2015;10:204–209.
16. De Keuster T, Lamoureux J, Kahn A. Epidemiology of dog bites: a Belgian experience of canine behavior and public health concerns. *Vet J* 2006;172:482–487.
17. Casey RA, Loftus B, Bolster C, et al. Human directed aggression in domestic dogs (*Canis familiaris*): occurrence in different contexts and risk factors. *Appl Anim Behav Sci* 2014;152:52–63.
18. AVMA Task Force on Canine Aggression and Human-Canine Interactions. A community approach to dog bite prevention. *J Am Vet Med Assoc* 2001;218:1732–1749.
19. Hsu Y, Liching S. Factors associated with aggressive responses in pet dogs. *Appl Anim Behav Sci* 2010;123:108–123.
20. Martinez AG, Pernas GS, Casalta JG, et al. Risk factors associated with behavioral problems in dogs. *J Vet Behav* 2011;6:225–231.
21. Guy NC, Luescher UA, Dohoo SE, et al. Demographic and aggressive characteristics of dogs in a general veterinary caseload. *Appl Anim Behav Sci* 2001;74:15–28.