

Canine Aggression: Dog Bites to People

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Canine aggression toward people has been cited as an underrecognized public health problem since the 1950s.¹⁻³ Recent estimates of the annual number of dog bites delivered to people range from one to three million, and of these, an estimated 585,000 bites result in injuries serious enough to require medical attention.^{4,5} Children are bitten more often than adults, and younger children are bitten more often than older children.^{4,6} Children are particularly susceptible to serious and fatal injuries resulting from dog bites.⁷⁻⁹ More than 60% of severe injuries and 85% of fatal injuries are delivered to children 12 years of age and younger.⁶ Serious bites to younger children commonly involve severe lacerations to the face, wounds may become infected, and children may experience disability as a result of the bite.^{1,10-12} Thus, substantial emotional and financial costs can be associated with dog bites for the bite victim and the victim's family.

In addition to the potential loss of use and loss of life to the victim, the consequence for the biting dog, even in nonsevere bite cases, is a reduction in its quality of life or loss of life (i.e., euthanasia). Dangerous or vicious dog laws may require, rightly or wrongly, the lengthy impoundment, confinement, banishment to another county, or destruction of a biting dog. As a result, significant personal costs can be incurred by the biting dog and dog owner's family.

An important goal of this chapter is to present a brief description of the factors that characterize commonly occurring dog-bite events and to identify some important causes. A second goal is to identify and discuss several important methodological issues surrounding research on dog bites and their causes. Measures for reducing the rate of dog bites to people have been proposed elsewhere.^{5,6,9,13}

AGGRESSION AS A CONSTRUCT

To classify dogs as if they were either "aggressive" or "nonaggressive" is for the most part inaccurate because aggressive behavior is not a *unitary phenomenon* or *unitary construct*.¹⁴ Seven different "kinds" of aggression in animals initially described by Moyer¹⁵ were revised by Borchelt and Voith,¹⁶ Borchelt,¹⁴ and others,¹⁷⁻¹⁹ resulting in eight functionally classified kinds of canine aggressive behavior. The eight major types of canine aggression observed by Borchelt include aggression related to fear, dominance, possessiveness, protectiveness (of people and territory), predation, punishment, pain,

and intraspecific aggression.¹⁴ Several of the categories reflect different neurobiologic mechanisms of aggression in dogs or other domesticated species. For example, in rats and mice different genetic and physiologic mechanisms have been shown to affect intraspecific territorial aggression, irritable or pain-induced aggression, and predatory aggression (although the latter category is often not included as "aggression" because of its association with feeding).²⁰ (Note, however, that Scott²¹ reports a positive relationship between canine predatory and intermale attacking.) In dogs, different mechanisms affect the probability of eliciting biting when a dog is mildly restrained,²² and eliciting reactivity to fearful stimuli that might result in defensive biting when an animal cannot escape.^{22,23} It is also likely that different neurobehavioral mechanisms influence both the frequency and intensity of biting in competition over resources as in *competitive aggression*⁹ or *possessive aggression*.¹⁴

If one is to accurately describe "an aggressive dog," one should refer to its *behavior*, not to the dog itself. Further, the behavioral event (the dog-bite event) should be classified within the functional category or categories that best represent(s) the aggressive behavior(s) exhibited. A dog whose behavior reaches the threshold for exhibiting fear-induced aggression might exhibit only that kind of aggression even though the dog is exposed to higher intensities of stimulation in other settings. Another dog might be equally likely to exhibit both fear-induced aggression and possessive aggression, and still another dog might exhibit three or more types of aggression. The more different kinds of aggression a dog exhibits, the more likely one is to suspect a single underlying or moderating cause. The developmental onset of each kind of aggression can be gradual (i.e., increasing in frequency and/or intensity with age), or acute, resulting from a single traumatic event, even in dogs that have received the best "socialization" and training.

The categories of aggression proposed by Borchelt and others are open to revision as additional research on canine aggression becomes available.²⁴ Applied animal behaviorists who have used these categories to design effective treatment programs for the reduction of dog bites to people have been successful in reducing the frequency and intensity of canine aggression.^{24,25} Treatment programs designed to reduce dominance aggression could backfire, however, if the source of the dog's biting is actually fear, and its response tendency is to avoid an individual rather than to confront and control. A good behavioral history leading to an accurate diagnosis of the cause(s) of aggression should be obtained before *any* recommendation for treatment.

FACTORS IN DOG BITES TO PEOPLE

Within each category of aggression, different aspects of a dog-bite event can influence the probability of biting. Among the many factors that contribute to a dog-bite event are those classified as characteristics of the dog, the victim, the dog-person relationship, and the bite-event setting.^{6,9}

Dog Characteristics

Dog characteristics include the dog's genetic preparedness to exhibit different kinds of aggressive behavior^{13,20,26} and the dog's medical health,²⁷ age,^{3,28,29} sex,^{3,28,30,31} reproductive status,^{5,14,25,32,33} and size.^{1,4,6,31,33,34}

Breed

Several studies have indicated that German shepherd dogs (or dogs that phenotypically resemble German shepherd dogs) are the breed most likely to bite.^{2,4,14,28,35,36} Attempts to describe various dog *breeds* as more or less genetically prepared to bite, however, have failed to take into account the extent to which dogs might have been misidentified as representing a specific breed. Misidentification may involve dogs that are genotypically but not phenotypically close to German shepherd dogs, resulting in an underestimate of dog bite risk attributable to those genotypes. (For example, F2-generation cocker spaniel × basenji crosses do not much resemble either cocker spaniels or basenjis.²²) More importantly, misidentification of dogs that are phenotypically but not genotypically close to German shepherd dogs may have the effect of overestimating the number of bites, and thus bite risk, attributed to German shepherd dogs. For example, any medium or large-sized, black and tan dog may be inappropriately identified as a German shepherd dog.^{3,30,37,38}

Other attempts to describe the "most aggressive" breeds have failed to take into account the possibility of independent genetic mechanisms controlling different kinds of aggression,^{18,20} the possibility of a dog's genotype interacting with other factors (e.g., early experience; see Elliot and King³⁹ for a good example), and the possibility of different breeds consisting of different diversities of genotype.

Determining which breeds are most aggressive is a difficult endeavor for a number of practical reasons as well. Computing breed-specific bite rates (i.e., the annual number of bites delivered by German shepherd dogs/the number of German shepherd dogs) may be a problem because the number of reported bites might underrepresent the actual number of bites delivered³⁴ or registration figures used to compute breed frequencies might not be accurate.³⁴ Furthermore, breed-specific bite rates might change over time because of changes in breed popularity (affect-

ing the number of dogs "available" to deliver bites); breed distributions might differ among different states, cities, and counties within a state; and linebred dogs within a geographic location for a particular breed might skew the breed bite rate for that location. For example, if a pair of golden retrievers in Atlanta whelp generations of biting dogs, and those offspring are bred by other Atlantans, how long would it take for those dogs to affect the golden retriever bite rate in Atlanta?

In another example, in Palm Beach County, Florida, German shepherd dogs, Labrador retrievers, and chow chows delivered the highest percentage of bites in 1992 (13.5%, 7.6%, and 7.2%, respectively); no information was provided on numbers of dogs registered per breed.⁴⁰ The highest percentage of severe bites per breed-specific bites, however, was delivered by cocker spaniels: 23.6% of the 59 cocker spaniel bites (2.6% of all reported dog bites) were classified as "severe"; only 13.8% of the 301 bites from German shepherd dogs were classified "severe."⁴¹ The same statistics taken in 1986–1989 indicated the highest percentage of severe bites/delivered bites in three of those four years were by golden retrievers (mean = 25% of 110 bites)! It is difficult to provide a clear answer to the question "Are German shepherd dogs, cocker spaniels, or golden retrievers the 'most aggressive' breed?" even if one restricts the geographic location to Palm Beach County.

As a third example, a case-control study of risk factors associated with first bites to nonfamily members resulting in medical treatment showed that German shepherd dogs were 16 times more likely to have delivered a bite than were any other breeds investigated, followed by chow chow dogs.⁴ The report did not include information on the kind of aggression that was exhibited and the results were based on a relatively small sample (18% of the reported bites in Denver in 1991). Clearly, an answer to the question "Which dogs (breeds) are most generically prepared to bite people?" awaits further study.

Medical Factors

Medical factors associated with the probability of aggression, such as liver, thyroid, or visual dysfunction, may directly affect aggressive behavior. Other medical factors, such as any condition resulting in heightened pain or irritability, for example, skin allergies or hip dysplasia, may indirectly influence biting. (See Reisner²⁷ for a review of the pathophysiologic basis of aggression.)

Age

Statistics on age reveal the clear majority of bites involve dogs younger than 5 years of age. Approximately 50% to 70% of reported dog bites implicate dogs in this age group.^{3,4,31,41} Severe bites, however, are delivered by dogs 3 to 4 years of age (mean = 3.5 years; range: 8 months to 10.5 years).^{9,42,43}

Age-specific bite percentages have been reported to be representative of the licensed population,^{3,31} although there is some indication that pets 6 to 11 months of age may exhibit the highest bite rate (number of bites/year).³ In Pittsburgh, dogs from that age group represented 4.8% of all licensed dogs, yet inflicted 13.1% of all reported bites. Other studies indicate that all age groups are equally likely to bite.³¹

Inspection of reports from applied animal behaviorists indicates the mean age of dogs referred for all kinds of aggression ranges from 2 years¹⁸ to 3 years,⁴⁴ and that young dogs (6 months to 2 years) may be especially prone to exhibit dominance aggression toward a family member.^{25,29,45} Dominance aggression and protective-territorial aggression commonly appear between 1 and 3 years of age or earlier, but other kinds of aggression may not be related to age.²⁹

Sex

Male dogs inflict approximately 70% to 76% of all reported dog bites,^{3,9,28,30,31,46} and deliver at least 80% of severe bites.^{9,43,b} Sex-related bite rate estimates (i.e., number of male dog bites/number of male dogs) also show people are at a higher risk for bites from male than from female dogs,^{4,28,38} although one estimate indicates bite rates to be in direct proportion to the number of male and female dogs in the population.³¹

Investigations of dog-bite fatalities show unneutered male dogs to be the most frequent perpetrators, especially in the breeds most frequently cited for fatal bites (i.e., German shepherd dogs, "pit bulls," chow chows, and rottweilers).⁵

Dogs presented to applied animal behaviorists for reduction of aggression are predominantly male.^{14,18,41,44} Males seem to be especially prone to dominance and protective/territorial aggression,^{14,18,24,25,29} but there appears to be no clear relationship between sex and fear-induced aggression.^{14,18}

Reproductive Status

Few statistics exist on the effects of gonadectomy on dog bites reported to health departments nationwide. A recent Centers for Disease Control and Prevention (CDCP) study that determined the dog-spe-

^aDiPace G: Personal communication, Field Operations Supervisor, Animal Care and Control, Board of County Commissioners, Palm Beach County, FL, 1993.

^bTexas Zoonosis Control Division: Personal communication, 1990.

cific factors independently associated with a dog biting a nonhousehold person, however, revealed that compared with controls, biting dogs were 6.2 times more likely to be male and 2.6 times more likely to be reproductively intact males and females.⁴

Inspection of the canine behavioral literature also indicates that more intact males are aggressive than are neutered males^{14,29,41} and that neutering seems to be effective in reducing male dogs' *dominance aggression* or *dominance-related aggression* toward people.^{25,29} Dominance-related aggression includes both possessive aggression (biting exhibited within the context of possessing a toy or food) and dominance aggression (biting elicited by, e.g., a member of the dog-owner's family standing over, staring at, and reaching toward the dog), although the two kinds of aggression are frequently exhibited in the same dog.¹⁴ The sex distribution of dogs exhibiting only dominance aggression, however, is different from that of dogs displaying dominance-related aggression, resulting in statistics that are often difficult to interpret clearly. For example, of the 174 male dog aggression cases seen by Borchelt,¹⁴ dominance aggression was diagnosed in 62 intact males and only 4 neutered males; possessive aggression occurred in 34 intact males (approximately 54% of the number of dogs diagnosed as dominant-aggressives) and 9 neutered males (more than twice the number of dominant-aggressive neutered males). It is not clear whether neutering affects agonistic behavior exhibited within the context of guarding/obtaining items (possessive aggression), within the context of a family member's "threatening" communicative behaviors (dominance aggression), or whether neutering affects biobehavioral mechanisms (including biting) associated with both kinds of aggression (as in "dominance-related" aggression).

Further, sampling error can affect the sex distributions reported in a specific study and might indirectly lead to spurious information regarding the influence of neutering on different kinds of aggression. For example, of the 110 dogs diagnosed for dominance-related aggression in a recent study,²⁴ only 28 dogs were intact males and 48 dogs were neutered males. Taken alone, it would appear that neutered males are more likely to exhibit dominance-related aggression than are intact males. (Note: there is no indication that the authors intended their sample to be used for this convenient example.)

The relationship between gonadectomy and aggression becomes even less clear for spayed and intact females. Recall that unneutered *males and females* were reported as an independent risk factor for a dog biting a nonhousehold person.⁴ Others have reported that with respect to dominance-related aggression, *spayed* females may be *more* likely to bite than sexual-

ly intact females,^{14,24,29} especially if female dogs show aggressive tendencies before spaying.³² Overall³³ presents a discussion of these results.

At least for males, gonadectomy is likely to result in a reduction of the overly assertive, controlling behaviors leading to biting, analogous to the reduction reported for canine intraspecific aggression.⁴⁷ Neutering is not likely to reduce the behavioral components related to defensive aggression (i.e., biting in the context of fear or pain; see Borchelt¹⁴ for a further discussion).

Size

The biting dog's *size* has been cited as a factor associated with reported bites to people,^{1,34} especially in recent cases involving fatal attacks.⁵ Both a dog's weight and an observer's impression have been used to determine dogs' size as "large" (>50 pounds), "medium" (15–50 pounds), and "small" (<15 pounds).^{1,31,34} Large dogs commonly deliver a higher percentage of reported bites than do medium or small dogs, although the "actual" bite rates (as opposed to those based on reports to health departments) may reflect the availability of different-sized dogs in the population.^{31,48} For example, of the 1480 free-ranging dogs observed on both public and private property in a California study, 44% were classified as large, 30% as medium, and 26% as small. The rank orderings were the same for dogs who bit people and for dogs who were nonaggressive to people.⁴⁸ It may also be that bite reports overestimate the number of bites from large dogs because of reporting bias,^{6,34} especially if the dogs are owned (as opposed to stray).³⁴ Serious bites to children, however, are commonly inflicted by large dogs because large dogs cause more serious wounds that require medical attention.^{4,5,42,49,50}

Non-Dog Characteristics

Bite likelihood is also a function of the characteristics of the victim and other factors, including the dog-victim relationship, the attack setting, and the rearing environment.

The Victim

Risk factors associated with the bite victim include the person's age, sex, and behavior in the dog's presence.

Age

Children aged 12 years and younger are victimized by dog bites more than any other age group. Reported bites to younger children, especially those 5 to 9 years of age, are higher than bites delivered to older children; 5- to 9-year-olds constitute 25% to 30% of

all dog bite victims.^{1,3,4,11,30,51} Not only are children bitten more frequently than adults, they are also bitten disproportionately to their representation in the population.^{30,31,38} For example, in St. Louis, 5- to 9-year-olds received 27.4% of all reported bites but represented only 8% of the population.³⁰

Fatal injuries are delivered to children 10 years and younger at an alarming rate. Children 5 days to 10 years of age were involved in approximately 72% of the 60 fatalities resulting from dog attacks in the four-year period from 1990 to 1993.⁵

Sex

Both bite frequencies and bite rates are higher for male than for female victims. Bite rates allow one to compare risk by equating the number of males and females available to bite (i.e., the number of bites of males/100,000 males in the population). Boys and men account for approximately 65% of all reported bites,^{4,30,31,34,51,52} and are 1.5 to 2.2 times more likely to be bitten than are females.^{3,36,38} It may be that compared with females, males make themselves more available to bite by coming into contact with dogs more often.⁴⁸

The "frequency of contact" hypothesis provides a convenient explanation for the differential bite rate, but has yet to be verified empirically. Indirect evidence in support of the hypothesis comes from studies reporting that boys and men prefer dogs as pets,^{2,46} even after being bitten by a dog,⁴⁶ and as a result are more likely to come into contact with potential biters (see Wright⁶ for a discussion of other mediating factors).

Victims of fatal bites are also more likely to be male.^{3,43,53,c} When age and sex are combined, however, a more meaningful picture emerges. Victims of fatal bites are those least able to defend themselves from dog attacks: the very young of both genders. Approximately 37% of the 60 fatal bites from 1990 to 1993 were delivered to boys 5 years of age and younger, compared with 22% for same-aged girls; taken together, boys and girls less than 6 years of age account for almost 6 of every 10 fatal bites.

Victim Behavior

A person's movement in the presence of a dog or dogs increases the likelihood of a dog bite. Case studies of serious and fatal attacks consistently show that when people move or try to defend themselves before and during an attack, the attack escalates; when movement ceases, the dogs release their grip and discontinue the attack.^{9,54} There may be exceptions to

this "rule" for certain dogs, (e.g., "pit bulls").

Almost any kind of stimulation provided in the presence of some dogs, such as yelling or sudden movements, increases bite likelihood. Results from behavioral assessment procedures designed to evaluate "nonfearful dogs" that have attacked people (used by this author and Borchelt; also see Wright & Lockwood⁵⁵) show that increased stimulation exacerbates aggression in dogs that have attacked people, but increases submissive behavior in "subordinate dogs." Even the mildest visual stimulation, such as staring at a dog, is sufficient to elicit growling and snapping in some biting dogs, whereas the same stimulation elicits submissive tail wags, look-aways, and "submissive grins" in comparison dogs.

Other Bite-Event Factors

Because dogs deliver a majority of bites to people's extremities, it is tempting to speculate about which *victim behaviors* precede common bite events. Approximately 76% (median value; range = 69%–79%) of the reported bites cited in large-sample studies were delivered to peoples' extremities^{1,4,28,34,51,52}; bites to the lower extremities (median = 42.8%) commonly exceeded bites to the upper extremities (median = 33.5%), followed by facial bites (median = 15%). According to one survey, however, the bites inflicted by *owned and unowned* dogs differ with respect to bite location and the bite event scenario: Owned dogs delivered almost three times the number of facial bites than did stray, unowned dogs (pets, 16%, strays, 5.9%), and owned dogs delivered fewer bites to the fingers and hands (pets, 20.5%, strays, 36.3%).³⁴ Do people behave differently in the presence of owned and unowned dogs? Are the bite scenarios (i.e., the situations or contexts within which a bite is delivered) different for owned and stray dogs?

The Dog-Victim Relationship

Recall that children are the recipients of a majority of dog bites. The behaviors exhibited by children in the presence of a potential biter may help to explain the relatively high percentage of facial bites from pets and finger and hand bites from strays. It has been reported that people believe strays are more likely to bite, and strays tend to be more fearful of people.^{30,46} Fearful dogs may exhibit defensive aggression in the presence of a child and bite the child's hand, the most salient moving object, when the child reaches above its nose to pet it.

An owned dog may also bite to defend itself from pain or a perceived threat, but companion dogs are also likely to bite in scenarios that are less common in strays. Unlike strays, owned dogs are likely to exhibit

^cLockwood R: Personal communication, Humane Society of the United States, 1995.

dominance and possessive aggression to people, and people known to the dog are its most frequent victims.^{14,29,56} An increased risk of biting a nonhousehold member has been reported for owned dogs *residing in households with at least one child*; perhaps these dogs have a greater opportunity to express protective/territorial aggression and possessive aggression as well as fear-induced aggression toward playmates visiting a household child.⁴ Further, an unusually high number of children are bitten by dogs chained for long periods of time (defending resources or dominance related, or fearful?), and these bites frequently involve a child's face.^{4,9}

Because young children compete with a pet for common resources, such as a toy or comfortable location in the home, and because those resources are usually located on the floor, as is the dog, children are likely candidates for facial bites. Children less than 5 years of age seen at a Chicago emergency room were reported to be at risk for head, face, and neck bites delivered by their own dog in their own home.⁵⁷

Other circumstances associated with the onset and escalation of dominance-related aggression may lead to a likelihood of facial bites, especially in children. Bending over or leaning on a dog, hugging or pushing it, reaching for or taking away an object, and other activities that place the child's face at the level of a dog's mouth increase the risk of facial bites. Bites from strays, on the other hand, are unlikely to occur in the context of these eliciting victim behaviors.³⁴ Unfortunately, bites from owned dogs account for 85% to 90% of reported bites.³⁴

Dog ownership, another dog-victim relationship factor, is associated with an increased risk of dog bites. People who own dogs are more frequently bitten than nonowners, but not necessarily by their own dog.^{58,59} Although bite rates have been reported not to differ for victims who like and dislike dogs,⁵⁸ compared with nonowners, people who own dogs are less fearful of dogs, are more likely to approach and interact with dogs, and are thus more likely to be bitten.^{58,59}

People's perception of a dog's "friendliness" may also be a contributing factor. People may misperceive the communicative behaviors that are associated with an increased likelihood of "dominance biting"; they are more likely to approach dogs displaying dominant signals than dogs displaying subordinate signals, and wrongly believe that dogs displaying submissive communicative signals are more likely to bite them than dogs displaying dominant signals.⁵⁹ Additional factors that contribute to the likelihood of a dog bite include geographic location, weather, time of year, time of day (more bites are delivered in the spring and summer months, and in the late afternoon), and quality of care (including early rearing and experience

with people, and recent traumatic events occurring in the presence of people).^{6,34}

SUMMARY

Canine aggression toward people is a complex, multivariate phenomenon. Informed explanations of bite likelihood necessitate more than simplistic statements regarding breed ("it's a rottweiler!"), teasing ("the dog was provoked"), or other univariate causes. Rather, explanations leading to an understanding of and a reduction in the dog-bite epidemic will require a clear description of the risk factors associated with dog-bite events.

Treatment procedures designed to resolve or reduce instances of canine aggression in clients' pets will require practitioners to obtain a clear description of each dog-bite event (i.e., a behavioral history), including an identification of the kind of aggressive behavior exhibited and an understanding of the underlying neurobehavioral mechanisms, as well as a clear description of the characteristics of the dog, the victim, the dog-victim relationship, and the attack setting. Prevention of future aggression should be aimed at eliminating or controlling those factors that contribute to the acquisition and maintenance of each dog-bite event.

REFERENCES

1. Harris DH, Imperato PJ, Oken B: Dog bites: An unrecognized epidemic. *Bull NY Acad Med* 50(9):981-1000, 1974.
2. Lauer EA, White WC, Lauer BA: Dog bites: A neglected problem in accident prevention. *Am J Dis Child* 136:202-204, 1982.
3. Parrish HM, Clack FB, Brobst D, Mock JF: Epidemiology of dog bites. *Publ Health Rep* 74:891-903, 1959.
4. Gershman KA, Sacks JJ, Wright JC: Which dogs bite? A case-control study of risk factors. *Pediatrics* 93(6):913-917, 1994.
5. Lockwood R: The ethology and epidemiology of canine aggression, in Serpel J (ed): *The Domestic Dog: Its Evolution, Behavior & Interactions with People*. Cambridge University Press, 1994.
6. Wright JC: Canine aggression toward people: Bite scenarios and prevention, in Marder AR, Voith VL (eds): *Vet Clin North Am [Small Anim Pract]* 21(2):299-314, 1991.
7. Lockwood R, Beck AM, Hornberger K: Dog bites among letter carriers in St. Louis. *Publ Health Rep* 90(3):267-270.
8. Sacks JJ, Sartin RW, Bonzo SE: Dog bite: Related fatalities from 1979 through 1988. *JAMA* 262:1489-1492, 1989.
9. Wright JC: Severe attacks by dogs: Characteristics of the dogs, the victims, and the attack settings. *Publ Health Rep* 100:55-61, 1985.
10. Karlson TA: The incidence of facial injuries from dog bites. *JAMA* 251:3265-3267, 1984.
11. Kizer KW, Town M: Epidemiologic and clinical aspects of animal bite injuries. *JACEP* 8:134-141, 1979.
12. Berzon DR, DeHoff JB: Medical costs and other aspects of dog bites in Baltimore. *Publ Health Rep* 89:377-381, 1974.
13. Lockwood R, Rindy K: Are "pit bulls" different? An analysis of the pit bull terrier controversy. *Anthrozoos* 1:2-8, 1987.

14. Borchelt PL: Aggressive behavior of dogs kept as companion animals: Classification and influence of sex, reproductive status and breed. *Appl Anim Ethol* 10:45-61, 1983.
15. Moyer KE: Kinds of aggression and their physiological basis. Part A. *Commun Behav Biol* 2:65-87, 1968.
16. Borchelt PL, Voith VL: Classification of animal behavior problems. *Vet Clin North Am [Small Anim Pract]* 12:571-585, 1982.
17. Hart BL, Hart LA: *Canine and Feline Behavioral Therapy*. Philadelphia, Lea & Febiger, 1985, p 275.
18. Landsberg GM: The distribution of canine behavior cases at three behavior referral practices. *Vet Med* October:1011-1018, 1991.
19. Wright JC: The development of social structure during the primary socialization period in German Shepherds. *Dev Psychobiol* 13(1):17-24, 1980.
20. Popova NK, Nikulina EM, Kulikov AV: Genetic analysis of different kinds of aggressive behavior. *Behav Genet* 23(5):491-497, 1993.
21. Scott JP: Aggression in canine females, in Bjorkqvist K, Niemela P (eds): *Of Mice and Women. Aspects of Female Aggression*. San Diego, Academic Press, 1992, pp 307-316.
22. Scott JP, Fuller JL: *Genetics and the Social Behavior of the Dog*. Chicago, University of Chicago Press, 1965, p 468.
23. Blanchard DC, Blanchard RJ: Inadequacy of pain-aggression hypothesis revealed in naturalistic settings. *Aggress Behav* 10:33-46, 1984.
24. Reisner IR, Erb HN, Houpt KA: Risk factors for behavior-related euthanasia among dominant-aggressive dogs: 110 cases (1989-1992). *JAVMA* 205(6):855-863, 1994.
25. Line S, Voith VL: Dominance aggression of dogs towards people: Behavioral profile and response to treatment. *Appl Anim Behav Sci* 16:77-83, 1986.
26. Podbersek AL, Blackshaw JK: Dog bites: Why, when and where. *Aust Vet Pract* 20:182-187, 1990.
27. Reisner IR: The pathophysiologic basis of behavior problems, in Marder AR, Voith VL (eds): *Vet Clin North Am [Small Anim Pract]* 21(2):207-224, 1991.
28. Hanna TL, Selby LA: Characteristics of the human and pet populations in animal bite incidents recorded at two Air Force bases. *Publ Health Rep* 96:580-584, 1981.
29. Voith VL, Borchelt PL: Diagnosis and treatment of dominance aggression in dogs. *Vet Clin North Am [Small Anim Pract]* 12:655-663, 1982.
30. Beck AM, Loring H, Lockwood R: The ecology of dog bite injury in St. Louis, Missouri. *Publ Health Rep* 90:262-267, 1975.
31. Daniels TJ: A study of dog bites on the Navaho reservation. *Publ Health Rep* 101:50-59, 1986.
32. O'Farrell V, Peachey E: Behavioral effects of spaying in bitches. *5th International Conference on the Relationships Between Humans and Animals*. Monaco, November, 1989.
33. Overall KL: Sex and aggression. *Canine Pract* 20(2):16-18, 1995.
34. Wright JC: Reported dog bites: Are owned and stray dogs different? *Anthrozoos* 4(2):111-119, 1990.
35. Spence G: A review of animal bites in Delaware - 1989 to 1990. *Del Med J* 62(12):1425-1433, 1990.
36. Maetz HM: Animal bites, a public health problem in Jefferson County, Alabama. *Publ Health Rep* 94:528-534, 1979.
37. Marcy SM: Infections due to dog and cat bites: Special series. Management of pediatric infectious diseases in office practice, in Klein JO, Marcy MS (eds): *Pediatric Infectious Disease*. Baltimore, Williams & Wilkins, 1982, pp 351-356.
38. Morton C: Dog bites in Norfolk, VA. *Health Serv Rep* 88:59-64, 1973.
39. Elliot O, King JA: Effects of early food deprivation upon later behavior in puppies. *Psycholog Rep* 6:391-400, 1960.
40. Dog Bites. *Anthrozoos* 7(1):71-72, 1993.
41. Wright JC, Nesselrode MS: Classification of behavior problems in dogs: Distribution of age, breed, sex and reproductive status. *Appl Anim Behav Sci* 19:169-178, 1987.
42. Wilberger JE, Pang D: Craniocerebral injuries from dog bites. *JAMA* 249:2685-2688.
43. Winkler WG: Human deaths induced by dog bites, United States, 1974-75. *Publ Health Rep* 92:425-429, 1977.
44. Beaver BV: Clinical classification of canine aggression. *Appl Anim Ethol* 10:35-43, 1983.
45. Voith VL: Diagnosing dominance aggression. *Mod Vet Pract* 62:717-718, 1981.
46. Beck AM, Jones BA: Unreported dog bites in children. *Publ Health Rep* 100:315-321, 1985.
47. Hopkins SG, Schubert TA, Hart BA: Castration of adult male dogs: Effects on aggression, roaming, urine marking and mounting. *JAVMA* 168:1108-1110, 1976.
48. Westbrook WH, Allen RD: Animal field research, in Allen RD, Westbrook WH (eds): *Handbook of Animal Welfare*. New York, Garland Press, 1979, pp 148-167.
49. Jacobs R: Summer summary of bite wound care: 1. The first crucial steps. *Mod Med* May:127-135, 1982.
50. Schultz RC, McMaster WC: The treatment of dog bite injuries, especially those of the face. *Plast Reconstr Surg* 49:494-500, 1972.
51. Brobst D, Parrish HM, Clark FB: The animal bite problem. *Vet Med* 54:251-256, 1959.
52. DeHoff JB, Ross L: Animal bites. *Maryland State Med J* 30:35-44, 1981.
53. Pinckney LE, Kennedy LA: Traumatic deaths from dog attacks in the United States. *Pediatrics* 69:193-196, 1982.
54. Borchelt PL, Lockwood R, Beck AM: Attacks by packs of dogs involving predation on human beings. *Publ Health Rep* 98:57-66, 1983.
55. Wright JC, Lockwood R: *Behavioral testing of dogs implicated in a fatal attack on a young child*. Paper presented at the Animal Behavior Society meeting, Williamstown, MA, June 1987.
56. Wright JC: Canine Behavior, in Rhoades JD (ed): *National Animal Control Training Guide*. Baton Rouge, LA, National Animal Control Assoc, 1989, pp 61-76.
57. Chun Y, Berkelhamer JE, Herold TE: Dog bites in children less than four years old. *Pediatrics* 69:119-120, 1982.
58. Lockwood R, Beck AM: Dog bites among letter carriers in St. Louis. *Publ Health Rep* 90:267-269, 1975.
59. Moss SP, Wright JC: The effects of dog ownership on judgments of dog bite likelihood. *Anthrozoos* 1:95-99, 1987.