

Article

Behavioral evaluation of 65 aggressive dogs following a reported bite event

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Abstract – Peer-reviewed scientific publications on the topic of dog bites are numerous. Montreal was one of the first municipalities in the province of Quebec to require mandatory assessment of aggressive dogs by veterinarians. In 2019, dogs reported as aggressive and considered a potential risk to public safety by city officials were scheduled for a mandatory behavioral assessment by a veterinarian. For the purpose of this study, only aggressive dogs that had bitten (N = 65) were included. The goals were to better describe the aggressive behavior of these dogs (behavioral sequence, type of aggression, and overall reactivity) and perhaps identify new possible risk factors related to severity of injury and dangerousness. The number of signs of increased arousal/reactivity was positively and significantly associated with the injury severity score. Dangerousness increased with size of dogs. Entire males were most dangerous despite absence of recognizable differences in body weight between neutered and unneutered males.

Résumé – **Évaluation comportementale de 65 chiens agressifs à la suite d'un épisode de morsure.** Les publications scientifiques révisées par des pairs sur le sujet des morsures canines sont nombreuses. La Ville de Montréal fut parmi les premières municipalités du Québec à exiger l'évaluation comportementale de chiens agressifs par des médecins vétérinaires. En 2019, les chiens rapportés comme agressifs et jugés plus problématiques par des représentants de la ville furent soumis à une évaluation comportementale obligatoire par un médecin vétérinaire. Dans le cadre de cette étude, seuls les chiens ayant mordu (N = 65) ont été inclus. Les objectifs de l'étude étaient de mieux décrire le comportement agressif et d'identifier possiblement des facteurs de risques quant à la sévérité des blessures et la dangerosité des chiens. Le nombre de signes de réactivité augmentée était positivement et significativement associé avec le score de sévérité des blessures. La dangerosité augmentait avec le poids de l'animal. Les mâles entiers étaient plus dangereux que les mâles castrés et ce, sans différence de poids significative entre les chiens stérilisés ou entiers.

(Traduit par les auteurs)

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Introduction

Dog bites are a public health concern and a complex issue. Peer-reviewed scientific publications on the topic of dog bites are numerous (1–11). Human medical literature covers injuries, treatments, costs, morbidity, and mortality. Studies on reported bite injuries from medical data records are generally retrospective. Unfortunately, according to 1 published article, information about clinical topics related to treatment and management of dog bites by human health care professionals

(medical doctors, nurses, public health experts, and mental health professionals) is assumed to be correct, but information on canine behavior is often incorrect (1). Examples according to these authors included misinformation on human-canine interactions, the significance of breed and breed characteristics, and the frequency of dog bite injuries.

The literature in veterinary medicine on dog bites covers dog characteristics, behavior, circumstances, targets (person or animal), injuries, and the victim's behavior.

Canine behavior can be normal or abnormal. Normal behavior in the dog can be desirable or undesirable from our point of view (species-appropriate behavioral patterns that humans disapprove or dislike). Abnormal behavior can be associated with both medical and behavioral disorders ("mental illness") and is characterized by one or several of the following signs: an altered behavioral sequence, inappropriate behavior given the context, excessive frequency given the context, and excessive duration and/or excessive severity given the context (12). Canine aggressive behavior is context-specific. Aggression may be appropriate under some circumstances (e.g., self-defense, communication)

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or inappropriate in other contexts (e.g., person walking away from dog yet chased and bitten without any prior interaction). In cases of inappropriate aggressive behavior, veterinarians will rule out medical conditions such as, but not limited to, neurological diseases, painful conditions, or anxiety disorders. These cases are considered “abnormal” aggression because they are associated with physical or mental disorders (12,13). Other contributing factors aside from health issues include individual genetics, fear, and learning.

Montreal was among the first municipalities in the province of Quebec to require mandatory assessment of aggressive dogs by veterinarians. Data specifically on behavioral assessments of aggressive dogs (detailed behavioral sequences, type of aggression, and overall reactivity) have, to the authors’ knowledge, never been published. The purpose of this study was to compile data collected during behavioral evaluations of aggressive dogs with a reported bite event and a mandatory behavioral assessment required by the city. The goals were to better describe the aggressive behavior and perhaps identify new possible risk factors related to injury severity and dangerousness.

Materials and methods

From 2016 to 2018, to improve public safety and prevent dog bites, the city of Montreal restructured animal services and made changes to by-laws. A new team of city officials and prevention agents working together now handle all reports of aggressive dogs. Reports come from various sources, mainly citizens and police officers. Prevention agents initially meet with the victims and dog owners to complete various forms. Based on their own assessment of the dog’s behavior during their visit, the dog’s environment, and the reported complaint (aggressive behavior with or without a bite, severity of injuries, context, etc.), the agents triage the cases. Dogs reported as aggressive and considered a potential risk to public safety by city officials are scheduled for a mandatory behavioral assessment by a veterinarian. This study covered dogs assessed in 2019 by either a veterinarian with additional training in dangerousness assessment (SL) or a Board-certified veterinary behaviorist (DF).

Information before and during the veterinarian’s behavioral assessment was compiled from police records, photographs of injuries, written witness declarations, direct observation of the dog, and owner input. During the appointment, the owners answered specific questions pertaining to the dog and their account of the event. Photographs of injuries were generally available. In some cases, veterinary medical records for the canine victims were also available.

During the evaluation, the dog’s signalment was recorded (breed according to owner, gender, spay-neuter status, estimated weight, age at adoption, source of the dog, and age at the time of the bite event). Specific questions on context, behavioral sequence of the dog (warning, pause, bite, and end), number of bites (single *versus* multiple) during the reported event, severity of the bite(s), victim (familiar, unfamiliar, person, or animal) and type of aggression (defensive, offensive, or predatory) were asked.

Questions on context were to determine if the aggressive behavior and/or severity, and/or duration, and/or frequency

was/were appropriate given the circumstances. Aggression in the context of pain or of a serious physical threat, for example, can be appropriate behavior. On the other hand, biting a person (or dog) who was not interacting with, not threatening, or even walking away (increasing distance), becomes inappropriate aggressive behavior given the context. Other examples of inappropriate behavior include all cases in which the severity of the single bite was excessive for the circumstances, events with multiple bites even if the victim was trying to withdraw or avoid interaction, and offensive aggression.

Questions on the behavioral sequence were to compile information about warning signs (growling, lip lifting, barking, etc.) prior to the bite. Additional questions included data on whether the dog paused between the warning and bite and whether the end of the aggressive sequence was volitional or required external intervention. The behavioral sequence was considered complete or “normal” if the sequence began with a warning (initiation), followed by a pause (the dog communicated and was waiting for a response/analyzing the situation), a single bite (action) followed with immediate volitional release (end of sequence). The behavioral sequence was considered as modified if some of the steps were omitted or altered (no warning, no pause, no spontaneous release of the bite, etc.) or rapid (warning, pause present but extremely short, single bite, spontaneous release).

Severities of injury were categorized into 5 groups: i) absent, ii) superficial, iii) moderate, iv) severe, and v) death. In cases without injury, the dog may rip clothing or pull hair but did not cause any visible lesion. Superficial injuries included abrasions, scratches, redness, superficial punctiform lesions, and mild bruises. Moderate lesions included deeper bite wounds (punctiform) and lacerations. Severe injuries required sutures, surgery, and hospitalization.

Aggression was defined as defensive if displayed to interrupt physical or verbal interactions and/or approaches from another individual, whereas aggression was considered offensive when the aggressor attacked the victim (victim did not actively interact with or approach the dog). Predatory aggression for the reported event was determined based on the behavioral sequence (silent direct approach, single bite not released volitionally, lifting and shaking the victim/animal, or multiple severe bites during the event, requiring external intervention to end the aggressive sequence) and/or death of the victim. History of predatory aggression was recorded when a dog had already captured and killed another animal prior to the reported event.

Signs compatible with increased arousal or reactivity (appears “unable to heat,” piloerection, rapid or modified behavioral sequence, startles easily, redirected aggression, offensive aggression, long recovery time following an event, multiple bites during the event) were also compiled based on owner report or observed during the appointment.

During evaluation, information was gathered regarding prior documented history of bite events as well as signs compatible with anxiety disorders and other medical conditions. Details collected regarding the bite event included interactions between the presented dog and the person or dog bitten, necessity of hospitalization and/or surgery for person or dog, and whether the presented dog was on leash or not at the time of the event.

Finally, dangerousness was based primarily on severity of injuries as well as appropriateness of aggressive behavior given the context, behavioral sequence, and type of aggression. Dangerousness levels were categorized as: very low, low, moderate, high, and very high. In cases of a very low level of dangerousness, the dog gives ample warning and then pauses. If this dog does eventually bite, there is no injury or perhaps a superficial scratch. The behavior is generally appropriate for the context (i.e., we understand and can justify why the dog was aggressive under the circumstances). The aggression is defensive and easily preventable. The following is an example of a low level of dangerousness: a dog bites once (single bite), the behavioral sequence may have been a little more rapid (no or little pause between the warning and bite), the skin is broken (punctiform injury) but the injury remains superficial. The aggressive behavior may or may not be appropriate for the context. The aggression is defensive. In the case of a moderate level of dangerousness, the dog has a rapid or modified behavioral sequence, bites once (single bite), and the injury is more severe than required by the context (i.e., behavior not appropriate for the context because of the increased severity or increased frequency of the behavior). The aggressive behavior is either defensive or offensive. High levels of dangerousness include several elements: the behavior of the dog is not appropriate for the context (and the severity, and/or the frequency, and/or the duration are excessive for the context), the behavioral sequence is modified, injuries may require medical attention (antibiotics), and the aggressive behavior is offensive. Very high levels of dangerousness include the above elements, but the injuries are very severe (often multiple bites during an event) and require hospitalization and/or surgery. The outcome for the victim may even be fatal.

A victim was familiar if the person or animal lived in the same household as the aggressive dog. Otherwise, the victim was an unfamiliar individual.

Statistical analyses

Weight of the dog was assigned to 1 of 4 ordinal categories: < 11 kg, ≥ 11 and ≤ 22 kg, > 22 and < 34 kg, and ≥ 34 kg. To test the association between nominal variables such as sex and ordinal variables such as weight class, injury severity, or dangerousness scale, we used the exact Mantel-Haenszel Chi-square. The exact Chi-square test was used to examine the association between nominal variables. The Spearman non-parametric correlation was used to examine the association between the number of signs and severity of injury. The effect of sex on actual weight was examined with the unequal variances *t*-test. The level of statistical significance was set at 0.05 throughout.

Results

General information

City officials received 538 reports of aggressive dogs in 2019, 467 of which required a meeting with the dog owner by prevention agents. Of the 121 dogs scheduled for a veterinary behavioral assessment, 18 dogs had been aggressive without biting (barking, growling, or lunging) and 76 had bitten, and 27 owners did not present themselves for the appointment.

For the purpose of this study, only aggressive dogs that had bitten were included. Sixty-five dogs were included (all assessed in 2019) with 38 males (58.5%) and 27 females (41.5%). Twenty-one males were neutered (55%) and 16 females were spayed (59%).

Owners named 18 different purebreds, as well as “pit bull” or other various mixed breeds. Forty percent of dogs were purebred, 32% were mixed breeds, and 27.7% were “pit bull” types/“pit bull” crosses.

Age at adoption ranged from birth to 9 y with a median of 3 mo. Age at the time of the bite ranged from 0.6 to 11.5 y with a median of 4 y. Weight ranged from 6.1 to 66 kg with a median of 27 kg.

Context and behavioral sequence

Aggressive behavior given the context was not appropriate in 63 of the 65 cases (97%). Overall, the behavioral sequence was modified (absence of warning and/or pause; multiple bites, no volitional release of bite, or spontaneous end of the aggressive sequence) in 50 out of 52 cases with available information (96.1%). Two dogs out of 52 (3.8%) had a complete behavioral sequence (warning, pause, single bite, release). Information on the entire behavioral sequence was missing in 13 of total cases (20%). Specific information on warning signs was missing in 7 cases (10.8%). Twenty-two of 58 dogs (38%) presented a warning such as barking, growling, or barking and growling prior to biting. Thirty-six out of 58 dogs (62%) did not bark or growl prior to biting. Forty-seven out of 49 dogs (96%) did not pause between the warning and the bite whereas 2 dogs (4%) did pause. Forty-nine out of 64 dogs bit once (76.5%) and 15 dogs bit multiple times during the reported event (23.4%). Information was contradictory between owner and victim for 1 of the 65 cases (1.5%).

Thirty-seven dogs bit a person (57%), 24 dogs bit another dog (36.9%), and 4 dogs (6.1%) bit both a person and dog during the reported event. Of the total 41 people bitten, 22 were men (53.6%), 10 were women (24.4%), 1 was a 16-year-old male teenager (2.4%), and 1 was a 17-year-old female teenager (2.4%). Seven children (17.1%), of which 3 girls (two 4-year-olds and one 11-year-old) and 4 boys (one 5-year-old, two 8-year-olds and one 11-year-old) were victims.

The person bitten interacted specifically with the dog in 11 cases. Examples included a man playing with an unfamiliar unleashed dog that became aroused and started biting, a person grabbing the dog by its collar and pinning the dog to the ground, a police officer using a stick to keep the dog at a distance, or an unfamiliar person accidentally touching the dog with his foot. Other examples listed such as a child running right up to a dog, a woman presenting her hand to a barking dog's face, a woman trying to open the dog's mouth (trying to separate fighting dogs), or 1 child hugging to kiss an unfamiliar dog were described. In all these cases except 2, the severity or number of bites were excessive for the circumstances. Interestingly, the dog threatened (he was not hit) with the stick, behaved appropriately. He growled, paused, and because the threat was still present, bit once and released volitionally without causing injury.

Severity of injuries

Severity of injuries varied from absent ($n = 4$) to superficial ($n = 28$), moderate ($n = 26$), or severe ($n = 5$). There were no fatal outcomes in the reported bite events of this study. Information on severity of injury was missing for 2 dogs. Surgery and hospitalization were necessary in 2 cases (1 woman and 1 child). Three victims required sutures (1 man, 1 woman, and 1 child). Two dogs required sutures and 1 dog required surgery (enucleation). One man hospitalized for a bite wound infection, required intravenous antibiotics for 7 d. The distribution of injury severity scores did not differ significantly with gender of the victim ($P = 1$), sterilization status of all dogs ($P = 0.086$), sterilization status of female dogs ($P = 0.50$), sterilization status of male dogs ($P = 0.17$), weight class of the dogs ($P = 0.18$), type of victim ($P = 1$), and whether dogs were free or on leash ($P = 0.71$). The distribution of injury severity scores was not significantly different if the dogs were on the leash or not for human victims ($P = 0.21$) or for dog victims ($P = 0.21$).

Type of aggression

The aggression was defensive in 35 cases (53.8%), offensive in 20 cases (30.8%), predatory in 2 cases (3.1%). One dog presented both defensive and offensive aggression (multiple bites to a woman and a familiar dog) and another dog presented redirected aggression to its owner and offensive aggression towards an unfamiliar dog. One dog with offensive aggression had a pattern of predatory aggression, but this was not confirmed with absolute certainty. The type of aggression could not be determined in 6 cases (9.2%). Twenty-six people were victims of defensive aggression (14 men, a 16-year-old teenager, 6 women, and 5 children: 4 boys and 1 girl). Thirteen people were victims of offensive aggression (7 men, 3 women, one 17-year-old teenager, and 2 children: 2 girls). Eight dogs were victims of defensive aggression and 11 dogs were victims of offensive aggression. The dog (aggressor) was unfamiliar to the victim in all cases except 3: i) one dog bit an unfamiliar dog and bit his own owner (redirected aggression); ii) a son's dog bit both the son's mother and the mother's dog; and iii) 1 woman was bitten by her roommate's dog. One event was predatory aggression on a small dog and 3 events were potentially predatory aggression (unconfirmed). Victims were respectively 1 adult male, 1 adult female, and 1 small dog. External intervention by owners or witnesses ended these 3 aggressive behavioral sequences.

Increased vigilance/reactivity

The number of signs of increased arousal/reactivity was positively and significantly associated with the injury severity score ($r_s = 0.28$, $n = 63$, $P = 0.028$).

Signs compatible with increased arousal and reactivity were: 4 "appear unable to hear," 44 piloerection, 11 startle easily to benign sounds (unrelated to the bite event), 5 redirected aggression, 25 offensive aggression (predatory aggression was added), 3 long recovery time after an event, 15 multiple bites during the event, 48 modified and 14 rapid behavioral sequence. Sixty-four (98.5%) dogs presented 1 to 5 signs compatible with increased arousal and reactivity. One dog had no signs. Eleven dogs (16.9%) had 1 sign, 19 dogs had 2 (29.2%), 20 dogs had

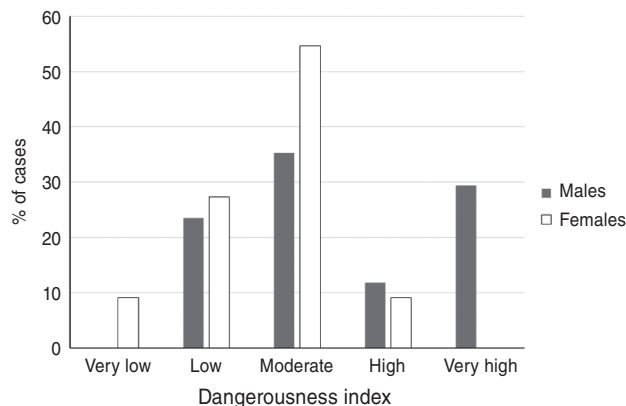


Figure 1. The distribution of dangerousness scores in entire male ($n = 38$) and female ($n = 27$) dogs.

3 (30.8%), 11 dogs had 4 (16.9%), and 3 dogs (4.6%) had 5 signs.

Other information

Prior documented history of bites was available in 8 cases. Twenty dogs (30.7%) were on leash at the time of the bite event. Eight dogs on leash (12.3%) were able to release themselves from the owner's grip or other support. Three dogs (4.6%) were wearing their leash but no one was holding the leash. Thirty-four dog were leash-free (52.3%). Sixteen were completely free outdoors (24.6%), 6 were free in the home (9.2%), 4 were free in a fenced-in yard (6.1%), 7 were free in a dog park (10.8%), and 1 was sitting in a car with open doors (1.5%). Prior history of predatory aggression was noted in 6 cases (9.2%). Owners reported medical conditions diagnosed by their veterinarian in 26 cases (40%). At least 7 owners reported allergies (10.7% of total dogs), 1 dog had an undiagnosed dermatological condition and 1 dog exhibited severe pruritus during the appointment. Fifty-eight dogs (89%) displayed signs compatible with an anxiety disorder.

Dangerousness

Dangerousness level was assessed as very low in 6 cases (9.2%), low in 22 cases (33.8%), moderate in 23 cases (35.4%), high in 8 cases (12.3%), and very high in 6 cases (9.2%). The distribution of dangerousness scores did not differ significantly in relation to the gender of the dog ($P = 0.063$). Approximately 29% of males (11/38) had a high level or very high level of dangerousness compared to 11% (3/27) of females (Figure 1). The distribution of dangerousness scores was shifted toward greater levels in entire *versus* sterilized dogs ($P = 0.02$). Indeed, almost 29% (8/28) of entire dogs had high or very high dangerousness levels compared to 16% (6/37) of sterilized dogs. The distribution of dangerousness scores was shifted toward greater levels in larger dogs ($P = 0.029$). Approximately 35% (6/17) of dogs weighing more than 34 kg had high or very high dangerousness levels compared to 0% of dogs weighing less than 11 kg, 12.5% of dogs weighing > 11 and < 22 kg, and 19% of dogs weighing > 22 and < 34 kg. The distribution of dangerousness scores did not differ with sterilization status in female dogs ($P = 0.56$) but

was shifted toward greater levels in entire male dogs ($P = 0.026$). Almost 41% (7/17) of entire males had a high or very high level of dangerousness *versus* 19% (4/21) of castrated dogs. Males overall weighed more on average than females ($P = 0.015$), but average weight did not differ according to sterilization status in all dogs ($P = 0.72$), in males only ($P = 0.85$) or females only ($P = 0.32$).

Discussion

This study adds new information on a certain population of aggressive dogs. For dogs to be included in this study, a citizen or police officer had to report an aggressive dog. The likelihood of reporting an event generally depends on the victim (choosing to report or not), a witness of the event, or the severity of the bite injury. It is therefore impossible to ascertain the total number of events *versus* reported events. Reported frequency of dog bites in 2005 in 22 Canadian municipalities ranged from 0 to 9 (median: 1.9) per 10 000 people, although these numbers were thought to represent a fraction of all dog bites that occurred in those municipalities (14). In a study covering a 6-year period, the city of Calgary in Canada had 4433 reported incidents of dog aggression towards people or other animals, 2906 (65%) of which were confirmed (5). In the Calgary study, severe dog-bite injuries to humans occurred more frequently in the family home than in any other setting. In a study of dog bites to humans in Chile, the authors reported that the victim knew the offending dog in most cases (63.7%) and 86.6% of the cases were single bites (15). A higher percentage of animal bite victims were men (56.6%) compared to women (43.3%). In contrast, in our study most victims were not familiar with the offending dog. As with the study from Chile, single bites (76.5%) occurred more frequently than multiple bites in our study.

The more signs compatible with increased arousal and reactivity a dog presented, the more severe were the injuries incurred by the victim. This result may improve earlier detection of “potentially dangerous” (dogs that are aggressive but have not bitten yet) and truly dangerous dogs. These dogs are exhibiting “abnormal” aggression (behavior or severity not appropriate for the context, altered behavioral sequence, and increased arousal and reactivity levels). One study reported that “reactivity to stimuli” (physical reactivity to sudden movement or sound at home) was involved in several types of canine aggression (owner-, child-, stranger-, and dog-directed) (16). Another study on development and validation of a psychometric tool for assessing impulsivity in the dog questioned owners on whether their dog “overreacts” (i.e., a relatively small event produces an excessive reaction) (17). In our study, we compiled “excessive startle responses,” which occurred with benign sounds or rapid movements not directed at the dog. Terminology varies from one study to another, but the signs observed are likely similar if not identical.

Intact males were most dangerous in our study group despite absence of recognizable differences in body weight between neutered and unneutered males. This finding may be a consequence of higher testosterone concentrations in entire males.

Owners recognizing signs of increased vigilance and reactivity in their dog could seek help from veterinary behaviorists

or veterinarians with specific training in behavioral medicine. Veterinary behaviorists treat aggressive dogs regularly, as reported in a study of 1644 dogs over a 10-year period in which 72.4% of dogs were presented for assessment and treatment of aggression (18). Increased arousal and reactivity can generally be reduced with medication.

Future studies are needed to determine if similar findings among other types of aggressive dogs (e.g., dogs aggressive towards family members or familiar dogs) are also observed.

Some published studies tried to gain insight into circumstances using terms not always well-defined such as provoked or unprovoked. Without a proper definition, such words do not necessarily add relevant information. In this group of dogs, the aggression was offensive for 13 human victims and 11 dog victims. Offensive aggression is generally unpredictable as opposed to defensive aggression in which context of active interaction or approach at close range allows predictability. Offensive aggression is “unprovoked” for the victim. One study on child-directed canine aggression reported that unfamiliar children bitten in the dog’s home had not actively interacted with the dog in 19% of cases (19). Unfamiliar children were bitten away from the dog’s home or yard in the absence of interaction in another 5% of cases. These canine behaviors are examples of inappropriate aggression, given the context of absence of child-initiated interaction prior to the bite. In this study of 111 cases, anxiety screens revealed abnormalities (i.e., anxiety disorders) in 77% of dogs. Fifty percent of these dogs had potential identified or suspected contributory medical conditions. Our study compiled objective information on the behavioral sequence and specifically on the presence or absence of warning prior to a bite. Sixty-two percent of dogs did not warn, making the aggression “abnormal.” Vocal warning signs are not expected during predation or in a context of perceived urgency of self-defense by the biting dog.

Prior predatory aggression events were compiled because data on prevalence of predatory aggression in dogs is lacking. In reported cases of fatal dog bites some of the dogs had a history of predatory attacks on prey prior to the fatal bites of humans (20,21). In some case reports, necropsy of dogs revealed various human body parts in the dog’s stomach confirming predatory aggression toward humans (22,23). In 16 fatal attacks in Spain, 3 dogs had already presented aggressive behavior toward humans or dogs in the past (24). In 4 cases, the dogs had no history of previous aggressive behavior, and the information was missing in 9 cases. The authors did not mention any prior history of predatory aggression of these dogs toward prey before the fatal attacks on humans. Future studies on dogs with predatory aggression (killing prey) could look at presence or absence of overall increased arousal and reactivity signs in these dogs. Not all dogs with predatory aggression are dangerous to humans. A subgroup is dangerous, and more research is required to detect these dogs early on before a fatal bite event.

Most scientific papers (human and veterinary) focus on breeds responsible for bites even though visual identification, the most common method of breed identification is difficult, imprecise, and unreliable (25,26). In a study on human-directed aggression, the authors reported that for all types of aggression,

the variables measured explained a relatively small amount of the variance between aggressive and non-aggressive animals, suggesting a much greater importance of factors specific to the experience of the individual dogs in the development of aggression (6). The data therein suggest that although general characteristics of dogs and owners may be a factor at population level, it would be inappropriate to make assumptions about an individual animal's risk of aggression towards humans based on characteristics such as breed. These authors also studied inter-dog aggression and suggested that general characteristics such as breed had a relatively small overall influence on the development of dog-directed aggressive behavior (7).

In conclusion, this study provides a portrait of aggressive behavior in dogs. We determined that the number of signs of increased arousal/reactivity was positively and significantly associated with the injury severity score. Dangerousness increased with size of dogs. Entire males were most dangerous despite absence of recognizable differences in body weight between neutered and unneutered males. Larger studies in the future would allow us to tease apart the contributions of various risk factors such as sex, body weight, overall arousal/reactivity, and prior history of aggression on aggressive behavior using more sophisticated statistical tools than simple univariate models.

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