ELSEVIER

Applied Animal Behaviour Science 74 (2001) 43–57

APPLIED ANIMAL BEHAVIOUR SCIENCE

www.elsevier.com/locate/applanim

A case series of biting dogs: characteristics of the dogs, their behaviour, and their victims

N.C. Guy[a,*], U.A. Luescher[b], S.E. Dohoo[a], E. Spangler[c], J.B. Miller[d], I.R. Dohoo[c], L.A. Bate[a]

[a]*Clinical Behaviour Service, Department of Anatomy and Physiology, Atlantic Veterinary College, University of Prince Edward Island, 550 University Avenue, Charlottetown, PEI, Canada C1A 4P3*
[b]*Department of Clinical Sciences, Purdue University, 248 Lynn Hall, West Lafayette, IN 47907-1248, USA*
[c]*Department of Health Management, 550 University Avenue, Charlottetown, PEI, Canada C1A 4P3*
[d]*Department of Companion Animals, 550 University Avenue, Charlottetown, PEI, Canada C1A 4P3*

Accepted 11 May 2001

Abstract

The characteristics of 227 biting dogs, their homes, and their victims were gathered in a detailed telephone survey of general veterinary clientele in the Canadian provinces of New Brunswick, Nova Scotia, and Prince Edward Island. All of the dogs had bitten either someone living in the same household, or someone who was a frequent visitor and was well known to the dog. There were 117 male and 110 female dogs included in this case series. Significantly more female dogs were neutered ($P = 0.03$), 58% of the dogs were purebred, and the most commonly reported breed was the Labrador Retriever ($n = 15$). The mean number of people living in each home was 3.13 (S.D. $\pm$ 0.08). Aggression which would traditionally be defined as dominant or possessive had been demonstrated by 75.6% of the dogs in at least one of 17 specific situations outlined in the questionnaire. Dogs with a history of this type of aggression were significantly older ($P = 0.02$) and of lower body weight ($P < 0.001$) when compared to the remainder of the dogs, and were more likely to be fearful of a variety of stimuli. The effect of fear in these dogs may be important in understanding the motivation for and treatment of aggression problems. For what the owner considered to be the worst bite incident, 42.4% could be attributed to behaviour which appeared to be characteristic of dominant or possessive aggression. If the reason for the worst bite incident was related to the commonly accepted criteria for dominance aggression, then the dogs were more often male and purebred. Owners of these dogs were also more likely to rank the bite as a more serious event ($P = 0.001$). Adults were the most common victims of dog bites, and most injuries were to the hands and arms (56.2%). A minority of injuries (9.3%) received medical attention, supporting previous evidence that dog bites are greatly underreported. A bite requiring medical attention was

* Corresponding author. Tel.: +1-902-566-0950; fax: +1-902-628-4321.
E-mail address: nguy@upei.ca (N.C. Guy).

0168-1591/01/$ – see front matter © 2001 Elsevier Science B.V. All rights reserved.
PII: S0168-1591(01)00155-1

scored as a more important incident by the owner and was more likely to have caused the owner to take precautions to prevent further injuries. Although the presence of aggression related to dominance was not associated with gender or breed, the severity of this form of aggression and its importance to the owner were greater for male and purebred dogs. These factors may explain the characteristics of dogs as they are reported by behaviour specialists working in a referral setting.
© 2001 Elsevier Science B.V. All rights reserved.

Keywords: Dog; Aggression; Dog bites; Human–animal relationships

1. Introduction

Aggressive behaviour by dogs is a serious problem, as is evidenced by the reported number of human injuries, the distribution of cases seen by behavioural specialists, and the reasons given for the relinquishment of dogs to humane societies (Landsberg, 1991; Wright, 1991; Miller et al., 1996; Hunthausen, 1997). Unfortunately, the information derived from these sources may not be applicable to the majority of dogs and owners seen in general practice. Most dog bites to humans are not reported to authorities (Beck and Jones, 1985; Wright, 1990; CHIRPP, 1993), and most people do not consult a specialist when they have a problem with their dog's behaviour.

Public health data derived from emergency room records and police reports describe some of the most serious incidents of canine aggression toward people. But it is also biased against the collection of data for those incidents when the owner is the victim. Owners are not predisposed to report bites by their own dog to any authority, and yet owners are estimated to be the most common victims of dog bites (Kizer, 1979; Wright, 1990). When a dog bite is reported, minimal information is collected on the characteristics of the dog, the victim, and the setting of the attack. Data gathered by (veterinary) behaviourists, on the other hand, includes a great deal of information detailing the aggression and possibly the lifestyle of the dog, but it is also based on a unique population due to the effect of referral bias (Fletcher et al., 1988, p. 59). Among other effects, the referral process increases the likelihood of diagnosing a problem that is either more serious or has been non-responsive to common treatment methods.

This case series is drawn from the population of dogs which make up the caseload of 20 general veterinary practices in maritime Canada. These are dogs with a history of having produced an injurious bite to a person living in the same household. As Patronek et al. (1996) have already identified that the use of veterinary services is associated with a protective effect against the relinquishment of dogs, the population of owned dogs who are taken to veterinarians may deserve investigation as a unique group. These dogs have not typically received any specialised intervention as a result of their behaviour. We have also characterised the victims of dog bites, and the severity of their injuries. The information presented helps bridge the gap between public health data describing bite injuries and the characteristics of dogs treated by behavioural specialists. For the veterinary profession, more understanding of the interactions between a client and their dog will enhance our ability to offer services which both promote and improve the human animal bond.

2. Materials and methods

2.1. Subjects

In 1996, 20 general veterinary practices in the maritime Canadian provinces of New Brunswick, Nova Scotia, and Prince Edward Island were recruited to administer a one page questionnaire to their dog-owning clients. Dogs were not selected for inclusion on the basis of their behaviour, but were a cross-section of the canine caseload. A total of 3226 questionnaires were completed, giving a response rate of 81.4% (Guy et al., 2001a). The second part of the study involved a longer telephone questionnaire which was undertaken with a sample of 640 of these owners, including all of those who had reported that their dog had a history of biting at least one family member, as well as a formal random selection of non-biting controls. These data were used in a risk factor analysis for an outcome of bites to human members of the household (Guy et al., 2001b).

2.2. Telephone survey design and implementation

The telephone questionnaires were administered by four female interviewers. Each questionnaire was 17 pages in length, and included 140 questions.[1] The survey was conducted mainly during the evening and weekend hours of November 1996 to January 1997. The questions were answered by an adult who lived in the home and took some responsibility for the care of the dog, but who did not have to be the same individual who had completed the original clinic questionnaire. Every reasonable effort was made to contact owners who had moved or who had incorrect phone numbers. All questions except one were in closed-end format, requiring either a yes/no/do not know response, a numerically ranked response, or selection from a list of possible responses by either the respondent or the interviewer. It contained the following six types of questions: (1) information about the home; (2) demographic information about the dog; (3) behaviour in the first 2 months of ownership; (4) general behaviour of the dog; (5) behaviour of the dog in the last 2 months of ownership; and (6) specific behaviour of the dog in respect to biting. All respondents were given the opportunity to ask questions or make comments at the end of the survey.

2.3. Case definition

A positive response on the telephone survey to the following question: ''has your dog ever bitten any member of your household or any person who is a frequent visitor in your home and is well known to the dog, even once, even if you think it may have happened by accident while he was playing?'' resulted in the dog being classified as a case for the purposes of this review. A bite was carefully defined in the instructions to the interviewers as ''the upper or lower teeth making contact with the victim's skin with sufficient pressure to cause a visible injury such as an indentation, welt, scrape, bruise, puncture, or tear in the

[1] A copy of the original telephone questionnaire is available from the first author on request.

skin. A dog mouthing a person's skin without applying sudden pressure is not considered a bite''. Contact with clothing was not considered a bite unless the dog had also contacted skin.

2.4. Data management

Descriptive statistics were performed to characterise the demographic, behavioural, and household aspects of the biting dogs. Whether or not a victim had received medical attention following a bite was examined to determine the relationship between bite severity and other factors. In order to summarise behavioural characteristics, each dog was given a score for dominance aggression and fearful behaviours. The dominance score was calculated as the sum of positive responses to a series of 17 questions concerning a history of aggression in situations typically attributed to dominant or possessive behaviour (Table 1). No attempt was made to ascertain the frequency or severity of the aggression reported in each of these scenarios, only whether aggression had occurred. Dominance aggression is a common diagnostic category in behavioural medicine, and is generally meant to describe aggression that is theoretically driven by challenges to the dog's rank in the social hierarchy of the household. For our purposes, the term 'dominance' will represent only those behaviours described in our questionnaire without any comment

Table 1
The list of situations read to owners in a telephone survey which were used to estimate a dominance score for their dog [a]

Sl. No.	Does your dog ever respond to any of the following situations by: growling, lifting a lip, snapping, lunging, or biting?
1	Touching her food when she is eating
2	Walking past her food when she is eating
3	Adding food to the dish while she is eating
4	Taking away a bone, rawhide, or toy
5	Taking back an object she has stolen (like socks)
6	Trying to move her from a favourite resting spot
7	Disturbing her while she is sleeping
8	Walking past her in a hallway or doorway
9	Patting her on the head or shoulders
10	Putting her collar on or taking it off
11	Pulling on her collar
12	Staring at her eye to eye
13	Trying to lift her
14	Wiping her feet or cutting her toenails
15	Grabbing her by the scruff
16	If someone raises their voice at her
17	If someone holds up a stick or newspaper, or raises their arm as if to threaten her
18	Grooming her
19	Cleaning her ears
20	If someone were to hit or slap her

[a] Adapted from a similar list by N. Dodman.

Table 2
List of the potentially fear-evoking stimuli for dogs which were described in the telephone survey with owners and which were used to estimate a score for fearfulness

Thunder	Strangers
Vacuum cleaners	Delivery people
Riding in the car	Veterinarians
Children	Dog groomers
Men	Other dogs

as to the dog's underlying motivation. Three of the questions were discarded in the analysis due to a large number of missing responses. These questions asked about the dog's response if the owner: (1) "grabbed the dog by the scruff"; (2) "held up a stick or a newspaper, or raised their arms as if to threaten"; or (3) if they "hit or slapped" the dog. A score for fearfulness was calculated based on the sum of positive responses to 10 questions about potentially fear-inducing stimuli (Table 2). Chi-square analyses, Student's *t*-tests and odds ratios were used to measure significance of associations between variables.

3. Results

3.1. Demographic characteristics of biting dogs and their homes

The telephone survey identified 227 dogs which met the criteria for a case (history of biting) as described above. When compared with the responses to the cross-sectional clinic survey (Guy et al., 2001a), 29 (12.8%) of the dogs had originally been classified as non-biters, and 198 (87.2%) were classified as biters by both surveys.

Characteristics of the biting dogs are described in Table 3. All of dogs in the survey were at least 6 months of age, due to there being a 6 month interval between the original clinic survey, which had generated the study population, and subsequent contact by the telephone interviewers. There were a total of 117 male and 110 female dogs, and the majority of dogs were neutered (87.7%). A significantly larger proportion of the female dogs were neutered when compared to the males ($P = 0.03$). Purebred status was reported for 58% of the dogs, the remaining being of mixed or unspecified breed.

The mean number of adults, teenagers, and children sharing the home with case dogs are also presented in Table 3. The mean number of people living in each household was 3.13 (S.D. $\pm$ 0.08) which is similar to the average Canadian family size of 3.1 published by Statistics Canada in the report of the 1996 national census (Statistics Canada, 1996). Most respondents (67.4%) reported that there were two adults living in the home, and 10 (4.4%) of the respondents said they lived alone, which is much lower than the proportion of 14.4% reported for this region in the 1996 census. Our results also indicate that there are a larger number of adult families without children (48.8%) among the owners of biting dogs than has been described by the census of the general population (34.1%). Dogs living in homes without children or teenagers were on average older ($P = 0.001$), but there was no significant difference in their body weight.

Table 3
Demographic characteristics of 227 client-owned dogs which had bitten a person living in the same household

Variable	Mean	S.D.	Range	Total responses
Age (years)	4.66	3.85	0.5–15	222
Weight (kg)	19.51	12.95	1.8–58.5	221
Age at adoption (months)	6.35	16.40	0–168	226
Age at neutering (years)	1.09	1.48	0.33–10	182
Number of adults in home	2.22	0.73	1–5	227
Number of teenagers in home	0.45	0.78	0–4	227
Number of children in home[a]	0.47	0.76	0–3	225
	Description		Number of dogs (%)	
Sex and neuter status	Intact male		20 (8.8)	
	Neutered male		97 (42.7)	
	Intact female		8 (3.5)	
	Neutered female		102 (44.9)	
Breed	Mixed breed		95 (41.9)	
	Labrador retriever		15 (6.6)	
	Springer spaniel		9 (4.0)	
	Golden retriever		8 (3.5)	
	Lhasa apso		7 (3.1)	
	Shih tzu		7 (3.1)	
	Cairn terrier		6 (2.6)	
	Cocker spaniel		5 (2.2)	
	Shetland sheepdog		5 (2.2)	
	Other (44 breeds)		70 (30.8)	

[a] Individuals $\leq$12 years of age.

3.2. Behavioural and lifestyle characteristics of biting dogs

Table 4 gives a sample of the behavioural and lifestyle characteristics of the biting dogs. Aggression over food in the first 2 months of ownership, sleeping on the owner's bed in the first 2 months of ownership, and a history of veterinary treatment for a skin disorder have previously been identified as significant risk factors for biting directed toward household members in this population (Guy et al., 2001b).

Biting dogs with any history of dominant or possessive type aggression, regardless of the reason given by the owner for the worst bite incident, differed significantly from all other biting dogs in a number of aspects. They were older at the time of the telephone interview ($P = 0.02$), and of lower body weight ($P < 0.001$). They also had significantly higher fear scores, as they were reported to be afraid of more stimuli by their owners ($P = 0.01$), and were more likely to be described by owners as being generally fearful (OR: 3.92, 95% CI: 1.19–12.73). In dogs with any history of dominant or possessive aggression, their owners considered the worst bite incident to be of greater importance on a ranking scale of 1–10 when compared with the responses of the owners of all other biting dogs ($P = 0.03$). There were no significant differences between male and female biting dogs in either: (1) their mean fear score; (2) their mean 'dominance' score; or (3) any history of dominant or

Table 4
Selected behavioural and lifestyle characteristics of 227 dogs which had bitten a person living in the same household

Variable	Positive responses (%)	*n*
Aggression over food in first 2 months of ownership[a]	28 (14.7)	190
Shows aggression potentially related to dominance in at least one of 17 situations listed in survey	127 (75.6)	168
Shows at least one of 11 potential conflict or compulsive behaviours listed in survey	192 (85.7)	224
Ever been destructive when left alone in home or car	146 (64.6)	226
Eliminated in home in past 2 months	58 (25.7)	226
Fearful of men and or children	62 (27.8)	223
Follows at least one command	216 (95.2)	227
Slept on someone's bed in first 2 months of ownership[a]	77 (40.3)	191
Slept on someone's bed in past 2 months	128 (56.6)	226
Allowed on furniture in past 2 months	170 (75.6)	225
Played tug-of-war in past 2 months	149 (65.9)	226
Veterinary treatment for a pruritic or malodorous skin disorder[a]	91 (40.3)	226

[a] Three variables that were previously detected as significant risk factors for biting behaviour in this population (Guy et al., 2001b).

possessive type aggression. Neutered and intact dogs were also not significantly different when compared for these same factors, and neither were differences detected between purebred and mixed breed dogs.

3.3. The relationship between victim, injury, and dog characteristics

Respondents were asked to estimate the number of times their dog had bitten members of three different age groups. The results are presented in Fig. 1, showing that adults were the most common victims. Of the entire population of potential victims (household members) exposed to these dogs, 63.8% were adults. Most dogs had bitten no more than five times, although a number of respondents reported that their dog had bitten ''too many times to count''. The risk of a bite to an adult did not increase in association with the presence of children in the home.

Respondents were asked to describe which parts of a person's body their dog had bitten. These results are given in Table 5, indicating that injuries to the hands and arms are the most common (56.2%). A total of 63 (27.8%) dogs had bitten more than one area of the body, though not necessarily on the same occasion. As a surrogate measure of the severity of the wound, the worst injury ever produced by the dog was classified as to whether or not the victim had received medical attention. Of the 226 dogs for which this information was reported, 21 (9.3%) had caused an injury which had been seen by a physician. No dogs which had bitten the feet, legs, or torso of the victim had produced an injury which required medical attention, unless the victim had also been bitten on the head. Although the sample size is small, it would appear that individuals who had received medical attention were more likely to have received bites from dogs which had at some point bitten one of their victims on the head.

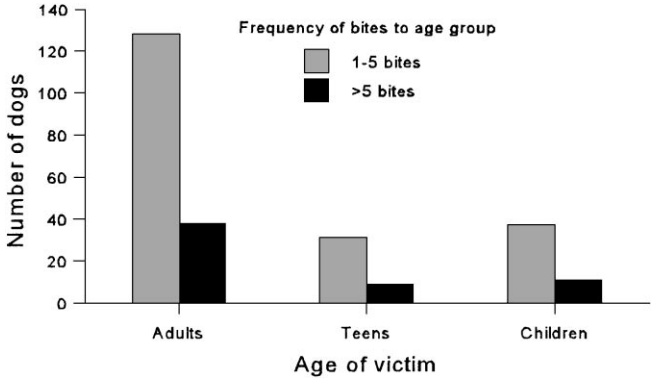


Fig. 1. Frequency of bites to people of different ages by 227 dogs. The number of dogs who had bitten adults (>18 years), teenagers (13–18 years) and children (≤12 years), are displayed by the frequency with which they had bitten people living in the same household. Some dogs had bitten victims in more than one age group. In total, 73.5% had bitten an adult at least once, 17.9% had bitten a teenager at least once, and 21.5% had bitten a child at least once. Adults made up 63.8% of all household residents.

The associations between a history of causing a bite requiring medical attention and other variables are described in Table 6. It should be noted that there was no significant difference in the body weight, sex, neuter status, or age at neutering between dogs that had or had not produced a bite needing medical attention. Dogs causing a bite that required medical attention were older at the time of the first bite incident. If the dog had produced a bite needing treatment, it was scored as a significantly more important incident by the owner on a scale of 1–10, where 10 was equivalent to the owner considering immediate euthanasia of the dog. An injury requiring medical attention also tended to be associated with more owners now taking precautions to prevent biting by the dog. There was a tendency for bites by male dogs to be ranked as more important events by the owners than bites by female dogs ($P = 0.10$).

Table 5
The relationship between the parts of the body which had been bitten and the number of victims receiving medical attention for what the owner considered to be the worst injury ever caused by the dog

Body part(s) bitten by the dog	Medical attention (%)		Total cases (%)
	Yes	No	
Hands or arms	10 (47.7)	117 (57.1)	127 (56.2)
Feet or legs	0 (0)	15 (7.3)	15 (6.6)
Torso	0 (0)	7 (3.4)	7 (3.1)
Head	3 (14.3)	11 (5.4)	14 (6.2)
Two or more parts, *not* including head/neck/torso	4 (19.0)	37 (18.0)	41 (18.1)
Two or more parts, including head/neck/torso	4 (19.0)	18 (8.8)	22 (9.7)
Total	21 (100)	205 (100)	226 (100)

Table 6
The relationship between whether a dog had ever produced a bite requiring medical attention and other survey responses (of 226 dogs, 21 (9.3%) caused a bite requiring medical attention)

Factors	Medical attention		P[a]	Total for all biting dogs (n)
	Yes	No		
Mean age of dogs in years at the time of telephone survey	5.5	4.6	0.28	4.7 (222)
Mean age of dogs in years when bit for the first time	3.8	2.4	0.05	2.6 (212)
Frequency of male dogs	0.57	0.52	0.60	0.52 (227)
Frequency of neutered dogs	0.76	0.89	0.10	0.88 (227)
Mean age of dogs in years when neutered	0.6	1.1	0.24	1.1 (182)
Mean body weight in kilograms	18.8	19.6	0.80	19.5 (221)
Mean 'dominance' score[b]	4.2	2.6	0.07	2.7 (168)
Mean bite 'importance' score[c]	5.4	2.6	<0.001	2.8 (224)
Proportion of respondents who now take precautions to prevent biting by their dog	0.57	0.37	0.07	0.39 (226)

[a] The statistical significance of the difference between values for dogs that did or did not produce a bite requiring medical attention.

[b] The 'dominance' score is calculated as the sum of the responses to 17 questions on the survey describing situations where the dog has shown aggression potentially related to dominance. The questions are given in Table 1.

[c] The relative importance of the worst bite incident to the owner on a scale of 1–10, where 1 is "of very little importance", and 10 "considered immediate euthanasia of the dog".

3.4. Etiology of the worst bite incident

A summary of the reasons given by owners for the dog having bitten at the time when the worst injury occurred are presented in Table 7. This was an open-ended question. Based on the descriptive terms used by the respondents, the behaviour was classified into seven

Table 7
Summary of the reasons given by owners as their explanation for why their dog had bitten at the time when the worst injury occurred

Classification	Owner's explanation for their dog's behaviour	Number of dogs (%)
Dominance	Possessive, moody, spoiled, jealous, tired, irritable, bothered when sleeping, when disciplined dog, restraint, lifting dog, unpredictable	95 (42.4)
Play	Excitement, accidental	64 (28.6)
Fear	Cornered, threatened, inadequate socialisation, easily startled	37 (16.5)
Health related	Pain, illness, medication	13 (5.8)
Protective	Dog protecting person from another household member	7 (3.1)
Re-directed	Victim interrupted dog fight	5 (2.2)
During grooming or bathing		1 (0.5)
Unable to classify		2 (0.9)
Total		224 (100)

different categories. The predominant etiology at 42.4% was the behaviour that appeared to be characteristic of dominance or possessive aggression according to traditional diagnostic criteria.

Upon comparison of the characteristics of dogs which had apparently bitten (at the time of the *worst* incident) for a reason related to dominance, to those dogs which had bitten for any other reason, there were several significant differences. The 'dominant' biters were more often male (OR: 1.70, 95% CI: 1.00–2.91), and purebred dogs as a group were at a higher risk for this type of aggression when compared to mixed breed dogs (OR: 1.79, 95% CI: 1.03–3.11). The worst bite incident was also ranked as a more serious event by the owner ($P = 0.001$) if they had given an explanation which tagged the biting behaviour as being potentially attributable to dominance. There were no significant differences between these two groups of biting dogs for their current age, weight, or neuter status, the age at which they had first bitten, fearfulness, whether or not the victim had received medical attention, and the owner's ability to predict when aggression was going to occur.

4. Discussion

4.1. Effectiveness of survey design

The conclusions of this survey are dependent upon the respondents' interpretation of their dog's behaviour, and their memory of events. Events as significant as a dog causing an injurious bite to a household member are unlikely to be completely forgotten, although some of the details may have changed with re-telling, and there is a potential for bias due to the influence of the dog's current behaviour (Fletcher et al., 1988, p. 203). Problems related to recall, however, are not a sufficient reason to disregard this type of research, as the owner is often the only available witness, and their assessment of the aggressive incident also provides important information about their relationship with their dog. To be practical, even prospective research into the behaviour of dogs within households would likely have to rely on an owner's report of their dog's behaviour, rather than objective measurements.

When reviewing the results, the reader should bear in mind that this is a case series of biting dogs, not dogs showing only more moderate forms of aggression. Biting was chosen as the standard because of the relative ease of defining it as a level of aggression in a telephone survey situation. Most owners, for example, would have difficulty identifying or describing many of the more subtle signs of canine aggression such as changes in posture. It was possible, however, to train telephone interviewers to identify and record an injurious bite from the owner's description of events. As a result, the conclusions reflect the behaviour of dogs which have shown aggression to the level of biting, but as human injury is the most significant outcome of unwanted canine behaviour, these are useful pieces of the aggression puzzle.

4.2. Dog bite injuries and medical attention

This study has determined that for the population of dogs which are part of the veterinary caseload, less than a tenth of the bites they have inflicted upon household members have

been seen by a doctor, perhaps reflecting the tendency for owners not to seek medical care for a bite by their own dog unless it is severe (Wright, 1990). The Canadian Hospital Injury Reporting and Prevention Program report (CHIRPP, 1996) has summarised the scenarios for bite incidents. It is based on emergency room admissions in a total of 16 pediatric and general hospitals across Canada. Although 30% of victims reported they had been bitten by the family dog, the majority had been bitten by the dog of a friend, acquaintance, neighbour, or relative, or by a stray or unknown dog. In spite of evidence that a family member is the most common victim of their dog (Kizer, 1979; Chun et al., 1982), our results and the CHIRRP data indicate that there may be a bias against the presentation of owner-victims for medical care. It should be noted that the CHIRRP system is biased toward the collection of data on children, and does not include patients who were seen by their family doctor. There are a number of reasons why people may be more likely to seek emergency medical attention if they have been bitten by a dog they do not own. It may be that such injuries are more serious, although this is not necessarily the case, as other research has indicated that a reported bite to the owner by their own dog tends to involve a more serious injury (Wright, 1990). It is probable that even minor bites by an unknown dog are inherently more worrisome or frightening, particularly when the victim is a child, and the parent is concerned about zoonotic disease or infection (Wright, 1990; Chun et al., 1982). In situations with the potential for litigation, victims may seek medical treatment in order to substantiate their claim of injury (Hattaway, 1997).

Our data indicate that adults are the most common victims of household aggression. As adults made up the majority of the population in households with biting dogs, it is not surprising that they are the group receiving the most injuries. Hospital reports, however, show that children are presented for medical treatment of dog bites in disproportionately large numbers when compared to their representation in the population (Beck et al., 1975; Chun et al., 1982; Sacks et al., 1996). In addition, children are more often bitten on the head (Karlson, 1984), a type of injury that is likely to receive immediate medical care. Sacks et al. (1996) have established that a higher proportion of dog bites among children resulted in medical care. Facial lacerations associated with dog bites in children are disproportionately severe when compared with lacerations from other common sources such as motor vehicle accidents (Karlson, 1984). It cannot be determined from the results of this survey whether the victims who had received medical attention were more often children. The results did show that when a dog had produced a bite requiring medical attention, it was also more likely to have a history of having inflicted an injury to the head.

4.3. Demographic characteristics of biting dogs and their households

The average family size recorded in this survey is essentially identical to that reported by Statistics Canada for the same year, suggesting that there is nothing unusual about the family size of people who own biting dogs. The family composition, however, may differ from the general population, in that there are fewer individuals living alone, and more homes without children. Dogs living in homes without children were significantly older, which may be attributable to a variety of factors. Some of these dogs may have been raised with the teenagers in the family, who have subsequently matured and were recorded as adults, or who have moved away from home, leaving an older dog behind with their

parents. Another possibility is that aggression is better tolerated by owners in homes without any children. In other words, aggressive dogs may be relinquished at an earlier age when there are children in the home.

The dogs examined in this case series were drawn from a large cross-sectional population having a breed distribution similar to the Canadian Kennel Club registrations (Guy et al., 2001a). The number of different dog breeds included in this phase of the study, however, makes the assessment of the relative aggressiveness of each breed difficult, as most are represented by only a few individuals.

4.4. Associations with apparently dominant behaviour

In referral practice, the majority of cases of canine aggression directed toward owners have traditionally been attributed to problems with 'dominance', or the dog attempting to achieve a higher social rank among household members (Voith, 1981; Borchelt, 1983; Landsberg, 1991). Whether or not a dog truly transfers the canine social hierarchy to humans is difficult to prove, and yet this has been the focus of behaviour modification recommendations for decades. Recent work has recognised the influence of anxiety and conflicting motivations in many cases that were formerly attributed solely to the dog's drive to achieve an alpha position among family members (Borchelt and Voith, 1996a, 1996b; Guy et al., 2001b; Reisner, 1997). As the ultimate goal of behaviour modification in these situations should be to develop a reliably non-aggressive response by the dog to troublesome stimuli, understanding the motivation for the aggression is extremely important.

In reviewing cases presented for aggression, behavioural specialists have repeatedly identified male and purebred dogs as forming the majority of their caseload, particularly in those cases where the aggression has been attributed to 'dominance' (Borchelt, 1983; Line and Voith, 1986; Landsberg, 1991; Beaver, 1994; Reisner et al., 1994). The classical definition of dominance aggression has been examined from two perspectives in this case series. The first was to record the responses of owners to a series of questions which are typical of those often used by behaviourists to identify dogs which may be showing aggression secondary to a perceived challenge to their social status. The second measurement of dominance was achieved by asking the owner to explain, in their own words, why they believed that their dog had bitten at the time when the worst incident had occurred. As a result, we have a measurement of the typical level of dominant or possessive type background aggression in biting dogs, in addition to an assessment of the circumstances at the time of the most serious event.

Not all of the biting dogs had a history of showing dominant or possessive aggression. This behaviour was more common in older or smaller dogs. It is of particular interest that dogs with some history of dominance aggression were also reported to be fearful of more stimuli and were more likely to be described as 'generally' fearful by their owners. This lends strength to the argument that dogs which are diagnosed as showing dominance aggression combined with ambivalent behaviour may actually be responding out of anxiety and learning (Campbell, 1985). Podberscek and Serpell (1997) discovered that higher levels of aggressive behaviour in English Cocker Spaniels was associated with greater reactivity to loud or high-pitched noises, which might also be interpreted by owners as greater fearfulness. More differences appear in an examination of the reasons given for the

worst bite incident. If the owner gave an explanation which would typically be attributed to a potential problem with dominance, such as if the dog were aggressive when restrained, disciplined, or challenged over the possession of valued resources, male and purebred dogs were over-represented, just as they are in the caseloads of behaviour specialists. It is possible that although some dominant and possessive behaviour is fairly common among all dogs, the culmination of that aggression in a serious bite incident is more common in male and purebred dogs. In most mammals, sexually dimorphic behaviour patterns depend on the exposure to testosterone in utero and in the first few weeks after birth (Salmeri et al., 1991). With or without castration, the behavioural framework of the adult male dog differs from that of the female. Reisner et al. (1994) discuss the possibility that serious aggression problems in dogs are not so much the outcome of the dog challenging the social hierarchy of the family, but are due to a lack of inhibition of the aggressive response. In other words, the dogs that are most dangerous are those which are most impulsive or reactive. Our data indicate that the owner considered the worst bite incident to be a more serious event if it could be attributed to dominance. The likelihood of a dog being seen by a behaviour specialist is obviously increased if the owner is more concerned about the behaviour, ultimately causing a referral bias for male and purebred dogs.

4.5. The owners' interpretation of the aggression and its importance

In a study of the risk factors for euthanasia in dogs presented because of dominance aggression, Reisner et al. (1994) determined that body weight was a significant factor in the prediction of the owner's decision whether or not to euthanise the dog. Dogs that were aggressive in response to benign dominance challenges and weighed more than 18.2 kg were 24 times more likely to be euthanised than dogs which were not aggressive in response to benign challenges and weighed less than 18.2 kg. Aggression in response to a benign dominance challenge is often perceived by owners as unpredictable or irrational behaviour by the dog. This type of behaviour is understandably more frightening for owners of large dogs. One could interpret the results of Reisner et al. to mean that owners are more likely to tolerate, and not euthanise, smaller aggressive dogs. Our finding that smaller dogs tend to show more dominance aggression may be a reflection of owner tolerance. Indeed, tolerance of this form of aggression may be more common among breeders of smaller dogs, such that small dogs with relatively unpredictable aggression are more likely to be retained within the gene pool. Reisner has shown that increased body weight can be associated with more predictable aggression and a lower frequency of aggression. In spite of the theoretical potential for a large dog to inflict more damage when it bites, there was no significant difference between the size of dogs in our survey and whether or not the bite they produced had required medical attention. The seriousness of aggression to the owner, therefore, is not related solely to the medical outcome for the victim, but also to the perceived physical and behavioural attributes of the dog.

Many owners will tolerate a low degree of aggression by their dog for a long period of time. When the bite had required medical attention, this was evidently a significant and memorable event for the owner, in that they ranked it as being more important, and were more likely to take precautions to prevent further incidents. It is unfortunate for victims that the potential danger of the dog's behaviour was not recognised until after the fact.

5. Conclusions

Our data confirms previous reports that the majority of dog bites are to the hands or arms of the victim, and that bites to the head predispose the victim to receiving medical attention. At the same time, however, most of the victims of dog bites within the homes of veterinary clients are actually adults, and not children, which is contrary to available public health information. This supports the idea that children are more likely to be presented for medical attention when they are bitten, either due to differences in the severity of injury or perhaps a parental sense of responsibility. It is evident that the perception of massive underreporting of dog bites by owned dogs is true, in that fewer than 10% of victims had received medical attention.

Three quarters of the biting dogs in this study had demonstrated aggression in a variety of situations that would diagnostically be attributed to dominance or possessiveness. This background level of aggression was generally not too worrisome for owners, but the form or intensity of the behaviour in male and purebred dogs may predispose them to presentation for behavioural therapy at the referral level. The potential for interactions between reactivity, fear, and what has traditionally been described as dominance aggression is clinically very relevant and requires further investigation as it has the potential to greatly influence the outcome of behaviour modification.

Acknowledgements

The authors wish to thank the Sir James Dunn Animal Welfare Centre and the Department of Anatomy and Physiology of the Atlantic Veterinary College, University of Prince Edward Island, for their financial support of this work, and Novartis Animal Health Canada for their contribution to travel costs. We would also like to thank Tanja Bihr, Maria Coombs, Tracy Doucette, and Jody Sark for their excellent work as telephone interviewers, as well as Suzette Acorn, Sharon Gormley, and Karen Van Lunen for their assistance in data entry. None of this work would have been possible without the interest and enthusiasm of the participating veterinarians, their staff, and of course their clients, to whom we are enormously grateful.

References

Beaver, B.V., 1994. Animal behaviour case of the month. J. Am. Vet. Med. Assoc. 204 (3), 350–351.

Beck, A.M., Jones, B.A., 1985. Unreported dog bites in children. Public Health Rep. 100 (3), 315–321.

Beck, A.M., Loring, H., Lockwood, R., 1975. The ecology of dog bite injury in St. Louis, Missouri. Public Health Rep. 90 (3), 262–267.

Borchelt, P.L., 1983. Aggressive behavior of dogs kept as companion animals: classification and influence of sex, reproductive status, and breed. Appl. Anim. Ethol. 10, 45–61.

Borchelt, P.L., Voith, V.L., 1996a. Aggression in dogs and cats. In: Borchelt, P.L., Voith, V.L. (Eds.), Readings in Companion Animal Behaviour. Veterinary Learning Systems Inc., New Jersey, p. 221.

Borchelt, P.L., Voith, V.L., 1996b. Dominance aggression. In: Borchelt, P.L., Voith, V.L. (Eds.), Readings in Companion Animal Behaviour. Veterinary Learning Systems Inc., New Jersey, p. 234.

Campbell, W.E., 1985. The enigmatic biter. Modern Vet. Pract. 66, 198–200.

Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP), 1993. Injuries associated with dog bites and dog attacks. Health Canada, Ottawa, Ont., Canada.

Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP), 1996. Injuries associated with dog bites and dog attacks. Health Canada, Ottawa, Ont., Canada.

Chun, Y.T., Berkelhamer, J.E., Herold, T.E., 1982. Dog bites to children less than 4 years old. Pediatrics 69, 119–120.

Fletcher, R.H., Fletcher, S.W., Wagner, E.H., 1988. Clinical Epidemiology: The Essentials. Williams and Wilkins, Baltimore, p. 59, 203.

Guy, N.C., Luescher, U.A., Dohoo, S.E., Spangler, E., Miller, J.B., Dohoo, I.R., Bate, L.A., 2001a. Demographic and aggressive characteristics of dogs in a general veterinary caseload. Appl. Anim. Behav. Sci. 74, 15–28.

Guy, N.C., Luescher, U.A., Dohoo, S.E., Spangler, E., Miller, J.B., Dohoo, I.R., Bate, L.A., 2001b. Risk factors for dog bites to owners in a general veterinary caseload. Appl. Anim. Behav. Sci. 74, 29–42.

Hattaway, D., 1997. Dogs and insurance. J. Am. Vet. Med. Assoc. 210 (8), 1143–1144.

Hunthausen, W., 1997. Effects of aggressive behavior on canine welfare. J. Am. Vet. Med. Assoc. 210 (8), 1134–1136.

Karlson, T.A., 1984. The incidence of facial injuries from dog bites. J. Am. Med. Assoc. 251 (24), 3265–3267.

Kizer, K.W., 1979. Epidemiologic and clinical aspects of animal bite injuries. J. Am. Coll. Emerg. Phys. 8 (4), 134–141.

Landsberg, G.M., 1991. The distribution of canine behavior cases at three behavior referral practices. Vet. Med. 86, 1011–1018.

Line, S., Voith, V.L., 1986. Dominance aggression of dogs towards people: behaviour profile and response to treatment. Appl. Anim. Behav. Sci. 16, 77–83.

Miller, D.D., Staats, S.R., Partlo, C., Rada, K., 1996. Factors associated with the decision to surrender a pet to an animal shelter. J. Am. Vet. Med. Assoc. 209 (4), 738–742.

Patronek, G.J., Glickman, L.T., Beck, A.M., McCabe, G.P., Ecker, C., 1996. Risk factors for relinquishment of dogs to an animal shelter. J. Am. Vet. Med. Assoc. 209 (3), 572–581.

Podberscek, A.L., Serpell, J.A., 1997. Environmental influences on the expression of aggressive behaviour in English Cocker Spaniels. Appl. Anim. Behav. Sci. 52, 215–227.

Reisner, I.L., 1997. Assessment, management, and prognosis of canine dominance-related aggression. Vet. Clin. N. Am., Small Anim. Pract. 27 (3), 479–495.

Reisner, I.L., Erb, H.E., Houpt, K.A., 1994. Risk factors for behavior-related euthanasia among dominant-aggressive dogs: 110 cases (1989–1992). J. Am. Vet. Med. Assoc. 205 (6), 855–863.

Sacks, J.J., Kresnow, M., Houston, B., 1996. Dog bites: how big a problem? Inject. Prev. 2, 52–54.

Salmeri, K.R., Olson, P.N., Bloomber, M.S., 1991. Elective gonadectomy in dogs: a review. J. Am. Vet. Med. Assoc. 198 (7), 1183–1192.

Statistics Canada, 1996. Report of the 1996 census, Ottawa, Ont., Canada.

Voith, V.L., 1981. Profile of 100 animal behavior cases. Modern Vet. Pract. 62 (6), 483–484.

Wright, J.C., 1990. Reported dog bites: are owned and stray dogs different. Anthrozoos 4 (2), 111–119.

Wright, J.C., 1991. Canine aggression toward people: bite scenarios and prevention. Vet. Clin. N. Am., Small Anim. Pract. 21 (2), 299–314.