Demographics and characteristics of dog-on-dog attacks

Marie Doane, Sirkku Sarenbo*

Abstract: Dog-on-dog aggression is a societal concern and a significant animal welfare issue. This survey study investigated 130 cases of intraspecific aggression, of which 14.6% were performed by a pack of dogs (2-4 dogs). The victim dogs were 82% of small and medium size, and as the severity of the injury increased so did the number of small dogs. Most attacks happened daytime in the summer, in public places. An experienced female dog owner was most often the owner of the victim dog. The dog-on-dog attacks were 96% perceived as unprovoked and 82.3% performed by an unknown dog. In 43.8% of the cases, the attacking dog failed to respond to the victim dog's submission signals.

It was the owner/caregiver of the victim dogs who identified the attacking dog, and in 25% of the 130 cases, the victim dog owners identified the attacking dog as a crossbred. The major difference in the distribution of the attacking dog types in comparison to the victim dog types suggests that they are distinctly different populations, shown by categorizing the breeds in groups and sections according to the FCI breeds nomenclature.

The majority of the attacks were carried out by Bull type Terriers (FCI Group 3 Section 3), and Molossian type breeds (Group 2 Section 2), including mixed breeds derived from these groups. Among the victim dogs, Companion and Toy dogs (Group 9), and Retrievers -Lushing Dogs -Water dogs (Group 8) as well as Small sized Terriers (Group 3 Section 2), were more represented. The severe intraspecific aggression shown by the attacking dogs may indicate a pathological condition.

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Keywords: dog bite, dog-on-dog attack, FCI breeds nomenclature, intraspecific aggression, survey study

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HIGHLIGHTS

- Small and medium sized dogs are more at risk for dog attacks with serious consequences.
- The attacking dog population is dominated by Bull type Terriers (Group 3 Section 3) and Molossian type breeds (Group 2 Section 2) while the victim dog population may reflect the width of the general dog population.
- 96% of the dog attacks were perceived unprovoked and 82.3% were performed by an unknown dog.
- The attacking dog failed to respond to the victim dog's submission signals in 43.8% of cases.

INTRODUCTION

Dog (*Canis lupus familiaris*) on dog attacks are an animal welfare issue that needs to be scientifically investigated as the attacked dog's welfare is severely threatened, and the attacking dog's welfare is also at stake as the consequences of the attack may affect its welfare (Montrose et al., 2020). The human aftermath for the people exposed to these attacks can be deeply psychologically debilitating.

Individual dog behavioral trends are not solely dependably predicted by which breed the individual dog belongs to (Hammond et al., 2022) as genetic and environmental factors affect the phenotypic display of the distinct types of aggression in dogs (van der Berg et al., 2005). A dog's early environment significantly influences its behavioral development and social behavior in adulthood (Harvey et al., 2016). Consistent exposure to positive environmental and social experiences from puppyhood onward into adulthood is essential (Foyer et al., 2014), as negative experiences may increase the risk of aggressive behavior (Wormald et al., 2016). The environment includes the maternal care provided by the dam postpartum, as deficiencies in early puppy care can influence the adult dog's behavioral traits, including fear and aggression (Foyer et al., 2016), illustrating the importance of responsible dog breeding.

There seems to be some confusion in the classification and use of terminology concerning dog aggression (Houpt, 2006; Overall, 2013; Miklósi, 2015; Jacobs et al., 2018). In general, aggression can be divided into two main types, affective aggression and appetitive aggression (Moran et al., 2014). Affective aggression can further be divided into defensive or offensive depending on the underlying emotion and the reactions of freeze, flight, or fight (Lindsay, 2001) and is signified by robust emotional and communicative module and is physiologically accompanied by a substantial sympathetic activation (Schilder et al., 2019). Intraspecific aggression is generally categorized as affective aggression and with fear as the primary core emotion. Appetitive aggression in intraspecific aggression is also present albeit very seldom and could be classified as predatory aggression (Schilder et al., 2019). Predatory aggression lacks sympathetic arousal and involves a determined and goal-directed attack (Weinshenker and Siegel, 2002). Instead of "predatory aggression" the terms "predatory behavior" or simply "predation" has been preferred in literature (Miklósi 2015; McLennan, 2023). Similarly, "aggressive behavior" is preferred to describe a style of behavior instead of "aggression" that is a d distinct unit of behavior (Mills, 2017).

The term "dog attack" is probably a negatively charged word for most people and includes the unwanted approach of a dog that is perceived as hostile. The dog attack can be directed at people or animals, including other dogs. According to Moxon et al. (2016) it is "when a dog sets upon another dog in a forceful, violent, hostile or aggressive way, involving physical contact". Additionally, it is the part of the aggressive interaction that results in physical injury (Miklósi, 2015). The damage a dog's bite can inflict depends - among other factors - on the learned bite inhibition of the biting dog (Caffrey et al., 2019). The idea is that a dog that has learned to inhibit its bite in puppyhood is

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more likely to inhibit its bite when exposed to real-life biting situations later in life (Miller et al., 2016). A dog with a bite history of injurious bites is used by practitioners as a strong indication and as a prediction for future bite and bite severity. A dog is likely to be biting again and then with the same or higher bite severity (Donaldson, 2004; Dunbar, 2017).

Statistics of dog-on-dog bites are rare and confusing, and depending on how they are interpreted different conclusions can be obtained. The total number of dog attacks is underrepresented in any available statistics, most dog-on-dog attacks are non-injurious and part of a dog's normal behavior (Schilder et al., 2019). The exact number of a given breed and additional crossbred contributions in a specific community is unknown and thus impossible to precisely calculate by how much any breed is overrepresented in any biting statistics (Duffy et al., 2008). Different breeds do however show differences in dog-directed aggression (Mehrkam and Lynne, 2014), for example 20% of Akita, Jack Russell terriers, and Pit Bull terriers were observed to be serious intraspecific aggressive, i.e. displaying bites or bite attempts (Duffy et al., 2008). Others have found that intraspecific aggression is frequent as 22-47% of dogs are aggressive toward unknown dogs (Tiira et al., 2016; Blackwell et al., 2008; Casey et al., 2013; Wormald et al., 2016). Bull type dogs including purebred and crossbreds are overrepresented among injurious intraspecific aggression (Schilder et al., 2019; Montrose et al., 2020; van Herwijnen et al., 2023) and the same is observed in severe human-directed aggression (Sacs et al., 2000; Golinko et al., 2017; Mora et al., 2018; van Herwijnen et al., 2023). However, characteristics and behavior of owners could also contribute to overrepresentation of Bull types as dog killing dogs (Schilder et al. 2019).

The owner's personality may influence what type of dog they choose to acquire. For example, owners of Rottweilers and German Shepherds harbored more ''aggressive'' personality traits than owners of Labrador and Golden retrievers (Wells and Hepper 2012). There is also a subsection of people that acquire dangerous dogs as a status symbol (Harding 2013) while other dog owners acquire the dog by impulse and opportunity, and not by an active decision-making process (Holland 2019).

A major concern associated with Bull types is their pronounced predisposition toward intraspecific aggression (McMillan and Reid, 2010). Intraspecific aggression and human-directed aggression show no or very low correlation suggesting that the causal factors are separate and distinct (Hsu and Sun 2010; Mehrkam and Lynne, 2014).

Today many of the dog breeds are selected primarily on morphology for show competition and their original breed purpose is no longer under genetic selection (Stafford, 2006; Svartberg, 2010;). Relaxation of the selection pressure of traits can lead to an increase in that trait's variance (McPhee, 2004). Traits that have earlier been under selection and are no longer selected for, can lead to a greater proportion of the population exhibiting the tail version of the trait from the originally selected distribution (McPhee and Silverman, 2004). Overall (2013) exemplifies this with the complex and variable trait of protectiveness that comprises many different behaviors and under selection generates a normal

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distribution of protective behaviors. In the tails of this distribution on one side inappropriately shy individuals could be found and on the other end of the distribution, inappropriately fierce individuals could be found. At the peak of the distribution the appropriate, protective dogs can be found for the selection. Suppose the selection for protectiveness relaxes or the dogs are bred uncritically. In that case, the tails in the distribution will widen, and more individual dogs will display inappropriately fierce and inappropriately shy behavior regarding protectiveness.

It is suggested that crossbreds may have more behavior problems in comparison to purebred dogs (Turcsán et al., 2017) and crossbreds may be more disposed to dog-on-dog aggressiveness than purebreds (Hsu and Sun, 2010). This is a possible display of the outcome of relaxation of selection pressure when breeds are mixed without distinct behavioral selection. Another hypothesis could be that crossbreds are socialized and habituated differently than purebreds.

Intraspecific aggression can constitute normal dog behavior that is usually settled through ritualized behavioral gestures including both threatening behaviors as well as affiliative and agonistic submission behaviors seldom leading to severe injuries as the conflict is settled (Cafazzo et al., 2010; Bonanni et al., 2017). Some dogs may develop pathologies in intraspecific aggression and can be defined as consistent and under the offender's volition while the aggression is not appropriate given the context (Overall 2013). Prior to the attack, any lack of interaction or signals from the victim dog is enough to exclude normal behaving inter-dog aggression. Dog-directed aggression pathology tends to escalate. Pathologically impacted aggressive dogs are impaired in at least one of the following essential competencies. 1. Interpreting behavioral signals accurately. 2. Interpreting/ processing the signal information accurately. 3. Planning appropriately after interpreting and processing the behavioral signals. 4. Acting the plan effectively including behavioral signaling (Overall, 2013). It was found that dogs displaying intraspecific aggression often had harmful experiences with other dogs earlier such as dog attacks or had limited social experiences (Schilder et al., 2019). However, for some dogs, intraspecific predatory aggression might be the pathology instead of severe intraspecific aggression.

Predatory aggression towards conspecifics is a pathology signified by silent aggression and depending on circumstance including one or more of the predatory behavior elements such as staring, salivating, stalking, and tail twitching. The attacks are performed quietly and unannounced and may include bites and shakes. As intraspecific aggression progresses the behaviors transform into more predatory-like aggression (Overall, 2013).

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Predatory behavior has been selected in hounds and not surprisingly some individuals in breeds such as greyhounds (FCI group 10 Section 3) will chase and kill small animals such as rabbits, cats, and small dogs given a chance. Whether this behavior can be prevented with early socialization to small animals and mitigation in former race dogs is questionable and the only safe option is to prevent any opportunity for this genotype to engage in the

behavior (Howell and Bennett, 2020). Additionally, several breeds have been selected for hunting specific target species such as deer, fox, badger, or rats (Stafford, 2006), to mention a few.

The scientific knowledge of the intricate behavior of pack-hunting dogs is relatively unknown (Miklósi, 2015). Feral dogs are known to hunt wildlife in packs of 2-8 individuals (Wierzbowska et al., 2016). Very little is scientifically investigated regarding dog attacks where multiple dogs attack another dog. Predatory drift is a term that is well known among dog professionals, and it refers to when a social interaction between dogs suddenly turn into predation. A small dog struggles and panics and the movement and noise trigger a predatory response in the other dog or dogs. This is especially perilous between dogs of different sizes and weight classes. Another version is play-chasing when suddenly, instead of playing, predation appears, and the chasing dogs are now predating (Donaldson, 2004). A behavior can be socially facilitated when one dog's behavior educes the same behavior in other individuals (Clayton and Clayton, 1978), explaining behavior during an attack by multiple dogs.

It has been suggested that predatory aggression and affective aggression, despite their differences in brain mechanisms, cannot be considered different types of aggression but regarded as diverse alternative neurobiological roads leading to abnormal aggression (Haller, 2013; Tulogdo et al., 2015). Dogs depend on learning and experience in the development of specific aggressive responses (Miklósi, 2015) and depending on experiences and underlying genotypes, different aggressive phenotypes emerge.

Behavior testing of dogs that have maimed or killed other dogs is difficult and problematic. For example, territorial, intraspecific, and predatory aggression is sometimes not expressed when testing shelter animals for aggression and thus perhaps a poor indicator of future aggressive behaviors (Christensen et al., 2007). When testing Pit Bulls from dogfighting lines, all of them did not display aggressive behavior towards a model dog (Miller et al., 2016). This can be attributed to many factors such as but not limited to, the model dog not being experienced like a real dog and fear in the tested dog for the test situation or the test evaluator (Miller et al., 2016). Another way of assessing the severity of dog-on-dog bites, retrospectively, is by using Dr. Ian Dunbar's Dog Bite Scale. The bite scale starts at Level 1 and ends at Level 6 with the death of the victim (Dunbar, 2017). Dunbar's Dog Bite Scale aims at assessing the severity of biting problems based on an objective evaluation of human wound pathology. In this work, the scale is used to assess injuries to dogs.

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Research aims and questions

This study is based on the responses of an online survey in which dog owners answered questions about the dog attack their dog suffered, and aims to describe the demographics, characteristics, and chronology of these dog-on-dog attacks.

Our research questions are as follows:

1. What are the demographics of the dogs that were attacked (e. g. sex, reproductive status, age) as well as their caregivers (e. g. gender, age, household circumstances)?

2. Which dog types, as classified in groups and sections by the FCI nomenclature, were most frequently involved in seriously injuring or killing other dogs, and which types, as classified by the FCI nomenclature, were most commonly the victims of such severe attacks?

3. What are the nature (when, where, how) and consequences (assessment of injury severity) of the attacks?

4. If certain dog types are overrepresented in dog-on-dog attacks, what factors contribute to this overrepresentation?

MATERIAL AND METHODS

A survey was created through a multilingual survey system software "Survey & Report" produced by the Swedish University Computer Network, "Sunet". The survey included an introductory text presenting the aims of the survey, responsible researchers and their contact information, and information that participating was voluntary and that the answers were given anonymously. The respondents were also informed that due to the nature of the matter some of the questions could be experienced emotionally difficult to answer, and that the results would be published and presented in the form of a scientific article. The purpose given was to map the circumstances and factors in conjunction with dog-on-dog attacks, and how the event affected the dog owner.

For the sake of simplicity, we use the terms "victim dog" for the dog that was injured or killed during the attack, and "attacking dog" for the dog that performed the attack and caused the injury, regardless of if it was the initiator of the attack or not.

The 52 questions consisted of single and multiple-choice questions, matrix, open text, numeric, and calendar questions (Appendix 1). Choices for the question about the owner gender were "female", "male", "other" and "I don't want to answer", and choices for the sex and reproductive status of the victim dog were male, female, neutered male and spayed female. Branching logics were used for questions 26 and 49 (if the victim dog died due to the attack, and if the dog attack was reported to an authority). Depending on the answers, follow-up questions were shown or hidden and if hidden, questions about the next topic became visible. Additionally, a comment field for additional feedback was included in questions 1, 3, 4, 11, 14-16, 10-23, 25, 26, 36, 37, 44, 47 and 48-52.

Questions 1-23 are included in this work and the survey answers are analyzed and presented as descriptive statistics in tables and figures.

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The publishing period was from June 30th to December 31st, 2023. The survey was distributed through a group consisting of people whose dogs had been attacked by other dogs. This approach represents a form of purposeful sampling (Emmel 2014) targeting extreme or deviant cases—namely individuals whose dogs had been injured or killed in such incidents. The group was established on July 20 and had 2 155 members on March 14, 2024 (Protect Our Pets UK, 2024). It was possible to reply once from one IP address (Internet Protocol address).

Dunbar's Dog Bite Scale was developed by Dr. Ian Dunbar and it classifies dog bites into 6 levels which are centered on evaluation of human wound pathology: number of bites, skin contact, depth of punctures, and tissue damage a dog bite inflicts (Dunbar, 2017). It is an objective assessment tool that was used in Question 22 of our survey, where the respondent was asked to estimate the severity of the injuries to their own dog.

The respondents were also asked to indicate the breeds or types of their dog and the attacking dog (questions 5 and 22), and after interpreting the answers both attacking and victim dogs were categorized into breed groups and sections according to the FCI breeds nomenclature (Federation Cynologique Internationale, 2024). It is not always easy to determine a dog's breed, but much easier to attribute an individual to an FCI breed group and within the breed group, a subgroup (or "section"), where breeds with similar appearance and or characteristics are gathered.

Crossbreds were also categorized into the FCI groups and sections, led by the first mentioned breed. The Group 3 Section 3, Bull type terrier included all breeds and crossbreds closely related to the American Pit Bull terrier (e.g. American Bully XL or "Pocket Bully", Pit Bull, "Staffy"). American Bulldog was categorized in Group 2 Section 2 Molossian type. Breeds named as "Lurcher" or "Terrier" were designated group only. Microsoft Excel 365 Workbook was used to calculate central tendencies (mean and mode) and to visualize the data with tables and graphs.

RESULTS

Demographics of the victim dog and its owner

The survey was completed by 130 respondents from the group with 2 155 members per March 2024 (Protect Our Pets, 2024). The respondents were 84.6% female and the rest male. The median and mode age group of the dog-owner at the attack was 51-60 years, with the distribution from 1-14 years up to 71- 80 years of age.

The respondents' country of origin was 89.2% Great Britain, 9.2 % USA and 0.8% Sweden. The median and mode size of the households was 2 persons (range 1-6) and 68% of respondents had owned as a median and mode of three or more dogs (range 1-10).

Of the dogs 56.9% were purchased from a breeder as puppies while 8.5% were

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obtained from an animal shelter/dog home as a puppy or a young dog. Twelve point two percent of the dogs were acquired as adult dogs from animal shelters/ dog homes. Of the dogs that were obtained from animal shelters/dog homes, 45% had no prior homes.

The purchase price for the dogs varied from 0-100 USD/GBP/EUR up to more than 2,500 USD/GBP/EUR, with a median purchase price of 301-500 USD/GBP/EUR and a mode of 501-1,000 USD/GBP/EUR. The victim dog coat colors were distributed across ten categories, and in addition, the color nuances were described in detail in 29 comments. About half of the victim dogs (n= 64) were either black (19.7%), white (15.7%) or fawn (15%).

The victim dog's sex was fairly evenly distributed with a slight overrepresentation of intact males and came from a household with a medium and mode of one dog in the household. The dog's median age at the time of the attack was 3-4 years while the mode was 7-10 years (Table 1). Fifteen of the victim dogs (11.5%) were younger than one year old.

Characteristics of dog-on-dog attacks

One hundred and eleven of the 130 attacks were performed by single-dog (85.4%) while 19 attacks (14.6%) were performed by multiple (range 2-4) dogs.

Sex and reproductive status	
Intact male	45 (35%)
Intact female	27 (21%)
Neutered male	25 (19%)
Spayed female	33 (25%)
Sum	*130 (100%)*
Number of dogs in the household	
1 dog	85 (65%)
2 dogs	33 (25%)
3-4 dogs	8 (6%)
5-6 dogs	2 (2%)
10 or more	2 (2%)
Sum	*130 (100%)*
Age at the time of the attack	
<12 months	15 (12%)
1-2 years old	22 (17%)
3-4 years old	30 (23%)
5-6 years old	15 (12%)
7-10 years old	31 (24%)
>10 years old	17 (13%)
Sum	*130 (100%)*

Table 1. Details of the victim dogs. Sex, reproductive status, age and number of dogs in the households.

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The month of the dog attack	n=130	Time of the day for the dog attack	n=130
Month	% responses	Time	% responses
January or February	11.5	5:00 -09:00	10.8
March or April	18.5	09:01-12:00	25.4
May or June	16.2	12:01-15:00	24.6
July or August	23.8	15:01-18:00 32	24.6
September or October	14.6	18:01-22:00 18	13.8
November or December	10		
I can't remember	5.4		

Table 2. Month of the year and time of the day for the dog attack.

Familiarity with attacking dogs (n=130)	
unfamiliar dog	107 (82%)
A familiar dog owned by a close friend or family	1 (1%)
Somewhat familiar dog belonging to an acquaintance	2 (2%)
Somewhat familiar dog belonging to a neighbor	15 (12%)
Other	5 (4%)
At the attack, my dog was… (choose all that apply)	
on short leash	70 (54%)
on flexi leash	17 (13%)
loose	14 (11%)
supervised by owner	22 (17%)
supervised by someone else	3 (2.3%)
without supervision	1 (0.77%)
other	3 (2.3%)
Location of the attack (n=130)	
inside your house or apartment	3 (2.3%)
in your garden or back yard, outside the apartment building	10 (7.7%)
inside the home or home territory of the attacking dog	1 (0.77%)
public beach	2 (1.5%)
public park	40 (31%)
public square or street	19 (15%)
outdoor public exercise track	2 (1.5%)
residential area with single-family houses	21 (16%)
residential area with multi-level houses	7 (5.4%)
public dog exercise area	1 (0.77%)
main road/forest	15 (12%)
parking lot	1 (0.77%)
other	8 (6.2%)

Table 3: Details of the attacking dogs and attack circumstances.

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In total 158 dogs were participating as attacking dogs. The dog attacks occurred all through the year but with an increased frequency from March through August (Table 2). None of the dog attacks occurred in the overnight hours and they did occur throughout the day with ~¾ occurring from 9:00-18:00 (Table 2).

The vast majority (82.3%) of the attacking dogs were unfamiliar to victim dog owners and 11.5% belonged to a neighbor. At the time of the attack, 14% of the victim dogs were loose and 1% were without supervision. The vast majority of the victim dogs were leashed either on a short leash or a retractable lead. Three point one percent of the dog attacks occurred indoors at the victim owner's home or at the attacking dog's home. The rest of the attacks took place in public places such as public parks, public squares, and residential areas (Table 3).

Of the respondents, 96.9% stated that they perceived the attacks as unprovoked and 43.8 % claimed that the attacking dog continued the attack despite the victim dog was signaling submission. None of the survey participants perceived that the victim dog provoked or initiated the attack. They also claimed that none of the victim dogs inflicted damage on the attacking dog nor was fighting initially on equal terms with the attacking dog (Table 4).

Respondents claimed that 30.8% of the person in charge of the attacking dog remained passive when their dog attacked while another 26.9% tried unsuccessfully to stop the attack. In 17.7% of the answers, the respondents perceived that the attacking dog escaped from a backyard or enclosure and that 14.6% of the attacking dogs broke free from the leash (Table 5).

Breed groups and affiliations as well as the distributions of injury severity of the attacking and victim dogs

The victim dogs were divided into three size categories: small, medium, and large (Fig 1). The majority of the victim dogs were small or medium sized while 14% of the victim dogs were large.

Dog behavior at attack	% of dogs
the other dog attacked my dog unprovoked	97%
the other dog continued the attack despite that my dog was submissive	44%
my dog provoked the other dog to attack	0%
my dog was the initial attacker	0%
my dog inflicted damage on the other dog	0%
my dog was fighting with the other dog, initially on equal terms	0%

Table 4. Dog behavior at attack (n=130).

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Please select all the statements that describe parts of the attack your dog suffered	No (%)
the dog was intentionally provoked to attack my dog	4 (3.1%)
the dog escaped from a backyard or fenced enclosure	23 (17.7%)
the dog escaped from a car	2 (1.5%)
the dog attacked while handled and on the leash	16 (12.3%)
the dog broke free from the leash	19 (14.6%)
the person in charge of the dog remained passive when the dog attacked my dog	40 (30.8%)
the person in charge of the dog unsuccessfully tried to stop the attack	35 (26.9%)
the dog was loose and unsupervised	36 (27.7%)
the dog was loose and supervised	37 (28.5%)
the dog was chasing wild animals	1 (0.8%)
my dog voluntarily approached the attacking dog and behaved provokingly	0 (0.0%)
other (please explain in comment)	10 (7.7%)

Table 5. Circumstances during the dog attacks (n=130).

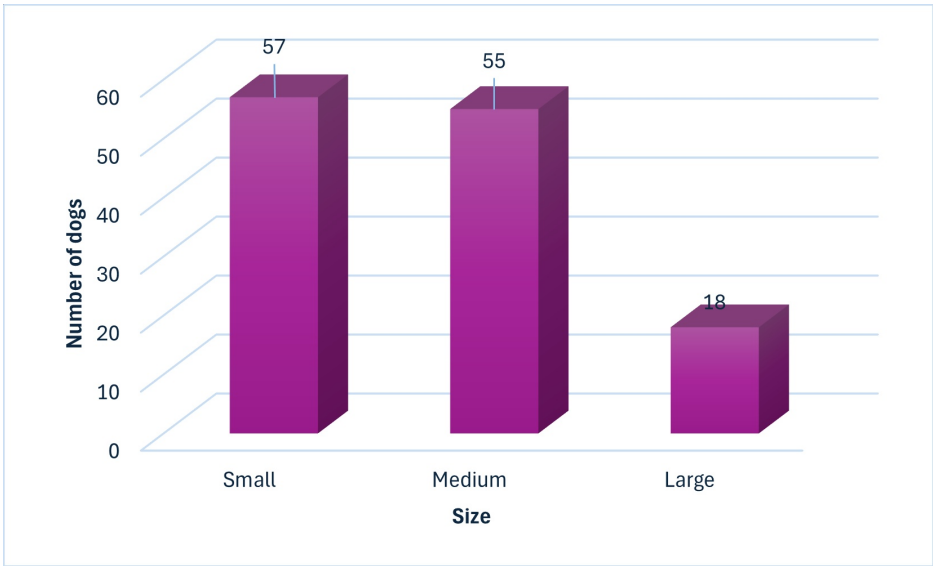

Figure 1. Distribution of the victim dog sizes (n=130).

The attacking dog breeds (inclusive crossbreds) were distributed over 16 different FCI sections. It was the victim dog owner who determined the breed of the attacking dog and 25% of the dogs were labeled as crossbreds or unsure of breed and assigned to the first breed that was labeled.

A disproportionate number of the attacking dogs belong to the Group 3 Section 3 Bull type terriers (56%). The Molossian type (Group 2 Section 2) was the second most represented with 16% (Fig.2).

The victim dogs (n=130) were distributed over 31 different FCI Sections (Fig 3), and among them Groups 3, 8, and 9 were more presented.

The injuries were categorized using the Dunbar's Dog Bite Scale (Dunbar 2017) as a measure of the severity of the attack. Single dog-attack victims (n=111) and multiple dog-attack victims (n=19) were assessed separately (Table 6).

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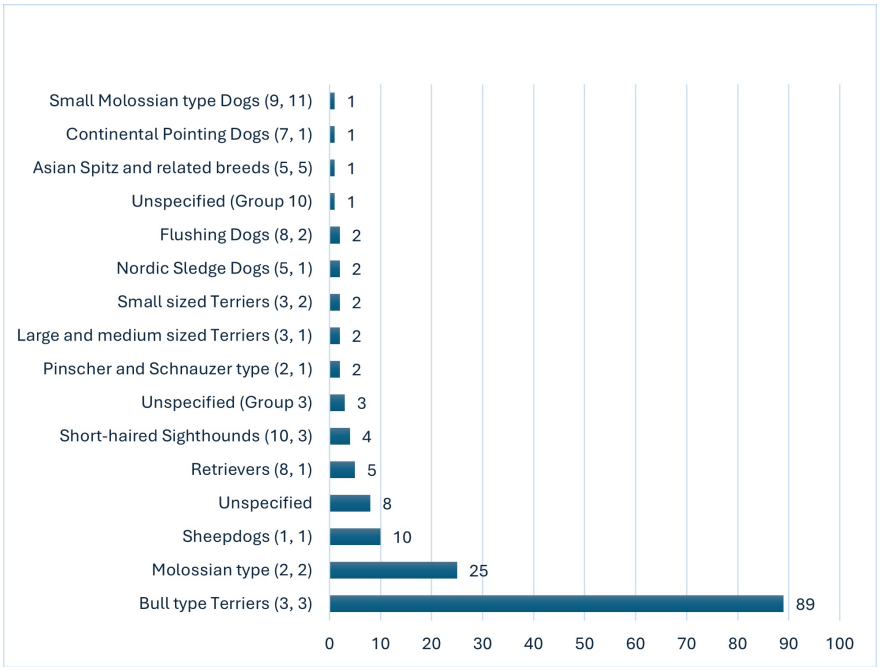

Figure 2. Distribution of attacking dogs (n=158). Designation of the FCI group followed by group and section number in parenthesis.

Dunbar's Dog Bite Scale	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Single Attack (n=111)						
Attacking dog	1(1), 2(1), 3.3(5), 7(1), 8(1), X(1)	1(3), 2(3), 3(1), 3.3(9), 5(1), 8(3), 10(2), X(1)	1(2), 2(2), 3.3(7), 8(1), X(2)	1(2), 2(3), 3.3(17), 5(1), 10((1)	2(2), 3.3(10), 8(1), 10(1), X(1)	1(1), 2(2), 3(1), 3.3(20), 5(1)
Victim dog	2(1), 3(2), 5(1), 6(1), 8(3), 9(1), 10(1)	2(2), 3(4), 3.3(1), 4(1), 8(6), 9(6), 10(2)	1(3), 2(1), 3(2), 3.3(1), 5(1), 7(1), 8(4), 9(1)	1(2), 2(1), 3(3), 4(1), 6(2), 7(2), 8(2), 9(5), 10(6)	1(1), 2(2),3.3(1), 8(4), 9(6), 10(1)	2(1), 3(7), 4(1), 5(4), 8(3), 9(8), 10(1)
Multiple Attack (n=19)						
Attacking dog		3.3(1), X(1)	3(1), 3.3(1)	3.3(1)	2(5), 3.3(5)	3.3(4)
Victim dog		5(1), 8(1)	3 (1)	2(1)	2(2), 3(2), 4(1), 6(1), 8(2), 9(1), 10(2)	2(1), 3(1), 8(1)
3.3 (Bull type Terrier) attacks	5 50%	10 40%	8 47%	19 73%	14 66.7%	24 83.3%
Total no. of victims	11	25	17	26	21	30

Table 6. Dunbar's Dog Bite Scale level distribution of victims and attacking dogs. FCI Group number followed by number of dogs belonging to the group in parenthesis. X= unknown breed or group. FCI Group 3 Section 3 Bull type terriers (=3.3)

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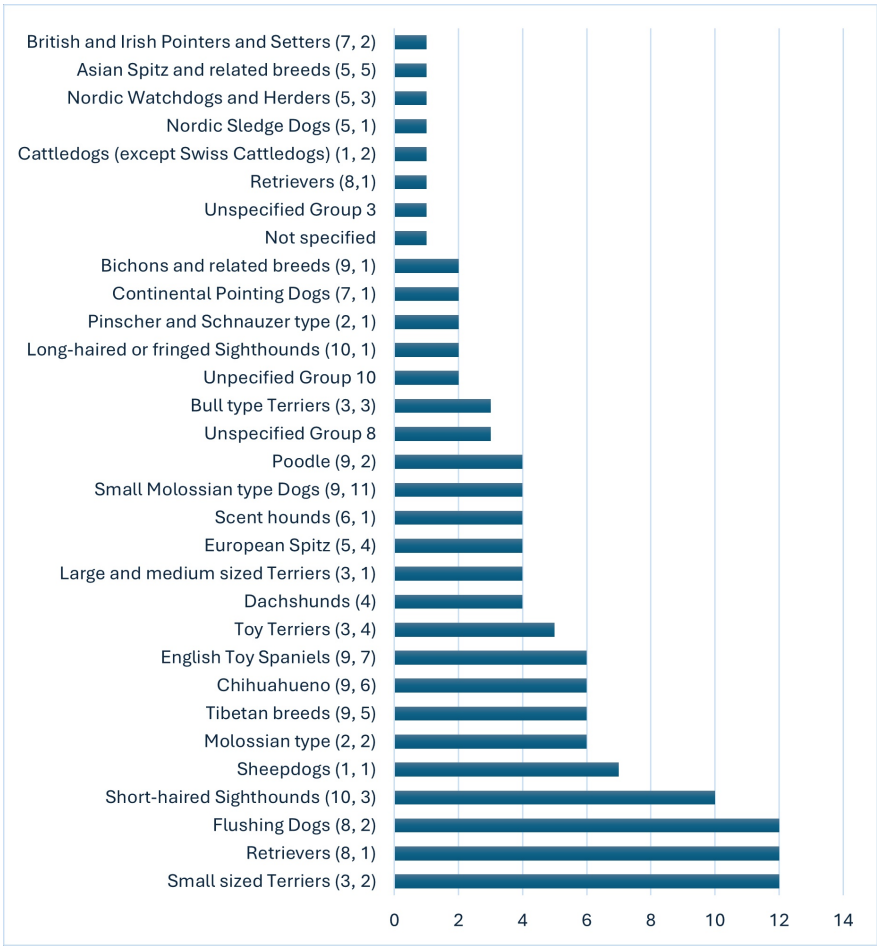

Figure 3. Distribution of victim dogs (n=130). Designation of the FCI group followed by group and section numbers in parenthesis.

Unknown types were listed in Group X (Table 6). The group was listed first and then within parentheses are the numbers of the dogs and they are plotted against the injury severity (Dunbar's Dog Bite Scale) that the victim dog endured. The owner of the victim dog scored the dog's injuries from the dog-on-dog attack using the Dunbar's Dog Bite Scale.

The distribution of Dunbar scores for the victims (N=130) was distributed among all six different scores with a trend of survey responders with a higher Dunbar score. Only one dog was counted per attack regardless of whether the attack was a single or multi-dog attack in Table 6. Of the 130 attacks 14.6% were performed by multiple dogs (range 2-4 dogs).

When separating the attacks into single-dog attacks and multiple-dog attacks the following distribution appears after categorizing the dogs into FCI breed groups and Dunbar's Dog Bite severity. Sixty-eight of the 111 single-dog attacks (63.3%) were performed by Bull type terriers (Group 3 Section 3), followed by Molossian type (Group 2 Section 2) at 11.8 %. The multidog attack distribution (one FCI breed group designation=one attack) follows the trend of single-dog attacks with 63% of the attacks performed by Bull type terriers

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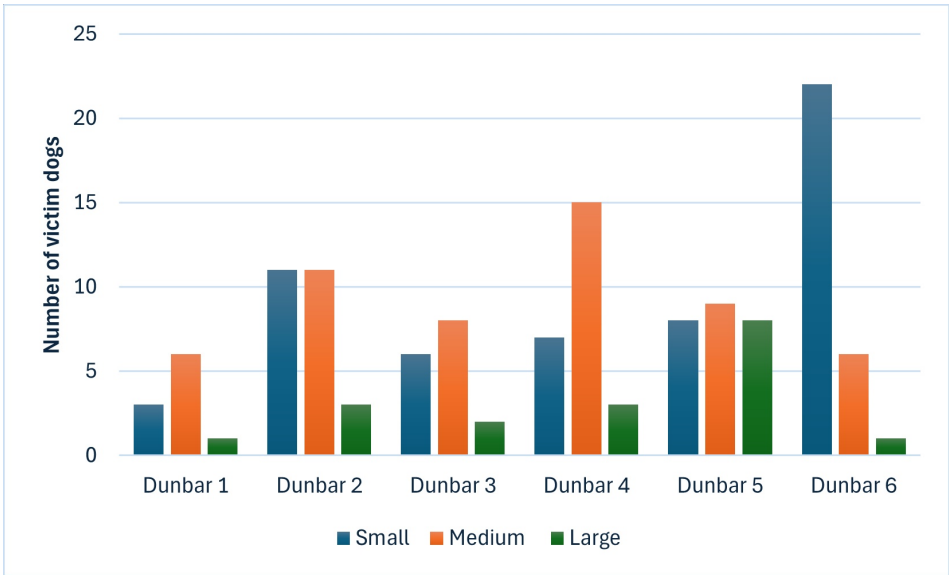

Figure 4. Distribution of victim dog sizes along the Dunbar's Dog Bite Scale (n=130)

followed by Molossian type at 26.3%.

Separating the victim dogs into single and multiple attacks into FCI breed groups reveals that Group 9 (Companion and Toy Dogs) was more represented with 24.3% of the victims as well as Group 8 (Retrievers – Flushing Dogs – Water Dogs) with 19.8%. Group 3 (Terriers) was also a numerous victim (16.2%). When it comes to the multiple dog attack victims it is Group 8 (Retrievers – Flushing Dogs – Water Dogs) that endure 26.3% of the multiple dog attacks while Group 2 (Pinscher and Schnauzer - Molossoid and Swiss Mountain and Cattle dogs) and Group 3 (Terriers) were suffering from 21.1% of the attacks.

Investigating the FCI breed group and section of the attacking dogs and the Dunbar's Dog Bite Scale as a measure of the severity of the attack, it becomes apparent that the Group 3 Section 3 Bull type terriers are overrepresented, and its representation increases as the bite severity increases. At Dunbar Level 6, 83.3% of the attacking dogs were Bull type terriers. Furthermore, 26.3% of the multiple dog attacks at Dunbar's Dog Bite Level 5 were by Group 2 Section 2 Molossian type as well as Bull type terriers.

In single dog attack victim's Dunbar's score, a trend line is discernable, as the Dunbar's score increases so does the number of Group 9 breeds (Companion and Toy Dogs). No discernable pattern emerges for Dunbar's score for the victim dogs that suffered an attack by multiple dogs. Many different FCI breed groups were victims of an attack from multiple dogs, though, for instance, the Bull type terrier Section was nearly absent.

Another way of illustrating the victim dog's severity of the injury was by illustrating Dunbar's Dog Bite Levels plotted against the size of the victim dogs (n=130). The trendline illustrates that as Dunbar's Dog Bite severity level increases so does the number of small dogs being the victim of attacks.

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Discussion

Limitations and strengths of methodology

Surveys may present challenges as a method. Errors in reporting facts can arise from memory problems (especially concerning events farther back in time), response biases or that the questions were interpreted differently by the respondents (Maruyama and Ryan, 2024). Questions with unwarranted assumptions may annoy respondents and produce invalid data (Maruyama and Ryan, 2024) or that the survey is left unanswered. It is also conceivable that the questionnaire is left unanswered to avoid reliving a traumatic event.

The number of respondents was n=130. This must be considered a small sample of dog owners who have experienced a dog-on-dog attack and not representative of all dog-on-dog attacks, not even within the actual potential survey respondents, Protect Our Pets, because the response rate was only 6%. However, results from purposeful sampling strategy represent cases that are considered unusual or extreme in some respects and are therefore those from which researchers can learn the most (Emmel 2014). Most respondents were women from the UK, which introduces another potential bias. It also raises the question of whether this group can be considered representative of the broader population of victims of dog-on-dog attacks. However the kind of participants in this survey are rarely described in the scientific literature, and the topic is rarely studied thus making this an important exploratory study. Furthermore, this work broadens the focus on specific dog breeds into subgroups, sections, where several breeds with similar characteristics have been gathered, in accordance with the FCI's breeds nomenclature. Directing legislative measures toward specific groups or sections could facilitate enforcement by eliminating the need to identify and classify individual breeds.

A limitation of the Dunbar Dog Bite scale could be that it is developed to human wound pathology, and it may need to be modified to better fit the dog's skin. Additionally, it does not differentiate between multiple Level 3 bites, which introduces ambiguity. For more precise application, it is recommended that a comprehensive review be conducted to determine which levels to include. Caffrey et al. (2019) suggest an intermediate category, such as a "Level 3.5," to account for multiple Level 3 bites. van Herwijnen et al. (2019) instead grouped the Dunbar scores into the categories of ‘moderate’, ‘severe’ or ‘extremely severe’ biting.

Demographics of the victim dog and its owner

The distribution of severity of the dog attacks shows that dog-on-dog attacks of all levels of severity are represented (Fig. 4) as well as both single attacks and attacks by multiple dogs.

The victim dog owners were 86.4% female. This could be due to women owning small dogs, being more exposed to dog-on-dog attacks because they more frequently walk their dog or being more likely to answer a survey. While the medium and mode of the age of the dog owner was 51-60 years only two

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respondents were younger than 20 years old. In a UK national dog survey, 73.5% of respondents (N= 354,046) representing 3.4% of the canine population in the UK were female dog owners and 48.2% were aged 45-64 (Anderson et al. 2023). In a Swedish study women were registered owners for 64-65% of the dog population between 2012 and 2022 (Sarenbo and Striwing, 2023). Most of the victim dog owners in this study were experienced dog owners who had previously owned three or more dogs suggesting that the attacks in many cases were unpredictable since an experienced dog owner is capable of reading and interpreting the dog's signals and avoiding the situation altogether if possible.

The sex of the victim dogs was fairly even distributed with 35% of the victims being intact males. The sex of the attacking dog is unknown since the question was not asked in the survey and highly likely in the heat of the attack that detail was missed by many of the victim dog's owners. Male dogs are overrepresented as attacking dogs (van Herwijnen et al., 2023) and males do often attack other males (Schilder et al., 2019). Of dogs attacking guide dogs the majority (62.4%) were male (Moxon et al., 2016). Very little information about the distribution of sexes of the victim dogs exists in the literature for comparison.

One could speculate that 65% of the dogs came from a household with one dog, that in some of the cases, the victim-dogs were poorly socialized to other dogs and maybe that contributed to the incident if it could be defined as inter-dog aggression (McEvoy et al., 2022). However, the main reason for dogs attacking other dogs is believed to be an earlier trauma, whereas the attacking dog has been attacked by a dog or dogs previously in life (Schilder et al., 2019). It is conceivable that some of the dogs that survived the attack in our study were also traumatized and develop fear and/or aggression towards dogs similar to the attacking dogs or generally towards all dogs.

Characteristics of the dog-on dog-attacks

Most attacks happened during daytime and in the summer that is the time of the year in the northern hemisphere when people in general are more active compared to the winter and night. Human-directed attacks were also more common during the summer (Montrose et al., 2020).

The majority of the victim dogs were supervised and on a short leash or a retractable lead when attacked, suggesting that it can be difficult to prevent the dog being bitten. Only 14% of the victim dogs were loose and 1% without supervision. Both supervision and whether on a leash were combined in this question which can result in difficulty in distinguishing between these factors. Ninety-seven percent of the attacks happened in the public space, further suggesting that severe intraspecific aggression is a societal as well as an animal welfare issue.

In the survey, 82.3% of the victim dogs were attacked by an unfamiliar dog -and 96% of the victim dog owners perceived that the attack was unprovoked-, suggesting intraspecific aggression, with elements of predatory aggression in some dogs. Aggression directed toward unfamiliar dogs is a common behavior

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problem among dogs (Haug 2008) and attacking unprovoked is one of the behavioral signatures of predatory behavior but, it is also a trait of progressing intraspecific aggression (Overall, 2013). Both behaviors could be fairly easily observed during an attack and could be used as part of an assessment of the risk of intraspecific aggression. A dog that attacks after being provoked by a familiar dog is possibly less likely to be pathologically intraspecific aggressive. None of the respondents stated that their dog provoked the attack nor was the initial attacker, or inflicted damage on the attacking dog.

The behavior impairments in inter-dog aggression may manifest as deficits in one or more key dog social abilities, including the ability to accurately interpret and respond to signals displayed by other dogs, formulating appropriate response strategies, and executing those strategies effectively (Overall, 2013). Dogs that attack seemingly unprovoked and inflict serious injuries or fatalities on other dogs might often demonstrate deficits in these areas. Specifically, the attacking dog may fail to recognize appeasement signals from the other dog, or it may be unable to process the incoming information or respond appropriately once the attack has commenced. In this study, approximately half of the attacking dogs engaged in aggression at or above Dunbar's Dog Bite Level 3 were reacting to signals of submission from the victim dog. However, the severity of injuries suggests a deficiency in processing the submissive cues and terminating the aggressive behavior. Heightened arousal may also confound their ability to cease the attack (d'Ingeo et al., 2021). The distinction between intraspecific aggression and predatory aggression remains challenging, as these behaviors may arise from distinct neural mechanisms and motivational drives. It is plausible that some dogs exhibit predatory aggression, while others display extreme intraspecific aggression. Research in other species, such as rats and cats, indicates that predatory aggression has distinct different neurological pathways (Haller, 2013; Tulogdi et al., 2015).

All cases are significant for the assaulted dog and their owner, however, the cases that result in significant injury and death must be viewed differently as dog-killing dogs should be considered dangerous towards other dogs, animals and potentially also to humans.

van Herwijnen et al. (2023) found that 63% of the attacking dogs' owners did not offer help when their dog bites people or dogs/other animals. In this study, 31% of the owners were perceived as passive when their dog attacked the victim dog. Twelve percent of the attacking dogs were leashed during the attack in this study while elsewhere, 29% (Sarenbo, 2019) and 14% (van Herwijnen et al., 2023) of the attacking dogs were on the leash while attacking another dog. Similar data emerges when viewing how many attacking dogs that pulled loose to attack, with this study counting 14% while elsewhere, 10% (van Herwijnen et al., 2023) and 17% (Sarenbo 2019) of the dogs broke off their leash.

Seventy-two percent of the attacking dogs were roaming in van Herwijnen et al. (2023). In this study, the dog was loose and unsupervised in 27.7% of the cases and an additional 28.5% were loose and supervised. It should be noted that the dogs that escaped from their backyards were probably unsupervised while many of the other attacks were of a supervised attacking dog, this reflects that

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the survey participant could click on all options that apply (Table 5). The findings of this study regarding whether the attacking dog was supervised, on a leash, and whether the owner of the attacking dog tried to intervene is similar to those reported in other studies (van Herwijnen et al., 2023; Sarenbo 2019). Overestimation of own ability to control the dog, risk-taking by letting dogs run loose, ignorance of previous legal orders, and giving too much responsibility to inexperienced dog walkers were behind several dog attacks in a study of seized dogs (Sarenbo 2019).

Breed groups and distribution of injury severity

When examining the attacking dogs' breed designation and affiliation, 16 different breeds and their mixes were represented and the subgroup of Bull type Terriers (Group 3 Section 3) stood out with 56.3% of the attacking dogs. Molossian type (Group 2 Section 2) is also overrepresented at 15.8% (Fig 2). A similar distribution emerges when the single dog attacks are illustrated using breed groups and sections. However, when examining the 19 multiple dog attacks Group 2 Section 2 (Molossian type) contribution has increased to 26.3% of the attacks while the Bull type Terrier still dominates (Table 6). These two groups are responsible for 89% of the multiple dog attacks and all (100%) the attacks above Dunbar's Level 3. One could argue that multiple dogs attack should be regarded as predatory if the injuries are severe and if the behavior of the attack is typical of a predatory attack. It can be stated that attacks with multiple dogs that attack another dog happen, and the outcome varies from a chase with no alteration to a predatory attack where the victim dog is severely mutilated or killed. In this study, 14.5% of the dog attacks were executed by more than one dog (range 2-4 dogs). Multiple dog attacks on humans have been reported in literature (e.g. Kneafsey and Condon, 1995; Di Nunzio et al., 2023; Sacco et al., 2024) but little is known about multiple dog attacks on dogs. A few case studies show that the attacked dog is bitten in many places all over the body, and the injuries are aggravated by the victim's attempts to free himself from the attacker (Roccaro et al. 2021). Dogs attacked by other dogs are rarely eaten.

The victim dog was represented by many different breeds (n= 31) and their mixes (Fig. 3) while some sections were more numerous. The victim dogs' distribution became more obvious when summarizing them into the FCI breed groups. Groups 8 and Group 9 are overrepresented disregarding the fact that many dogs in the community are of those breeds. Of the victim dogs 18.5% (n= 24) belong to Group 3, terriers, and of these, 2.3% (n = 3) to Section 3 Bull type terriers. Among the victims of an attack of multiple dogs, the distribution of different breeds was wide, and no breeds had more than two individual victims (Table 6). This suggests that these could be opportunistic attacks and that the more serious cases were predatory aggression.

When comparing the attacking dog's breed distribution with the victim's breed distribution a different picture emerges. There are striking differences between the populations of dogs. The victim dog population may be mirroring the general UK dog population including crossbreds. In 2021, top five breeds in the UK were Labrador retriever (Group 8 Section 1), Cocker Spaniel (Group 8

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Section 2), Cockerpoo-Cocker Spaniel/Poodle, Jack Russell Terrier (Group 3 Section 2), and Border Collie, Group 1 Section 1 (Anderson et al. 2023), and based by number of the UK Kennel Club registrations the top five breeds were Labrador Retriever, French Bulldog (Group 9 Section 11), Cocker spaniel, Dachshund (Group 4, 1. b) Miniature Smooth-Haired) and Bulldog, Group 2 Section 2 (Statista 2022). It could be argued that if excessive intraspecific aggression were normal dog behavior it would display in that the distribution of victim dogs should be like the attacking dogs. The attacking dogs might be focusing on a specific type of dog (e.g., size, and breed type) and this is reflected in the type of victim dogs.

Group 3 Section 3 Bull type terriers stands out at 61.5% of the attacking dog population (n=130). Elsewhere, Bull type terriers (referred as American Staffordshire terrier and Pit Bull terrier types) were also overrepresented at 56% of the attacking dogs that severely maimed or killed their victims (Schilder et al., 2019). Also van Herwijnen et al. (2023) found that 58% of dogs confiscated by authorities for human and or dog/other animal biting were Pit Bull terrier type. Their study did not state what type of dog participated in the different incidents, however, 80.7% of the dog and or animal attacks were classified as severe or extremely severe following Dunbar's Dog Bite Scale. Other studies have found a similar pattern whereas the Bull type terriers are overrepresented in human-directed attacks (Golinko et al., 2017; Sarenbo, 2019; van Herwijnen et al., 2023). An "irresponsible" owner is often claimed as a cause of a dog attack, but it is important to remember that human failure is always possible, no matter how experienced the owner is. With a phenotype that would allow for more serious damage infliction when intraspecific aggression occurs is much more likely to cause severe injury or even death. In incidents involving attacks by multiple dogs, failures in management practices are frequently observed. These may include inadequate containment measures, such as broken gates or fences, unsecured doors, or situations where children are left unsupervised with the dogs or unintentionally allow them to escape (Sarenbo, 2019).

Majority (82%) of the victim dogs were small and medium size dogs. Perhaps this is representative of the dog population that most dogs are either small or medium-sized, however, if some of the attacking dogs are displaying predatory aggression, small and medium dogs would be more proximate as a prey. Similarly, in Schilder et al. (2019) 83% of the victim dogs were small-sized. Size could be a risk factor for victim dogs to be exposed to intraspecific aggression. In this study, it was also apparent that as Dunbar's severity level increased so did the number of smaller dogs. Small dogs may be at greater risk of being attacked. They are often vulnerable and more easily injured than large dogs and perhaps the attacking dog in some cases chooses small dogs as their target and prey. It is also possible that the general UK dog population consists primarily of small and medium sized dogs.

Use of Dunbar's Dog Bite scale as a tool has several advantages. It is straightforward, easy to understand, and inexpensive. The scale has also been modified for practical use (Yin, 2012; Caffrey et al., 2019). The City of Calgary for instance, when researching dog aggression, methodically applies a modified Dunbar's scale (Caffrey et al., 2019). Using Yins (2012) modification and

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Dunbar's Dog Bite Scale (Dunbar 2017)	Background and behavioral information of the attacking dog (Yin 2012; Dunbar 2017)
Level 1. Obnoxious or aggressive behavior but no skin-contact by teeth.	This dog was giving a warning as their earlier signs of fear or discontent were missed or ignored. This behavior can progress to an actual bite if not intervened
Level 2. Skin-contact by teeth but no skin-puncture. However, there may be skin nicks (less than one tenth of an inch deep) and slight bleeding caused by forward or lateral movement of teeth against skin, but no vertical punctures	This dog is displaying a high degree of bite inhibition. This is a progression from Level 1. It should still be regarded as a warning. This behavior can progress to an actual bite if not intervened.
Level 3. One to four punctures from a single bite with no puncture deeper than half the length of the dog's canine teeth. Maybe lacerations in a single direction, caused by the victim pulling hand away, owner pulling dog away, or gravity (little dog jumps, bites and drops to floor).	Once the dog has bitten one time with a concurring injury the risk of reoccurring is considerable. Treatment is long-term and can be dangerous, however, at the lower end of this level (one bite puncture) the success rate is acceptable. Rigorous bite-inhibition exercises are essential
Level 4. One to four punctures from a single bite with at least one puncture deeper than half the length of the dog's canine teeth. May also have deep bruising around the wound (dog held on for N seconds and bore down) or lacerations in both directions (dog held on and shook its head from side to side).	Inadequate bite inhibition makes this dog at level 4 very dangerous. Teaching bite inhibiting to mature dogs is especially problematic and the prognosis is poor. This is a dangerous dog and will bite again at the same or progressive level, given an opportunity. At this level, a small child can die.
Level 5. Multiple-bite incident with at least two Level 4 bites or multiple-attack incident with at least one Level 4 bite in each.	Numerous bites indicate a higher arousal level of the dog. The dog is extremely dangerous and mutilates. Dr. Dunbar recommends euthanasia.
Level 6. Victim dead.	The dog is extremely dangerous and mutilates. Dr. Dunbar recommends euthanasia.

Table 7. Dr. Dunbar's Dog Bite Scale for use for mitigation purposes

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explanations on Dunbar's Dog Bite scale as well as the original version of Dunbar (2017), important background and behavioral information of the attacking dog can be obtained. This information (Table 7) illustrates that Dunbar's Dog Bite Scale can be used as part of a risk assessment when determining mitigation decisions in dog intraspecific aggression cases.

In this study background information was not given in the survey since the participant needed to evaluate the injuries their dog obtained without interpreting the attacking dogs' behavior or background. However, using the background information it becomes apparent that a dog biting a Dunbar's Level 4 or higher is a dangerous dog. Dr. Dunbar recommends euthanasia at Levels 5 and 6 because the danger is prominent to other animals and because this dog's welfare is severely impaired as they should live the rest of their life in solitary confinement.

Distribution of Dunbar's Dog Bite severity shows that despite self-selecting to participate in this study there was a fair number of cases in each Dunbar's Dog Bite Severity Level (Table 6). Nevertheless, not surprisingly 59% of the victims were found in Dunbar's Dog bite Levels 4, 5, and 6. Respondents with severely injured dogs are expected to be more motivated to participate in the survey. Fifty-one dogs were either killed or severely maimed in this study and the information rarely exists on both the dog victim and the attacker.

The victim dog owners assessed the injuries their dogs sustained in the attack. This can of course be problematic especially when the memory is very traumatic and the injury on Dunbar's Level 1-2 is influenced by trauma and should probably be interpreted with caution. However, our suggestion is that injured dogs are Dunbar's Dog Bite scored by veterinarians who should have training in Dunbar's Dog Bite scoring. This should ensure an accurate and unbiased assessment of the injured dog. Included with the Dunbar's Dog Bite score should also be an illustration of where the injuries were sustained. The bite location can give further information about the aggression. Predatory behavior bites from dogs are often multiple bites located on the neck, throat, and the lower part of the body including legs and underbelly (Overall, 2013; Levin et al., 2008). Instead of being predation, the attack could be categorized as hyper-intraspecific aggression (Schilder et al., 2019). Furthermore, the pathology of intraspecific aggression in late stages also resembles predatory aggression (Overall, 2013).

About 15% (n=19) of the cases in this study were multiple dogs' attacks. Of the 19 multiple dogs' attacks, 15 (79%) were Dunbar's Dog Bite Level 4 and above, rendering an overall plausible predatory aggression rate from the multiple dogs' attack at 11.5% in this study.

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Why are Bull type terriers overrepresented?

The Bull type terrier overrepresentation could be partly due to the victim dog owner having a prejudice towards Bull type terriers and seeing Bull type terriers in the dog that attacked their dog disregarding if that is correct. In this study, crossbreds were assigned a breed designation if at least one breed was

known. The media reports on attacks can negatively influence the public's perception of these breeds (Wells et al., 2012). It could also be due to false identification of the attacking dogs and labeling them as Bull type (Webster, 2019).

It is a common to assume behavioral conformity within breed by the morphological similarities of individuals. The behavioral variation is substantial both between and within different breeds (Miklósi, 2015). The exemption is the traits that were originally genetically selected for specific tasks, and dogs do genetically differ behaviorally in these traits such as sled, herding, and livestock guarding dogs (Coppinger et al., 2015). The same could apply to dogs bred for fighting. The genetic selection is possible because dogs can enter the predatory motor pattern sequence at any phase, without having to enter them in certain order: orient > eye > stalk > chase > grab-bite > kill-bite > dissect > consume (Coppinger et al., 2015). The desired phases are either suppressed or exaggerated in breeding of dogs for different tasks, and the expression of the exaggerated phase is pleasant and self-rewarding for the dog. It is also suggested that fighting dog breeds may "engage in predatory behaviors during stressful situations in order to restore their emotional homeostasis" (d'Ingeo et al., 2021).

Because of their characteristics, Pit Bull and Staffordshire Bull terrier crossbreds, Mastiffs, Akitas, Rottweilers, and Presa Canarios are used as status or weapon dogs (Harding, 2012). Other breeds are used as fashion dogs and it is stated that in modern breeding, it is the morphology and the health of dogs that have been affected, not their behavioral traits (Ghirlanda et al., 2013).

Dogs that display aggression to trigger stimulus, have most often a learned conditioned response (Haug, 2008). However, the intensity and the direction of the response is a very intricate interaction between the genotype and the phenotype the dog develops through its environment. The behavioral phenotype that develops is only possible given the specific genotype. To give a specific and obvious example, a Bichon Havanese will never, regardless of environmental stimulus, develop into an effective police dog or a champion herding dog. It seems unfair to entirely blame the dog owner when a dog displays pathological aggression. The dog owner has a great responsibility to control the environmental factors the dog experiences. However, the behavioral reaction to the experience is also greatly influenced by the genetic makeup of the dog. Dog breeders, breeder associations and the authorities have a vast responsibility to improve the societal fitness of all dogs that interact in society, as well as educate potential owners.

According to Overall (2013), "breeds selected for one or a few particular and specific behaviors may be more at risk for developing undesirable variation for those behaviors, and when dogs of a certain breed develop a behavioral pathology, that pathology is informed by breed". Most dogs historically selectively bred for fighting are behaving normally. However, a percentage of these dogs may be more at risk for developing inappropriate out-of-context (i. e. pathological) dog aggression. In a study where the scarring on presumably fighting Pit Bulls was used to assess dog-directed aggression in that population,

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it was found that dogs with increasingly more scarring were progressively more dog aggressive. Nevertheless, it is vital to observe that 28% of dogs without scars were aggressive towards other dogs, although 22% of dogs with 40 or more scars were not dog aggressive (Miller et al., 2016). This suggests that there is a true heritability to dog aggression in these fighting lines. Interestingly Duffy et al. (2008) found a display of severe intraspecific aggression in 20% of Bull type dogs. This might suggest that the dogfighting abilities remain intact in the Bull type dog population.

Dog-directed aggression is well-known among breeders and is also expressed in breed standards, for example in the American Pit Bull Terrier (United Kennel Club, 2017) and in the breed description of Staffordshire Bull Terrier (Swedish Staffordshire terrier Club, 2024).

The personality traits are also probably affected by their original breed purpose, for example, Akita was historically a fighting dog, and Jack Russell was developed to vacate foxes and other quarry from the den. The "Pit Bull" is not a breed designation (rather a designation of certain dog type), however, so are the Staffordshire Bull Terrier and American Staffordshire Terrier derived originally from the same ancestry and historically selected for and bred to fight. It is not surprising that these examples of dog breeds display an elevated level of dog-directed aggression following their historical breed purpose. It is claimed that these types of dogs were selectively bred to fight other dogs while not biting people (Rocca, 1992; McMillan and Reid, 2010). The dogfighting trait is no longer a desired trait however, according to the author's knowledge no actual organized selection against this specific phenotype of dog-directed aggression is performed in the breed organizations. It is common that no actual selection against aggressive behaviors is performed in the different breeds (Miklósi, 2015). Another aspect worthy of consideration is whether owners of dog-aggressive dogs are more tolerant of this behavior. A behavior is only considered a behavior problem if the dog owner labels it as such (Murray et al., 2021), perhaps unconsciously disregarding the animal welfare issue for the dog itself and future potential victims.

It is established that within breed variation is large in intraspecific aggression while there are differences between breeds (Duffy et al., 2008) thus breed alone is a poor indicator of a specific individual dog's propensity for intraspecific aggression. However, the Bull type terrier (as Group 3 Section 3 according to the FCI breeds nomenclature) overrepresentation in this study, with its limitations, is unquestionable. Investigating population breed-level differences is of less interest when the purpose is to find the dog with pathological behaviors. Perhaps the question that should be asked is whether there are dog types that display increased levels of pathological displays of dog-directed aggression. It could be argued that the Bull type is showing a pathological level of inter-dog aggression in a subset of their population as this study suggests.

Most dog owners are responsible and capable of controlling their dogs, nonetheless, there are owners that fail to prevent dogs from developing pathologically intraspecific aggressive behaviors. Dogs that were confiscated by authorities for biting had often several caregivers prior to the biting incident

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(van Herwijnen et al., 2023). In general, it was more common that Bull type dogs (e.g. Pit Bull terrier, American Bully and American Staffordshire terrier) changed owners than other breeds or types (Sarenbo and Striwing, 2024). It was also found that suspicion of animal abuse, substance abuse, and antisocial behavior toward authorities of the dog owners are some of the hazards associated with dog bites (van Herwijnen et al., 2023). It is possible that the greatest risk with Bull type dogs is that they are in a high proportion chosen by people who are unsuitable to own a dog, in combination with a propensity for dog-on-dog aggression. The Bull types are in some cases marketed, for example, the Staffordshire Bull terrier as, "Highly intelligent and affectionate especially with children" (The Kennel Club, 2024). It could be argued that a dog type with a propensity for dog aggression and possibly developing pathologies such as predatory aggression should never be marketed as a family or children's dog. A main point to make is that the dogs that maim and kill other dogs are displaying a pathology regardless of type. It should not be considered as accidents and normal dog behaviors. The dog that displays pathological intraspecific aggression should be labeled as such and mitigated.

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APPENDIX 1

Questionnaire

1. Select your country of residence.
2. What size is (was) your dog?
3. What is (was) your dog's coat color?
4. How old was your dog at the time of the attack?
5. What breed is (was) your dog? If a mixed breed, please explain.
6. What sex is (was) your dog?
7. The dog owner's age (years) at the time of the attack
8. You, the dog owner is (gender)
9. How many persons are living in your household?
10. How many dogs were living in your household at the time of the dog attack?
11. From where and when did you get your dog?
12. If your dog is (was) a rescue dog, how many homes did it have before becoming your dog?
13. The price of your dog when purchased?
14. How many dogs have you owned in total?
15. How would you describe your dog's health prior to the attack?
16. Choose the statements, if applicable, that describe your dog's everyday life behavior prior to the attack

My dog

- suffered from separation anxiety
- was fearful towards unknown dogs
- was aggressive towards unknown dogs
- guarded resources such as feed bowl, bed, chewing bone
- was sleeping when home alone
- was barking a lot when home alone
- was sometimes barking when home alone

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was urinating and defecating inside the house when home alone

was destructive and destroying things when home alone

was 100% house broken

displayed tail chasing

displayed other behaviors (please explain in Comment)

none applicable

Comments

17. Location of the dog attack.

18. Please select the statements that applies at the time of the attack on your dog by another dog.: My dog was, on a short leash, on a flexi leash (a retractable dog leash), loose, supervised by me, supervised by someone else (please explain who, in Comment), without supervision (e.g. alone in the backyard), tied outside a grocery store or similar.

19. Please select the alternative(s) that describe(s) the dog attack if other, please explain, the other dog attacked my dog unprovoked, my dog provoked the other dog to attack, the other dog continued the attack despite that my dog was submissive, my dog was the initial attacker, my dog inflicted damage on the other dog, my dog was fighting with the other dog, initially on equal terms.

20. Please select all the statements that describes parts of the attack your dog suffered: the dog was intentionally provoked to attack my dog, the dog escaped from a back yard or fenced enclosure, the dog escaped from a car, the dog attacked while handled and on the leash, the dog broke free from the leash, the dog was tied outside a grocery store or similar, the person in charge of the dog remained passive when the dog attacked my dog, the person in charge of the dog unsuccessfully tried to stop the attack, the dog was loose and unsupervised, the dog was loose and supervised, the dog was chasing wild animals, my dog voluntarily approached the attacking dog and behaved provokingly, other (please explain in comment).

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21. Which of the following statements describe the familiarity of the dog that attacked your dog: Unfamiliar dog, A familiar dog owned by a close friend or family, somewhat familiar dog belonging to an acquaintance, somewhat familiar dog belonging to a neighbor.

22. Please describe the breed or type of the attacking dog.

23. Compare with Dr Dunbar bite scale that includes 6 levels. Which level do you rate the bite your dog was subjected to?

a. Level 1. Obnoxious or aggressive behavior but no skin-contact by teeth.

b. Level 2. Skin-contact by teeth but no skin-puncture. However, may be skin nicks (less than one tenth of an inch deep) and slight bleeding caused by forward or lateral movement of teeth against skin, but no vertical punctures.

c. Level 3. One to four punctures from a single bite with no puncture deeper than half the length of the dog's canine teeth. Maybe lacerations in a single direction, caused by victim pulling hand away, owner pulling dog away, or gravity (little dog jumps, bites and drops to floor).

d. Level 4. One to four punctures from a single bite with at least one puncture deeper than half the length of the dog's canine teeth. May also have deep bruising around the wound (dog held on for N seconds and bore down) or lacerations in both directions (dog held on and shook its head from side to side).

e. Level 5. Multiple-bite incident with at least two Level 4 bites or multiple-attack incident with at least one Level 4 bite in each.

f. Level 6. Victim dead.

24. Please describe the breed or type of the attacking dog

25. Compare with Dr Dunbar bite scale that includes 6 levels. Which level do you rate the bite your dog was subjected to?

a. Level 1. Obnoxious or aggressive behavior but no skin-contact by teeth.

b. Level 2. Skin-contact by teeth but no skin-puncture. However, may be skin nicks (less than one tenth of an inch deep) and slight bleeding caused by forward or lateral movement of teeth against skin, but no vertical punctures.

c. Level 3. One to four punctures from a single bite with no puncture deeper than half the length of the dog's canine teeth. Maybe lacerations in a single direction, caused by victim pulling hand away, owner pulling dog away, or gravity (little dog jumps, bites and drops to floor).

d. Level 4. One to four punctures from a single bite with at least one puncture deeper than half the length of the dog's canine teeth. May also have deep bruising around the wound (dog held on for N seconds and bore down) or lacerations in both directions (dog held on and shook its head from side to side).

e. Level 5. Multiple-bite incident with at least two Level 4 bites or multiple-attack incident with at least one Level 4 bite in each.

f. Level 6. Victim dead.

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comments

26. Please select the options that apply

a. My dog died on the scene of the attack

b. My dog received veterinary care for the injuries

c. My dog was euthanized by veterinarian

d. My dog received care for the injuries at home but died

e. My dog survived the attack

Comments

27. My dog recovered from the dog attack without any physical or mental consequences

a. agree

b. somewhat agree

c. neither agree or disagree

d. somewhat disagree

e. disagree

28. My dog recovered physically but is showing long-term mental distress as a result of the attack

a. agree

b. somewhat agree

c. neither agree or disagree

d. somewhat disagree

e. disagree

29. My dog as a result of the attack is scared of unfamiliar dogs

a. agree

b. somewhat agree

c. neither agree or disagree

d. somewhat disagree

e. disagree

30. My dog as a result of the attack is scared of all dogs

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a. agree

b. somewhat agree

c. neither agree or disagree

d. somewhat disagree

e. disagree

31. My dog, as a result of the attack, is scared of dogs similar to the attacking dog

a. agree

b. somewhat agree

c. neither agree or disagree

d. somewhat disagree

e. disagree

32. My dog, as a result of the attack, is aggressive towards dogs similar to the attacking dog

a. agree

b. somewhat agree

c. neither agree or disagree

d. somewhat disagree

e. disagree

33. My dog, as a result of the attack, is aggressive towards all dogs

a. agree

b. somewhat agree

c. neither agree or disagree

d. somewhat disagree

e. disagree

34. My dog, as a result of the attack, is aggressive towards all unfamiliar dogs

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a. agree

b. somewhat agree

c. neither agree or disagree

d. somewhat disagree

e. disagree

35. Please describe how the attack affected your dog, please include both physical and mental effects

36. Were you bitten or struck during the attack? Please select the best options

a. No

b. Yes, bitten by my dog

c. Yes, bitten by the attacking dog

d. Yes, bitten when I tried to separate the dogs

e. Yes, bitten but I don't know by which dog

f. Yes, I was struck by the dog during the attack and fell down to the ground

g. comments

37. If you were bitten, based on Dr Dunbars biting scale, how severe was the dogs bite? (please go to next question if you were not bitten)

a. Level 1. Obnoxious or aggressive behavior but no skin-contact by teeth.

b. Level 2. Skin-contact by teeth but no skin-puncture. However, may be skin nicks (less than one tenth of an inch deep) and slight bleeding caused by forward or lateral movement of teeth against skin, but no vertical punctures.

c. Level 3. One to four punctures from a single bite with no puncture deeper than half the length of the dog's canine teeth. Maybe lacerations in a single direction, caused by victim pulling hand away, owner pulling dog away, or gravity (little dog jumps, bites and drops to floor).

d. Level 4. One to four punctures from a single bite with at least one puncture deeper than half the length of the dog's canine teeth. May also have deep bruising around the wound (dog held on for N seconds and bore down) or lacerations in both directions (dog held on and shook its head from side to side).

e. Level 5. Multiple-bite incident with at least two Level 4 bites or

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multiple-attack incident with at least one Level 4 bite in each.

f. comments

38. My family and/or I have recovered totally from the dog attack, with no physical or mental long-term effect

a. agree

b. somewhat agree

c. neither agree or disagree

d. somewhat disagree

e. disagree

39. My family and/or I have recovered physically but show long-term mental distress

a. agree

b. somewhat agree

c. neither agree or disagree

d. somewhat disagree

e. disagree

40. My family and/or I, as a result of the dog attack, is scared of unfamiliar dogs

a. agree

b. somewhat agree

c. neither agree or disagree

d. somewhat disagree

e. disagree

42. My family and/or I have nightmares as a result of the dog attack

a. agree

b. somewhat agree

c. neither agree or disagree

d. somewhat disagree

e. disagree

43. My family and/or I felt depressed after the dog attack

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a a. agree

b. somewhat agree

c. neither agree or disagree

d. somewhat disagree

e. disagree

44. My family and/or I quality of life is negatively affected by the dog attack

a. agree

b. somewhat agree

c. neither agree or disagree

d. somewhat disagree

e. disagree

f. comments

45. Approximately how long were you/your family affected by the dog attack, psychologically and physically?

46. Please describe the physical and mental effects (both long-term och short- term) the dog attack had on you and or your family

47. Did you or your family receive compensation for the damage the attacking dog caused?

a. Yes

b. No

Comments

48. What, if any, were the consequences of the attack to the attacking dogs owner?

a. None

b. The attacking dog was seized by an authority

c. The attacking dog was euthanized by an authority

d. The attacking dog was euthanized by its owner

e. I don't know

f. Other (Please explain in comments)

Comments

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49. Did you report the dog attack to an authority?

a. Yes

b. No

c. If No, please explain why not

50. To which authority was the report (complaint) made?

a. County Administrative Board

b. Local Animal Control Agency

c. Local Council's Animal Welfare Department

d. The Police Authority

e. RSPCA

f. Other (Please specify in Comments)

Comments

51. Describe how satisfied you are with your experience of how your dog attack complaint was met by the authorities (e.g. police, prosecutor), on a scale of 0-100 (Please move the arrow to the right)

a. Very unsatisfied Very satisfied

b. If very unsatisfied, please explain why

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