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Dog bites in a U.S. county: age, body part and breed in paediatric dog bites

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Abstract

Aim: To compare characteristics of gender, age, body part and breed in dog bites.

Methods: We reviewed 14 956 dog bites (4195 paediatric) reported to the Allegheny County Health Department, USA, between 2007 and 2015. Using predefined age groups, we performed linear regression to assess for subject age and bite frequency and used binary logistic regression to evaluate for differences in gender and body part. We used chi-squared test with Bonferroni correction to evaluate for differences in reported breeds with age.

Results: There was a negative correlation (−0.80, $r^2 = 0.64$) between age and bite frequency. Children 0–3 years had a higher odds ratio (OR) of bites to the face [21.12, 95% confidence interval (CI): 17.61–25.33] and a lower OR of bites to the upper (OR: 0.14, 95% CI: 0.12–0.18) and lower (OR: 0.19, 95% CI: 0.14–0.27) extremities. 'Pit bulls' accounted for 27.2% of dog bites and were more common in children 13–18 years ($p < 0.01$). Shih-Tzu bites were more common in children three years of age and younger ($p < 0.01$).

Conclusion: Dog bites occur with higher frequency at younger ages, and head and neck injuries are more common in younger children. Pit bull bites are more common in adolescents and Shih-Tzu bites more common in younger children.

Keywords

Bite; Canine; Child; Dog; Paediatric

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CONFLICT OF INTEREST

Drs. Ramgopal, Bykowski, Pitetti and Hickey, and Ms. Brungo have no conflicts of interest to disclose.

INTRODUCTION

Domestic dogs are popular both in the United States and globally. Within the United States, an estimated 36.5% of households have at least one pet dog (1). Because of the widespread prevalence of domestic dogs, dog bites remain a persistent public health problem. Data from the Centers for Disease Control in 2015 suggest a crude rate of 108 dog bites per 100 000 population (2). Dog bites account for the majority of mammalian bites in developed countries (3) and can cause significant morbidity, including injury to vital structures (4), psychological stress (5), cosmetic disfigurement (6) and in rare cases, death (7).

Multiple investigators have evaluated the epidemiologic characteristics of dog bites (5,7–14). Previous studies have also attempted to identify age-related differences in dog bites using hospital and county specific data (8,10,12). Detailed information comparing patient and breed characteristics may be beneficial from a preventative standpoint to reduce the burden of this common traumatic injury. Additionally, age-related data with respect to dog breed have not previously been evaluated. A better understanding of dog breeds at higher risk of causing bites in children would be beneficial from an injury prevention standpoint.

In this study, we seek to compare characteristics that differ between adult and paediatric dog bites using data provided from reports from an urban county. Using a large, multi-year data set derived from county dog bite reports, we seek to identify differences in presentation and anatomic involvement between children and adults. Additionally, we seek to identify dog breeds that have a higher rate of bites in paediatric subjects as compared to adults.

METHODS

We performed a retrospective cohort study by a review of reported dog bites to the Allegheny County Health Department. Allegheny County is the second most populous county in Pennsylvania, with an estimated population of 1.2 million in 2016 (15). In our county, dog bites are considered a reportable disease and medical facilities, including emergency departments and urgent care clinics, are required to report any patients presenting with a dog bite to the county health department. Dog bites are reported using standardised forms (http://www.achd.net/infectd/pubs/pdf/animalbiteform.pdf) that are faxed to the county health department. Prior to data collection, Institutional Review Board approval was obtained from the University of Pittsburgh.

Report data are entered into a Microsoft Excel database by the Allegheny County Health Department. We reviewed charts collected from January 1, 2007 to December 31, 2015. Charts were electronically reviewed for data accuracy and to ascertain patient age, sex, dog breed and body part bitten. Records were removed from the study if no patient age was reported or if bites were caused by other animals (i.e. bats, snakes, cats) or they were not a dog bite (i.e. licks and scratches.)

Anatomic location of bites was categorized into (i) head and neck, (ii) upper extremity, (iii) lower extremity including buttocks, (iv) chest and abdomen and (v) genitourinary. Because a patient may have been bitten in more than one part of their body, a variable was added into the data set for each anatomic region and the presence/absence of a bite for each region was

documented in a binary manner. When provided, animal location was categorised into two variables (patients' home or elsewhere) and tabulated. Age relationships were obtained using *a priori* defined age groups: three years of age and under (toddler age group), four to six years of age (early childhood), seven to 12 years of age (middle childhood), 13–18 years of age (adolescents) and over 18 years (adults).

IBM SPSS Statistics (version 24.0) was used for data analysis. Linear regression of bite frequency was performed to identify for association of age with frequency of reported bites. Binary logistic regression was used to identify differences in gender and anatomic location between paediatric groups to the adult group, obtaining odds ratios (OR) with 95% confidence intervals (CI) and p values.

We evaluated the relative incidence of dog bites by breed across age groups. For those breeds which constituted greater than or equal to one per cent of recorded bites, Fisher's exact test was performed obtaining two-tailed p values comparing proportions of bites in paediatric age groups as compared to adults. In order to minimise the risk of Type I error, a Bonferroni correction was applied to p-values. The Bonferroni-adjusted p-values <0.05 were considered statistically significant. For purposes of comparison, we also attempted to obtain relative estimates for various breeds in the community by evaluating dog registrations as provided by the Allegheny County Treasury, looking specifically at registrations due to expire in 2016. For breed analysis, we removed records of 'mixed' breed dogs and those for which a breed was not documented from both the dog bite records and the Treasury records prior to this analysis as we felt that these were a heterogeneous grouping that lack shared characteristics. These figures were compared to the incidence of bite by dog breed.

RESULTS

Patient inclusion

A total of 22 657 records were provided by the Allegheny County Health Department. From these, a total of 14 956 (66.0%) patients with reported dog bites were included for analysis in this study. Details regarding patient inclusion are provided in Figure 1.

Dog bites by patient age

A total of 4195 (28.0%) dog bites occurred in patients ≤18 years of age and 10 761 (72.0%) dog bites occurred in patients >18 years of age. The frequency of dog bites by patient age is illustrated in Figure 2. There was a negative correlation between patient age and frequency of reported dog bites (correlation coefficient = −0.80, $r^2 = 0.64$).

Dog bites by patient gender

Patient gender was reported in 14 311 (95.7%) individuals. Among adults, there was a female predominance (5889/10 295 reports, 57.2%). However, across all paediatric age groups, there were a higher proportion of male subjects (Table 1). The OR of a dog bite to male victims was 1.38 in patients three years of age and under (95% CI: 1.19–1.61, p < 0.001), 1.55 in patients four to six years of age (1.33–1.80, p < 0.001), 1.81 in patients seven

to 12 years of age (95% CI: 1.62–2.01, $p < 0.001$) and 1.42 in patients 13–18 years of age (1.325–1.61, $p < 0.001$) when compared to the adult group.

Anatomic location

About 475/658 (72.2%) of victims three years of age and under had a head and neck bite, a percentage that decreased to 1067/9749 (10.9%) in adults. Upper extremity bites were present in 157/658 (23.9%) of children three years of age and under compared to 6613/9749 (67.8%) of adults (Table 1). The odds ratio of a bite to the face was 21.12 (95% CI: 17.61–25.33, $p < 0.001$) for children three years of age and under as compared to adults. Children three years of age and under were less likely to have bites to the upper (OR: 0.14, 95% CI: 0.12–0.18, $p < 0.001$) and lower extremities (OR: 0.19, 95% CI: 0.14–0.27, $p < 0.001$) as compared to adults (Table 2).

Dog bites by breed

A listed dog breed was available for 7998 (53.5%) cases. Breeds classified as ‘mixed’ constituted 1807 reported dog bites (22.5%) and were removed from further breed analysis. Using public data for dog licences expiring in 2016, a total of 27 015 registrations were reviewed, of which breed data were available for 26 868 (99.5%). Of these, 9045 records (33.7%) were classified as ‘mixed’ breeds. Among those breeds not recorded as ‘mixed’, ‘pit bulls’, which comprised 4.9% of purebred dogs, accounted for 27.2% of all reported bites.

Using Bonferroni correction, all p values were multiplied by 96 (to account for multiple tests involving 24 dog breeds and four paediatric age groups). The p value was adjusted to 1 if the Bonferroni correction exceeded this value. Age group testing suggested that pit bull bites were more common in children 13–18 years of age ($p < 0.01$) and that Shih-Tzu bites were more common in children three years of age and under ($p < 0.01$). Full results are presented in Table 3.

DISCUSSION

The purpose of this study was to identify age-related characteristics in gender, anatomic distribution and canine breed in paediatric dog bites. Notably, we identified a decreasing number of reported dog bites with increasing age, a relative increase among boys presenting with dog bites, and a greater frequency of head and neck bites in children as compared to adults. Pit bulls constituted 27% of all reported dog bites but accounted for only 4.9% of the local dog population. Pit bull bites were more common in adolescents, and Shih-Tzu bites were more common in very young children when compared to adults. This study is the first to consider age-related differences in dog breeds causing bites while also confirming previous findings regarding age and anatomic distribution of paediatric dog bites using the largest data set to date.

This study confirms previously identified trends using a larger dataset. We found a negative correlation between age and dog bite, which likely reflects a higher incidence of dog bites in younger patients. Our data corroborate similar institutional (8,11,14,16), countywide (17) and emergency department survey data (18). Younger children may be less likely to

recognise animal aggression and more liable to behaviour that may provoke dogs, leading to a higher rate of reported bites in younger subjects.

Paediatric studies suggest a slight male predominance of bites (8,14,19). The slight increase in males with dog bites in this study may be related to risk-taking behaviour being more common among younger boys compared to girls. Behavioural studies suggest that girls seek animal company more frequently than boys (20) and may form stronger emotional attachments to them (21), thereby lowering their risk of animal provocation, although this has not been established.

We found that head and neck bites were more common in younger children. This may be due to the shorter height of children, making the face more accessible to an aggressive animal. The increased frequency of dog bites to the face in younger children has been noted in hospital-based studies (8,14,22). In contrast, the decreased frequency of extremity dog bites is highlighted by a retrospective study in a paediatric population which found that only 22.4% of dog bites involved the upper extremity and 35% involved the lower extremity (23).

This study found an increase in Shih-Tzu bites in young children and pit bull bites in adolescents relative to adults. These findings may relate to breed-specific behavioural characteristics or to behaviours in children that may provoke aggressive behaviour. The increase in pit bull bites among adolescents may be due to increased risk-taking behaviour in this age group. Behavioural characteristics among Shih-Tzus may make them more aggressive towards very young children, although this tendency has not been previously described in this breed. These findings have implications for pet ownership: families who are considering a pet dog may do better to avoid these breeds if they have children who are in these higher risk age groups.

Pit bulls accounted for approximately one-quarter of purebred dog bites. The disproportionate rate of dog bites by pit bulls has been previously reported (10,16,24). The high frequency of pit bull is likely due to several reasons. Pit bulls are heterogeneous and typically refer to three breeds of dog: the American Staffordshire terrier, the Staffordshire bull terrier and the American pit bull terrier. Because of this, the term ‘pit bull-type’ dog is likely a more accurate term than ‘pit bull’ to refer to these three breeds collectively. Pit bulls have been historically bred for dog fighting (25), thereby contributing towards a lower threshold for aggressive tendencies. Beyond this, other dogs with a similar appearance, including mixed breeds and boxers, may be falsely classified in animal reporting data (26).

There are several limitations to this study. Not all dog bites are reported (27). This study was unable to account for duplicate bites. Incomplete records could not be fully analysed. Dog breeds were ascertained based on the documentation provided by the reporting individual. While this may lead to inaccurate or over-reporting of some breeds, breed figures are likely to be accurate for children as the majority of paediatric dog bites occur in the child’s home. Population estimates are derived from treasury data, and the number of dogs who are unregistered with the county is not established. Additionally, as we evaluated the community proportions of dog breeds from a single year, the community analysis did not account for trends or changes in breeds over time or for special types of dog registrations available from

the county which last for multiple years. Some breeds may have disproportionate rates of under-registration, which could not be evaluated in this study.

We found the major risk factors for dog bites to be younger age, male sex and a breed of a dog with a proclivity towards biting. Using a large data set from an urban county, we were able to confirm multiple attributes that are associated with this important public health problem. The use of a larger, countywide data set allowed for the determination of risk factors of dog bites including breed-specific data within various age groups compared to adults. These data may be useful to paediatricians and veterinarians providing anticipatory guidance towards families considering adding a pet to their home in order to minimise or prevent the risk of dog bites. Simple educational interventions, such as instructional videos (28), online modules (29) and hospital-based kiosk assessments (30), may carry promise in animal bite prevention.

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Abbreviations

CI	Confidence interval
OR	Odds ratio

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Key notes

- Dog bites cause significant morbidity in children. Better data are needed to identify epidemiologic and breedrelated characteristics of bites.
- Bites are more frequent in boys, and younger children have a higher incidence of head and neck bites. Pit bull bites occur more in adolescents, and Shih-Tzu bites occur more in younger children.
- These data may be used in the development of preventative strategies for paediatric dog bites based on breed.

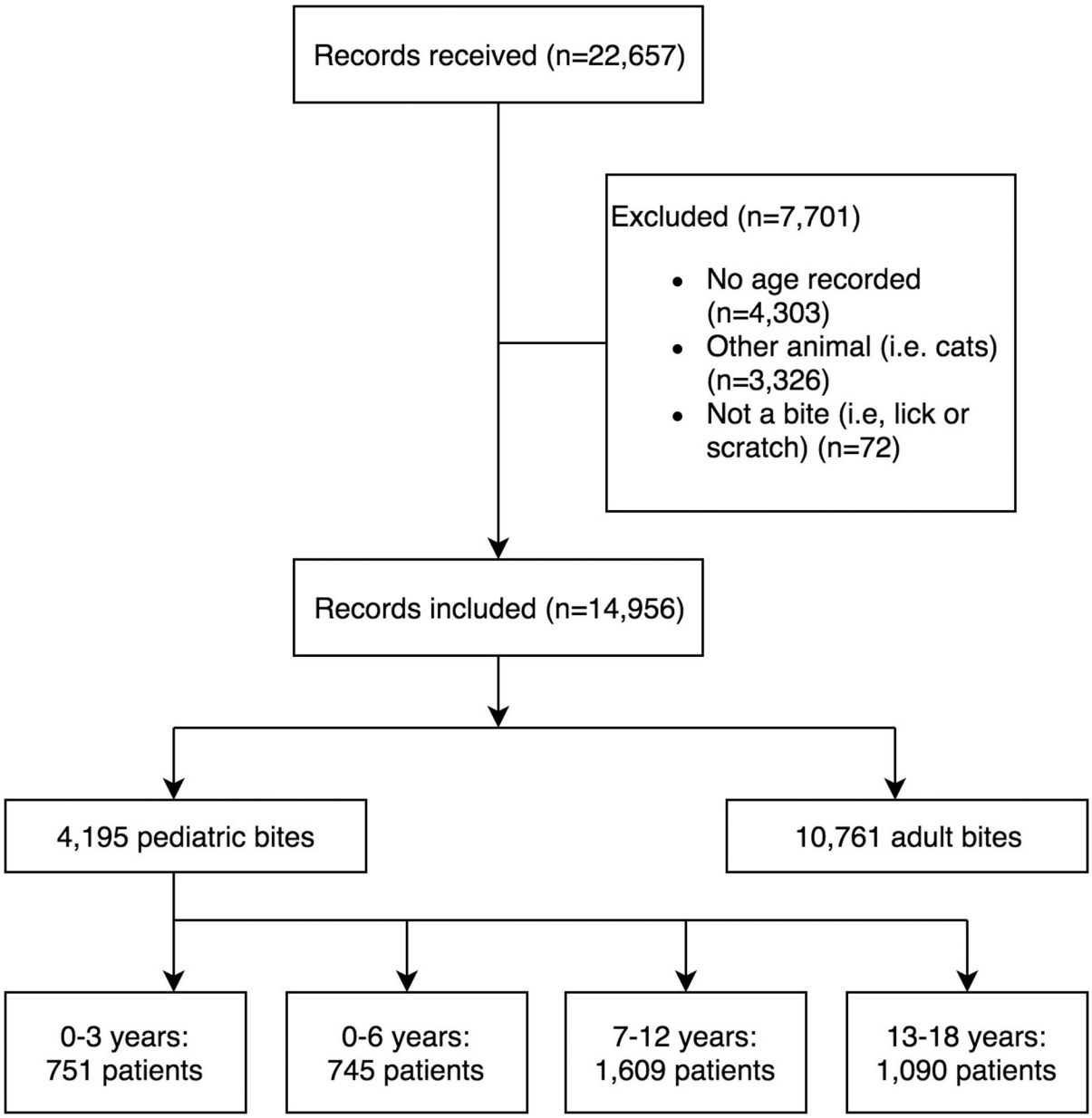

Figure 1.
Study patient inclusion.

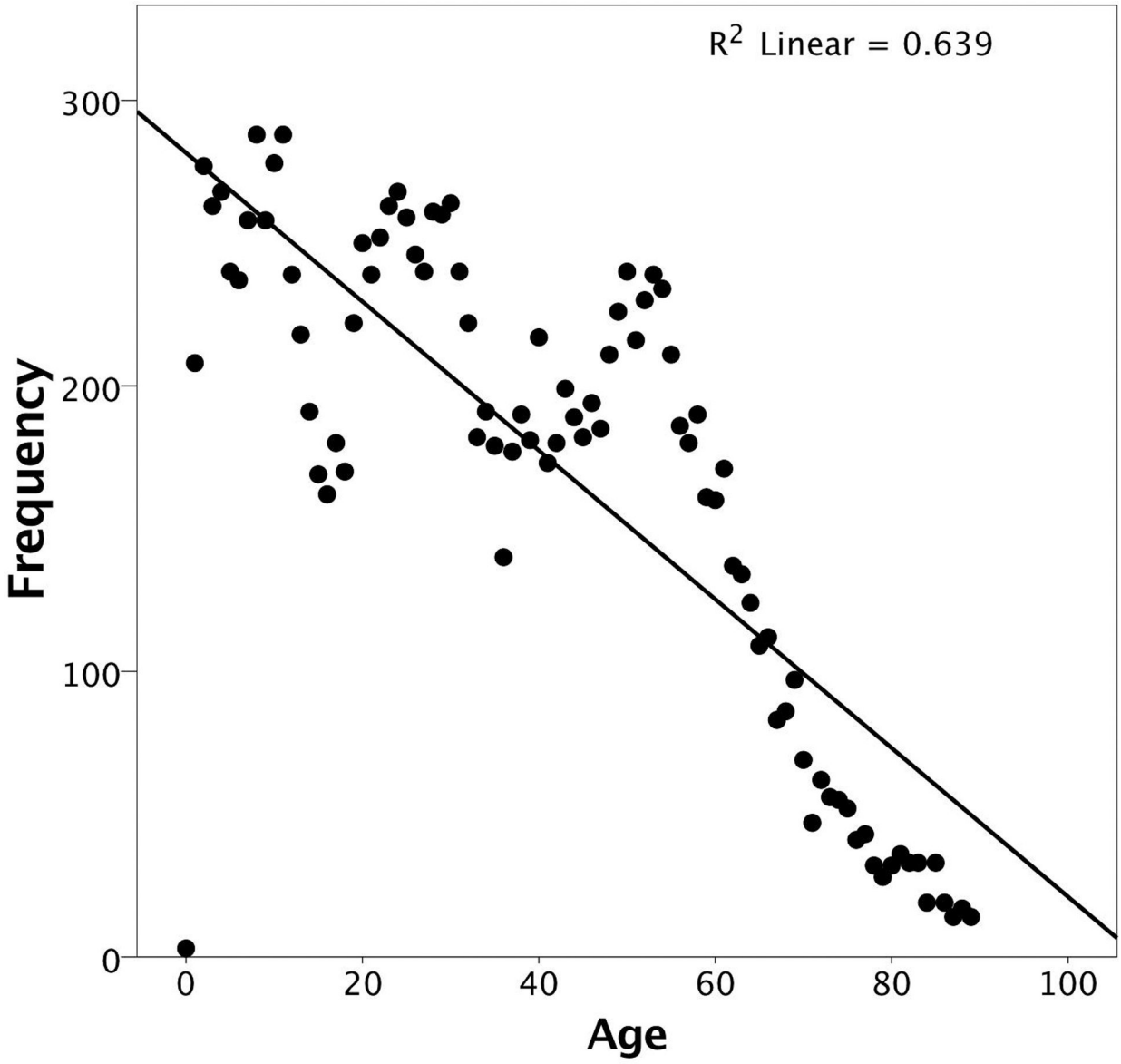

Figure 2.

Line graph depicting frequency of dog bites at each individual age. Assuming a linear relationship, the frequency of dog bites with age had a negative association with a correlation coefficient of −0.80 and r^2 of 0.64.

Table 1

Patient demographic data, anatomic location of bite and place of bite

	0–3 years	Four to six years	Seven years to 12 years	13–18 years	≥19 years
Number of patients	751	745	1609	1090	10 761
Number males (%)[†]	367/722 (50.8%)	383/714 (53.6%)	883/1536 (57.5%)	537/1044 (51.4%)	4406/10 295 (42.8%)
Anatomic location of bite[‡]					
Head and neck	475 (72.2%)	388 (58.6%)	499 (34.4%)	212 (21.2%)	1067 (10.9%)
Trunk (chest, abdomen, back)	9 (1.4%)	30 (4.5%)	86 (5.9%)	39 (3.9%)	193 (2.0%)
Lower extremity	36 (5.5%)	108 (16.3%)	405 (27.9%)	284 (28.4%)	2258 (23.2%)
Upper extremity	157 (23.9%)	164 (24.8%)	543 (37.4%)	500 (50.0%)	6613 (67.8%)
Genitourinary	1 (0.2%)	3 (0.5%)	6 (0.4%)	10 (1.0%)	32 (0.3%)
Not stated	93 (12.4%)	83 (11.1%)	159 (9.9%)	89 (8.2%)	1012 (9.4%)
Dog location[§]					
Owner’s property	597/680 (87.8%)	586/649 (90.3%)	1231/1373 (89.7%)	797/906 (88.0%)	7219/8652 (83.4%)

[†]Denominator represents the total number of subjects in each age group for which patient gender was reported.

[‡]Anatomic location of bite: patients may have been bitten on more than one part of their body, so percentages do not sum to 100%

[§]Denominator is the total number of subjects for geographic data was reported in the specified age group.

Table 2

Odds ratio, 95% confidence intervals and p value of dog bites in different regions of the body across paediatric age groups, using adults as a reference group

Group	Test	Head and neck	Chest/Abdomen	Lower extremity	Upper extremity	Genitourinary
0–3 years	OR (95% CI)	21.12 (17.61–25.33)	0.69 (0.35–1.35)	0.19 (0.14–0.27)	0.14 (0.12–0.18)	0.46 (0.06–3.39)
	p	<0.001	0.274	<0.001	<0.001	0.448
Four to six years	OR (95% CI)	11.52 (9.75–13.62)	2.35 (1.59–3.48)	0.65 (0.52–0.80)	0.16 (0.13–0.19)	1.38 (0.42–4.53)
	p	<0.001	<0.001	<0.001	<0.001	0.593
Seven years to 12 years	OR (95% CI)	4.27 (3.77–4.84)	3.12 (2.41–4.05)	1.29 (1.13–1.46)	0.28 (0.25–0.32)	1.26 (0.53–3.02)
	p	<0.001	<0.001	<0.001	<0.001	0.602
13–18 years	OR (95% CI)	2.19 (1.86–2.58)	2.01 (1.41–2.85)	1.31 (1.14–1.52)	0.47 (0.42–0.54)	3.06 (1.50–6.25)
	p	<0.001	<0.001	<0.001	<0.001	0.002

Analysis performed using binary logistic regression.

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Table 3

Frequency of reported dog breeds (for dogs with a breed other than 'mixed') across patient age for those breeds that accounted for >1% of bites

Breed	Total no. bites	0–3 years	Four to six years	Seven years to 12 years	13–18 years	>18 years	No. county registrations (%)*
Pit Bull	1687 (27.2%)	66 (20.7%)	90 (6.0%)	207 (30.4%)	**184 (36.7%)**	1140 (26.4%)	886 (4.9%)
p		1	1	1	**<0.01**		
German Shepherd	647 (10.5%)	29 (9.1%)	33 (8.9%)	75 (11.0%)	46 (9.2%)	464 (10.7%)	930 (5.2%)
p		1	1	1	1		
Labrador Retriever	448 (7.2%)	24 (0.8%)	30 (8.1%)	52 (7.6%)	30 (6.0%)	312 (7.2%)	1787 (10.0%)
p		1	1	1	1		
Boxer	282 (4.6%)	14 (4.4%)	13 (3.5%)	29 (4.3%)	20 (4.0%)	206 (4.8%)	580 (3.3%)
p		1	1	1	1		
Rottweiler	240 (3.9%)	9 (2.8%)	12 (3.2%)	20 (2.9%)	27 (5.3%)	172 (4.0%)	241 (1.4%)
p		1	1	1	1		
Beagle	202 (3.3%)	17 (5.3%)	6 (1.6%)	24 (3.5%)	18 (3.6%)	137 (3.2%)	682 (3.8%)
p		1	1	1	1		
Jack Russell	181 (2.9%)	8 (2.5%)	12 (3.2%)	20 (2.9%)	9 (1.8%)	132 (3.1%)	153 (0.86%)
p		1	1	1	1		
Bulldog	177 (2.9%)	10 (3.1%)	13 (3.5%)	24 (3.5%)	12 (2.4%)	118 (2.7%)	395 (2.2%)
p		1	1	1	1		
Chihuahua	160 (2.6%)	11 (3.4%)	13 (3.5%)	18 (2.6%)	6 (1.2%)	112 (2.6%)	778 (4.4%)
p		1	1	1	1		
Husky	145 (2.3%)	7 (2.2%)	9 (2.4%)	6 (0.9%)	13 (2.6%)	110 (2.5%)	226 (1.3%)
p		1	1	0.53	1		
Golden Retriever	140 (2.3%)	6 (1.9%)	9 (2.4%)	6 (2.8%)	14 (2.8%)	90 (2.1%)	1062 (6.0%)
p		1	1	1	1		
Dachshund	137 (2.2%)	9 (2.8%)	7 (1.9%)	14 (2.1%)	9 (1.8%)	98 (2.3%)	504 (2.8%)
p		1	1	1	1		
Mastiff	116 (1.9%)	5 (1.6%)	6 (1.6%)	14 (2.1%)	9 (1.8%)	82 (1.9%)	158 (0.90%)
p		1	1	1	1		
Shih-Tzu	115 (1.9%)	**18 (5.6%)**	12 (3.2%)	13 (1.9%)	8 (1.6%)	64 (1.5%)	756 (4.2%)
p		**<0.01**	1	1	1		

Breed	Total no. bites	0–3 years	Four to six years	Seven years to 12 years	13–18 years	>18 years	No. county registrations (%)*
Poodle	79 (1.6%)	7 (2.2%)	0 (0%)	4 (0.6%)	14 (2.8%)	74 (1.7%)	371 (2.1%)
p		1	0.36	1	1		
Cocker Spaniel	90 (1.5%)	7 (2.2%)	6 (1.6%)	7 (1.0%)	5 (1.0%)	65 (1.5%)	271 (1.5%)
p		1	1	1	1		
Yorkshire Terrier	84 (1.4%)	1 (0.3%)	9 (2.4%)	10 (1.5%)	8 (1.6%)	56 (1.3%)	633 (3.6%)
p		1	1	1	1		
Great Dane	79 (1.3%)	5 (1.6%)	8 (2.2%)	11 (1.6%)	0 (0%)	55 (1.2%)	96 (0.54%)
p		1	1	1	0.33		
Australian Shepherd	70 (1.1%)	2 (0.6%)	6 (1.6%)	9 (1.3%)	3 (0.6%)	50 (1.2%)	177 (0.99%)
p		1	1	1	1		
Doberman Pinscher	68 (1.1%)	5 (1.6%)	3 (0.8%)	10 (1.5%)	6 (1.2%)	44 (1.0%)	147 (0.82%)
p		1	1	1	1		
Boston Terrier	67 (1.1%)	4 (1.3%)	9 (2.4%)	5 (0.7%)	7 (1.4%)	42 (1.0%)	200 (1.1%)
p		1	1	1	1		
Border Collie	66 (1.1%)	5 (1.6%)	5 (1.4%)	6 (0.9%)	1 (0.2%)	49 (1.1%)	186 (1.0%)
p		1	1	1	1		
Akita	64 (0.9%)	3 (0.9%)	7 (1.9%)	11 (1.6%)	4 (0.8%)	39 (0.9%)	31 (0.12%)
p		1	1	1	1		
Collie	63 (1.0%)	1 (0.3%)	6 (1.6%)	7 (1.0%)	8 (1.6%)	41 (0.9%)	100 (0.56%)
p		1	1	1	1		
Total	6191	319	370	681	502	4319	17 823

Two-tailed p values are obtained by Fisher's exact test followed by Bonferroni's correction.

*Estimated community prevalence derived from owner-reported data on dog registrations expiring in 2016 from the Allegheny County Treasurer, removing all mixed breed from data set prior to calculations.