Article

Animal control measures and their relationship to the reported incidence of dog bites in urban Canadian municipalities

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Abstract — Various measures, including ticketing, licensing, and breed-specific legislation, are used by municipalities to control dog bites, but their effectiveness is largely unknown. Thirty-six urban Canadian municipalities provided information about their animal control practices, resourcing, and (for 22 municipalities) rate of reported dog bites. Municipalities differed widely in rates of licensing (4% to 75%) and ticketing (0.1 to 83 per 10 000 people), even where staffing and budgets were similar. Reported frequency of dog bites ranged from 0 to 9.0 (median 1.9) per 10 000 people. Rates were generally higher in municipalities with higher ticketing, licensing, staffing, and budget levels. However, in municipalities with very active ticketing the reported bite rate was much lower than predicted by a linear regression on ticketing rate (quadratic regression, R^2 = 0.52), likely reflecting a reduction in actual bites with very active enforcement. Municipalities with and without breed-specific legislation did not differ in reported bite rate. Ticketing appeared most effective in reducing dog bites, although it may also lead to increased reporting.

Résumé — Les mesures de contrôle animalier et leur lien avec l'incidence des morsures de chiens signalées dans les municipalités urbaines canadiennes. Diverses mesures, incluant des contraventions, des permis et des lois visant des races particulières, sont utilisées par les municipalités pour limiter les morsures de chiens, mais leur efficacité est en grande partie inconnue. Trente-six municipalités urbaines canadiennes ont fourni des renseignements à propos de leurs pratiques et de leurs ressources de contrôle animalier ainsi que (pour 22 municipalités) les taux de morsures de chiens signalés. Les municipalités présentaient des différences importantes pour les taux d'immatriculation (de 4 % à 75 %) et les contraventions (de 0,1 à 83 par 10 000 personnes), même lorsque le personnel et les budgets étaient semblables. La fréquence signalée des morsures de chiens allait de 0 à 9,0 (médiane de 1,9) par 10 000 personnes. Les taux étaient généralement supérieurs dans les municipalités qui affichaient un plus grand nombre de contraventions et qui possédaient des ressources humaines et budgétaires plus importantes. Cependant, dans les municipalités très actives pour les contraventions, les taux des morsures signalées étaient de beaucoup inférieurs aux prédictions d'une régression linéaire des taux de contravention (régression quadratique, R^2 = 0,52), ce qui reflétait probablement une réduction du nombre de morsures réelles en raison d'une application très active. Les municipalités avec ou sans loi ciblant les espèces particulières ne présentaient pas de différence au niveau des taux de morsures signalées. Les contraventions semblaient les plus efficaces pour réduire les morsures de chiens, quoique cela puisse aussi susciter une hausse des déclarations.

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Introduction

Dog bites appear to be a significant but under-reported risk to public safety. Based mainly on a national telephone survey conducted in the United States in 1994 (1), the Centers for Disease Control estimate that 1.8% of Americans are bitten annually by dogs (2). Canadian data are lacking; however, the Canada Safety Council estimates a similar prevalence (3). Although media attention to dog bites (4) has led to calls for improved animal control measures including more effective legislation, higher penalties, increased enforcement, and public education (5,6), the effectiveness of such measures is not well-established.

In many countries, including Canada, animal control is managed by municipal governments. Local autonomy allows communities to be responsive to local needs and values, but it also results in a patchwork of regional programs with different legislation, resourcing levels, and levels of emphasis on enforcement, licensing, and education. As one aspect of the variation, some municipalities have created breed-specific legislation (BSL) which bans or limits ownership of specified breeds.

Because of the decentralized nature of animal control in Canada, the range of practices and their effectiveness is largely unknown. The objectives of this research were to: i) compare ticketing, dog licensing, public education, animal control budget and staffing levels in various urban Canadian municipalities; ii) determine the rate of reported dog bites in those municipalities; and iii) ascertain the relationship between reported dog bite rates and control measures.

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Table 1. Range and (median) values for licensing rate, ticketing rate, budget rate, staffing rate, and reported dog bite rate in different provinces/regions

Province/Region	N	Licensing (% estimated dogs)	Ticketing /10 000	Budget $1000/10 000	Staffing /1 000 000	Reported dog bites[a] /10 000
British Columbia	13	14–65 (30)	0.1–48.5 (5.5)	15.3–100.6 (39.2)	15–111 (45)	0.0–9.0 (1.8)
Alberta	2	42–57 (49)	14.1–36.0 (25.0)	26.4–37.0 (31.7)	22–31 (26)	2.1–3.1 (2.6)
Saskatchewan	2	31–76 (53)	67.5–83.4 (75.4)	7.4–48.3 (27.8)	34–82 (58)	2.4
Manitoba	1	35	4.6	29.8	17	2.0
Ontario	10	7–41 (15)	1.3–5.0 (3.2)	16.8–56.6 (33.1)	8–50 (27)	0.2–1.9 (1.9)
Quebec	7	4–16 (20)	0.1–20.1 (0.9)	6.6–18.1 (7.8)	7–29 (13)	0.1–8.1 (0.3)
Atlantic Region	1	5	0.9	25.2	61	1.5
All	36	4–75 (21)	0.1–83.4 (4.7)	6.6–100.6 (28.4)	7–111 (31)	0.0–9.0 (1.9)

N = number of municipalities that participated in the study.
[a] Sample size for reported dog bite rate was, respectively: British Columbia 9, Alberta 2, Saskatchewan 1, Manitoba 1, Ontario 3, Quebec 5, Atlantic Region 1. All: 22.

Materials and methods

Eighty-five Canadian municipalities were identified with populations of ≥ 30 000 people, defined as urban because they comprise either a Census Metropolitan Area or a Census Agglomeration as defined by Statistics Canada (7). Each municipality was telephoned by a bilingual (French/English) research assistant who secured the name and contact information of the person responsible for animal control services in the municipality. A questionnaire was sent to this person with a covering letter which explained the project. The questionnaire, composed of open and closed questions, queried the municipality's demographics, its estimated dog population, its animal control practices and enforcement programs, animal control resourcing level, and the number of dog bites reported to animal control authorities. Data were requested for each of 2003, 2004, and 2005. Thirty-six completed questionnaires (42%) were received from municipalities differing widely in size and location, with no evidence of demographic differences between non-respondents and respondents.

Because only 2 municipalities collected data on dog populations, the number of dogs in each municipality was estimated as follows. A 2001 Ipsos-Reid survey of 1500 urban households across Canada had found an average of 0.4 dogs per household (8). The 2006 Canadian census indicated that the Canadian population comprised 31.6 million people (9) divided into 12.4 million households (10) for a mean of 2.54 people per household. These values — 0.4 dogs per household, and 2.54 people per household — indicate a national average of 0.157 dogs per person. The "estimated dog population" in each municipality was calculated by applying this national average to the human population of the municipality. The other variables derived from the results were:

- Licensing rate: The number of dog licenses sold annually in the municipality as a percentage of the estimated dog population.
- Ticketing rate: The number of violation notices (tickets) issued annually by animal control enforcement staff per 10 000 human population.
- Budget rate: The annual expenditure on animal control services, expressed in Canadian dollars per 10 000 human population.
- Staffing rate: The number of full-time-equivalent animal control (enforcement) staff employed per 1 000 000 human population.
- Public education rate: The annual expenditure on public education, excluding staff costs, expressed in dollars per 10 000 human population.
- Reported dog bite rate: The number of dog bites reported annually to animal control authorities per 10 000 human population.

Data analysis

Analysis was based on 2005 data because that year had the highest response rate for most items. Data for other years were similar. Data were analyzed by non-parametric methods where possible because of the non-normal distribution of most data. To identify relationships between variables, Spearman's rank order correlation coefficients (two-tailed) were first calculated among the key variables. Further analysis of reported dog bite rate was done by regression analysis (SAS Version 9.1; SAS Institute, Cary, North Carolina, USA) because no non-parametric equivalent was available. Specifically, reported dog bite rate (as the outcome variable) was tested against the linear and quadratic effects of ticketing rate, licensing rate, budget rate, and staffing rate.

The results also allowed a comparison of municipalities that did and did not have BSL. A simple comparison of municipalities with and without BSL was performed using the nonparametric Mann-Whitney *U*-test which is appropriate for data that do not meet the assumptions of parametric analysis (11). To provide a more powerful comparison (but less correct for data that are not normally distributed), this regression analysis was repeated with the municipality's use or non-use of BSL included as a treatment. The analysis thus tested for any differences between municipalities with and without BSL after variation due to effects of ticketing rate, licensing rate, budget rate, and staffing rate had been taken into account. The analysis also tested for any interaction of the treatment (BSL versus non-BSL municipalities) and these variables.

Results

The participating animal control agencies served approximately 32% of Canada's estimated population of 31.6 million (9). The populations ranged from 32 500 to 2.7 million (median 146 000) and population densities ranged from 244 to 9119 (median 1411) people/km^2. Dog populations as estimated from the national average were very similar to estimates provided by the municipalities, except that the number provided by the city of Toronto was lower than the estimated value. (Dog ownership in this multicultural city may be less than the national average.) Local estimates were highly correlated with estimates made on the basis of the national average if Toronto were excluded ($r = 0.93$, $P < 0.001$).

Enforcement and resourcing

Municipalities differed widely on all variables (Table 1). The percentage of dogs licensed ranged from a low of 4% in 1 municipality to 76% in another. Ticketing rates showed wide variation, from 0.1 to 83 tickets per 10 000 people, with a median rate of 4.7. Budget rate for animal control (expressed to the nearest $1000) was less variable, with a median of $28 450 per 10 000 people and generally low values in the province of Quebec as reflected by a low median. The number of animal control staff (full-time equivalents) per 1 000 000 people was variable, with a median of 31 and low values in most Quebec municipalities.

All municipalities reported providing some form of public education. Twenty-six of 36 municipalities distributed written materials, while only a few provided more interactive methods such as face-to-face courses and seminars (dog management, dog obedience, by-law awareness, dog bite prevention) or canine behavioral counselling and training assistance for dog owners. Municipalities reported annual public education expenditures that ranged from $0 (3 municipalities) to $4100 per 10 000 people, with a median of $260 per 10 000 people, or roughly 1% of the overall animal control budget. However, in most municipalities (30/36), this figure did not reflect total educational effort because education was integrated into the duties of enforcement staff.

Staffing, budget, and licensing rates were significantly correlated with each other ($r_s = 0.50$ to 0.61; Table 2). Ticketing rate was significantly correlated with licensing rate ($r_s = 0.59$) but not with budget rate or staffing rate (Table 2). The 7 municipalities with a ticketing rate > 10 tickets per 10 000 people resembled the national average in budget and staffing rates. In these municipalities, which included 2 in each of Alberta, Saskatchewan, and Quebec and 1 in British Columbia, staffing rates ranged from 13 to 85 animal control officers per 1 000 000 people, with a median of 31, and animal control budgets ranged from $7000 to $101 000 per 10 000 people, with a median of $26 000. At least 5 of these 7 municipalities were engaged in formal organizational efforts to increase by-law compliance.

Table 2. Spearman rank-order correlation coefficients for reported dog bite rate and 4 measures of enforcement and resourcing

	Licensing rate	Budget rate	Staffing rate	Reported dog bite rate
Ticketing rate	0.59[b] $n = 27$	0.34 $n = 23$	0.38 $n = 27$	0.86[c] $n = 18$
Licensing rate		0.61[c] $n = 29$	0.54[c] $n = 35$	0.82[c] $n = 21$
Budget rate			0.50[b] $n = 29$	0.63[b] $n = 19$
Staffing rate				0.44[a] $n = 21$

[a] $P < 0.05$.
[b] $P < 0.01$.
[c] $P < 0.001$.

Reported dog bites

Twenty-two municipalities provided data on reported dog bites. Reported dog bite rate was variable, from 0.0 per 10 000 people in 1 jurisdiction to 9.0 in another and a median of 1.9 (Table 1). Seven municipalities indicated that the information was unavailable and 8 gave no reason for not responding to survey questions about reported dog bites. The reporting officers of 24/34 municipalities felt that the dog bite issue was less severe or had not changed over the previous 5 y.

Neither population size nor density showed a significant relationship to reported dog bite rates. However, the reported dog bite rate was generally very low in municipalities with very low rates of ticketing, licensing, budget, and staff, but was higher when these variables were in the medium range. As a result, reported dog bite rates showed a clear positive correlation with each of these variables (Table 2). However, at higher rates of ticketing and licensing, the reported dog bite rate was much lower than would be expected based on a linear trend. Regression analysis of reported dog bite rate on ticketing rate (Figure 1) showed a much better fit with a quadratic regression in the shape of an inverted U ($R^2 = 0.519$) than with linear regression ($R^2 = 0.189$). Both linear and quadratic components were significant ($P < 0.01$, Table 3), although the *P*-values are not considered to be reliable because the assumptions of parametric analysis were not met. A similar but weaker relationship was seen with licensing rate. Specifically, the reported dog bite rate showed a significant positive linear regression on licensing rate ($P < 0.05$), while the negative quadratic component approached significance ($P < 0.10$, Table 3). Reported dog bite rate showed no significant regression on budget rate or staffing rate (Table 3), nor was there any significant relationship with public education expenditure.

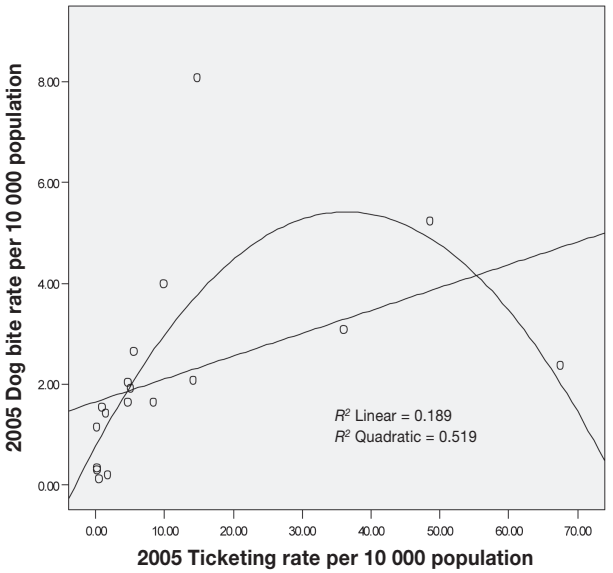

Figure 1. Linear and quadratic regression of reported dog bite rate on ticketing rate.

Thirteen municipalities [British Columbia (n = 7), Ontario (n = 3), Alberta (n = 1), Manitoba (n = 1), and Quebec (n = 1)] had some form of BSL and 23 did not. The Mann-Whitney U-test revealed no significant differences between municipalities with and without BSL in the rates of licensing, ticketing, budget, and reported dog bites (Table 4). Staffing rate was somewhat lower in municipalities without BSL (U = 84.00, $P < 0.05$). The more precise comparison based on regression analysis showed no difference between municipalities with and without BSL in reported dog bite rate, after the linear and quadratic effects of ticketing rate and other variables had been taken into account, and no significant interaction between the treatment (use or non-use of BSL) and the other variables.

Discussion

In the absence of actual dog ownership information, municipal dog populations were estimated by applying national population data to all municipalities. Dog ownership rates may not be uniform among municipalities, however, the estimates that resulted from applying the national average were highly correlated with the municipalities' own estimates, with one exception.

There were large differences between municipalities that appeared to reflect very different animal control strategies. With the exception of Saskatchewan and the Atlantic region, all provinces included some municipalities with breed-specific by-laws. Most (but not all) Quebec municipalities had low commitment of resources and some of the lowest levels of enforcement and of compliance with licensing requirements. On average, municipalities in Ontario, British Columbia, and the prairie provinces had similar levels of budget and staffing. However, several municipalities, widely dispersed across the country, put greater emphasis on enforcement and had much higher rates of ticketing and licensing, despite similar levels of expenditure.

The reported dog bites likely represented a small fraction of all dog bites that occurred in the municipalities. Studies have found that the reporting rate for dog bites was very low in Canada (12) and in Pennsylvania (13). If the published estimate of 1.8% of Americans bitten each year (1) is roughly applicable in Canada, then the median value of 1.9 per 10 000 as found in this study would represent roughly 1% of the total number of bites inflicted. Presumably, this is due in part to a high percentage of "household" bites (bites by a dog to a family member, which are rarely reported to authorities) and a very low rate of reporting non-household bites (1,14,15).

The positive correlation between reported dog bite rate and enforcement indicators likely reflects a higher reporting rate in municipalities with active animal control programs. Where there is very little enforcement, animal control authorities may be relatively invisible to the public, whereas moderate levels of enforcement may create greater public awareness and willingness to report bite incidents. An alternative explanation — namely that large pre-existing differences in reported dog bite rate caused municipalities to adopt very different enforcement strategies — seems less plausible. While some differences in reported dog bite rate may occur and influence local responses, the very large differences observed — with municipalities differing by 10-fold or 100-fold in the same province — seem unlikely to occur as background variation that then triggers different approaches by local authorities.

Despite the positive correlation, if enforcement is effective in actually reducing dog bites, then we would expect fewer reported dog bites at very high levels of enforcement, since reduction in actual biting would compensate to some degree for the increase in reporting. The regression analysis was consistent with this view. Specifically, in the regression of reported dog bite rate on ticketing rate, an inverted U curve (quadratic regression) made

Table 3. Linear and quadratic regression of reported dog bite rate on 4 independent variables

	Parameter estimate		
Independent variable	Intercept ± SE	Linear coefficient ± SE	Quadratic coefficient ± SE
Ticketing rate	0.77 ± 0.50	0.25 ± 0.07[b]	−0.003 ± 0.001[b]
Licensing rate	−0.46 ± 1.13	0.19 ± 0.08[a]	−0.002 ± 0.001[c]
Budget rate	0.981 ± 0.56	0.00 ± 0.00	0.000 ± 0.000
Staffing rate	0.15 ± 1.4	11.09 ± 6.73[c]	−8.77 ± 6.12

SE — standard error.
[a] $P < 0.05$.
[b] $P < 0.01$.
[c] $P < 0.10$.

Table 4. Median values for reported dog bite rate and 4 measures of enforcement and resourcing for the 13 municipalities with breed-specific legislation (BSL) and the 23 municipalities without (Non-BSL)

	Municipality	
Variable	BSL (n = 13)	Non-BSL (n = 23)
Reported dog bites per 10 000	1.7	1.8
% Dogs licensed	29.7	16.1
Budget per 10 000	$28 000	$27 000
Tickets issued per 10 000	4.6	4.5
Staff per 1 000 000	44	25[a]

[a] $P < 0.05$, BSL *versus* Non-BSL municipalities.

a much better fit to the data than a linear regression, possibly because the actual dog bite rate declined at very high rates of ticketing. A similar but weaker relationship was found with licensing rate. Because licensing and ticketing were closely correlated, it is not clear that licensing by itself has any effect on dog bite incidence. Nonetheless, licensing may be an important part of a successful enforcement program, since it allows dogs and owners to be identified, and in some municipalities the revenue from license fees is sufficient to fund effective enforcement.

The regression analysis and associated *P*-values must be interpreted carefully because the data do not conform to the assumptions of multivariate analysis. First, although the municipalities are widely distributed across the country and represent a substantial fraction of the total population, they are a non-random sample. Hence, they can be seen as informative of the situation but not randomly selected. Second, the data were far from normally distributed, with some municipalities being very different from the average and exerting a disproportionate influence on the analysis. For these reasons, the regression analysis should be regarded not as testing hypotheses through the use of theoretically ideal data, but as fitting the best curve to actual data as a basis for identifying the most plausible interpretation of the relationships.

The data also provided a basis for comparing reported dog bite rates in municipalities with and without BSL. Neither the simple non-parametric comparison, nor the comparison after adjusting for the effect of enforcement in the regression analysis, provided any evidence that municipalities with BSL had fewer dog bites. Similar negative conclusions have been reached in studies that used other means of assessing the effectiveness of BSL (16–18). Moreover, other Canadian studies suggest that breeds commonly banned in breed-specific legislation account for a relatively small fraction of dog bites (19) and fatalities (20), and that these breeds are not more likely to bite than a matched sample of other breeds (21).

Education is often considered to be a key component in reducing dog bites (6,22). In this study, only about 1% of animal control budgets were identified for education. However, many municipalities may have used enforcement staff to conduct some education. Hence the lack of relationship between education budget and reported dog bites should not be interpreted to mean that education is ineffective.

In conclusion, this study showed a wide range in dog control activities in various Canadian municipalities, including different levels of resourcing combined with varying levels of licensing, enforcement, and other measures. The results are most consistent with the view that i) a high level of ticketing, perhaps combined with effective licensing, may lead to a reduction in dog bites, although it may also be accompanied by an increase in reporting of bites; and ii) seemingly effective enforcement levels were achieved in some municipalities at levels of budget and staffing commonly seen in Canadian municipalities. The data provided no evidence of lower dog bite incidence in municipalities with breed-specific legislation.

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