

Dog bite and injury prevention—analysis, critical review, and research agenda

J Ozanne-Smith, K Ashby, V Z Stathakis

Abstract

Objectives—To analyze Australian dog bite injury data and make international comparisons; to review risk and protective factors relating to the dog, injured person, and environment; and to recommend action for prevention and research.

Methods—Australian dog bite injury data, complemented by detailed Victorian and regional data from routine health records and vital statistics, were analyzed to determine incidence, severity, nature, circumstances, and trends. International comparison data were extracted from published reports. Risk and protective factor studies were selected for review from electronic and bibliographic searches where data were recent, sample sizes substantial, and bias limited.

Results—The Australian dog bite death rate (0.004/100 000) is lower than both the United States (0.05–0.07/100 000) and Canadian rates (0.007/100 000). Victorian hospitalized trend rates were stable between 1987 and 1998, but there was a decline for children <5 years ($p=0.019$) corresponding with a reduction in dog ownership. Children 0–4 years have the highest rate of serious injury, particularly facial. Adults have longer hospitalizations, most frequently for upper extremity injury. Risk factors include: child, males, households with dogs, certain breeds, male dogs, home location, and leashed dog.

Conclusions—Dog bite rates are high and it may therefore be assumed that current preventative interventions are inadequate. Responsible dog ownership, including separating young children from dogs, avoiding high risk dogs, neutering, regulatory enforcement, and standardized monitoring of bite rates are required. Controlled investigations of further risk and protective factors, and validated methods of breed identification, are needed.

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Keywords: dog bite; risk factors; epidemiology; research

Dog bite has been identified for many years as a source of potentially serious but infrequently fatal injury. It is only since the advent of computerized injury data that it has become possible to describe fully the true dimensions and nature of this public health problem. The availability of a specific mechanism of injury

code (E code 906.0) for dog bite in the *International Classification of Diseases (ICD)*¹ considerably enhances the possibilities for describing and monitoring deaths and hospitalizations and for making international comparisons.

We analyzed Australian data on dog bite injury and reviewed the international comparative data. We also reviewed risk and protective factors relating to the dog, the injured person, and the environment and the implications for prevention. From these analyses and review we established a research agenda for dog bite prevention.

Method

Australian dog bite injury data were obtained from the National Injury Surveillance Unit at Flinders University, which holds national death and hospitalization data. Data for the state of Victoria (estimated population 4.7 million) were analyzed to complement the national data, particularly with respect to secular trends, using a log linear Poisson regression model, and circumstances of injury, including the identification of potential risk factors. Sources were the Victorian Inpatient Minimum Database (hospital admissions), the Victorian Injury Surveillance System (emergency department presentations), and the Victorian Coroner's Facilitation System (coronial data). Each of these data sources is described in detail elsewhere.^{2–3} The availability of data at varying levels of severity allows for a depth of understanding of dog bite not often achieved elsewhere. A logistical algorithm was used to exclude readmissions and transferred patients. International comparative data were extracted from published literature and from the internet.^{4–5}

Literature reviews used a variety of sources to identify risk factor data, including exposure. Electronic searches were conducted using Medline, Cinahl, and Sociofile. Bibliographic searches were based on articles retrieved from the computerized searches.

Results

Weiss *et al* report United States (US) rate ratio data⁶ derived from dog bite rates and national estimates based on a 1992 to 1994 national probabilistic survey of emergency department treated cases and official death reports. For each US dog bite fatality, there are an estimated 670 hospitalizations and 16 000 emergency department visits.

Monash University
Accident Research
Centre, PO Box 70A,
Monash University,
Victoria 3800,
Australia
J Ozanne-Smith
K Ashby
V Z Stathakis

Correspondence to:
Professor Ozanne-Smith
joan.ozanne-smith@general.monash.edu.au

Table 1 Comparison of reported national/international dog bite rates by severity (rates/100 000)

Country	Period	Death rate	Hospital admission rate	Emergency department presentation rate	All medically treated rate	Total dog bite rate
Australia	1995/96	0.004	7.7			
Adelaide ²⁶	Jan 1990–July 1993			73		
Latrobe Valley ¹¹ (rural Victoria)	1994/95			151	263	
Canada*	1994–96		2.6			
Guelph ³⁴	1987–97	0.007				
	1986–87					160 (reported to health unit for review and police complaints reports)
England ²⁵						
Salisbury: high SES				150		
Thanet: low SES				300		
Netherlands ³⁵	1992–96			78		
New Zealand ²⁴	1988		4.8			
Dunedin	1989–90			175		
Hamilton	1988			173		
Lower Hutt	1990			85		
United States ^{6 7 30}	1992–94			129		1800 (national telephone survey)
	1995–96	0.05–0.07				
	1994				300	
Pittsburgh ³⁶	1993					589 (animal control and police reports)

SES = socioeconomic status. *Laboratory Centre for Disease Control, Health Canada, analysis of data from Statistics Canada and Canadian Institute for Health Information, unpublished results.

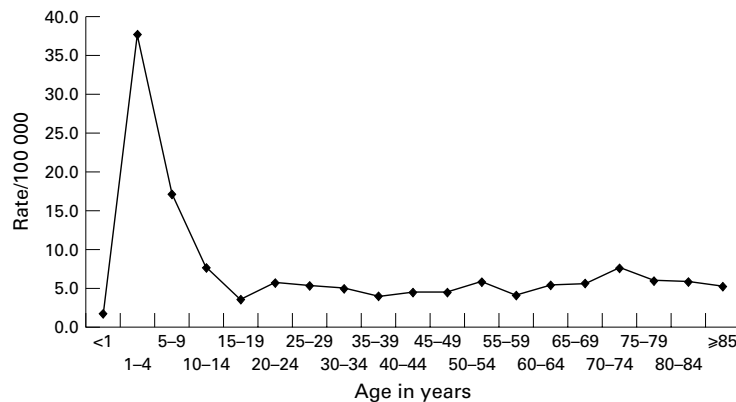


Figure 1 Dog bite hospitalization rates per 100 000 by age group, Australia, July 1995 to June 1996.⁹

DEATHS

Comparison of international data on dog bite deaths indicates similar rates between countries (table 1). The Australian annual average rate was 0.004 per 100 000 population between 1979 and 1996, with a steady frequency of 0–2 cases per year. The US rate for 1995–96 is expressed as a range because death certificate data were not available for validation and possibly only 74% of cases were reported.⁷ The rates ranged from 0.05/100 000 to 0.07/100 000.⁷

In the US, from 1979–88, 70% of dog bite deaths were to children under 10 years⁸ and, in 1995–96, 80% were children.⁷ The highest rate in 1995–96 was for infants under 3 months of age.⁷ Among the 11 Australian deaths reported between 1979 and 1996,⁹ 36% were children aged under 5 years, 36% were 70 years and over, and the remainder were between 35 and 69 years.

Although males were over-represented in US dog bite deaths (60.5%), there was no clear gender pattern among the small number of Australian deaths.

Other risk factors for deaths in the US included: more than one dog involved (64%)⁷; owner's property (70%)⁷; certain dog breeds; history of aggression; sleeping infant; child's

unauthorized access to a fenced yard or yard with leashed dogs; and dog escaping enclosure or restraint.⁸ Of the 199 US dog bite fatalities for which breed is known, pure breed pit bull and pit bull cross breeds were most frequently involved, followed by Rottweiler and Rottweiler cross breeds, and German shepherd and German shepherd cross breeds. Other identified high risk pure breeds included husky, Alaskan malamute, Doberman, chow-chow, Great Dane, St Bernard, and Akita.⁷

HOSPITAL ADMISSIONS

One complete year (July 1995 to June 1996) of hospital admission data was available for all Australian states and territories. The national hospitalization rate was 7.7/100 000. The distribution of hospitalized dog bite victims by age group is shown for Australia in fig 1.⁹ Clearly, the highest risk is in the 1–4 years age group, followed by 5–9 year olds.

Data from elsewhere show quite similar patterns. Hospital admission rates are shown in table 1. The trend for all age hospitalized dog bite in Victoria, Australia showed no overall reduction for 1987–88 to 1997–98. However, a significant downward trend for the 0–4 year age group since 1993–94 ($p=0.019$) is evident. National records over this period are not available.

Length of stay in hospital is taken as a proxy for severity. In Australia, July 1993 to June 1996, the average length of stay increased with the age of the victim. The majority of child admissions were under two days, while after 35 years, the majority, and an increasing proportion with age, were admitted for longer periods. Of victims aged over 75, 47% were hospitalised for eight or more days.

EMERGENCY DEPARTMENT PRESENTATIONS

Emergency department presentations to 25 Victorian hospitals during 1996 and 1997 showed a different pattern by age group compared with admitted cases. Of the 2439 cases for which information was complete, 11.5% were admitted. Although children aged 0–9 represented 56.8% of admissions, this age

Table 2 Risk factors for dog bite injury: place factors

Source	Study design	Home location	Victim's home	Other home	Dog's home	Public places
Ashby, 1996 ¹⁰ (Australia)	ED surveillance, n=1916	66% of child, 40% of adult cases where location specified	32% of child, 34% of adult cases where location specified	34% of child, 6% of adult cases where location specified		19% of child, 38% of adult cases where location specified
Flores <i>et al</i> , 1997 ¹² (Canada)	ED surveillance, telephone follow up, n=385	78%	40%	38%		
Shewell and Nancarrow, 1991 ³⁸ (UK)	Case series in plastic surgery practice, n=146				85%	
South Australian Health Commission 1990 ³³ (Australia)	ED surveillance children 0–12 years, registry of Adelaide dogs					25%

ED = emergency department.

group accounted for only 24.9% of non-admitted emergency department cases.

A previous surveillance collection of seven Victorian public hospital emergency departments between 1988 and 1996 provided details of location of the injury event, body part injured, and circumstances of injury for almost 2000 cases of dog bite.¹⁰ For children under 15 years of age 66% (1331 cases) occurred at their own home or homes at which they were visitors. Although public places contributed only 19% of child cases, they accounted for 38% of the 585 adult cases.¹⁰

The body region affected shows different patterns for children and adults. The face and scalp represent 51% of bites to children in Victorian emergency department data and 82% of admitted cases,¹⁰ while 50% of adult bites presented to emergency departments were to the upper extremity.

Comparative rates of emergency department and medically treated (hospitalized, emergency department and general practitioner visits) dog bite are shown in table 1.¹¹ The reported rates are of the same order of magnitude, in part a function of the large number of dog bite cases, though different data collection methods were used.

EXPOSURE

Clearly, the general population is not a specific measure of exposure to dog bite. Dog ownership by household is identified by many studies as a risk factor (table 2).^{10 12} A 1992 survey of a representative sample of 4000 Melbourne households found that 33.5% of all households, 34.8% of households with children under 5 years, and 22.4% of households where a usual resident was 60 years or older, owned dogs.¹³ A repeat survey in 1998 found similar total household ownership of dogs (34.6%), but a reduction in dog ownership in households with children under 5 years (30.8%).¹⁴ Urban dog ownership by household (34.6%) was lower than rural (49.7%).¹⁴

Similarly, Australian telephone surveys of dog ownership, undertaken in 1994 and 1996, of 1011 and 12 041 respondents respectively,^{15 16} estimated a national dog population of 3.9 million with 42% of Australian households owning an average of 1.5 dogs. The 1994 survey also reported a 1:1 male to female dog ratio and 77% of dogs in the small to medium size range.¹⁵

A 1998 Victorian study¹⁷ that surveyed 78 Victorian municipalities to identify and measure the level of enforcement of the Domestic Animals (Feral and Nuisance) Act 1994,¹⁸ also collected dog population data. More than 75% of the 34 respondent municipalities kept computerized data on registrations and infringements. As was found in the household survey the rate of registered dogs per 100 dwellings was significantly higher in rural municipalities (49.2/100 dwellings, 95% confidence interval (CI) 43.4 to 55.0) than in metropolitan municipalities (30.1/100 dwellings, 95% CI 20.7 to 39.5) ($p<0.01$).¹⁴ Rural municipalities also recorded a significantly greater number of bites, rushes (dog rushing at victim), and dogs destroyed per 1000 registered dogs than metropolitan areas.

The 1992 Melbourne rate of dog ownership was similar to the 1991 US figure—36.5% of households. The US dog population for that year was estimated at 53.5 million.¹⁹

DOG BREED

Caution should be exercised in interpreting breed data with regard to both dog bite (numerator) and dog population (denominator) data.^{20 21} Of households with dogs in the 1992 Melbourne household survey, 41.2% had pure breed and 58.8% cross breed dogs (154.7/100 000 and 220.7/100 000 households, respectively).¹³ Identification by breed proved unreliable, however, because of the uncertainty of breed assignment by owners and interviewers, particularly for cross breeds. Importantly, the term “pit bull” appears to be used for several breeds including the bull terrier, American Staffordshire bull terrier (also known as American pit bull terrier), and Staffordshire bull terrier. Confusion may be perpetuated by the media misinforming the public regarding dog breed.^{20 22 23}

RISK FACTORS

Our data analyses and literature review identified a number of consistently reported risk factors for non-fatal dog bite. However, only one case-control study was identified to support the associations found in a number of large case series.¹⁹

Risk factors relating to the place, the victim, and the dog are reported in tables 2, 3, and 4 respectively. Major risk factors identified in Australian and overseas studies include: children, especially under 5 years; male victims;

Table 3 Risk factors for dog bite injury: person factors

Source and date	Study design	Children over-represented	Males over-represented	Body part injured	Victim known to dog
Ashby, 1996 ¹⁰ (Australia)	ED surveillance, n=1916	Yes	Yes	51% child face/head; 33% adults hand	
Flores <i>et al</i> , 1997 ¹² (Canada)	ED surveillance, telephone follow up, n=385	Yes	Yes	74% 1-4 years face/head 68% adults arms/legs	71.2%
Gerschman <i>et al</i> , 1994 ¹⁹ (US)	Case-control study non-household members, n=178 pairs	Yes	Yes		
Jarrett, 1991 ³⁷ (UK)	Case series in ED	Yes			
Shewell and Nancarrow, 1991 ³⁸ (UK)	Case series in plastic surgery practice (1982-89), n=146	Yes	No		
Patrick and O'Rourke, 1998 ²⁸ (US)	Random sample of animal control surveillance data, El Paso, Texas, n=300	Yes	Yes		
Avner and Baker, 1991 ³⁹ (US)	Case series of children attending hospital, n=168		Yes		77%
Thompson, 1997 ²⁶ (Australia)	ED surveillance, n=356 (dog attacks) and population survey, n=3093	Yes	Yes	90% child admissions head/face	

ED = emergency department.

Table 4 Risk factors for dog bite injury: dog factors

Source	Study design	Dog gender	Dog breed	Over-representation of breed	Interaction before attack	Unprovoked attack	Previous history of biting
Ashby, 1996 ¹⁰ (Australia)	ED surveillance, n=1916		German shepherd, bull terrier, heeler, Rottweiler		Playing: 17% Petting: 10% Feeding: 5%		
Flores <i>et al</i> , 1997 ¹² (Canada)	ED surveillance, telephone follow up, n=385	73% male	German shepherd, cocker spaniel, Rottweiler, golden retriever		Ordinary interaction: 38% Teasing: 33% No interaction: 29%	29%	72%, no previous history of biting
Gerschman <i>et al</i> , 1994 ¹⁹ (US)	Case-control study, non-household members, n=178 pairs	Male OR 6.2 (2.5 to 15.1)		German shepherd OR 16.4 (3.8 to 71.4) Chow-chow OR 4.0 (1.2 to 13.7)			
Shewell and Nancarrow, 1991 ³⁸ (UK)	Case series in plastic surgery practice, n=146	85% male (of 96 cases)	Staffordshire bull terrier, Jack Russell		Playing: 12% Petting: 13% Waking: 15%	42%	
Greenhalgh, <i>et al</i> , 1991 ⁴⁰ (Australia)	ED case series, children, n=159			German shepherd			Uncommon
Avner and Baker, 1989 ³⁹ (US)	Case series of child hospital attendances, n=168		German shepherd 20.8%, pit bull 19.6%		46% provoked	Significantly more pit bull terrier attacks unprovoked	
Patrick and O'Rourke, 1998 ²⁸ (US)	Random sample of animal control surveillance data, n=300				50% provoked in children <5 years, significantly more likely to provoke than older children		
Thompson, 1997 ²⁶ (Australia)	ED surveillance, n=356, population survey, n=3093		German shepherd, pit bull terrier, blue/red heeler, Doberman, Rottweiler	All 4-5 times higher frequency than other breeds			
South Australian Health Commission 1990 ³³ (Australia)	ED surveillance children 0-12 years, registry of Adelaide dogs			% Attacks v % dog population Bull terrier 5.4, German shepherd 4.2, Doberman 4.0, Rottweiler 2.6, blue heeler 2.4, collie 1.2			

ED = emergency department.

households with dogs; over-representation of some breeds; male dogs; victim known to the dog; home location (child's or other home); dog's home.

Discussion

Few reliable rate data have been published for serious dog bite injuries, despite the availability of a specific E code. Where available, from the US,⁶⁻⁸ New Zealand,²⁴ Canada (Laboratory Centre for Disease Control, Health Canada, analysis of Statistics Canada data, unpublished results), the UK,²⁵ and Australia,⁹ rates appear to be similar for deaths and medically treated injuries. The Australian death and hospitalization rates for dog bite are 0.004 and 7.7 per

100 000, respectively. Direct comparison is complicated, however, by the variety of ways in which data were collected, including routine injury surveillance, case series studies based on treatment sources, dog bite reporting systems, and surveys.

The evidence suggests that the rate of dog ownership by households is similar for the US and Australia (35% Melbourne,¹⁴ 42% Australia,^{15 16} and 37% US¹⁹).

Victorian data indicate no reduction in the rate of dog bite injury over the 11 years 1987-88 to 1997-98, except for a significant reduction in hospitalizations for children aged 0-4 years, since 1993. This reduction coincides with changes to the Domestic Animals (Feral and Nuisance) Act 1994,¹⁸ some enforcement by

local governments, publication of dog bite statistics, and public information supplied by the media and child injury prevention organizations. The 1998 repeat of the 1992 Melbourne household survey indicated a reduction in dog ownership for households with young children.¹⁴

Further research and development is required to inform additional interventions. Standardized methods for reporting dog bite (and dog attack) are required. Dog bite injury should be routinely coded by the ICD9 E code or the corresponding ICD10 code. A modification is required to the ICD coding system to specifically and separately record both bite and other dog attacks. The latter represent about 14% of all dog related injuries.¹⁰

Similarly, standardized methods for measuring and reporting dog populations are required. Good comparative data may contribute to the identification of international best practices for prevention. Reliable and practical methods for identifying dog breed need to be developed and validated, and the names of dog breeds should be clarified internationally. An atlas of common dog breeds and cross breeds is needed, including photographs with height and length measures. This would provide a reference against which panels of experts could identify breeds from photographs of dogs involved in attacks.

An alternative approach has been tried where survey data on the size of dog(s) is collected. This simplified information may prove more reliable than breed, and is possibly just as relevant as a risk factor.

Controlled studies of further risk and protective factors should be undertaken. Validated instruments will be required to determine breed, temperament, and level of training. Agreed terminology is also required for terms such as provoked/unprovoked attack and normal interaction with dogs. Rigorous evaluation studies should be conducted in association with future interventions. Studies are also required to identify barriers to the implementation of generally accepted preventive measures such as neutering of male dogs and avoidance of high risk dogs, particularly in households with young children.

Implications for prevention

Many published articles recommend preventive measures, including strict controls on high risk breeds,²⁶ constraining measures such as leashing,^{26 27} "user pays" liability insurance,²⁶ dog training,^{21 27} education for dog owners and families,^{21 28-30} informed pet selection,^{19 28 30} and enforcement of regulations.¹⁷ Bandow specifically recommends that all dogs should be socialized to accept children, that young children should never be left alone with a dog, and that owners be encouraged to inhibit biting behaviour.²¹

Only two interventions were reported as effective.^{31 32} The first was a police policy change from "bite-and-hold" (where the dog is trained to apply force, by mouth, as a technique to subdue individuals suspected for felony crimes) to the less injurious "find-and-bark"

Key points

- Highest rate of serious injury from dog bite is to children under 5 years of age.
- The all age hospitalisation rate for dog bite in Victoria, Australia showed no overall reduction over the 11 year period (1987–88 to 1997–98).
- Average length of stay in hospital increases with the age of the victim, with almost 50% of those aged over 75 years being hospitalised for eight or more days.
- Emergency department surveillance data found that for children under 15 years, 66% of dog bite injuries occurred at their own home or at homes at which they were visitors, while 19% were in public places.
- Fifty one per cent of bites to children were to the face and scalp. Emergency department surveillance data also found that 38% of adult dog bite injuries occurred in public places.
- Identified risk factors include children, males, households with dogs, certain breeds, male dogs, home location, and leashed dogs.
- There is a need for responsible pet ownership which includes separating young children from dogs or at the very least, never leaving them alone with a dog as well as avoiding high risk dogs and neutering male dogs.
- Controlled investigation of risk, protective factors, and validated methods of breed identification are needed.

(where the dog is trained to find a perpetrator and bark to subdue, without force by mouth) for law enforcement involving dog teams operating in Los Angeles County. This intervention resulted in a decrease in the number of dog bite cases presenting to a jail ward emergency department from 639 (1988–91) to 66 (1992–95) and a decrease in the severity of injuries.³¹

Oswald, using a pre-test/post-test evaluation design, examined the effects of a potentially dangerous dog program in limiting the opportunity for these dogs to repeat biting behaviour.³² In a random sample of 422 dogs pre-program and 372 post-program, 25% of dogs pre-program repeated biting behaviour within one year. Post-program, the repeat incidence was significantly reduced to 7% ($p = 0.01$).³²

Most other interventions have not been evaluated, and debate about some measures, particularly breed specific legislation, continue in the literature and the media.^{21 22 33}

The Victorian studies reported here, together with the literature review, identify the need to reduce exposure by separating young children from dogs, particularly male dogs and certain breeds, particularly in the child's own home or in a home being visited. The Victorian experience suggests that well publicised strengthening of dog regulations can significantly reduce dog bite rates to young children.

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