

ORIGINAL RESEARCH

## Human Fatalities Resulting From Dog Attacks in the United States, 1979–2005

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**Introduction.**—Dog attacks are a major public health concern worldwide. Dogs bite over 4 million people resulting in the hospitalization of 6000 to 13 000 people each year in the United States. Rarely deaths may occur after an attack.

**Methods.**—This study utilized the compressed mortality files from CDC WONDER to evaluate deaths from dog attacks over the 27-year period 1979–2005.

**Results.**—An average of approximately 19 deaths was reported annually from dog attacks during this time period. Males and children less than 10 years of age had the highest rate of death from dog attacks. Deaths have been reported in 49 states with Alaska reporting the highest death rate from dog attacks. The number of deaths and death rate from dog attacks appear to be increasing.

**Conclusions.**—Deaths from dog attacks appear to be increasing as the population of both humans and dogs has increased during this time period. Children have the greatest risk of death. There is a need for a national reporting system on dog bites to fully capture the extent of fatalities and look at risk factors surrounding the attack. The development of effective prevention practices is dependent upon examination of these risk factors.

*Key words:* dog bite, fatality, attacks, prevention

Injuries, illnesses, and fatalities resulting from encounters with dogs are a major public health concern worldwide. Dogs not only cause morbidity and mortality as a result of bites, they may also transmit zoonotic infections, which may also result in illness or death.<sup>1</sup> In fact, dogs are the main source of rabies transmission to humans worldwide.<sup>2</sup> It is estimated that 3% to 18% of dog bite wounds become infected, with occasional cases of meningitis, endocarditis, and septic shock leading to death reported.<sup>3</sup> Dogs not only cause puncture, tearing, and crush injuries from bites, they can also scratch/paw, causing abrasions and lacerations. Fractures may occur, especially in the elderly, when they trip over their dogs or are knocked down by them.<sup>4</sup> Injuries may also occur indirectly as a result of dogs, as might be the case with a jogger who is running away to avoid a dog and trips and falls on the pavement.

Information on the extent of traumatic injuries from dog attacks is incomplete. The number of bites is thought to be underreported.<sup>5,6</sup> In a survey of dog bites

in Pennsylvania, the rate of dog bites was 36 times higher than what had been reported to authorities.<sup>5</sup> Studies on dog bites in the United States report a bite rate varying from 129 per 100 000 up to 2400 per 100 000.<sup>6</sup> According to national estimates, almost 1000 persons per day are seen in emergency departments for dog bites.<sup>7</sup> It has been estimated that 1 out of 2 people will suffer from a dog-related injury during his lifetime.<sup>8</sup>

A study in the United States in 1994 estimated that injuries from dog bites occurred in approximately 4.7 million people, 800 000 of which presented for medical treatment, of which 333 000 sought treatment in emergency departments.<sup>9</sup> An estimated 34 million US households included a dog in 1994.<sup>10</sup> In 2001, a Centers for Disease Control and Prevention (CDC) study estimated 368 000 people were treated in emergency departments for dog bites.<sup>11</sup> An estimated 6000 to 13 000 hospitalizations occur yearly as a result of dog bites.<sup>7,12</sup> From 1979 to 1994, dog attacks resulted in 279 deaths to humans in the United States, resulting in an average of 17 to 18 deaths per year.<sup>13–15</sup>

The present study is an update of the epidemiology of fatalities resulting from dog attacks in the United

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States for the 27-year period ranging from 1979 to 2005. The US dog population has increased during this 27-year time frame. It is estimated that there were over 72 million dogs in 44.8 million US households in 2006.<sup>16</sup> While the number of households that include a dog increased from 34.1 million in 1988 to 44.8 million in 2006, dog ownership as a percent of the US household population increased by 2%, from 37% in 1988 to 39% in 2006.<sup>16</sup>

## Methods

Data on fatalities from dog bite-related attacks for the 27-year period (1979–2005) were obtained utilizing the CDC Wide-Ranging OnLine Data for Epidemiologic Research (CDC WONDER) program.<sup>17</sup> This program can be used to access the Compressed Mortality File. The mortality data on the Compressed Mortality File are based on records for all deaths occurring in the 50 states and the District of Columbia. State of residence, age group, race (white, black, and other), gender, population, year of death, underlying cause of death using a 4-digit International Classification of Diseases (ICD) code, the number of deaths, crude death rates, and age-adjusted death rates can be obtained.

The cause of death in the Compressed Mortality File is the underlying cause of death, which is defined by the World Health Organization as “the disease or injury, which initiated the train of events leading directly to death, or the circumstances of the accident or violence, which produced the fatal injury.” Underlying cause of death is selected from the conditions entered by the physician on the cause-of-death section of the death certificate. When more than one cause or condition is entered by the physician, the underlying cause is determined by the sequence of conditions on the certificate, the provisions of the ICD, and associated selection rules and modifications.

The underlying cause of death is classified in accordance with the ICD. Deaths for 1979–98 are classified using the ninth revision of the ICD (ICD-9). Deaths for 1999 and beyond are classified using the 10th revision (ICD-10). For deaths due to injuries and poisonings that occurred during the 1979–98 period, the external cause of death is coded (E800–E999), and for deaths occurring from 1999 to 2005, the external cause of mortality is coded from V01–Y98. For fatal dog bites from 1979 to 1998, the ICD-9 category (Dog bites) is coded E906.0 (see [ftp://ftp.cdc.gov/pub/Health\\_Statistics/NCHS/Publications/ICD-9/ucod.txt](ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Publications/ICD-9/ucod.txt)). For 1999 to 2005, the ICD-10 category for death resulting from being bitten or struck by a dog is coded W54 (see <http://www.who.int/classifications/apps/>

icd/icd10online/). Cases of fatalities secondary to an infection from a bite are not included.

Descriptive statistics are used to present data. Poisson regression was used to investigate a temporal trend in the annual number of deaths from dog bites.<sup>18</sup> The annual percentage change in death rates was estimated with log-linear regression.<sup>19</sup> *P* values <.05 are considered statistically significant.

## Results

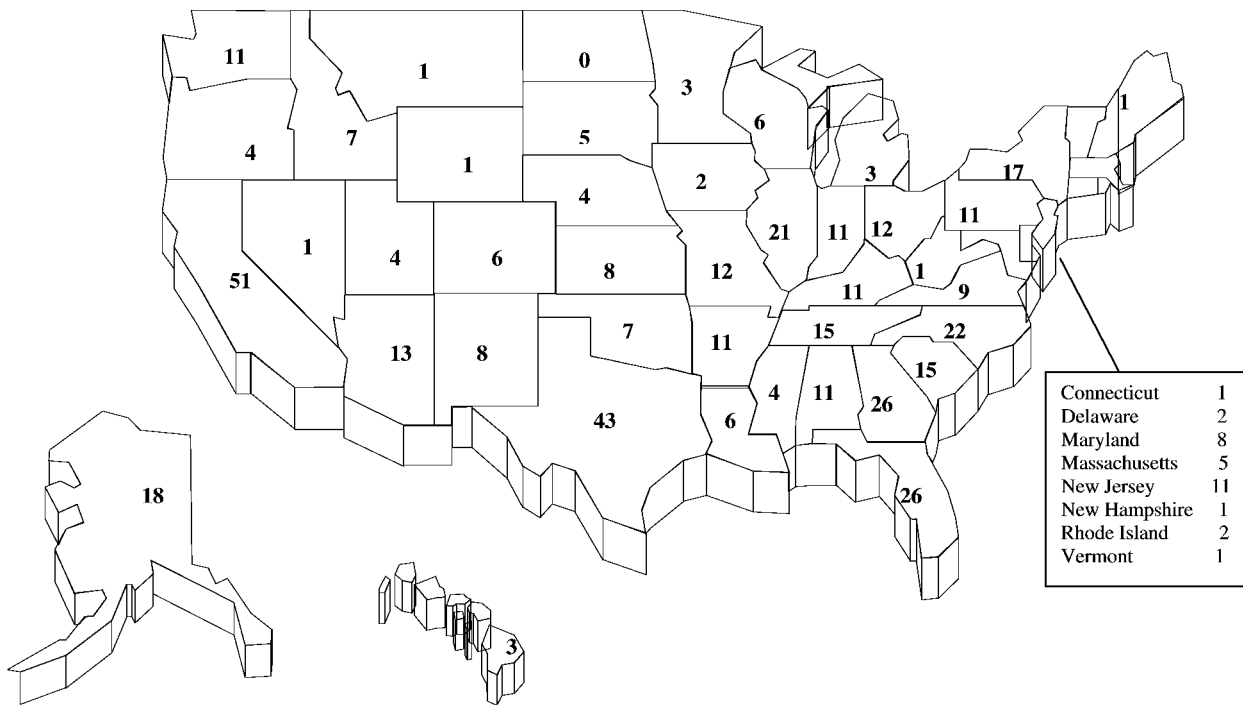
During this 27-year time period there were 504 deaths reported. An average of 18.67 deaths occurred per year, with a range of 11 to 33 deaths. Deaths were reported to have occurred in every state except North Dakota. Six states (Texas, California, Florida, Illinois, Georgia, and North Carolina) accounted for 37.5% of the reported cases (Figure 1). However, when evaluated by deaths per 10 million population, Alaska had the highest death rate of all states (Table 1).

Of the victims, 58.1% were males and 41.9% were females, compared to 48.87% males and 51.13% females in the US population (*P* < .05).<sup>17</sup> By race, 81.3% of victims were white, 14.3% were black, and 4.4% were classified as “other.” This was not statistically different compared with the racial background of the United States.<sup>17</sup> White males comprised 46.8% of victims, followed by white females (34.5%), black males (8.5%), black females (5.7%), other males (2.8%), and other females (1.6%) (Table 2).

When evaluated by age, victims less than 1 year of age accounted for 10.9% of deaths. Victims less than 10 years of age accounted for 55.6% of the cases, while individuals 65 years or older accounted for 24.0% of the cases. The highest number of deaths occurred in children aged 1 to 4 years of age, which accounted for 29.9% of the total deaths. Infants less than 1 year in age had the highest age-specific death rate (Table 2).

The mean death rate was calculated as 0.71 per 10 million persons for this period of time. The death rate in males was 0.86 per 10 million males, compared to females at 0.59 per 10 million females. The death rate by race was 0.825 per 10 million blacks, 0.757 per 10 million “other” races, and 0.705 per 10 million whites. There was no significant difference between blacks and whites in terms of the annual death rate (*P* = .71).

The death rate by race in children aged 1 to 4 years was 3.79 per 10 million whites, 3.15 per 10 million blacks, and 5.26 per 10 million “others.” The death rate in children less than 1 year of age was 5.41 per 10 million whites, 5.37 per 10 million blacks, and 2.05 per 10 million “others.” The death rate in adults 55 years and over was twice as high in blacks compared to whites



**Figure 1.** Fatal dog-related injuries, 1979–2005.

and “other” races (1.38, 0.60, and 0.62 per 10 million, respectively). For adults >75 years of age, the rate in blacks was 3.87 per 10 million, 1.88 per 10 million whites, and 1.40 per 10 million “other” races.

Results from the Poisson regression analysis indicated a significant increasing trend in the annual number of deaths from dog bites from 1979 to 2005 ( $P = .0017$ ). The average annual increase in death rates was 1.7% (Figure 2).

## Discussion

Injuries from encounters with dogs are a major public health concern. The rate of fatal and nonfatal bites varies by sex, race, and age. This study focused on the epidemiology of fatal dog attacks.

The present study found children 1 to 4 years of age to have the highest number of deaths, while infants less than 1 year of age had the highest death rate. Consistent with the results of other studies, children less than 10 years of age appear to be at the highest risk of fatal and nonfatal injuries from dog attacks. Sacks et al<sup>15</sup> reported that 70% of deaths from dog bites from 1979 to 1988 occurred in children under 10 years of age. Weiss et al,<sup>7</sup> in a study of emergency department visits for dog bites, found that males 5 to 9 years of age had the highest rate of dog bite–associated injuries. Shuler et al<sup>20</sup> also found that males 5 to 9 years old had the highest rate of dog

bite–associated injuries. A study of dog bite injuries in Spain found that male children 5 to 9 years of age had the highest rate of injuries.<sup>21</sup> In a study in Pennsylvania, Moore et al<sup>22</sup> found that children under 5 years of age had the highest incidence of animal bites. In a national study, 42% of dog bite victims treated in emergency departments were under 15 years of age.<sup>11</sup> In general, most severe and fatal dog bite cases occur in young children or the elderly.<sup>23–25</sup> In contrast, one study found a higher rate of dog bites in adults.<sup>26</sup> The present study also noted the death rate in the elderly to be high. Studies have shown that the elderly experience a higher in-hospital fatality rate from trauma compared to younger persons. Comorbid conditions, preinjury medications, reduced physiologic reserve, and the physical changes of aging must be considered in the treatment of traumatically injured elderly and may partially explain the higher death rate after an injury.<sup>27,28</sup>

This study found males to have an approximately 1.5 times greater death rate than females. Results from this study are consistent with those of most other US studies in finding males to be at increased risk of injury or death from a dog bite.<sup>7,13</sup> This seems to be consistent not only in the United States but in other countries as well.<sup>29–35</sup> In a national study of dog bite–related fatalities in the United States in 1995–96, 72% of the victims were male.<sup>13</sup> In a study of nonfatal bite injuries treated in emergency departments in the United States, the rate of

**Table 1.** Age, sex, and race as percentage of total deaths from dog bites (1979–2005)

Age (y)	Death rate*	Sex†	White	Black	Other	Deaths	Percent- age of deaths‡
<1	5.29	M	21	4	0	25	5.0
		F	24	5	1	30	6.0
1–4	3.76	M	83	13	7	103	20.4
		F	38	7	3	48	9.5
5–9	1.48	M	45	4	4	53	10.5
		F	18	1	2	21	4.2
10–19	0.126	M	6	4	0	10	2.0
		F	3	0	0	3	0.6
20–34	0.097	M	11	1	0	12	2.4
		F	4	0	0	4	0.8
35–54	0.247	M	19	6	1	26	5.2
		F	16	2	1	19	3.8
55–74	0.673	M	24	6	1	31	6.2
		F	34	8	1	43	8.5
>74	2.02	M	27	5	1	33	6.5
		F	37	6	0	43	8.5
Totals			410	72	22	504	100.1

\*Age-specific death rate per 10 million.

†M indicates male; F, female.

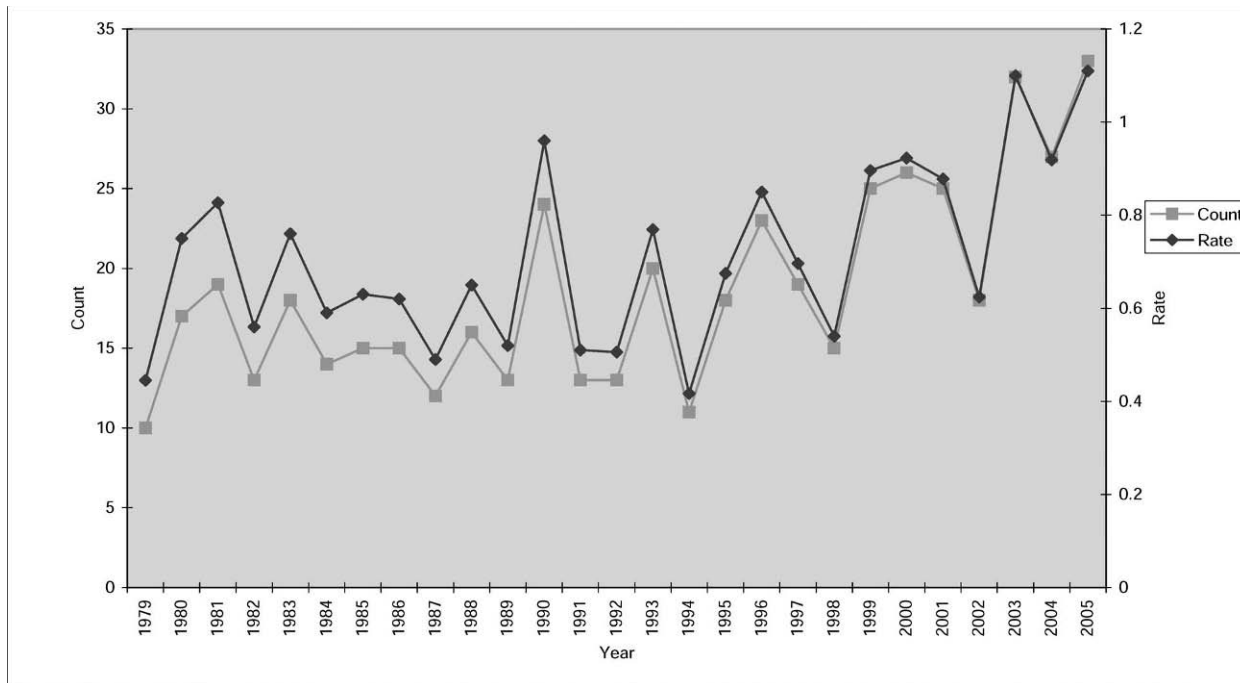
‡May not total 100% as a result of rounding.

dog bites in children under 15 years of age was 1.36 ( $P < .05$ ) times greater in males, but decreased to a non-significant 1.16 times greater in males aged 15 years and older.<sup>9</sup> While in the present study it could not be determined why males have a higher death rate, males have been found to be at higher risk of injury in many activities.<sup>36</sup> This study found that more deaths occurred in elderly females than elderly males, which may reflect the fact that females make up a greater percent (59.6%) of the elderly population in this country.<sup>17</sup> However, there was no significant difference in the death rate among elderly males or elderly females (data not shown).

This present study found no significant difference by race in frequency of dog-related deaths when compared to the US population.<sup>17</sup> However, there is a difference in dog ownership among the racial groups. Ninety-two percent of dog owners are white, compared to 3% of

**Table 2.** Rate of dog-related deaths by state, 1979–2005

State	Rate per 10 million population
Alaska	11.83
South Dakota	2.56
Idaho	2.31
New Mexico	1.83
Arkansas	1.64
South Carolina	1.52
Georgia	1.47
Arizona	1.17
Kansas	1.16
North Carolina	1.15
Delaware	1.11
Tennessee	1.08
Kentucky	1.06
Colorado	1.01
Hawaii	0.98
Alabama	0.97
Nebraska	0.90
Texas	0.87
Missouri	0.84
Washington	0.79
Oklahoma	0.78
Utah	0.77
Wyoming	0.76
Michigan	0.74
Rhode Island	0.73
Florida	0.71
Indiana	0.71
Vermont	0.65
Illinois	0.65
California	0.63
Maryland	0.61
Mississippi	0.55
Virginia	0.52
Louisiana	0.51
New Jersey	0.51
Oregon	0.48
Montana	0.44
Wisconsin	0.43
Ohio	0.40
New York	0.34
New Hampshire	0.33
Pennsylvania	0.33
Maine	0.30
Massachusetts	0.30
Iowa	0.26
Nevada	0.25
Minnesota	0.24
West Virginia	0.20
Connecticut	0.11
North Dakota	0



**Figure 2.** Deaths and death rates from dog attacks, 1979–2005.

blacks and 3% of other races.<sup>16</sup> It is not known if the victim was the owner of the dog or dogs that attacked. The breed of dog that attacked the victim is not reported, so it is not known if blacks or other races were more likely to own larger, more aggressive dogs that may have turned on them. It is also not known if blacks or other races are more likely to provoke an attack, such as teasing or running from a dog. A recent study indicated that living in low-income neighborhoods was a risk factor for dog bites.<sup>20</sup> Unfortunately, most studies on dog bites do not report on the race of the victim.

Six states (California, Texas, Florida, Georgia, Illinois, and North Carolina) contributed 37.5% of the cases reported. However, they also compose an estimated 36% of the US population.<sup>37</sup> A recent national survey did not find a geographic difference in dog ownership. Dog ownership parallels the US population at large.<sup>16</sup> However, when evaluating by rate of deaths from dog attacks, differences are apparent. Alaska had the highest death rate of all the states. Castrodale<sup>38</sup> found the hospitalization rate for dog bites was higher in Alaska than the national average and higher in the native vs nonnative population. Reasons to explain these differences require further research.<sup>38</sup>

As the populations of dogs and humans increase, more deaths are likely to be reported. The National Canine Research Council reported that the number of human deaths increased from 10 in 1950 (when the dog population was estimated to be 20 to 22 million) to 12 deaths

in 1970 (with a dog population of 31 million) to 15 deaths in 1980 (when the dog population was 40 million) to 19 deaths in 2000 (when the dog population was estimated at 60+ million). While the dog population tripled during this time frame, the human population and number of human deaths nearly doubled.<sup>39</sup>

The data in the current study show that not only has the number of deaths from dog attacks been on the increase in the last couple of decades, but so has the death rate. Reasons for the increase are not completely understood. However, both the number of dogs as well as the number of people owning dogs has also increased over this time interval. The population of large dogs owned has increased from 45% to 48% from 1998 to 2006.<sup>16</sup> Other suggested explanations include less knowledge of animal behavior, more integration of dogs into the household, thereby increasing exposure, and, to a limited extent, gang-related dog-fighting activities affecting the behavior of dogs (Dr Dianne Dunning, North Carolina State University College of Veterinary Medicine, oral communication, June 19, 2008).

Limitations of this study include the fact that it includes no information on many important factors, including location (indoors/outdoors) of attack, activity of the person or dog at the time of attack, breed or size of dog, sex of dog, reproductive status (neutered or not) of the dog, health of the dog or victim, known or unknown dog status, ownership of dog, and whether attack was provoked or not. No information on the location of

wounds or other clinical information is provided. It is possible that a few cases of dog bite deaths may have been miscoded or missed if dog bite-related deaths are coded as other conditions or if death is not recorded as being due to a dog bite but perhaps is considered a secondary effect of the bite. There are many studies utilizing mortality records that note misclassification and miscoding leading to over- or underestimates of diseases.<sup>40–43</sup> Sacks et al<sup>14</sup> evaluated dog-related deaths from 1989 to 1994 using data on dog bite-related fatalities using the NEXIS search service, the National Center for Health Statistics multiple-cause mortality tapes, and reports from the Humane Society of the United States. They identified 109 deaths during this 6-year time period. They found miscoding errors or missing data responsible for 21 deaths reported by NEXIS/Humane Society of the United States but not listed on the National Center for Health Statistics data tapes. The current study found only 94 dog bite-related deaths recorded on CDC WONDER during this same time interval. Thus, it is likely that CDC WONDER underreports the total number of deaths from dog attacks that occur.

It may be possible to prevent dog-related injuries by studying both fatal and nonfatal attacks. Researchers have shown that almost 80% of reported dog bite cases in persons under 19 years of age involve an animal owned by the victim's family or the victim's neighbors,<sup>14,24,44</sup> but this may not be true in underdeveloped countries.<sup>24,45</sup> Most victims are involved in normal, apparently nonprovoking activities before the dog attack. Prevention strategies to prevent dog attacks have been suggested by others.<sup>14,24,46–49</sup> Some but not all studies find that neutering the dog may decrease aggressiveness.<sup>49,50</sup> Chaining the dog has been identified as a risk factor for dog bites.<sup>49</sup> Children need to be taught how to behave around dogs and to not tease, provoke, or run from dogs. Parents should speak with veterinarians when it comes to choosing a pet and should learn how to properly socialize the pet. Cities and counties should develop ordinances on aggressive animals, and all animal bites should be thoroughly investigated.

In conclusion, dog bites result in approximately 19 deaths per year in the United States. The majority of fatal attacks occur in males and in children under 10 years of age. The rate of deaths from dog attacks appears to be increasing. Future research on animal-related fatalities should incorporate various sources of data including news reports, Humane Society reports, emergency department and medical examiner reports, and police and animal control officer reports to determine factors behind the animal attack. A national mandatory reporting system on animal attacks would also provide useful information for researchers and policy makers.

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