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ORIGINAL RESEARCH

Animal-Related Fatalities in the United States—An Update

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Objective.—To evaluate the causes of human fatalities in the United States from 1991 to 2001 that were caused by venomous and nonvenomous animal encounters exclusive of zoonotic infections or animal-vehicle collisions.

Methods.—An inquiry of CDC Wonder, a database for epidemiologic research, was used to provide information on animal-related fatalities on the basis of ICD-9 and ICD-10 codes.

Results.—From 1991 to 2001, 1943 persons died in the United States after venomous and nonvenomous animal encounters. An average of 177 fatalities per year were recorded. Venomous animal encounters were responsible for 39% of the fatalities. White males appear to be the group most likely to die from an encounter. Most fatalities occurred in the southern United States.

Conclusions.—Although the average number of fatalities from animal encounters has increased compared with the previous decade, the death rate has remained essentially unchanged. The medical and financial costs from both fatal and nonfatal animal encounters have a significant impact on public health.

Key words: snake, spider, fatalities, animal, venomous, nonvenomous

Introduction

Injuries and illnesses from animal encounters continue to be a major public health problem.[1–3] Animals can cause injuries by various mechanisms that include bite, sting, crush, gore, stomp, buck off, fall on, peck, or scratch. Millions of injuries, hundreds of thousands of emergency department visits, and thousands of hospitalizations, at a cost of hundreds of millions of dollars, occur yearly because of animal encounters.[3,4] Fortunately, the majority of such injuries are minor. However, many injuries remain undocumented and many people die, primarily in third-world countries, before receiving adequate medical care.[5] This study is an update of fatal injuries resulting from animal encounters in the United States between 1991 and 2001. Fatalities from zoonotic infections and animal-vehicle collisions are not included in this report.

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Methods

All human fatalities and causes of death are reported annually to the National Center for Health Statistics. CDC Wonder (www.cdcwonder.gov), an online database for epidemiologic research developed by the Centers for Disease Control and Prevention, was used to query data from the Center. The total number of fatalities from animal encounters in the United States for the time period 1991 to 2001 was obtained.

The fatalities from 1991 to 1998 were coded by the International Classification of Diseases, 9th edition (ICD-9). From 1999 to 2001, the International Classification of Diseases, 10th edition (ICD-10) was used. There are slight differences in how injuries are classified. The ICD-9 uses external cause-of-injury codes (E-codes) 905 and 906 to identify the animal-related fatalities (Table 1). E-code 905 includes the release of venom through fangs, spines, tentacles, or other venom apparatus and chemicals released by animals and insects. This category excludes the eating of poisonous plants or animals. Other animal-related injuries are classified as E-906. This classification excludes poisoning and toxic reactions caused by venomous animals, road vehicle accidents in-

Table 1. Code and category of animal-related fatalities

E-905.0	Venomous snakes and lizards
E-905.1	Venomous spiders
E-905.2	Scorpions
E-905.3	Hornets, wasps, bees
E-905.4	Centipede and venomous millipede
E-905.5	Other venomous arthropods: sting of ant, caterpillar
E-905.6	Venomous marine animals and plants
E-905.8	Other specified
E-905.9	Sting or venomous bite not otherwise specified
E-906.0	Dog bite
E-906.1	Rat bite
E-906.2	Bite of nonvenomous snakes and lizards
E-906.3	Bite of other animal except arthropod: cats, moray eels, sharks, rodents except rat
E-906.4	Bite of nonvenomous arthropods
E-906.8	Other specified injury by animal, including butted by animal, fallen on by horse or other animal not being ridden, gored by animal, implantation of quills of porcupine, pecked by bird, run over by animal not being ridden, stepped on by animal not being ridden
E-906.9	Unspecified injury caused by animal
X20	Contact with venomous snakes and lizards
X21	Contact with venomous spiders
X22	Contact with scorpions
X23	Contact with hornets, wasps, bees
X24	Contact with centipedes and millipedes (tropical)
X25	Contact with other specified venomous arthropod
X26	Contact with venomous marine animals and plants
X27	Contact with other specified venomous animals
X29	Contact with unspecified venomous animal or plant
W53	Bitten by rat
W54	Bitten or struck by dog
W55	Bitten or struck by other mammals
W56	Contact with marine animal
W57	Bitten or stung by nonvenomous insect and other nonvenomous arthropods
W58	Bitten or struck by crocodile or alligator
W59	Bitten or rushed by other reptiles

volving animals, and tripping or falling over an animal. ICD-10 uses different codes. External causes of death use V-, W-, X-, and Y-codes. For animal-related injuries, W- and X-codes are used (Table 1).

Data were evaluated by race, sex, age, and region of country. Race was classified as white, black, and ''other race.'' Age was categorized into the following groups for analysis: 0 to 4, 5 to 9, 10 to 19, 20 to 64, and 65 years and older. Regions of the country were categorized as West (Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming), Midwest (Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin), South (Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia), and Northeast (Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont).

Rates of animal-related fatalities were calculated for each category defined by E-, W-, and X-codes. Rates are based on the year 2000 United States population. Excluded from this study are fatalities from collisions between animals and vehicles, from animals being ridden, and from zoonotic infections.

ICD-10 does not have a category for ''other specified animal.'' Instead, ICD-10 includes separate categories for alligators, other mammals, marine animals, and other reptiles. These are combined with the ICD-9 category (E906.8) of ''other specified animal'' injury for purposes of analysis.

Results

Between 1991 and 2001, 1943 persons were reported fatally injured by animals. An average of approximately

Table 2. Rank order of animal-related fatalities in the United States (1991–2001)

Animal	*No. of deaths*	*% of fatalities*
Other specified	846	43.5
Hornet, bee, wasp	533	27.4
Dog	208	10.7
Other specified venomous arthropod	67	3.4
Spider	66	3.4
Nonvenomous arthropod	63	3.2
Snake	57	2.9
Other animal except arthropod	32	1.6
Unspecified animal	32	1.6
Unspecified venomous animal	23	1.2
Scorpion	5	0.26
Centipede	5	0.26
Rat	3	0.15
Venomous marine animal	2	0.10
Other specified venomous animal	1	0.05

177 fatalities occurred annually, with a range of 152 in 1994 to 212 in 2000. The total number of fatalities during this time period was 759 for venomous animals (average of 69 per year, range 57–81) and 1184 for nonvenomous animals (average of 107.6 per year, range 78–149). For every year, nonvenomous animal-related fatalities exceeded those caused by venomous animals.

ANIMAL

An average of 177 fatalities per year occurred from both venomous and nonvenomous animals. Animal-related fatalities under the category ''other specified animal'' (E906.8) comprised 43.5% of all reported fatalities, followed by hornets, bees, and wasps at 27.4% (Table 2). When evaluated by venomous or nonvenomous categories, venomous animals caused 39.1% and nonvenomous animals caused 60.9% of the fatalities. Of the venomous animals, hornets, bees, and wasps caused the majority of fatalities (70.2%) (Table 3). The average number of fatalities per year was 48 for hymenoptera, 6 for spiders, and 5 for snakes. Of the nonvenomous category, animal-related fatalities under the category ''other specified animal'' comprised the majority of the fatalities (71.5%) (Table 4). Among identified nonvenomous animals, dogs caused the majority of fatalities (about 19 per year). Death rates per million persons per year were calculated for venomous animals (0.256), nonvenomous animals (0.399), and all animals combined (0.655) (Table 5).

Table 3. Venomous animal-related fatalities in the United States (1991–2001)

Animal	*No. of deaths*	*% of fatalities*
Hornet, bee, wasp	533	70.2
Other specified venomous arthropod	67	8.8
Spider	66	8.7
Snake	57	7.5
Unspecified venomous animal	23	3.0
Scorpion	5	0.66
Centipede	5	0.66
Venomous marine animal	2	0.27
Other specified venomous animal	1	0.13

SEX AND RACE

Males accounted for 72.4% of the cases and females 27.6% (Table 6). For venomous animal attacks, males accounted for 74.6% of the injuries and females 25.4%. For nonvenomous animal attacks, males accounted for 70.9% of the injuries and females 29.1%. The overall death rate was 0.969 per million per year for males and 0.354 per million per year for females. Males had a 2.9 times greater risk of venomous animal-related fatality and a 2.4 times greater risk of nonvenomous animal-related fatality than did females.

By race, whites had a higher percentage (91%) and higher rate of fatalities compared with the other racial groups. The death rate per million per year was 0.726 for whites, 0.317 for blacks, and 0.324 for other races. The percentage of venomous animal-related fatalities was 91.7% for whites, 7.5% for blacks, and 0.8% for other races. The percentage of nonvenomous animal-related fatalities was 91.4% for whites, 3.3% for blacks, and 5.3% for other races.

Table 4. Nonvenomous animal-related fatalities in the United States (1991–2001)

Animal	*No. of deaths*	*% of fatalities*
Other specified animal	846	71.5
Dog	208	17.6
Nonvenomous arthropod	63	5.3
Other animal except arthropod	32	2.7
Unspecified animal	32	2.7
Rat	3	0.25

Table 5. Animal-related fatalities in the United States (1991–2001)

Animal	*Average no. of deaths*	*Range*	*Death rate per million per year*
	Venomous animals		
Snake	5.2	0–12	0.019
Spider	6	4–9	0.022
Scorpion	0.45	0–2	0.0017
Hornet, bee, wasp	48.5	39–64	0.179
Centipede	0.45	0–3	0.0017
Other specified venomous arthropod	6	2–11	0.023
Venomous marine animal	0.18	0–2	0.00067
Other specified venomous animal	0.09	0–1	0.00034
Unspecified venomous animal	2.1	0–4	0.0078
Total venomous	68.9	57–81	0.256
	Nonvenomous animals		
Dog	18.9	11–26	0.070
Rat	0.27	0–1	0.001
Nonvenomous snake	0	0	0
Other animal except arthropod	4	2–8	0.011
Nonvenomous arthropod	5.7	2–10	0.021
Other specified animal*	76.9	51–113	0.285
Unspecified animal	4	1–8	0.011
Total nonvenomous	109.7	78–149	0.399
Overall total	178.7	152–212	0.655

*Note that this category includes E906.8 plus W55 to W59 categories.

Table 6. Animal-related fatalities in the United States by sex and race (1991–2001)

Animal	*Male*	*Female*	*White*	*Black*	*Other*	*Total*
Snake	48	9	55	2	0	57
Spider	37	29	57	8	1	66
Scorpion	2	3	5	0	0	5
Hornet, bee, wasp	408	125	494	35	4	533
Centipede	3	2	5	0	0	5
Other venomous arthropod	47	20	59	8	0	67
Venomous marine animal	2	0	2	0	0	2
Other specified venomous animal	1	0	1	0	0	1
Unspecified venomous animal	18	5	18	4	1	23
Dog	134	74	164	35	9	208
Rat	3	0	2	0	1	3
Nonvenomous snake	0	0	0	0	0	0
Other animal except arthropod	15	17	26	4	2	32
Nonvenomous arthropod	49	14	57	4	2	63
Other specified animal	416	148	541	6	17	564
Unspecified animal	21	11	27	4	1	32
Alligator	4	1	5	0	0	5
Other mammal	157	40	190	1	6	197
Marine animal	4	0	4	0	0	4
Other reptile	37	39	66	9	1	76
Total	1406	537	1778	120	45	1943

Table 7. Age (years) and animal-related fatalities in the United States (1991–2001)

Animal	*0–4*	*5–9*	*10–19*	*20–64*	*≥65*	*Total*
Snake	3	3	3	36	12	57
Spider	2	1	0	44	19	66
Scorpion	1	0	0	4	0	5
Hornet, bee, wasp	2	1	8	397	125	533
Centipede	0	0	1	3	1	5
Other specified venomous arthropod	0	0	1	43	23	67
Venomous marine animal	0	0	0	1	1	2
Other specified venomous animal	0	0	0	1	0	1
Unspecified venomous animal	1	0	0	16	6	23
Dog	81	35	7	39	46	208
Rat	0	0	1	2	0	3
Nonvenomous snake	0	0	0	0	0	0
Other animal except arthropod	3	1	1	16	11	32
Nonvenomous arthropod	0	2	2	37	22	63
Other specified	38	30	57	268	171	564
Unspecified animal	6	0	4	13	9	32
Alligator	0	0	0	3	2	5
Other mammal	15	7	12	98	65	197
Marine animal	0	0	1	2	1	4
Other reptile	1	0	0	16	59	76
Total	153	80	98	1039	573	1943

AGE

Five age categories were created for analysis of the data (Table 7): 0 to 4 years (7.8%), 5 to 9 years (4.1%), 10 to 19 years (5%), 20 to 64 years (53.4%), and 65 years and older (29.5%). The elderly appear to be overrepresented in the fatalities caused by hymenoptera, dogs, other specified animals, other mammals, and other reptiles. The youngest individuals are overrepresented in the fatalities caused by dogs.

REGION

CDC Wonder categorizes the United States into 4 regions for data analysis. Overall, percentages for fatalities were 45.4% in the South, 11% in the Northeast, 18.8% in the West, and 24.8% in the Midwest. The percentages for venomous animal-related injuries were 52.2% in the South, 14.5% in the Northeast, 12.9% in the West, and 20.4% in the Midwest. The percentages for nonvenomous animal-related injuries were 41% in the South, 8.9% in the Northeast, 22.6% in the West, and 27.5% in the Midwest (Table 8).

Discussion

Encounters with animals cause hundreds of fatalities, millions of nonfatal injuries, and cost hundreds of millions of dollars annually in the United States.[4] In addition to inflicting traumatic injuries, animals transmit numerous zoonotic infections. Thousands of cases of Lyme disease and West Nile virus occur in the United States yearly and are responsible for many fatalities and cases of chronic illness.[6] Zoonotic infections are responsible for hundreds of fatalities each year in the United States.

Excluding motor vehicle or animal-ridden events and zoonotic infections, animals caused a yearly average of 177 fatalities in the United States from 1991 to 2001. Although this is an increase from the 157 average fatalities reported from 1979 to 1990, the US population has risen and the fatality rate remains essentially the same as in 1979 to 1990 (6.55 vs 6.57 fatalities per 10 million population). Studies have shown an additional 200 fatalities occur yearly from deer-vehicle collisions in the United States.[7,8]

Venomous animals caused an average of 69 fatalities per year from 1991 to 2001, compared with 46 per year from 1950 to 1959 and 60 per year from 1979 to 1990 (Table 9). Parrish[9] found a higher percentage of fatalities from venomous snakes, spiders, and scorpions, compared to Langley and Morrow[10] and the present study that found a higher percentage attributed to hymenoptera. Interestingly, spider-related fatalities surpassed snake-related fatalities from 1991 to 2001. This may be because of increasing destruction of snake habitat and

Table 8. Animal-related fatalities in the United States by region of country (1991–2001)

Animal	*South*	*Northeast*	*West*	*Midwest*	*Total*
Snake	40	2	13	2	57
Spider	35	2	15	14	66
Scorpion	1	1	2	1	5
Hornet, bee, wasp	251	98	58	126	533
Centipede	1	1	3	0	5
Other venomous arthropod	55	2	1	9	67
Venomous marine animal	2	0	0	0	2
Other specified venomous animal	1	0	0	0	1
Unspecified venomous animal	10	4	6	3	23
Dog	86	21	53	48	208
Rat	1	0	1	1	3
Nonvenomous snake	0	0	0	0	0
Other animal except arthropod	14	3	11	4	32
Nonvenomous arthropod	37	5	7	14	63
Other specified animal	241	42	130	151	564
Unspecified animal	14	4	7	7	32
Alligator	5	0	0	0	5
Other mammal	72	15	50	60	197
Marine animal	4	0	0	0	4
Other reptile	12	15	8	41	76
Total	882	215	365	481	1943

lower snake population numbers.[11,12] The death rate from venomous animals was 0.256 per million for the present study compared with 0.251 from 1979 to 1990 and 0.28 from 1950 to 1959.

Nonvenomous animals caused more fatalities than did venomous animals. In previous reports, as reflected by location of injury, most nonvenomous injuries are probably caused by farm animals.[10] CDC Wonder does not provide the location of injury. In a study of nonvenomous animal-related fatalities in Sweden from 1975 to 1984, horses and cattle caused 93% of the fatalities.[13] Some fatalities from nonvenomous arthropods may be a result of anaphylaxis after a bite.[14]

Males are more likely to die from venomous and nonvenomous animal-related injuries than are females.[10,15] This probably reflects the greater exposure of males to outdoor activities such as farming and hunting. Some studies suggest that males may be more likely to develop a severe reaction after a bee sting.[16–18] Males may also have more underlying diseases, such as coronary atherosclerosis, which may be a significant risk factor for a major adverse event after an insect sting.[19,20]

Table 9. Percentage of venomous animal-related fatalities in the United States

Animal	*Parrish[9] (1950–1959)*	*Langley and Morrow[10] (1979–1990)*	*Current study (1991–2001)*
Hymenoptera	49.8	73.4	70.2
Snake	30.0	9.2	7.5
Spider	14.1	6.8	8.7
Scorpion	1.7	0.56	0.66
Marine	0.40	0.42	0.27
Unknown/unspecified	3.9	1.1	2.5
Centipede	. . .	0.14	0.66
Other venomous arthropod	. . .	7.9	8.8
Other specified venomous animal	. . .	0.42	0.13

Whites appear to have a greater risk of fatality from an animal encounter than do blacks or other races. Reasons are not entirely clear, but whites are more likely to be hunters (97% are white) and farm operators (97%), thus increasing their risk of exposure to large farm animals as well as wild animals.[21,22] The numbers of Hispanic farm workers are increasing,[21] which may partially explain why other races are more likely to be killed by nonvenomous animals than are blacks.

Children younger than 10 years and adults ages 65 and older appear to be at increased risk of death from dog attacks. In 2001, an estimated 368 245 persons were treated for dog bite injuries.[3] The injury rate was highest for children ages 5 to 9 years. For children younger than 15 years, the injury rate was significantly higher for boys (293.2 per 100 000) than for girls (216.7 per 100 000). The rate for persons ages 15 years and older was not significantly different (102.9 vs 88).[3] In this study, males were 1.8 times more likely to be killed by dogs. The elderly, who comprise approximately 13% of the population,[23] also were more likely to die from hymenoptera stings and ''other'' animal categories. Fatalities from hymenoptera may be because of increased likelihood of serious underlying disease, such as cardiovascular disease. It is not clear why the elderly are more likely to die from ''other'' animals, but the elderly are more likely to die when involved in traumatic events.[24]

By region of the United States, the South has the largest percentage of animal-related fatalities. Part of this may be because of warmer weather increasing insect populations in the South and colder weather limiting the spread of venomous animals, such as fire ants, to higher latitudes. Alligators and several species of venomous snakes are more likely to be found in the South. Warmer temperatures in the South may also increase the likelihood that children will more likely play outdoors year round, thus increasing their chance of exposure to animals. Studies show that species richness in human pathogens is correlated with latitude.[25]

The major weakness of this study is that no individual death certificates or reports were available to verify fatalities reported. For example, fatalities from centipedes or tropical millipedes are essentially unheard of; however, 5 were recorded during this time period. Although sex, age range, and the states where the fatalities occurred are available, the actual cases cannot be verified as attributable to centipedes. It is interesting that no case reports from these centipede-related fatalities have been reported in PubMed (www.pubmed.gov), although a recent study suggests possible myocardial ischemia after a nonfatal centipede sting as a mechanism that could lead to death.[26]

A weakness of the International Classification of Disease reporting system is that many large animals such as bears, sharks, cows, and horses are all included in the ''other specified animal'' category. Therefore, the actual number of fatalities caused by a specific species is not known for many animals. Future editions should consider adding more categories of specific animals. CDC Wonder does not provide information on the location of death and activity at the time of injury; however, this information would be useful in developing education programs on prevention of animal-related injuries.

As previously noted, other animal-related fatalities are not included in this study. Up to 200 fatalities per year may result from vehicle-animal collisions.[7,8] Also, fatalities resulting from falling off a ridden animal are classified differently and are not included in this study. These accidents are classified as E-code 828. From 1991 to 1998, an average of 88 fatalities per year were attributed to riding an animal, usually a horse. Including these numbers and the few cases of unknown fatalities possibly caused by anaphylactic reactions to animal stings[27] and motor vehicle accidents as a result of swerving to miss an animal on the highway, it is likely that 500 to 600 fatalities per year can be attributed to animal-human interactions, not including infections transmitted by animals.

It is possible to decrease fatalities and serious injuries from animal attacks. Children should be educated about the potential danger of animals, especially dogs. Helmets should be worn when riding horses.[28,29] Individuals with a history of systemic reactions from insect stings should carry epinephrine kits.[18] Hikers and campers should check with rangers before embarking in bear and cougar territories. Swimmers should avoid areas where sharks are known to frequent, especially during times of the day when sharks are most likely to feed.[30] Wild animals should not be fed, for this tends to make them less fearful of humans. If injured by a wild animal, an individual should seek medical treatment. The use of insect repellants is effective in preventing many types of insect bites and stings.[31] Also, methods to prevent deer-vehicle collisions are being evaluated.[32]

Several hundred fatalities occur in the United States yearly from encounters with animals. Many, if not most, of these fatalities can be prevented. Advances in antivenom therapy and hymenoptera desensitization therapy will likely prevent fatalities and lessen adverse effects from use of these products. Continuing education of farmers and farm families about the hazards of working with large animals is important. Advances in automobile-detection technology and use of fencing in areas of high animal density should decrease animal-vehicle collisions. National parks, which protect our natural resources and can serve as a haven to protect endangered

species, may offer opportunities for viewing wildlife. Guided tours can describe the importance of various ecosystems to visitors while allowing them to view potentially dangerous animals in a controlled environment.

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