Dog Bite Injuries among American Indian and Alaska Native Children

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Objective To examine dog bites among American Indian (AI) and Alaska Native (AN) children visiting Indian Health Service and tribal health facilities.

Study design We retrospectively analyzed hospitalizations and outpatient visits with a diagnosis of dog bite between 2001 and 2008 in AI/AN children aged <20 years. Rates of dog bite hospitalizations and outpatient visits were estimated by age group, sex, region, and number and location of open wounds using Indian Health Service data. Analyses of hospitalizations for the general US population aged <20 years used the Nationwide Inpatient Sample.

Results The average annual dog bite hospitalization rate was higher among AI/AN children in Alaska (6.1/100 000 population) and the Southwest region (5.3/100 000) compared with the general US child population (3.1/100 000; 95% CI, 2.9-3.3/100 000). The average annual outpatient visit rate in AI/AN children was highest in the Alaska (596.4/100 000), Southwest (540.0/100 000), and Northern Plains West (537.6/100 000) regions. The hospitalization rate was highest in both AI/AN and US males aged <5 years, and outpatient visit rates were highest in AI/AN males aged 5-9 years. Open wounds diagnoses were most commonly seen on the head, neck, and face in hospitalized children (45.5% of open wounds in AI/AN children, 59.3% in US children; SE, 1.0%) and on the leg in AI/AN outpatients (35.6%).

Conclusion Dog bites represent a significant public health threat in AI/AN children in the Alaska, the Southwest, and Northern Plains West regions of the US. Enhanced animal control and education efforts should reduce dog bite injuries and associated problems with pets and stray dogs, such as emerging infectious diseases. *(J Pediatr 2013;162:1270-5)*.

Dog bites are a significant, yet preventable, public health problem in the US, affecting an estimated 4.5 million people (ie, 1.5% of the population) annually.[1] More than 330 000 US emergency department visits were related to dog bites each year between 1992 and 1994, 4% of which resulted in hospitalization.[2] Studies analyzing dog bites in the general US population have found that children, especially boys, are represented disproportionately.[1-12]

Few previous studies have investigated dog bite injuries among the American Indian (AI)/Alaska Native (AN) population. A study of the Navajo population found that annual incidences of dog bites reported to the Indian Health Service (IHS) in the early 1980s were comparable to the high incidences reported in major US urban centers during this period, with the highest age group–specific rates in children and statistically equivalent rates in males and females.[13] Another study found that dog bite hospitalization rates in Alaska were highest in males, and that the AN population had a >3-fold rate than the non-AN population.[14] Studies delving further into dog bite injuries in the AI/AN population are lacking, despite known problems with dog overpopulation and associated emerging infections (eg, Rocky Mountain spotted fever) within AI/AN communities.[13,15-18]

In the present study, we analyzed dog bite injuries reported between 2001 and 2008 in children aged <20 years. We examined hospitalization rates for the AI/AN population and the general US population, and analyzed outpatient visit rates for the AI/AN population. We discuss animal control and community education efforts, as well as the relationship between dogs and emerging zoonoses.

Methods

We selected and analyzed hospital discharge data with dog bite diagnoses for the period 2001-2008 among both the AI/AN population and the general US

AI	American Indian
AN	Alaska Native
ICD-9-CM	*International Classification of Diseases, Ninth Revision, Clinical Modification*
IHS	Indian Health Service
NIS	Nationwide Inpatient Sample
NPIRS	National Patient Information Reporting System
RR	Rate ratio

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population aged <20 years, as well as outpatient visit data with dog bite diagnoses for the AI/AN population aged <20 years during this period. A dog bite hospitalization or outpatient visit was defined by an *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) code for dog bite injury (E906.0) listed anywhere on the patient record.[19] Open wound diagnoses were analyzed by body location to summarize the nature of injuries. Open wounds listed on the patient record, including traumatic amputations, (ICD-9-CM codes 870-897) were categorized as follows: head, neck, face (870-874); torso (875-879); arm (880-881, 884, 887); hand, wrist, fingers (882-883, 885-886), and leg (890-897). Patient records could include more than 1 ICD-9-CM open wound code.

We analyzed all inpatient and outpatient visit records for AI/AN children within the IHS health care system reported in the IHS Direct and Contract Health Service Database from the IHS National Patient Information Reporting System (NPIRS) for calendar years 2001-2008.[20,21] These data include records of all hospital discharges and outpatient visits from IHS- or tribal-operated hospitals and from community hospitals and facilities contracted with the IHS or tribes to provide healthcare services to eligible AI/AN individuals.[22] The IHS regions were defined based on IHS Administrative Areas as follows (**Figure**): East (Nashville), Northern Plains East (Bemidji), Northern Plains West (Aberdeen, Billings), Alaska, Southern Plains (Oklahoma), Southwest (Albuquerque, Navajo, Phoenix-Tucson), and West (California, Portland). The West region was not included in hospitalization analyses because it does not contain any IHS- or tribal-operated hospitals, and because contract health services inpatient reporting is limited.

Average annual dog bite hospitalization and outpatient visit rates were estimated as the number of visits per 100 000 persons from the corresponding population. IHS annual user populations, defined as all registered AI/AN individuals who used an IHS-funded healthcare service at least once during the previous 3 years,[22,23] were used as denominators. For some IHS regions, to protect patient privacy, hospitalization counts and rates may be too low to report. The AI/AN population used in this study does not represent all AI/AN individuals in the US.

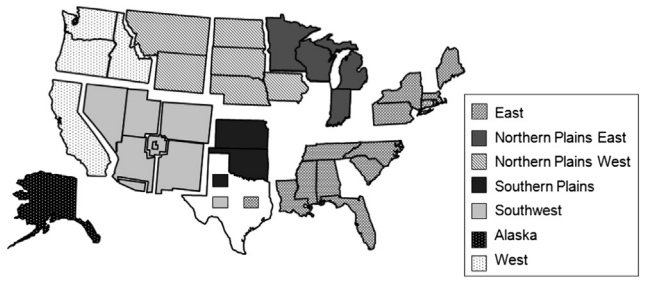

Figure. IHS regions. The West region does not keep a registry of inpatient data. Texas is administered by 3 IHS Administrative Areas (Nashville, Oklahoma City, and Albuquerque).

We used the Nationwide Inpatient Sample (NIS; http://www.hcup-us.ahrq.gov/nisoverview.jsp) from the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project, a nationally representative sample of US hospitals that includes approximately 20% of all US hospitals, to analyze hospital discharge data for the general US population in 2001-2008. Hospitals in the sample include short-term, nonfederal general and specialty hospitals (http://www.hcup-us.ahrq.gov/nisoverview.jsp); IHS/tribal hospitals are not included. The NIS is the largest all-payer (ie, Medicare, Medicaid, private insurance, and uninsured) source of hospitalization data in the US, with approximately 8 million unweighted hospital stays each year. We determined national hospitalization rate estimates using weighting methodology developed for the NIS,[24,25] with rates (and their 95% CIs) calculated as the weighted number of visits over the corresponding population. Bridged-race census population estimates from the National Center for Health Statistics were used as population denominators in rate calculations.[26]

We calculated rate ratios (RRs) with 95% CIs to compare dog bite IHS hospitalization rates and outpatient visit rates in AI/AN children. Within the general US children population, we calculated weighted RRs with 95% CIs for hospitalization rate comparisons,[27] and used Poisson[28] and weighted least squares[29] regression methods to investigate temporal changes in rates among the AI/AN and general US populations, respectively. This study did not involve human subjects and therefore was Institutional Review Board exempt.

Results

Hospitalizations

During 2001-2008, the average annual dog bite hospitalization rate in AI/AN children aged <20 years was similar or slightly higher than that for the general US population aged <20 years (3.4/100 000 vs 3.1/100 000; 95% CI, 2.9-3.3/100 000) (**Table I**). The rate for young AI/AN males appeared higher than the rate for young males in the general US population (4.4/100 000 vs 3.5/100 000; 95% CI, 3.3-3.8/100 000). The rates in young females did not appear to differ between the 2 populations (2.4/100 000 for AI/AN vs 2.6/100 000; 95% CI, 2.4-2.8/100 000 for the general US population). In both populations, rates were significantly higher in males compared with females (RR, 1.8; 95% CI, 1.3-2.6 for AI/AN; RR, 1.3; 95% CI, 1.2-1.5 for the general US population).

The vast majority (80%) of dog bite hospitalizations in AI/AN children aged <20 years occurred in the IHS Alaska and Southwest regions. Average annual dog bite hospitalization rates were higher in Alaska (6.1/100 000) and the Southwest (5.3/100 000) AI/AN populations compared with the general US child population (**Table I**). Compared with young males in the general US population, the rate was almost 3-fold higher in young AI/AN males in Alaska (9.7/100 000) and nearly 2-fold higher in those in the Southwest region (6.3/100 000). The overall annual dog bite hospitalization rates

Table I. Number and average annual rate summaries of dog bite hospitalizations in AI/AN children and the general US population, and outpatient visits in AI/AN children aged <20 years, 2001-2008*

	Hospitalizations				Outpatient visits	
	AI/AN population†		General US population		AI/AN population	
Characteristic	No.	Rate/100 000	Weighted no. (SE)	Rate/100 000 (95% CI)	No.	Rate/100 000
Total	136	3.4	20 303 (692)	3.1 (2.9-3.3)	17 515	392.4
Sex						
Male	88	4.4	11 733 (443)	3.5 (3.3-3.8)	9994	444.9
Female	48	2.4	8339 (319)	2.6 (2.4-2.8)	7521	339.1
Age, years						
0-4	50	5.2	7893 (355)	4.9 (4.5-5.3)	3993	373
5-9	42	4.3	6228 (247)	3.9 (3.6-4.2)	5629	508.2
10-14	24	2.4	3936 (186)	2.4 (2.2-2.6)	4574	404.7
15-19	20	2	2246 (117)	1.3 (1.2-1.5)	3319	287.2
More than 1 open wound	16	0.4	2217 (125)	0.3 (0.3-0.4)	503	11.3
IHS region‡						
Alaska	26	6.1	-	-	2530	596.4
East	†	†	-	-	427	348.1
Northern Plains East	†	†	-	-	592	206.3
Northern Plains West	19	3	-	-	3422	537.6
Southern Plains	†	†	-	-	1314	146.6
Southwest	83	5.3	-	-	8535	540
West	-	-	-	-	695	134.5

*IHS direct and contract service inpatient and outpatient visit data were used for analysis of AI/AN children, and the NIS was used for analysis of the general US population. Dog bite, ICD-9-CM code E906.0.
†Values withheld owing to small numbers of hospitalizations (<10).
‡The IHS West region was not included in the hospitalization analysis because the region does not have IHS- or tribal-operated hospitals. US data cannot be organized into geographic regions comparable with those for IHS and are not included.

decreased significantly in both the AI/AN population aged <20 years ($P = .047$) and the general US population aged <20 years ($P = .013$) during 2001-2008.

We analyzed visits with more than one open wound diagnosis, hypothesizing that these data may be a proxy for injury severity (Table I). The average annual hospitalization rate was similar in AI/AN children and the general US population aged <20 years experiencing more than one open wound (0.4/100 000 vs 0.3/100 000; 95% CI, 0.3-0.4/100 000); however, rates appeared higher in the Southwest and Alaska AI/AN child populations (data not shown owing to the small number of hospitalizations).

Outpatient Visits

The average annual dog bite outpatient visit rate in AI/AN children aged <20 years during 2001-2008 was 392.4/100 000 (Table I). Rates were highest in the Alaska (596.4/100 000), Southwest (540.0/100 000), and Northern Plains West (537.6/100 000) IHS regions (Table I). Overall, rates were higher in young males than young females (444.9/100 000 vs 339.1/100 000); this pattern, although not always statistically significant, was seen in all IHS regions (Table II). The highest rates were seen in 5- to 9-year-old males in the Alaska (1030.5/100 000), Northern Plains West (808.7/100 000), and Southwest (793.5/100 000) IHS regions. The rates were higher in young males than in young females in all age groups in the Southwest and Alaska AI/AN pediatric populations; in the Northern Plains West regions, the rate was higher in females than in males in the 15-19 year age group. The overall rate of outpatient visit rates associated with dog bites in AI/AN children decreased during the study period ($P = .012$), with significant declines observed among males ($P = .006$), 5- to 9-year-olds ($P < .001$), and in the Northern Plains West ($P = .002$) and Southwest ($P < .001$) IHS regions.

The average annual outpatient visit rates for AI/AN children experiencing more than 1 open wound was highest in Alaska (21.9/100 000), followed by the Northern Plains West (14.8/100 000) and Southwest (14.4/100 000) regions (Table II). The annual rate of visits involving more than 1 open wound were higher in young males than in young females in the Northern Plains East (12.3/100 000 vs data not shown owing to low numbers), Northern Plains West (18.7/100 000 vs 10.8/100 000), and Southwest (17.2/100 000 vs 11.6/100 000) IHS regions.

Open Wound Diagnoses

Hospitalizations most commonly involved open wounds to the head, neck, and face compared with wounds to other body areas (Table III). Of the 165 open wounds reported in AI/AN children hospitalized with dog bites during 2001-2008, 75 (45.5%) were to the head, neck, or face, and 36 (21.8%) were to the leg. For the general US population aged <20 years, the estimated 30 266 ± 1193 open wounds reported during the study period included 17 950 ± 828 (59.3% ± 1.0%) to the head, neck, or face and 4166 ± 200 (13.8% ± 0.5%) to the hand, wrist, and fingers. IHS outpatient visits by AI/AN children aged <20 years during the study period included 14 749 open wounds, with more

Table II. Summary of average annual rate and number of dog bite outpatient visits in AI/AN children aged <20 years by IHS region, 2001-2008*

Characteristic	Outpatient visit rate/100 000 (no. outpatient visits)						
	Alaska	East	N Plains East	N Plains West	S Plains	Southwest	West
Total, all ages	596.4 (2530)	348.1 (427)	206.3 (592)	537.6 (3422)	146.6 (1314)	540 (8535)	134.5 (695)
Male	691.5 (1493)	377.4 (234)	208.4 (305)	604 (1942)	165.7 (748)	617.5 (4874)	153.4 (398)
Female	497.8 (1037)	318.1 (193)	204.1 (287)	469.8 (1480)	127.3 (566)	462.7 (3661)	115.4 (297)
More than 1 open wound	21.9 (93)	†	8 (23)	14.8 (94)	4.8 (43)	14.4 (228)	2.7 (14)
Male	22.2 (48)	†	12.3 (18)	18.7 (60)	5.5 (25)	17.2 (136)	†
Female	21.6 (45)	†	†	10.8 (34)	4 (18)	11.6 (92)	†
Age 0-4 years	548.8 (595)	309.3 (91)	214.4 (141)	470.2 (766)	163.7 (338)	488.5 (1891)	154.9 (171)
Male	635 (356)	358.6 (54)	244.7 (83)	555.1 (461)	192.8 (204)	582.3 (1134)	181.5 (103)
Female	456.4 (239)	257.7 (37)	182.1 (58)	381.9 (305)	133.2 (134)	393.5 (757)	126.7 (68)
Age 5-9 years	885.8 (916)	435.6 (138)	260.4 (185)	709.9 (1103)	186.6 (433)	683.5 (2632)	172.2 (222)
Male	1030.5 (549)	443 (71)	272.2 (99)	808.7 (637)	210.4 (247)	793.5 (1536)	185.8 (121)
Female	732 (367)	428 (67)	248 (86)	608.3 (466)	162.3 (186)	572.4 (1096)	129.7 (101)
Age 10-14 years	647.8 (685)	385.1 (120)	220.6 (163)	583.2 (908)	149.9 (340)	548.7 (2206)	112.6 (152)
Male	760.8 (406)	405.1 (64)	198.2 (75)	675.1 (531)	137.2 (192)	614.6 (1236)	147.6 (100)
Female	532.6 (279)	364.4 (56)	244.2 (88)	489.4 (377)	132.2 (1478)	482.7 (970)	77.4 (52)
Age 15-19 years	313.3 (334)	256.5 (78)	135 (103)	396.7 (645)	87.9 (203)	444.5 (1806)	105.3 (150)
Male	342.1 (182)	297.7 (45)	125.5 (48)	386.2 (313)	92.6 (105)	484.3 (968)	105.9 (74)
Female	284.5 (152)	215.8 (33)	144.5 (55)	407.3 (332)	83.3 (98)	406.1 (838)	104.6 (76)

*IHS direct and contract service outpatient visit data were used for analysis. Dog bite, ICD-9-CM code E906.0.
†Values withheld owing to small number of outpatient visits (<10).

open wounds to the leg (5248; 35.6%) than to the head, neck, or face (3745; 25.4%).

Discussion

Our analysis of dog bite injuries reveals high hospitalization and outpatient visit rates in AI/AN children aged <20 years in specific IHS regions. Hospitalization rates were nearly twice as high in the Alaska and Southwest AI/AN pediatric populations compared with the general US population aged <20 years. Outpatient visit rates for AI/AN children were highest in the Alaska, Southwest, and Northern Plains West IHS regions. The elevated rates in children, especially boys, reported here are generally consistent with those found in previous studies of dog bite victims in the AI/AN population (eg, bite rate in Navajos,[13] hospitalization rate in ANs[14]) and the general US population (eg, incidence,[1,3,8] hospitalization rate,[4,6,7,9] emergency department visit rate,[2,10] fatality rate[11]).

A survey of dog bites treated in US emergency departments during 1992-1994 found that bite wounds to the head, neck and face were more common in children than in adults.[2] In our study population, the majority of open wounds occurred to the head, neck, or face (45% in AI/AN children and 59% in the general US pediatric population). Given the potential severity of open wounds to the head, neck, and face, it is not surprising that the percentage of these injuries (25%) was lower than that of open wounds to the extremities (ie, leg [36%] and arm, hand, wrist, and fingers [29% combined]) in outpatient visits for AI/AN children.

Dog bites have been examined previously within the Southwest and Alaska regions,[13,14] where our study found high rates of dog bite hospitalization and outpatient visits. On the Navajo Reservation—a 25 000-square-mile rural area (ie, approximately 6 persons per square mile) in the Southwest region that includes portions of Arizona, Utah, and New Mexico—rates of dog bites during 1981-1983 were comparable with those in large urban centers with similarly high ratios of dogs

Table III. Locations of open wounds associated with dog bite hospitalizations in AI/AN children and the general US population, and in dog bite outpatient visits in AI/AN children aged <20 years, 2001-2008*,†

Open wound location	Hospitalizations				Outpatient visits	
	AI/AN population		General US population‡		AI/AN population	
	Number	Percent of total	Number (SE)	Percent of total (SE)	Number	Percent of total
Total	165	100	30 266 (1193)	100	14 749	100
Head, neck, face	75	45.5	17 950 (828)	59.3 (1.0)	3745	25.4
Torso	14	8.5	1646 (127)	5.4 (0.4)	1501	10.2
Arm§	22	13.3	3481 (179)	11.5 (0.4)	2075	14.1
Hand, wrist, fingers	18	10.9	4166 (200)	13.8 (0.5)	2180	14.8
Leg	36	21.8	3022 (163)	10.0 (0.4)	5248	35.6

*Diagnosis code E906.0 from the ICD-9-CM. Specific ICD-9-CM diagnosis codes for location of open wound are provided in the methods.
†Hospitalizations and outpatient visits can have more than one open wound code.
‡Data from the NIS of the Healthcare Cost and Utilization Project.
§Not including hand, wrist, and fingers.

to humans, such as Baltimore and St Louis.[13] Calculated from IHS-reported dog bites on the Navajo Reservation, rates of 586 per 100 000 (in 1981), 691 (in 1982), and 539 (in 1983) were seen across all age groups. In comparison, dog bites were responsible for 540 outpatient visits, and 5.3 hospitalizations per 100 000 children aged <20 years per year across the Southwest population during our 2001-2008 study period.

An analysis of hospitalizations captured during 1991-2002 by the Alaska Trauma Registry found, among other interesting findings, that ANs of all ages were hospitalized for dog bite injuries at more than 3 times the annual rate of non-ANs (9.3/100 000 vs 2.8/100 000) at Alaska's acute care hospitals.[14] Among ANs aged <20 years, dog bites were associated with 16.5 hospitalizations per 100 000 per year (L. Castrodale, Alaska Department of Health and Social Services, Division of Public Health, personal communication). This rate is notably higher than the 2001-2008 NPIRS-based annual hospitalization rate of 6.1/100 000 reported here for ANs aged <20 years. The 2001-2008 NPIRS-based rates include only visits at IHS-operated or tribal-operated hospitals and community hospitals and facilities contracted with the IHS or tribes, whereas the 1991-2002 Alaska Trauma Registry–based rates may capture some patients not included in the NPIRS-based calculations (ie, AN dog bite victims receiving care at nontribal hospitals). Regardless, during 2001-2008, average annual hospitalization rates in children aged <20 years in the IHS Alaska region were higher than those in the other IHS regions and approximately double that of the general US population aged <20 years. Although small hospitalization numbers prevented us from analyzing changes in rate over time by specific IHS regions, including Alaska, we did detect an overall decrease in hospitalizations during 2001-2008 among AI/AN children aged <20 years, and thus the substantial difference in calculated rates between 1991-2002 and 2001-2008 may reflect a genuine long-term rate decrease. If so, this suggests that progress has been made subsequent to the increased emphasis on dog bite prevention in AN villages. Further research is needed to confirm this finding and to determine what types of education and interventions have been most effective.

This study has some limitations. First, AI/AN individuals may receive medical care from non–IHS-funded sources, even though IHS facilities offer prepaid comprehensive care and other advantages (eg, rural locations) that encourage their use.[30,31] Thus, the user population likely does not include records for all eligible AI/AN children. Second, incomplete or inaccurate diagnoses, if present in the databases analyzed, would introduce error, as would the existence of any variations in diagnoses and reporting by region or healthcare facility. Third, outpatient visit data for the general US population were not included in our analysis, because the cause of injury was not available for all years of the study period (http://www.cdc.gov/nchs/data/ahcd/body_NAMCSOPD.pdf).

The high hospitalization and outpatient visit rates of dog bite victims in the AI/AN population aged <20 years, especially in the Alaska and Southwest regions, is likely related to the large numbers of free-roaming dogs reported on AI/AN land.[13,16] The public health burden associated with dog overpopulation is not limited to increased injury risk. Dogs can also transmit diseases to humans, either directly (eg, rabies virus[32]) or indirectly via arthropod vectors commonly found on stray dogs, such as ticks and fleas.[33-36] For example, recent outbreaks of Rocky Mountain spotted fever, a tick-borne zoonosis caused by the bacterium *Rickettsia rickettsii*, have been reported in multiple AI communities in the Southwest region.[17,18,37] This disease has emerged in a new tick vector (*Rhipicephalus sanguineus*, the brown dog tick), and its spread is believed to be associated with unmanaged dog populations on AI reservations. Surveillance efforts should be continued for emerging zoonoses in the AI/AN population, especially in the Alaska, Southwest, and Northern Plains West regions. Although precise measures of dog numbers in these communities are lacking, anecdotal evidence suggests that dog overpopulation is a major problem, and has been for many years, owing to a lack of resources for veterinary services and effective animal control practices. This problem must be addressed to eliminate the disparity found in dog bite injuries among the AI/AN population versus the general US population.

Our most important finding is the identification of dog bites as a serious public health threat in AI/AN children in the Alaska, Southwest, and Northern Plains West regions. A study across all age groups would help determine whether the patterns of dog bite injuries reported here for AI/AN children apply to AI/AN adults as well. One result that warrants further examination is the higher percentage of hospitalizations involving head, neck, and face injuries among children in the general US population (59%) relative to the AI/AN population (46%). Are the characteristics of dog attacks truly different across these populations, or does this lower percentage indicate that AI/AN children are less likely to be hospitalized for what are presumably among the most serious injuries?

It is worth emphasizing that dog bites are preventable. This study highlights the need for sustained investment in dog control efforts in high-risk AI/AN communities, but such an investment is important in any community with a high rate of dog bite injuries, whether on AI/AN land or not. As stated a quarter of a century ago by Daniels,[13] these efforts will be less effective and more costly without increased efforts to educate the public in ways to avoid dog bites. A recent survey found poor knowledge among children about how to prevent dog bites, with 43% of children failing a test on the topic.[38] Younger children performed more poorly than older children, and children with nonwhite parents performed more poorly than children with white parents. The study also found that only 30% of children had ever received any education about dog bite prevention. Although that study focused on visitors of an urban pediatric trauma center in the US, dog bite rates among children in major cities are comparable with those in AI/AN communities reported here. Efforts to improve knowledge of dog bite prevention should focus on children,[5,39,40] especially young boys. ■

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