

Research Article

Injury Patterns and Demographics in Child and Adolescent Assault Victims Presenting to US Emergency Departments

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Objective. To correlate injury patterns with patient demographics in child and adolescent assault victims. **Methods.** The National Electronic Injury Surveillance System-All Injury Program data for the years 2005 through 2015 was used. Injuries due to assault were identified and analyzed with SUDAAN 11.0.01™ software to account for the weighted, stratified nature of the data. **Results.** There were an estimated 4,407,009 ED visits for assault in patients ≤ 19 years of age. With increasing age, the percentage of females decreased. Sexual assaults were more common in females (87.4%), and robbery/burglary was more common in males (79.8%). When the perpetrator was a spouse/partner, the assault victim was most commonly female (88.8%), and when a stranger, the assault victim was most commonly male (71.5%). With increasing age, the percentage of sexual assaults decreased while the reason for the assault being unknown increased. The assault occurred in the home in 59.6% of those ≤ 4 years of age, decreasing to 18.7% in those 15 to 19 years of age. The anatomic location was the head/neck in 32.8% of those ≤ 4 years of age, increasing to 60.6% in those 15-19 years old. Those ≤ 4 years old had the highest hospital admission rate (8.3%). The main diagnoses were concussion (3.0%), contusion/abrasion (33.3%), fracture (11.5%), laceration (11.5%), internal organ injury (11.5%), puncture (2.8%), and strain/sprain (20.7%). The number of assaults from 2005 to 2015 decreased for all age groups except for those ≤ 4 years old. **Conclusions.** These data provide a comprehensive overview of child and adolescent assault victims presenting to the ED in the USA and can be used as background data for further study. The decreasing numbers of assaults over the 11 years of the study are encouraging, and challenges still exist in decreasing the number for those ≤ 4 years old.

1. Introduction

Violence and assault are significant public health issues [1]. Although they have been studied in the general population, there are few overall studies of assault in children and adolescents that correlate injury patterns with the demographics of age and gender. Most studies in children and adolescents only address particular anatomic areas (e.g., craniofacial) or singular mechanisms of injury (firearm injuries, sexual assault, and nonaccidental trauma). Barmparas et al. [2] studied children admitted to a trauma center for assault using the National Trauma Data Bank; however, such results are skewed to more serious injuries as these children were seen at a major trauma center. Mollen et al. [3] reviewed youth violence patients presenting to three hospitals in the Philadelphia area, but the study was limited by age (8 to 24 years),

as well as urban location. The purpose of this study was to analyze all child/adolescent assault patients in the USA presenting to emergency departments (ED) and correlate the injury patterns with patient demographics by age and gender. Such information will be very useful to all health care providers involved in caring for injured children and adolescents. Understanding injury patterns with their associated demographics will be helpful information for such a health care provider by giving clues to the potential for assault when not immediately divulged by the patient.

2. Materials and Methods

Children and adolescents were defined as individuals ≤ 19 years of age. The National Electronic Injury Surveillance System- (NEISS-) All Injury Program (AIP) data was used for

this study. The NEISS is a stratified, weighted dataset managed by the US Consumer Product Safety Commission (USCPSC) which collects injury data from ~100 hospitals in the United States and its territories having an emergency department (ED). It was initially designed for injuries due to consumer products. However, not all injuries are from consumer products; thus, the USCPSC selected ~65 of these hospitals (actual numbers vary slightly from year to year) to obtain data for all nonfatal injuries, regardless of the association with consumer products. This has been designated the All Injury Program (AIP). This data is in the public domain and housed by the Inter-University Consortium for Political and Social Research (ICPSR). It can be accessed at <https://www.icpsr.umich.edu/icpsrweb/ICPSR/search/studies?q=all+injury+program>. Use of this publicly available deidentified data was considered exempt by our local Institutional Review Board.

The database includes date of ED visit, gender/race/age of the injured patient, diagnosis, disposition from the ED, incident locale, body part injured, perpetrator and type of assault, reason for assault, causative agent/event of the injury, and hospital size (strata). Detailed descriptions of these variables are given in the appendix. The NEISS-AIP data for the years 2005 through 2015 was used. These years were chosen because 2015 was the last available year at the time the study began in mid-2019, and data before 2005 was coded differently for many variables, making it difficult to combine the years before 2005 with those afterwards. Injuries due to assault were identified using the code INTENT=1 (assault). Race was classified as White, Black, Amerindian (Hispanic and Native American), and Asian [4]. NEISS does not code for Polynesian and Indo-Mediterranean peoples.

2.1. Statistical Analysis. Statistical analyses were performed with SUDAAN 11.0.01™ software (RTI International, Research Triangle Park, North Carolina, 2013) which accounts for the weighted, stratified nature of the data. The estimated number of injuries/ED visits is calculated, along with 95% confidence intervals (CIs) of the estimate. When the actual number of patients (n) is <20, the estimated number (N) becomes unstable and should be interpreted with caution; thus, we report both the n and N . The annual incidence of ED visits for assault was calculated using the US Census Bureau data. Analyses between groups of continuous data were performed with the t -test (2 groups) or ANOVA (3 or more groups). Differences between groups of categorical data were analyzed by the χ^2 test. A $p < 0.05$ was considered to be statistically significant.

3. Results

There were a total of 5,702,369 ED visits in the NEISS-AIP database from 2005 through 2015, for an estimated 337,627,315 patients. Of these estimated 337,627,315 patients, there were an estimated 18,116,132 (14,855,602–22,013,301) due to assault (5.4%). Of these assault patients, an estimated 4,407,009 (4,139,536–4,686,643) were in those ≤ 19 years of age (24.3% of all assault patients).

The average age of these 4,407,009 patients was 14.5 years. Age group distribution was 286,883 (228,316–359,410) (6.5%) (≤4 years), 322,164 (282,865–366,449) (7.3%) (5 to 9 years), 995,807 (922,941–1,072,512) (22.6%) (10 to 14 years), and 2,794,290 (92,693,157–2,892,438) (63.5%) (15 to 19 years old). There were 2,653,938 (60.2%) males and 1,752,659 females (39.8%). Racial composition was known in 3,506,513 patients: White in 1,517,881 (993,044–2089,531) (43.3%), Black in 1,264,225 (974,460–1,586,346) (36.1%), Amerindian in 692,581 (351,002–1,236,046) (19.8%), and Asian in 31,826 (16,831–59,961) (0.9%). Disposition from the ED was known in 4,329,619 patients: 4,110,966 (3,997,537–4,187,175) (94.9%) were treated and released and 281,653 (142,444–332,082) (5.1%) were admitted to the hospital.

3.1. Analyses by Gender. There were differences by gender for all demographic variables (Table 1). With increasing age, the percentage of female patients decreased. Sexual assaults occurred most commonly in females (87.4%), and robbery/burglary most commonly in males (79.8%) (Figure 1(a)) When the perpetrator was a spouse/partner, the assault victim was most commonly female (88.8%); when it was a stranger, the assault victim was most commonly male (71.5%) (Figure 1(b)). When the assault occurred at home, the victim was female in 55.9%, and when on the street, the victim was male in 71.0%. When the injury involved the lower trunk, 70.5% of the victims were female, and when the upper extremity, only 32.8% were female. When the victim was admitted to the hospital, 78.8% were male.

3.2. Analyses by Age Groups. The NEISS data is divided into different age groups; for this study, the groups were ≤4 years, 5 to 9 years, 10 to 14 years, and 15 to 19 years old. With increasing age (Table 2), the percentage of sexual assaults decreased while the reason for the assault being unknown increased (Figure 2(a)). Similarly, the perpetrator being a parent decreased with increasing age (Figure 2(b)) while the identity being unknown increased. The home was the incident locale in 59.6% of those ≤ 4 years of age which decreased to 18.7% in those 15 to 19 years of age. Injuries involving the head/neck increased from 32.8% in those ≤ 4 years of age to 60.6% in those 15 to 19 years of age, while lower trunk injuries decreased from 38.9% in those ≤ 4 years to 8.1% in those 15 to 19 years old. While the vast majority of patients in all four groups were discharged from the ED, those ≤ 4 years old had the highest hospital admission rate (8.3%).

3.3. Analyses by Diagnosis. There were seven major diagnoses (Table 3) that accounted for 99.6% of all the injuries. These were concussions ($N = 129,580$ —3.0%), contusion/abrasion ($N = 1,459,483$ —33.3%), fracture ($N = 504,522$ —11.5%), laceration ($N = 758,519$ —17.3%), internal organ injury ($N = 505,545$ —11.5%), puncture ($N = 122,679$ —2.8%), and strain/sprain ($N = 906,855$ —20.7%). The punctures and lacerations (penetrating trauma) comprised 20.1% of the assaults with blunt trauma comprising the remaining 79.9%. The common penetrating trauma was overwhelmingly in the 15- to 19-year-old age group (76.6% of the

TABLE 1: General demographics and demographics by gender.

	All			Male			Female			p value						
	n	N	U95%	%	L95%	n	N	U95%	%		L95%	n	N	U95%	%	L95%
Average age ± 1 SD (years)			14.5 ± 5.1			14.8 ± 4.8			14.0 ± 5.4						<10 ⁻⁴	
Age group (years)																
≤4	10,017	286,857	359,382	6.5	228,298	4,176	119,739	146,910	97,411	4.5	5,841	167,118	210,389	132,084	9.5	58.3
5 to 9	9,748	322,079	366,420	7.3	282,843	5,287	183,605	212,821	158,027	6.9	4,461	138,475	157,135	121,749	7.9	43.0
10 to 14	25,031	995,786	1,072,429	22.6	922,869	14,658	604,745	651,433	560,375	22.8	10,373	391,041	426,733	357,538	22.3	39.3
15 to 19	57,749	2,794,082	2,892,214	63.5	2,692,948	35,430	1,738,937	1,798,125	1,677,950	65.7	22,319	1,055,145	1,099,767	1,009,550	60.2	37.8
Race																
White	27,090	1,517,881	2,089,390	43.3	992,977	15,349	903,556	1,260,861	579,068	42.7	11,741	614,325	830,312	412,866	44.3	40.5
Black	40,032	1,264,082	1,592,551	36.1	974,043	23,349	751,445	955,018	570,173	35.5	16,683	512,636	635,124	401,204	36.9	40.6
Amerindian	12,877	692,488	1,235,612	350,978	19.7	7,853	440,438	779,645	224,087	20.8	5,024	252,050	455,485	127,025	18.2	36.4
Asian	699	31,826	59,957	16,830	0.9	471	22,587	42,784	11,861	1.1	228	9,239	17,492	4,859	0.7	29.0
Reason																
Altercation	27,268	1,244,983	1,331,674	1,161,579	28.3	17,564	814,419	878,188	753,188	30.7	9,704	430,565	484,961	380,327	24.6	34.6
Robbery/burglary	1,253	53,672	73,150	39,219	1.2	1,024	42,806	56,529	32,378	1.6	229	10,865	17,702	6,660	0.6	20.2
Sexual assault	14,810	453,496	583,433	349,884	10.3	2,275	57,234	77,760	41,932	2.2	12,535	396,262	488,116	317,407	22.6	87.4
Other specified	2,677	87,088	103,114	73,590	2.0	1,607	53,934	66,348	43,790	2.0	1,070	33,154	37,857	28,919	1.9	38.1
Unknown	56,551	2,558,422	2,685,821	2,428,916	58.1	37,117	1,678,462	1,747,618	1,607,225	63.2	19,434	879,960	936,972	822,873	50.2	34.4
Perpetrator																
Spouse/partner	3,190	168,516	189,043	150,265	3.8	358	18,912	22,824	15,658	0.7	2,832	149,604	164,575	135,831	8.5	88.8
Parent	8,245	293,505	333,579	257,786	6.7	3,672	132,079	151,540	114,916	5.0	4,573	161,426	179,823	144,770	9.2	55.0
Other relative	8,660	319,136	350,324	290,835	7.2	3,878	151,728	168,790	136,412	5.7	4,782	167,408	182,101	153,883	9.6	52.5
Friend/acquaintance	22,655	942,928	1,001,619	886,607	21.4	12,854	568,282	611,202	527,603	21.4	9,801	374,646	394,173	355,790	21.4	39.7
Multiple	15,281	642,918	763,663	538,486	14.6	9,346	409,989	490,713	340,500	15.4	5,935	232,930	273,415	197,700	13.3	36.2
Stranger	2,883	113,461	140,570	91,657	2.6	2,023	81,162	99,788	65,818	3.1	860	32,298	41,012	25,414	1.8	28.5
Other specified	2,303	110,746	120,741	101,792	2.5	1,780	86,635	96,073	78,026	3.3	523	24,111	26,816	21,733	1.4	21.8
Unknown	39,072	1,801,229	1,911,582	1,693,015	40.9	25,616	1,198,517	1,272,563	1,125,270	45.2	13,456	602,712	644,803	561,902	34.4	33.5
Incident locale																
Unknown	36,784	1,620,207	1,930,530	1,332,996	36.8	22,069	993,134	1,195,334	806,266	37.4	14,715	627,073	739,096	523,344	35.8	38.7
Home	26,586	1,019,068	1,204,764	854,439	23.1	11,136	449,374	540,076	371,286	16.9	15,450	569,694	659,701	486,538	32.5	55.9
School/sports	19,195	862,116	943,893	786,137	19.6	12,680	585,871	641,457	533,707	22.1	6,515	276,246	309,520	245,898	15.8	32.0
Street	9,485	440,176	621,330	307,580	10.0	6,814	312,618	438,165	219,481	11.8	2,671	127,558	186,483	86,231	7.3	29.0
Other property	10,708	464,533	581,671	368,832	10.5	7,045	312,590	399,683	242,570	11.8	3,663	151,943	185,607	123,913	8.7	32.7
Anatomic location																
Unknown	2,572	87,316	137,045	55,523	2.0	781	25,706	39,278	16,720	1.0	1,791	61,610	100,953	37,156	3.5	70.6

TABLE 1: Continued.

	All			Male			Female			% female	p value					
	n	N	U95%	L95%	%	n	N	U95%	L95%			%				
Head/neck	54,620	2,489,646	2,583,147	2,395,426	56.5	35,868	1,654,719	1,690,028	1,614,125	62.3	18,752	834,927	899,289	770,995	47.6	33.5
Upper trunk	6,976	308,217	331,817	285,988	7.0	4,521	199,149	218,950	180,999	7.5	2,455	109,068	117,954	100,778	6.2	35.4
Lower trunk	15,961	520,630	642,923	419,067	11.8	4,411	153,453	178,079	131,901	5.8	11,550	367,177	459,722	289,013	20.9	70.5
Upper extremity	15,442	700,595	743,834	659,227	15.9	10,316	471,143	643,845	598,728	17.8	5,126	229,451	255,012	206,113	13.1	32.8
Lower extremity	7,197	300,192	341,511	263,515	6.8	3,851	149,766	172,241	130,043	5.6	3,346	150,426	179,472	125,666	8.6	50.1
Disposition from ED																
Release	94,251	4,110,626	4,186,797	3,997,177	95.0	53,657	2,441,560	2,498,849	2,358,485	93.4	40,594	1,669,065	1,687,753	1,638,350	97.3	40.6
Admit	6,712	218,603	332,052	142,432	5.0	5,211	172,298	255,374	115,010	6.6	1,501	46,305	77,020	27,617	2.7	21.2
Hospital size																
Small	6,408	779,276	1,096,361	538,927	17.7	3,647	443,477	634,291	301,487	16.7	2,761	335,799	464,104	236,434	19.2	43.1
Medium	6,966	887,698	1,234,288	619,568	20.1	4,260	539,925	756,106	373,409	20.3	2,706	347,773	486,363	241,166	19.8	39.2
Large	17,353	1,535,598	2,189,197	990,162	34.8	10,910	965,666	1,386,151	611,201	36.4	6,443	569,932	804,646	376,471	32.5	37.1
Very large	41,098	937,644	1,302,590	653,498	21.3	24,827	566,153	802,816	384,821	21.3	16,271	371,490	504,766	265,878	21.2	39.6
Children's	30,943	266,381	479,878	144,536	6.0	16,104	138,716	253,982	74,045	5.2	14,839	127,665	227,495	69,581	7.3	47.9

n = actual number of ED visits; N = estimated number of ED visits; U95% = lower 95% confidence interval of the estimate; L95% = upper 95% confidence interval of the estimate. Those categories comprising less than 1% of the variables as described in the appendix are excluded; thus, the percentage sum will not add up to 100.



FIGURE 1: Differences by gender in child and adolescent assault victims. (a) By reason for assault ($p < 10^{-4}$). (b) By perpetrator of assault ($p < 10^{-4}$).

lacerations and 79.1% of the punctures were in those 15 to 19 years old). These diagnoses differed markedly by age group (Figure 3(a)) and gender (Figure 3(b)). Strain/sprains were most common in females, and fractures in males.

3.4. *Changes Over Time.* There was a gradual decrease in the number of assaults from 2005 to 2015 for all age groups except for those < 4 years old (Figure 4).

4. Discussion

While there are some similar studies, none have focused on all injured patients who present to the emergency department

across a whole country. Most focus on a certain city or county [3, 5, 6], only patients admitted to the hospital [2], or a certain type/cause of injury [7–12]. This study is more expansive, studying all assault victims in children and adolescents, not just those admitted to the hospital or having a particular type of injury, involving a particular anatomic area or encompassing a particular geographic location. In this study, only 5.0% of the patients were admitted to the hospital.

4.1. *Literature Comparison.* The study most similar to the present one is that of Barmparas et al. [2]. However, they used the National Trauma Data Bank, only studying patients admitted to the hospital. They found a slightly higher median

TABLE 2: Demographics by age group.

Sex	≤4 years		5 to 9 years		10 to 14 years		15 to 19 years		P value													
	n	N	n	N	n	N	n	N														
Male	4,176	119,739	111,042	128,627	41.7	5,287	183,605	170,316	196,598	57.0	14,658	604,775	592,393	616,889	60.7	35,430	1,738,937	1,681,758	1,794,918	62.2	<10 ⁻⁴	
Female	5,841	167,118	158,230	175,815	58.3	4,461	138,475	125,482	151,764	43.0	10,373	391,041	378,897	403,393	39.3	22,319	1,055,145	999,164	1,112,324	37.8		
Race																						
White	3,652	120,734	85,764	153,782	54.6	2,725	106,686	61,341	158,418	41.5	5,943	320,890	196,764	463,823	39.8	14,749	968,890	647,627	1,316,096	43.7	<10 ⁻⁴	
Black	2,790	58,623	39,541	82,732	26.5	3,735	90,703	64,761	120,523	35.3	10,987	315,873	241,475	397,159	39.1	22,432	796,637	616,366	996,827	35.9		
Amerindian	1,184	40,819	23,123	67,443	18.4	1,270	56,185	28,640	98,799	21.9	3,187	164,481	78,689	304,750	20.4	7,220	430,248	217,945	769,792	19.4		
Asian	58	1,093	553	2,146	0.5	88	3,515	1,800	6,787	0.0	154	5,627	3,067	10,976	0.7	398	21,369	10,864	41,904	1.0		
Reason																						
Alteration	533	17,315	13,024	22,893	6.0	1,187	41,309	36,694	46,424	12.8	7,681	308,946	281,813	336,583	31.0	17,853	87,678	819,286	936,367	3.1	<10 ⁻⁴	
Robbery/burglary	12	338	172	631	0.1	18	616	226	1,675	0.2	198	7,055	4,182	11,950	0.7	1,016	45,392	33,811	60,916	1.6		
Sexual assault	4,441	117,669	99,061	137,216	41.0	3,240	80,435	61,598	102,770	25.0	3,143	89,755	69,607	115,016	9.0	3,986	165,624	125,743	216,837	5.9		
Other specified	957	23,181	19,910	26,967	8.1	490	14,286	11,888	17,139	4.4	578	20,045	16,530	24,198	2.0	651	29,555	22,913	38,282	1.1		
Unknown	4,075	128,333	111,970	145,105	44.7	4,812	185,502	166,752	203,608	57.6	13,395	568,737	537,337	599,575	57.1	34,078	1,669,333	1,590,230	1,746,711	59.7		
Perpetrator																						
Spouse/partner	17	809	430	1,549	0.3	6	68	32	161	0.0	157	5,368	3,983	7,170	0.5	3,007	162,203	144,465	181,908	5.8	<10 ⁻⁴	
Parent	2,933	86,586	80,872	92,520	30.2	1,616	53,295	43,589	64,658	16.5	1,829	66,290	57,956	75,681	6.7	1,867	87,334	76,005	100,315	3.1		
Other relative	1,905	49,724	44,696	55,168	17.3	2,115	63,766	58,054	69,877	19.8	2,046	81,267	72,395	91,116	8.2	2,595	124,378	112,330	137,758	4.5		
Unrelated caregiver	302	7,818	6,197	9,869	2.7	73	2,302	1,546	3,447	0.7	44	20	996	2,490	0.0	35	1,468	838	2,235	0.1		
Friend/acquaintance	1,955	53,864	49,946	58,008	18.8	3,504	119,545	105,799	133,956	37.1	8,756	360,802	344,250	377,809	36.2	8,436	408,563	354,037	470,000	14.6		
Multiple	629	15,486	13,168	18,188	5.4	737	22,615	20,361	25,097	7.0	4,080	150,827	120,791	186,714	15.1	9,823	453,753	381,141	537,342	16.2		
Stranger	43	1,234	832	1,807	0.4	55	2,064	1,450	2,932	0.6	415	12,433	10,058	15,335	1.2	2,352	97,008	77,402	121,552	3.5		
Other specified	37	1,649	1,148	2,381	0.6	95	3,297	2,513	4,317	1.0	728	30,247	26,688	34,256	3.0	1,423	75,552	68,181	83,549	2.7		
Unknown	2,179	69,713	63,258	76,598	24.3	1,546	55,083	49,001	61,727	17.1	6,969	286,770	259,607	315,571	28.8	28,199	1,383,384	1,316,949	1,449,957	49.5		
Incident locale																						
Unknown	2,542	84,218	69,254	100,925	29.4	2,218	74,272	58,054	93,428	23.1	7,268	270,454	220,273	327,222	27.2	24,653	1,187,179	955,647	1,431,235	42.5	<10 ⁻⁴	
Home	6,445	170,958	155,749	182,687	59.6	4,411	131,254	109,987	153,640	40.7	5,358	193,660	161,022	231,027	19.4	10,356	522,617	426,688	634,304	18.7		
School/sports	671	19,845	15,262	25,676	6.9	2,546	95,004	70,747	123,518	29.5	8,579	377,087	347,935	407,185	37.9	7,399	370,264	314,916	433,394	13.3		
Street	112	3,725	2,238	6,168	1.3	260	9,457	7,216	12,339	2.9	1,690	77,337	51,882	113,721	7.8	7,366	348,235	243,383	489,560	12.5		
Other property	248	8,107	6,053	10,844	2.8	313	12,168	8,698	16,978	3.8	2,134	77,150	60,645	97,689	7.7	7,974	365,657	289,488	458,264	13.1		
Anatomic location																						
Head/neck	3,043	93,972	78,950	110,364	32.8	3,607	131,804	115,013	149,259	40.9	13,852	567,114	542,914	591,908	57.0	34,026	1,693,398	1,643,043	1,742,799	60.6	<10 ⁻⁴	
Upper trunk	458	13,063	10,902	15,635	4.6	588	21,683	19,491	24,130	6.7	1,501	65,076	59,748	70,901	6.5	4,382	206,583	189,173	225,220	7.4		
Lower trunk	4,317	111,495	91,430	132,970	38.9	3,251	84,128	66,398	104,639	26.1	3,213	98,207	78,967	121,488	9.9	5,136	225,432	184,144	274,958	8.1		
Upper extremity	586	16,650	13,971	19,795	5.8	1,036	37,670	33,956	41,752	11.7	4,438	184,055	172,673	195,975	18.5	9,374	461,971	432,556	492,913	16.5		
Lower extremity	17,168	33,846	27,971	40,766	11.8	816	33,390	27,674	40,142	10.4	1,501	64,013	56,064	72,993	6.4	3,811	168,324	145,583	194,483	6.0		
Disposition from ED																						
Release	8,736	259,819	244,976	269,225	91.7	9,409	312,693	306,250	315,844	98.1	23,984	963,933	945,877	973,868	97.8	52,093	2,573,306	2,493,535	2,627,796	94.1	0.0005	
Admit	1,142	23,456	14,050	38,299	8.3	207	6,019	2,868	12,462	1.9	780	21,665	11,729	39,720	2.2	4,408	161,133	106,643	240,904	5.9		
Hospital size																						
Small	534	65,216	44,610	91,745	22.7	535	65,156	41,205	98,196	20.2	1,495	181,770	120,493	264,686	18.3	3,843	467,014	325,814	653,305	16.7	<10 ⁻⁴	

TABLE 2: Continued.

	≤4 years			5 to 9 years			10 to 14 years			15 to 19 years			P value							
	n	N	L95%	n	N	L95%	n	N	L95%	n	N	L95%		%	U95%	%				
Medium	237	31,526	19,795	48,942	11.0	336	43,526	27,030	67,816	13.5	1,504	193,179	125,372	285,597	19.4	4,889	619,468	440,380	844,993	22.2
Large	1,022	90,183	57,836	130,331	31.4	1,272	111,658	60,148	177,416	34.7	3,856	340,230	195,875	285,597	34.2	11,165	990,152	655,261	1,385,409	35.4
Very large	2,039	46,684	27,684	74,963	16.3	2,557	58,396	34,021	94,491	18.1	8,722	199,260	121,488	521,604	20.0	27,610	629,400	455,469	845,832	22.5
Children's	6,188	53,274	27,311	94,930	18.6	5,049	43,428	22,713	78,093	13.5	9,455	81,368	43,517	309,198	8.2	10,245	88,255	47,503	162,069	3.2

n = actual number of ED visits; N = estimated number of ED visits; L95% = lower 95% confidence interval of the estimate; U95% = upper 95% confidence interval of the estimate. Those categories comprising less than 1% of the variables as described in the appendix are excluded; thus, the percentage sum will not add up to 100.

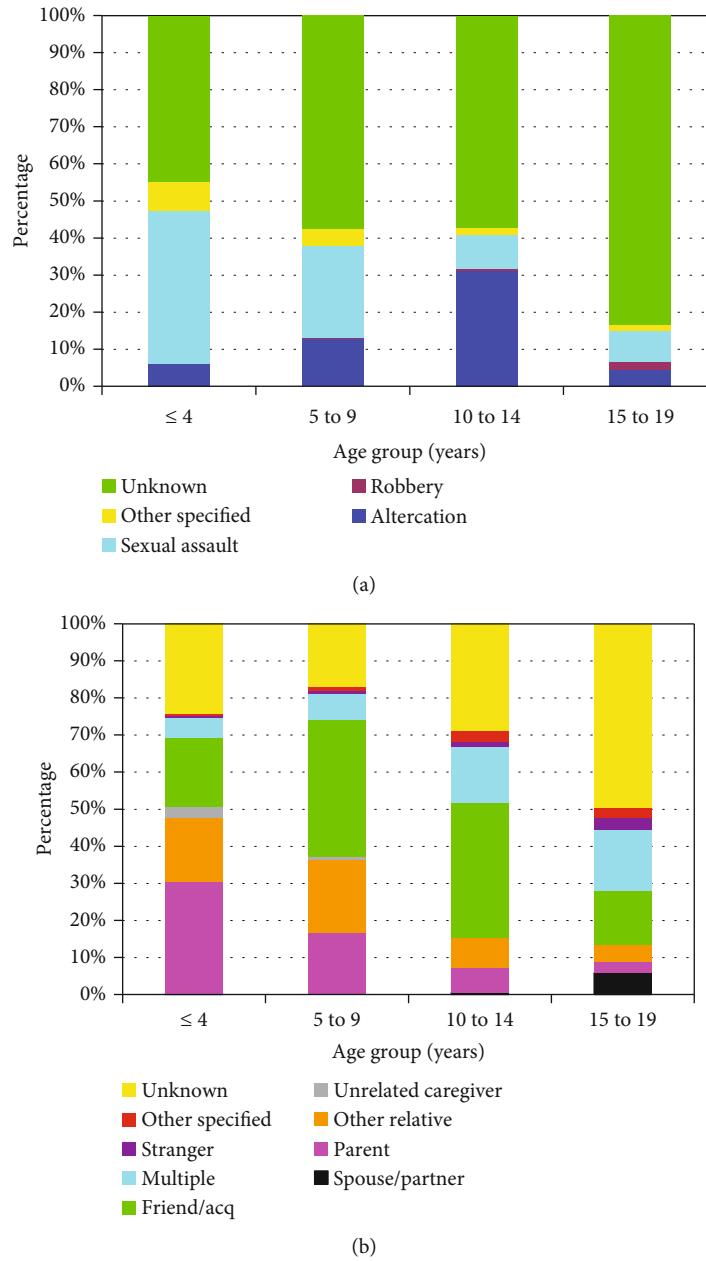


FIGURE 2: Differences by gender in child and adolescent assault victims. (a) By reason for assault ($p < 10^{-4}$). (b) By perpetrator of assault ($p < 10^{-4}$).

age (16 years vs. 15 years). Both studies noted that most of the assault victims were adolescents. They noted that with increasing age, a greater proportion of their patients were Black and fewer were White. While this trend was also seen in our data until age 15 years, in those aged 15 to 19, there was an increase in the proportion of White patients (Table 2). Amerindian and Asian races demonstrated a consistent proportion across all four age groups. Barmparas et al. [2] found that younger children were more likely to sustain a head injury, while we found that they were more likely to have lower trunk injury. This difference is likely due to the fact that they only studied those admitted to the hospital. In this study, all other age groups were more likely to have a head injury, especially concussions in those 15 to 19 years

of age. Additionally, the present study used different classifications for reason of injury. When known, a sexual assault was the most common reason for the assault, except for those 10 to 14 years of age, who were most likely to be injured in an altercation. This also likely explains the fact that most of the injuries in the group ≤ 4 years old involved the lower trunk (sexual assault) as discussed above. We found that adolescents were most likely to be injured in the street, while younger patients were more likely to be injured at home. Children 10 to 14 years of age were most likely to be assaulted at school and by a friend or acquaintance. This finding is consistent with other studies [6, 11] which found that older children and adolescents tended to experience more violent injury further away from home.

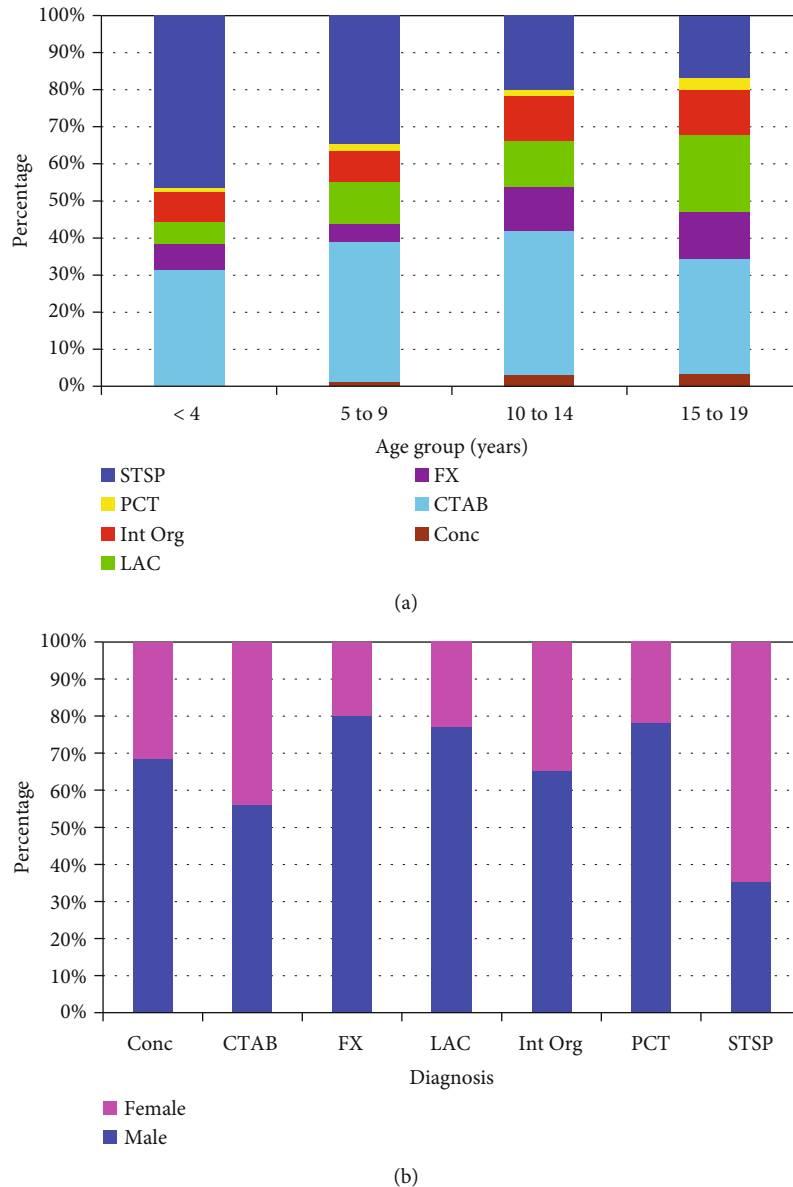


FIGURE 3: Diagnosis in child and adolescent assault victims. STSP = strain/sprain; PCT = puncture; Int Org = internal organ injury; LAC = laceration; FX = fracture; CTAB = contusion/abrasion; Conc = Concussion. (a) By age group ($p < 10^{-4}$). (b) By gender ($p < 10^{-4}$).

The study of Herbert et al. [5] from Cape Town, South Africa, had a younger population while Mollen et al. [3] studied victims of violence limited in the age from 8 to 24 years; however, both noted that most of the injuries were either to the extremities or the head. We found that in those ≤ 4 years old, most of the injuries were to the lower trunk, which has been noted by others to be more serious than other areas of injury [5].

4.2. Our Findings. Most patients in this study were children 15 to 19 years old (64.7%). They were more likely to be male in all age groups except those ≤ 4 years old. As has been previously noted, victims of sexual assault are more likely to be female [13]. In this study, females were more likely to be injured by a partner (8.5% vs. 0.7%) compared to males, but both sexes were more likely to be assaulted by a known

person. More importantly, sexual assault accounted for 87.4% of all assaults in females (Table 1). This is likely a low estimate, as many cases of sexual assault are not reported to health care providers [14–18] or police [19]. The perpetrator was unknown in 45.2% of male and 33.5% of female victims (Table 1).

All of the diagnoses (concussions, contusions/abrasions, fractures, lacerations, internal organ injuries, and punctures) were most likely to occur in 15- to 19-year-olds and male patients and least likely to occur in the younger patients. Strains and sprains were the only injuries to occur more often in female patients and have a younger average age of injury presentation. This finding differs from Mollen et al. [3] who found that females were more likely to sustain bruises/abrasions and be injured in an event involving multiple perpetrators. They also noted that older patients were less likely to

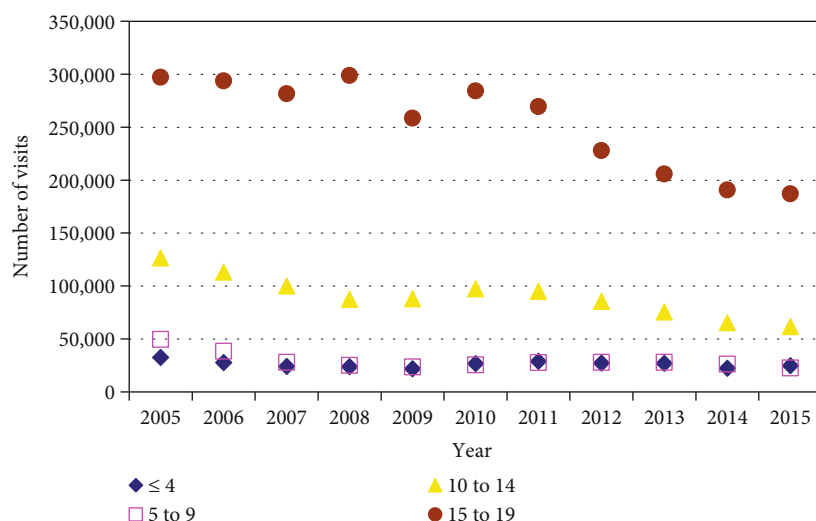


FIGURE 4: Number of assaults in child and adolescent assault victims over time and by age group. There was a gradual decrease for all age groups except for those ≤ 4 years of age. The number of assaults decreased by 23.7% for those ≤ 4 years old ($p = 0.28$, $r^2 = 0.13$), 54.4% for those 5 to 9 years old ($p = 0.026$, $r^2 = 0.44$), 51.1% for those 10 to 14 years old ($p < 10^{-6}$, $r^2 = 0.84$), and 37.0% for those 15 to 19 years old ($p = 0.0007$, $r^2 = 0.84$).

sustain a fracture [3]. This information may coincide with results from a study of Indianapolis youth [6] which found that there was a significant spike in violent injury events between the ages of 13 and 16. This is in contrast to Mollen et al. [3] who found that females were more likely to sustain bruises/abrasions and be injured by multiple perpetrators. They also found that older patients were less likely to sustain a fracture. The discrepancies between this study and that of Mollen et al. [3] are likely due to the fact that their study was limited to the Philadelphia area, thus not representative of the entire US, as well as limiting the patient age from 8 to 24 years.

Although concussions only accounted for 3.0% of the diagnoses, nearly all occurred in those ≥ 10 years of age. This is likely due to the fact that those ≥ 10 years old also accounted for nearly all of the altercations. Altercations often involve fighting, where exchanges of blows are likely to result in a concussion if delivered to the head. Within the youngest age group (≤ 4 years old), strains/sprains were quite common. These are typically less severe injuries than fractures, concussions, and internal organ injuries. The exact reason why there are more strains/sprains in this age group cannot be stated with certainty. Possible explanations are that, in spite of parents being the most common perpetrator of the assault of the four different age groups, the assault involved lower amounts of energy being delivered to the patient, resulting in a strain/sprain. Also, if the perpetrator was another child, such as in a day care center, a younger child would also likely not be able to deliver adequate injury that would result in a fracture or concussion. However, nearly 50% of the children in the ≤ 4 -year-old age group were assaulted by parents or other relatives. These could also be defined as child abuse, battered child syndrome, or nonaccidental trauma. This leads to the next topic.

4.3. Government and Other Social Factors. All 50 of the states in the US have mandatory reporting of potential or actual child abuse to appropriate legal authorities for certain professionals and groups [20]. These include social workers, teachers/other school personnel, all health care workers, counselors and mental health professions, child care providers, and law enforcement officers. Also, anyone can file a concern for child maltreatment with appropriate authorities, and in 18 states, it is law that any person who suspects child abuse or neglect is required to report such concerns [20]. Most states have a toll-free number to call to report suspected abuse. Child Welfare Information Gateway, a service of the Children's Bureau (<https://www.childwelfare.gov>), provides a list of state child abuse reporting numbers. Another source on how and where to file a report of suspected child abuse and neglect is the National Child Abuse Hotline and can be reached 7 days a week, 24 hours a day, at its toll-free number, 1.800.4-A-CHILD (1.800.422.4453).

Once such a report has been filed, then each state's Child Protective Services agency follows its own investigation algorithm. The Child Protective Services response is often differential [21]. In serious cases, the state will take legal custody of the child and place them into foster care. In less serious cases, they will use community agencies to support families who are considered lower risk, recognizing that variations in families' needs and strengths require different approaches. In-home services play an important role in safety and permanence for the majority of families that receive a report of child maltreatment [22].

There is now an even stronger push to keep children in their own home when possible. The 2018 signing of the Family First Prevention Services Act (H.R. 1892) [23] redirects federal funds to provide services to keep children safely with their families and out of foster care, and when foster care is needed, it allows federal reimbursement for care in family-

based settings and certain residential treatment programs for children with emotional and behavioral disturbance requiring special treatment. As the data used in this was collected before the implementation of this law, further research and follow-up will be needed to assess its impact on the incidence of child maltreatment occurring in their own home.

4.4. Limitations. There are certain limitations to this study. One potential limitation is the accuracy of the NEISS data. However, two studies have demonstrated over 90% accuracy [24, 25]. The NEISS only identifies individuals who sought care in an ED. It does not include those who might have been treated in urgent care centers, physician offices, and other non-ED venues or those persons who did not seek medical care, and therefore, the assault was never reported to any agency collecting such data. Another limitation is injury severity. The only proxy of injury severity with NEISS data is disposition from the ED as being treated and released or admitted to the hospital. The NEISS-AIP does not include fatal injuries nor does it record the Injury Severity Score. Finally, the race was not known in 20.4% of the patients; this is due to either the patient refusing to divulge such information or it not being collected on the medical record so that the NEISS coders could include it. However, acknowledging these limitations, we noted many interesting findings as described above.

5. Conclusion

These data provide a comprehensive overview of child and adolescent assault victims presenting to the ED in the USA. They can be used as background data for further study. The decreasing numbers of assaults over the 11 years of the study are encouraging, but there still exist challenges in decreasing the number for those ≤ 4 years old.

Appendix

A. NEISS Definitions [26]

A.1 Assault. Assault is defined as injury from an act of violence where physical force by one or more persons is used with the intent of causing harm, injury, or death to another person or an intentional poisoning by another person. This category includes perpetrators as well as intended and unintended victims of violent acts (e.g., innocent bystanders). This category excludes unintentional shooting victims (other than those occurring during an act of violence), unintentional drug overdoses, and children or teenagers "horsing" around.

A.2 Hospital Strata. Four are based on size (the total number of ED visits reported by the hospital, which are small (0–16,830), medium (16,831–21,850), large (28,151–41,130), and very large (>41,130)), and one includes children's hospitals of all sizes. The actual age is also categorized into 18 different groups in 5-year increments with the last group including all those ≥ 85 years old. The injured body part is classified into five major locations (head/neck, upper trunk, lower trunk, upper extremity, and lower extremity).

A.3 Incident Locale. This is categorized into home/apartment/mobile, school/sports, street, other property, farm, and unknown. Other property consists of stores, office buildings, restaurants, churches, hotel/motels, hospital/nursing homes, adult day care facility, fraternity/sorority houses, theaters, sidewalks, and parking lots/garages.

A.4 Perpetrator. This is categorized into spouse/partner, parent, other relative, unrelated caregiver, friend/acquaintance, official authorities, multiple perpetrators, stranger, other specified, and unknown.

A.5 Reason for Assault. This is categorized into altercation, robbery/burglary, drug-related, sexual assault, gang-related, other specified, and unknown.

A.6 Causative Agent of Injury. This is categorized into motor vehicle occupant, motorcyclist, pedal cyclist, pedestrian, other transport, fall, struck by/against, cut/pierced, overexertion, fire/burn, poisoning, inhalation/suffocation, drowning/near drowning, machinery, foreign body, dog bite, other bite/sting, firearm gunshot, BB/pellet gunshot, and natural/environmental causes.

Data Availability

The raw data is in the public domain and housed by the Inter-University Consortium for Political and Social Research (ICPSR). It can be accessed at <https://www.icpsr.umich.edu/icpsrweb/ICPSR/search/studies?q=all+injury+program>. The refined data are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Authors' Contributions

RTL conceived and designed the study. RTL, SP, and MS collected and analyzed the data. RTL performed the statistical analyses. RTL, SP, and MS prepared the original manuscript. RTL, SP, and MS participated in manuscript reviews and approved the final manuscript.

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References

- [1] S. A. Sumner, J. A. Mercy, L. L. Dahlberg, S. D. Hillis, J. Klevens, and D. Houry, "Violence in the United States," *JAMA*, vol. 314, no. 5, pp. 478–488, 2015.
- [2] G. Barmparas, N. K. Dhillon, E. J. T. Smith et al., "Assault in children admitted to trauma centers: injury patterns and outcomes from a 5-year review of the national trauma data bank," *International Journal of Surgery*, vol. 43, pp. 137–144, 2017.

- [3] C. J. Mollen, J. A. Fein, T. N. Vu, F. S. Shofer, and E. M. Datner, "Characterization of nonfatal events and injuries resulting from youth violence in patients presenting to an emergency department," *Pediatric Emergency Care*, vol. 19, no. 6, pp. 379–384, 2003.
- [4] P. B. Eveleth and J. M. Tanner, *Worldwide Variation in Human Growth*, University Press, Cambridge, 2nd edition, 1990.
- [5] H. K. Herbert, A. B. van As, A. M. Bachani et al., "Patterns of pediatric injury in South Africa: an analysis of hospital data between 1997 and 2006," *Journal of Trauma and Acute Care Surgery*, vol. 73, no. 1, pp. 168–174, 2012.
- [6] J. D. H. Walthall, A. Burgess, E. Weinstein, C. Miramonti, T. Arkins, and S. Wiehe, "Descriptive correlates of urban pediatric violent injury using emergency medical service patient-level data," *Pediatric Emergency Care*, vol. 34, no. 2, pp. 69–75, 2018.
- [7] A. R. de Jong, A. R. Hervada, and G. A. Emmett, "Epidemiologic variations in childhood sexual abuse," *Child Abuse & Neglect*, vol. 7, no. 2, pp. 155–162, 1983.
- [8] S. G. Gebran, P. J. Wasicek, A. Elegbede et al., "Characterization of age-related injury patterns and surgical treatment of pediatric facial fractures," *Journal of Craniofacial Surgery*, vol. 30, no. 7, pp. 2189–2193, 2019.
- [9] R. Gise, T. Truong, A. Parsikia, and J. N. Mbekeani, "A comparison of pediatric ocular injuries based on intention in patients admitted with trauma," *BMC Ophthalmology*, vol. 19, no. 1, p. 37, 2019.
- [10] B. Kalesan, S. Dabic, S. Vasan, S. Stylianos, and S. Galea, "Racial/ethnic specific trends in pediatric firearm-related hospitalizations in the United States, 1998–2011," *Maternal and Child Health Journal*, vol. 20, no. 5, pp. 1082–1090, 2016.
- [11] P. Vulliamy, M. Faulkner, G. Kirkwood et al., "Temporal and geographic patterns of stab injuries in young people: a retrospective cohort study from a UK major trauma centre," *BMJ Open*, vol. 8, no. 10, article e023114, 2018.
- [12] D. A. J. Wainwright, J. K. Moffitt, M. Bartz-Kurycki et al., "The trends of pediatric facial fractures due to violence in a level one trauma population," *Journal of Craniofacial Surgery*, vol. 30, no. 7, pp. 1970–1973, 2019.
- [13] R. T. Loder and T. P. Robinson, "The demographics of patients presenting for sexual assault to US emergency departments," *Journal of Forensic and Legal Medicine*, vol. 69, article 101887, 2020.
- [14] M.-L. Larsen, M. Hilden, and Ø. Lidegaard, "Sexual assault: a descriptive study of 2500 female victims over a 10-year period," *BJOG: An International Journal of Obstetrics & Gynaecology*, vol. 122, no. 4, pp. 577–584, 2015.
- [15] C. M. Rennison, "Rape and sexual assault: reporting to police and medical attention, 1992–2000. NCJ 194530 US Department of Justice," Bureau of Justice Statistics. NCJ, 2002, March 2019, <https://www.bjs.gov/content/pub/pdf/rsarp00.pdf>.
- [16] P. Tjaden and N. Thoennes, *Full Report of the Prevalence, Incidence, and Consequences of Violence against Women. Findings from the National Violence against Women Survey (NCJ 183781)*, National Department of Justice, Washington, DC, 2000, March 2019, <https://www.ncjrs.gov/pdffiles1/nij/183781.pdf>.
- [17] K. B. Wolitzky-Taylor, H. S. Resnick, A. B. Amstadter, J. L. McCauley, K. J. Ruggiero, and D. G. Kilpatrick, "Reporting rape in a national sample of college women," *Journal of American College Health*, vol. 59, no. 7, pp. 582–587, 2011.
- [18] K. M. Feldhaus, D. Houry, and R. Kaminsky, "Lifetime sexual assault prevalence rates and reporting practices in an emergency department population," *Annals of Emergency Medicine*, vol. 36, no. 1, pp. 23–27, 2000.
- [19] B. S. Fisher, L. E. Daigle, F. T. Cullen, and M. G. Turner, "Reporting sexual victimization to the police and Others," *Criminal Justice and Behavior*, vol. 30, no. 1, pp. 6–38, 2003.
- [20] Children's Bureau, United States Department of Health and Human Services, "Administration for Children & Families. Mandatory reporters of child abuse and neglect," 2019, September 2020, <https://www.childwelfare.gov/pubPDFs/mandapdf>.
- [21] Children's Bureau, United States Department of Health and Human Services, "Administration for Children & Families. Differential response to reports of child abuse and neglect," 2014, September 2020, <https://www.childwelfare.gov/topics/responding/alternative/>.
- [22] Children's Bureau, United States Department of Health & Human Services, "Administration for Children & Families," 2014, September 2020, https://www.childwelfare.gov/pubPDFs/inhome_services.pdf.
- [23] V. Buchannan and S. M. Levin, *The Family First Prevention Services Act (H. R. 1892)*, House of Representatives, United States Congress, 2018, September 2020, <https://www.congress.gov/bill/115th-congress/house-bill/253?q=%7B%22search%22%3A%5B%22family+first+prevention+services+act%22%5D%7D&r=1>.
- [24] J. L. Annet, J. A. Mercy, D. R. Gibson, and G. W. Ryan, "National estimates of nonfatal firearm-related injuries. Beyond the tip of the iceberg," *JAMA*, vol. 273, no. 22, pp. 1749–1754, 1995.
- [25] R. S. Hopkins, "Consumer product-related injuries in Athens, Ohio, 1980–85: assessment of emergency room-based surveillance," *American Journal of Preventive Medicine*, vol. 5, no. 2, pp. 104–112, 1989.
- [26] United States Department of Health and Human Services, Centers for Disease Control and Prevention, and US Consumer Product Safety Commission, *National Electronic Injury Surveillance System All Injury Program, 2015. Codebook*, Inter University Consortium for Political and Social Research, 2015.