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ORIGINAL ARTICLE

Non-fatal horse related injuries treated in emergency departments in the United States, 2001–2003

K E Thomas, J L Annet, J Gilchrist, D M Bixby-Hammett



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See end of article for authors' affiliations

Correspondence to:
Karen E Thomas, OSP/
NCIPC/CDC, 4770 Buford
Highway NE, Mailstop
K-59, Atlanta, GA 30341,
USA; KETHomas@cdc.gov

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Objective: To characterise and provide nationally representative estimates of persons with non-fatal horse related injuries treated in American emergency departments.

Methods: The National Electronic Injury Surveillance System All Injury Program (NEISS–AIP) is a stratified probability sample comprising 66 hospitals. Data on injuries treated in these emergency departments are collected and reported. NEISS–AIP data on all types (horseback riding and otherwise) of non-fatal horse related injuries from 2001 to 2003 were analysed.

Results: An estimated 102 904 persons with non-fatal horse related injuries (35.7 per 100 000 population) were treated in American emergency departments each year from 2001 to 2003 inclusive. Non-fatal injury rates were higher for females (41.5 per 100 000) than for males (29.8 per 100 000). Most patients were injured while mounted on a horse (66.1%), commonly from falling or being thrown by the horse; while not mounted, injuries most often resulted from being kicked by the horse. The body parts most often injured were the head/neck region (23.2%), lower extremity (22.2%), and upper extremity (21.5%). The most common principal diagnoses were contusions/abrasions (31.4%) and fractures (25.2%). For each year that was studied, an estimated 11 502 people sustained traumatic brain injuries from horse related incidents. Overall, more than 11% of those injured were admitted to hospital.

Conclusions: Horse related injuries are a public health concern not just for riders but for anyone in close contact with horses. Prevention programmes should target horseback riders and horse caregivers to promote helmet use and educate participants about horse behaviour, proper handling of horses, and safe riding practices.

Horseback riding is a popular recreational activity in the USA, particularly within certain demographic groups and regions of the country. In the USA, there are an estimated 9.2 million horses,¹ with more than 19 million people aged 16 years and older participating in riding activities.² Along with participation comes the risk of injury. A survey conducted of randomly selected households receiving a national horseback riding equipment catalogue found that 27.5% of participants aged 25 years and younger who rode six or more times a year had been treated by a physician in the past two years for a horse related injury, and 6.1% had been admitted to hospital for a horse related injury in their lifetime.³ Even though horse related activities have fewer participants than other sports and recreation activities, horseback riding is the eighth leading cause of emergency department treated, sports and recreation related injuries among female participants.⁴

Horseback riding and related activities have unique characteristics, with implications for the injuries sustained. Horse related sports are among the few sports in which participants from two different species function as a team, with the horse having the ability to act independently and unpredictably.⁵ In addition, horses are large and fast—often weighing 450 kg (1000 pounds) or more and travelling up to 48 km/h (30 mph)—with the rider's head up to 3 m (over 9 ft) above the ground.^{5–6} Even when not mounted on a horse, a person can be seriously injured—a horse's kick can generate a force up to 1.8 times its body weight.⁷

Although many studies describe injuries sustained in horse related incidents, most describe patients treated in a single medical centre.^{7–15} Most national studies conducted in the USA have focused on paediatric populations.^{16–17} This study provides current and comprehensive national estimates of all

types (horseback riding and otherwise) of non-fatal horse related injuries treated in American hospital emergency departments, and characterises these injury incidents by demographics of the person injured, injury circumstances, types of injury, and disposition at discharge from the emergency department. In addition, previous injury prevention recommendations are discussed and placed in context using the surveillance data.

METHODS

The National Electronic Injury Surveillance System (NEISS) is an emergency department surveillance system operated by the US Consumer Product Safety Commission.¹⁸ The system was designed to generate national estimates of consumer product related injuries. NEISS is a nationally representative stratified sample of 99 hospitals in the USA and its territories that have at least six beds and provide 24 hour emergency care. The hospitals are stratified into four categories based on the annual number of emergency department visits, with a fifth stratum for children's hospitals.

The NEISS All Injury Program (NEISS–AIP) is a subsample of 66 of the 99 NEISS hospitals.¹⁹ In these emergency departments, data are collected on all injuries, regardless of cause or consumer product involvement. NEISS–AIP collects data on approximately 500 000 injury related emergency department visits annually, including age, sex, day and month of treatment, consumer products involved, primary body part injured, principal diagnosis, disposition at emergency department discharge, and a two line narrative describing the injuries and circumstances. Because the

Abbreviations: ATV, all-terrain vehicle; NEISS–AIP, National Electronic Injury Surveillance System All Injury Program; SR, sports and recreation

analysis of NEISS–AIP data does not involve patient contact, these data are exempt from institutional review board approval.

Cases were defined as patients injured while engaged in horse related activities (riding, mounting or dismounting, caring for a horse while not mounted, riding in a horse drawn buggy/cart, or being run over by a horse drawn vehicle). Cases were identified if one of two criteria was met: (1) if one of the two consumer product codes was “horseback riding—activity, apparel, or equipment”; or (2) if one of the product codes was “animal induced injury” and the narrative included the word “horse” or “pony.” Because NEISS–AIP does not capture all deaths, patients who were dead on arrival or who died while in the emergency department were excluded. Other types of cases were also excluded: motor vehicle occupants injured in a collision with a horse; injuries involving horse related equipment without mention of a horse (for example, tripped over a saddle on the floor); injuries associated with donkeys or mules; persons injured while in the barn or pasture with no mention of direct horse involvement (for example, falling while in the barn to feed horses); and persons who sought emergency department care because of a second unrelated injury incident (for example, motor vehicle crash today, fell off horse last week). In addition to the routinely collected NEISS–AIP variables, one author reviewed the narratives and coded additional circumstance variables. These included the mechanism of injury (fall, crush); whether the person was mounted, not mounted, or in the process of mounting/dismounting; other circumstances (horse tripped, person fell, and so on); and specific diagnoses (such as traumatic brain injury).

Each case was assigned a sample weight based on the inverse probability of selection and both non-response and post-stratification adjustments to account for changes in the total number of American hospital emergency department visits over time. These weights were summed to produce

national estimates. The national estimates were based on weighted data for 4122 cases of horse related injuries seen in NEISS–AIP hospitals from 2001 to 2003 inclusive. Estimates were annualised by dividing the weighted totals by 3. Rates were calculated using the US Census 2001–2003 bridged race population estimates obtained from the National Center for Health Statistics.²⁰ Confidence intervals were calculated using a direct variance estimation procedure that accounted for the sample weights and complex sampling design.

RESULTS

Each year from 2001 to 2003, an estimated 102 904 people (35.7 per 100 000 population) were treated in American hospital emergency departments for horse related injuries. About 19% of those were 14 years of age or younger (table 1). Overall, females had higher rates of injury than males, but sex specific rates and the differences between female and

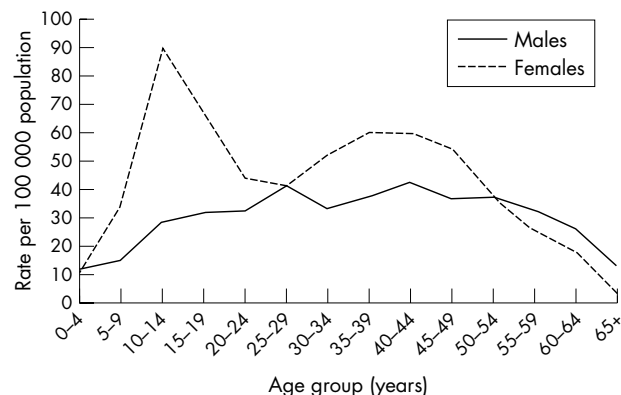


Figure 1 National annual rates of non-fatal horse related injuries treated in emergency departments, by sex and age group—USA, 2001–2003.

Table 1 National estimates* and rates† of non-fatal horse related injuries treated in emergency departments, by age group, sex, and disposition at emergency department discharge—USA, 2001–2003

Characteristic	Annual estimate	Percentage	Rate	(95% CI)
<i>Age (years)</i>				
0–4	2188	2.1	11.2	(7.1 to 15.3)
5–9	4936	4.8	24.7	(17.4 to 32.0)
10–14	12 392	12.0	58.9	(43.4 to 74.3)
15–19	10 053	9.8	49.4	(35.3 to 63.4)
20–24	7795	7.6	38.4	(28.2 to 48.7)
25–29	7854	7.6	41.3	(31.3 to 51.4)
30–34	8843	8.6	42.6	(30.4 to 54.8)
35–39	10 640	10.3	48.8	(35.3 to 62.2)
40–44	11 807	11.5	51.6	(37.5 to 65.7)
45–49	9763	9.5	45.9	(31.8 to 60.0)
50–54	7004	6.8	37.4	(27.7 to 47.1)
55–59	4377	4.3	29.2	(18.4 to 40.0)
60–64	2555	2.5	22.0	(12.1 to 31.9)
65+	2665	2.6	7.5	(4.7 to 10.2)
Unknown	33	0.0	–	–
<i>Sex</i>				
Male	42 162	41.0	29.8	(22.1 to 37.5)
Female	60 703	59.0	41.5	(30.2 to 52.7)
Unknown	39	0.0	–	–
<i>Disposition at ED discharge</i>				
Treated and released	90 776	88.2	31.5	(24.1 to 39.0)
Admitted to hospital/transferred	11 481	11.2	4.0	(2.3 to 5.7)
Other/unknown	646	0.6	–	–
Total	102 904	100.0	35.7	(26.9 to 44.6)

*Numbers may not add up to totals because of rounding.

†Per 100 000 population.

CI, confidence interval; ED, emergency department.

Table 2 National estimates* of non-fatal horse related injuries treated in emergency departments, by selected injury characteristics, overall, and for those mounted or not mounted at time of injury—USA, 2001–2003

Characteristic	Total†			Mounted			Not mounted		
	Annual estimate	(95% CI)	%	Annual estimate	(95% CI)	%	Annual estimate	(95% CI)	%
<i>Was the person mounted?</i>									
Mounted	68 027	(50 253 to 85 800)	66.1	68 027	(50 253 to 85 800)	100.0	—	—	—
Not mounted	30 288	(23 224 to 37 353)	29.4	—	—	—	30 288	(23 224 to 37 353)	100.0
Mounting	1061	(627 to 1495)	1.0	—	—	—	—	—	—
Dismounting	1438	(837 to 2039)	1.4	—	—	—	—	—	—
Other/unknown	2090	(993 to 3187)	2.0	—	—	—	—	—	—
<i>Mechanism of injury</i>									
Fall	56 654	(42 081 to 71 227)	55.1	53 691	(40 103 to 67 280)	78.9	1200	(678 to 1723)	4.0
Struck by or against	24 721	(18 815 to 30 626)	24.0	6576	(4182 to 8970)	9.7	17 155	(13 405 to 20 905)	56.6
Crush	13 572	(9498 to 17 646)	13.2	5377	(3566 to 7188)	7.9	7740	(5262 to 10 218)	25.6
Overexertion	5489	(3977 to 7001)	5.3	2169	(1393 to 2945)	3.2	2330	(1551 to 3109)	7.7
Bite	1779	(1087 to 2470)	1.7	—	—	—	1779	(1087 to 2470)	5.9
Other/unknown	689†	(270 to 1109)	0.7	213†	(52 to 375)	0.3	84†	(–50 to 218)	0.3
<i>Was the injury work related?</i>									
Yes	5977	(4126 to 7829)	5.8	2461	(1363 to 3558)	3.6	3278	(2218 to 4338)	10.8
No	95 922	(71 249 to 120 595)	93.2	65 106	(47 597 to 82 616)	95.7	26 506	(20 085 to 32 927)	87.5
Unknown	1004	(450 to 1558)	1.0	459†	(118 to 800)	0.7	504†	(203 to 806)	1.7
<i>Primary body part injured</i>									
Head/neck									
Head	23 883	(15 739 to 32 026)	23.2	16 789	(10 360 to 23 219)	24.7	6107	(4328 to 7886)	20.2
Face	13 785	(9771 to 19 599)	13.4	10 957	(6127 to 15 787)	16.1	2398	(1427 to 3370)	7.9
Neck	5753	(4190 to 7316)	5.6	2554	(1756 to 3353)	3.8	2869	(1985 to 3754)	9.5
Eye, mouth, ear	2988	(1978 to 3998)	2.9	2564	(1567 to 3560)	3.8	322†	(8 to 636)	1.1
Upper trunk									
Shoulder	1356	(864 to 1848)	1.3	715	(358 to 1071)	1.1	517	(240 to 794)	1.7
Other upper trunk	18 208	(13 270 to 23 146)	17.7	13 747	(9566 to 17 539)	20.2	3999	(2807 to 5190)	13.2
Lower trunk	8073	(6023 to 10 123)	7.8	6445	(4681 to 8209)	9.5	1450	(1003 to 1896)	4.8
Upper extremities									
Upper arm	10 135	(8119 to 13 450)	9.8	7302	(4712 to 9892)	10.7	2549	(1667 to 3431)	8.4
Elbow	15 034	(11 403 to 18 664)	14.6	12 921	(9685 to 16 157)	19.0	1832	(1246 to 2418)	6.0
Lower arm	22 093	(17 112 to 27 073)	21.5	13 127	(10 028 to 16 227)	19.3	7723	(5867 to 9579)	25.5
Wrist	1737	(1104 to 2370)	1.7	1200	(738 to 1662)	1.8	368†	(131 to 606)	1.2
Hand	3112	(2068 to 4156)	3.0	2379	(1645 to 3113)	3.5	531†	(207 to 854)	1.8
Finger	5240	(3864 to 6616)	5.1	3430	(2434 to 4426)	5.0	1426	(907 to 1946)	4.7
Lower extremities									
Upper leg	4119	(2971 to 5267)	4.0	3352	(2385 to 4318)	4.9	635	(375 to 894)	2.1
Knee	2924	(2161 to 3687)	2.8	1026	(600 to 1451)	1.5	1793	(1265 to 2322)	5.9
Lower leg	4961	(3509 to 6414)	4.8	1741	(1095 to 2387)	2.6	2970	(2108 to 3831)	9.8
Ankle	22 801	(17 359 to 28 243)	22.2	10 704	(8148 to 13 260)	15.7	10 517	(7716 to 13 318)	34.7
Foot	2346	(1535 to 3157)	2.3	1202	(630 to 1774)	1.8	1070	(640 to 1500)	3.5
Toe	4056	(2999 to 5112)	3.9	2441	(1672 to 3210)	3.6	1270	(809 to 1730)	4.2
Other/unknown	4925	(3627 to 6224)	4.8	2364	(1640 to 3089)	3.5	2267	(1572 to 2961)	7.5
	5359	(3935 to 6783)	5.2	3628	(2716 to 4539)	5.3	983	(499 to 1467)	3.2
	4778	(3214 to 6341)	4.6	950	(588 to 1311)	1.4	3719	(2275 to 5163)	12.3
	1337	(737 to 1937)	1.3	120†	(–53 to 293)	0.2	1209	(686 to 1731)	4.0
	886	(483 to 1288)	0.9	737	(349 to 1125)	1.1	112†	(–49 to 272)	0.4

Table 2 Continued

Characteristic	Total†			Mounted			Not mounted		
	Annual estimate	95% CI	%	Annual estimate	95% CI	%	Annual estimate	95% CI	%
Principal diagnosis	32 293	(25 224 to 39 362)	31.4	18 956	(14 592 to 23 320)	27.9	12 357	(9338 to 15 375)	40.8
Contusion/abrasion	25 905	(18 924 to 32 887)	25.2	19 032	(13 801 to 24 264)	28.0	5712	(3946 to 7477)	18.9
Fracture	16 233	(12 036 to 20 429)	15.8	12 551	(9100 to 16 002)	18.5	2499	(1676 to 3321)	8.3
Strain/sprain	9985	(4687 to 15 284)	9.7	8068	(3685 to 12 451)	11.9	1641	(774 to 2508)	5.4
Concussion/internal injury (head)	7933	(5945 to 9922)	7.7	3536	(2407 to 4665)	5.2	3893	(2892 to 4894)	12.9
Laceration	1891	(1196 to 2587)	1.8	1095	(570 to 1620)	1.6	686	(386 to 986)	2.3
Haematoma	1864	(1233 to 2494)	1.8	1414	(859 to 1968)	2.1	353‡	(133 to 573)	1.2
Dislocation	6799	(4348 to 9249)	6.6	3374	(1661 to 5087)	5.0	3148	(2165 to 4131)	10.4
Other/unknown									

*Numbers may not add up to totals because of rounding.
†Total† will not equal sum of "Mounted" and "Not mounted" because Total includes the additional categories of "Mounting", "Dismounting", and "Other/unknown".
‡Estimate may be unstable because the coefficient of variation is more than 30%.
CI, confidence interval.

male rates varied across age groups (table 1, fig 1). Injury rates for females peaked at 10–14 years (90.6 per 100 000) and at 35–44 years (60.2 per 100 000). Ages 10–14 years also had the greatest difference in rates by sex, the female rate being more than three times the male rate. For patients aged 55 years and older, males had somewhat higher rates than females. Of all patients treated for horse related injuries, more than 11% were admitted to hospital or transferred for a higher level of care.

Overall, the most common mechanism of injury was a fall (55.1%), followed by being struck by or against (24.0%) (table 2). Almost 6% of injuries were work related. The most common primary body parts injured were the head/neck (23.2%), lower extremities (22.2%), and upper extremities (21.5%). The most frequent principal diagnoses were contusions/abrasions (31.4%), fractures (25.2%), and strains/sprains (15.8%).

Nearly two thirds of injured persons were mounted on horseback at the time of the event causing the injury. For those mounted, the most common mechanism was a fall (78.9%), with the most common principal diagnoses being fractures (28.0%) and contusions/abrasions (27.9%). A majority (63.9%) of injuries were either to the trunk or head/neck region. For those not mounted, the most common mechanisms were being struck by/against (56.6%) and being crushed (25.6%), and the most common principal diagnoses were contusions/abrasions (40.8%) and fractures (18.9%). A majority (60.2%) of injuries for those not mounted involved the extremities.

Based on the principal diagnosis along with injuries described in the narrative, 11.2% of those injured had a traumatic brain injury (n = 11 502; 95% confidence interval (CI), 5663 to 17 340). The narratives also suggested that 1.6% of patients were treated for hip or pelvic fractures, and 1.5% sustained spinal fractures. Most injuries (55.7%) were treated in the months of May to September, and 40.1% were treated on Saturday or Sunday (results not in table).

The two most common circumstances of injury were first, falling or being thrown by the horse while mounted (44.6%), and second, being kicked by a horse while not mounted (11.2%) (table 3). Less common circumstances of injury included falling or being thrown while mounted because the horse reared, bucked, or was spooked (7.5%), and being stepped on by the horse while not mounted (6.1%).

The distribution of injuries by primary body part affected and principal diagnosis differed for persons who were mounted and not mounted at the time of injury (table 4). Of those mounted, the most common diagnoses were traumatic brain injury (that is, concussions/internal injuries to the head) (11.9%); fractures/dislocations to the upper extremities (11.0%); fractures/dislocations to the upper trunk (9.0%); and contusions/abrasions to the lower trunk (8.0%). Of those not mounted, the most frequent diagnoses were contusions/abrasions to the lower extremities (18.2%), contusions/abrasions to the upper extremities (8.6%), fractures/dislocations to the lower extremities (7.5%), and lacerations to the head (7.2%).

DISCUSSION

Most horse related injuries occur among females, which is in contrast to other injury causes which are often more prevalent for males.²¹ These injuries are quite severe, with a larger percentage admitted to hospital than for other causes of injury (11.2% v 5.5% for all injuries), and with a substantial number sustaining more serious diagnoses such as fractures and head injuries.²¹

The annual number of horse related injuries from 2001–2003 reported in this study (102 904) is higher than the estimates previously reported using NEISS. A study using 1990 NEISS data estimated that 74 349 persons with horse

Table 3 National estimates* of non-fatal horse related injuries treated in emergency departments, by injury circumstances†—USA, 2001–2003

Circumstance	Annual estimate	(95% CI)	Percentage
<i>Mounted</i>			
<i>Fall/thrown</i>			
And no other circumstances reported	45 875	(34 598 to 57 152)	44.6
And struck by or against object (eg, fence, tree)	1896	(993 to 2800)	1.8
And was stepped on, trampled, or kicked by horse	1277	(598 to 1956)	1.2
And horse fell/rolled	1173‡	(409 to 1938)	1.1
And other circumstance(s)	522‡	(120 to 924)	0.5
<i>Bucked/reared/spooked</i>			
And no other circumstances reported	153‡	(22 to 284)	0.1
And person fell or was thrown	7755	(4367 to 11 142)	7.5
And other circumstance(s)	777	(394 to 1160)	0.8
<i>While riding</i>			
And no other circumstances reported	1718	(1098 to 2338)	1.7
Struck against object	1915	(1169 to 2661)	1.9
And other circumstance(s)	832	(440 to 1223)	0.8
<i>Horse tripped, fell, and/or rolled</i>			
And no other circumstances reported	2475	(1696 to 3253)	2.4
And person fell or was thrown	1044	(425 to 1664)	1.0
And other circumstance(s)	189‡	(37 to 341)	0.2
Other/unknown circumstance(s)	425‡	(165 to 685)	0.4
<i>Not mounted</i>			
<i>Kicked</i>			
Stepped on	11 534	(8917 to 14 150)	11.2
Pushed into, pulled, jerked, or knocked down	6315	(4243 to 8388)	6.1
Bitten	3076	(2215 to 3938)	3.0
Bucked/reared/spooked	1817	(1087 to 2547)	1.8
Struck by or against object	1485	(761 to 2209)	1.4
Struck by or against object	1459	(913 to 2004)	1.4
Body part caught	1279	(832 to 1725)	1.2
Hit by horse's head	1017	(616 to 1419)	1.0
Horse tripped/fell/rolled	831	(413 to 1249)	0.8
Other/unknown circumstance(s)	1475	(929 to 2021)	1.4
<i>Mounting/dismounting</i>			
<i>Fell</i>			
Jumped off	995	(447 to 1544)	1.0
Other/unknown circumstance(s)	652	(325 to 979)	0.6
Other/unknown circumstance(s)	852	(541 to 1163)	0.8
Other/unknown mounted status	2090	(993 to 3187)	2.0

*Numbers may not add up to totals because of rounding.

†Circumstance categories are mutually exclusive. Cases were coded to the furthest level of detail known.

‡Estimate may be unstable because the coefficient of variation is more than 30%.

CI, confidence interval.

Table 4 National estimates* of non-fatal horse related injuries treated in emergency departments, by primary body part injured and principal diagnosis for those mounted or not mounted at time of injury—USA, 2001–2003

Primary body part affected and principal diagnosis	Mounted			Not mounted		
	Annual estimate	(95% CI)	%	Annual estimate	(95% CI)	%
Head/neck	16 789	(10 360 to 23 219)	24.7	6107	(4328 to 7886)	20.2
Concussion/internal injury	8068	(3685 to 12 451)	11.9	1641	(774 to 2508)	5.4
Contusion/abrasion	2675	(1801 to 3549)	3.9	1120	(686 to 1554)	3.7
Laceration	2400	(1604 to 3196)	3.5	2193	(1573 to 2812)	7.2
Other	3647	(2188 to 5106)	5.4	1153	(590 to 1716)	3.8
Upper trunk	13 747	(9956 to 17 539)	20.2	3999	(2807 to 5190)	13.2
Contusion/abrasion	4799	(3447 to 6151)	7.1	1920	(1161 to 2678)	6.3
Fracture/dislocation	6122	(4180 to 8064)	9.0	1008	(597 to 1419)	3.3
Other	2826	(1661 to 3992)	4.2	1071	(705 to 1437)	3.5
Lower trunk	12 921	(9685 to 16 157)	19.0	1832	(1246 to 2418)	6.1
Contusion/abrasion	5475	(4089 to 6861)	8.0	1196	(732 to 1660)	4.0
Strain/sprain	3653	(2469 to 4837)	5.4	275‡	(100 to 449)	0.9
Other	3793	(2464 to 5123)	5.6	361‡	(135 to 588)	1.2
Upper extremities	13 127	(10 028 to 16 227)	19.3	7723	(5867 to 9579)	25.5
Contusion/abrasion	2649	(1849 to 3450)	3.9	2596	(1893 to 3299)	8.6
Fracture/dislocation	7477	(5547 to 9408)	11.0	2160	(1319 to 3001)	7.1
Laceration	577	(282 to 873)	0.8	1043	(677 to 1409)	3.4
Other	2423	(1655 to 3192)	3.6	1924	(1303 to 2545)	6.4
Lower extremities	10 704	(8148 to 13 260)	15.7	10 517	(7716 to 13 318)	34.7
Contusion/abrasion	2823	(1928 to 3718)	4.1	5525	(3868 to 7182)	18.2
Fracture/dislocation	3523	(2414 to 4632)	5.2	2263	(1422 to 3104)	7.5
Strain/sprain	3426	(2453 to 4399)	5.0	1082	(637 to 1528)	3.6
Other	933	(539 to 1327)	1.4	1647	(954 to 2340)	5.4
Other/unknown body part	737	(349 to 1125)	1.1	112‡	(–49 to 272)	0.4

*Numbers may not add up to totals because of rounding.

†Estimate may be unstable because the coefficient of variation is more than 30%.

CI, confidence interval.

related injuries were treated in American hospital emergency departments.¹⁷ NEISS estimates for 2000 and 2001 (that is, 79 094 and 79 746, respectively) were reported in a newsletter for the American Medical Equestrian Association.²² Estimates in previous reports were based only on NEISS cases with a product code indicating "horseback riding—activity, apparel, or equipment," whereas our estimates also used the narratives to identify other cases with horse related injuries. Our more comprehensive definition resulted in a 10-fold increase, from 2907 to 30 288, in the annual estimated number of cases identified as injured when not mounted.

The results observed in this study are generally consistent with previous studies. First, the greater number of females with horse related injuries in this study (59%) is consistent with the percentage of females seen in previous studies (52% to 85%).^{8–11 16 23} Second, the age patterns of those injured in this study are also consistent with previous studies, with most showing a peak for those aged 10 to 14 or 10 to 19 years,^{9 13 23} and some showing a second peak for those aged 30 to 40.^{13 23} Third, as in this study, most previous studies have found that falling/being thrown from the horse and being kicked are the two most common incidents leading to injuries.^{9–12 16 24 25} Finally, the figure of 11% of patients admitted to hospital or transferred in this study corresponds to hospital admission rates in other studies (7% to 30%).^{9 10 13 14 23 26–28}

Horse related injuries share some similarities and dissimilarities with other sports and recreation (SR) injuries. Both horse related and SR injuries peak among adolescents aged 10 to 14 years⁴; however, SR injuries generally do not peak a second time in the 35 to 49 year age group. Although the SR injury rate for males is twice that for females, the horse related injury rate is 1.4 times higher for females than for males. Horse related injuries are also more severe, as evidenced by 11.2% being admitted to hospital or transferred, as opposed to 2.3% for SR injuries.

Comparisons between horse related injuries and all-terrain vehicle (ATV) injuries are relevant. Both involve potentially high speeds, an "off road" environment, and riders external to both "vehicles." Each year, about 127 000 ATV related injuries are treated in American hospital emergency departments, similar to the number of horse related injuries, and a comparable percentage is admitted to hospital or transferred (12.2% for ATV injuries *v* 11.2% for horse related injuries). The composition of serious injuries as determined by principal diagnoses is also similar, with 26.0% of ATV related patients sustaining fractures and 7.8% diagnosed as having traumatic brain injuries, compared with 25.2% and 9.7%, respectively, for patients with horse related injuries (unpublished NEISS-AIP data). Given the similarity of horse related and ATV injuries, surprisingly safety regulation/legislation only involves ATV riders (helmet use, minimum age requirements, and safety education)²⁹; no such regulations exist for horseback riders.

Limitations

This study had several limitations. First, because data are lacking on the number of participants in horse related activities, injury rates were calculated based on US population estimates and could not account for different exposures to horses by age and sex. Second, because the narratives varied in detail, data were not systematically available on factors potentially associated with the injury incident, such as protective equipment use (helmets, vests); alcohol use; skill level of the rider; information about the horse's nature or behaviour; and environmental conditions. Third, NEISS-AIP data only capture injuries treated in hospital emergency departments, not injuries treated elsewhere or not at all. Fourth, NEISS-AIP data only allow one body part diagnosis

to be recorded; when possible, however, other severe injuries mentioned in the narratives were coded. Finally, data are not presented by race because of the high percentage (26%) of cases with no race specified.

Implications for prevention

The frequency and severity of horse related injuries indicate that prevention programmes are needed. Measures can be taken to prevent horse related injuries, either by reducing the likelihood of incidents that may result in injuries (primary prevention: securing saddle, education) or by reducing the likelihood of injuries once an incident has occurred (secondary prevention: helmet use).

Probably the most important measure individuals can take to reduce serious injuries is to wear a helmet meeting the standards of the American Society for Testing and Materials (ASTM)/Safety Equipment Institute (SEI), such as ASTM standard F1163, or a similarly certified helmet. Currently, the American Academy of Pediatrics, the American Medical Association, the US Pony Club, and other organised groups recommend the use of ASTM/SEI helmets.^{5 6 30} The mechanisms for head injury are similar to those for activities in which helmets have proven effective (riding a bicycle, motorcycle, or ATV), and many horse related studies have shown either a reduction in injuries following increased helmet use or less severe injuries among people wearing helmets.^{5 7 15 31} Helmets should fit well and be properly secured.⁵ Because of the risk of being kicked while not mounted, some experts have recommended wearing helmets even when not mounted for young children and for certain activities (Malavase D, personal communication); in this study, 16% of the patients with a principal diagnosis of traumatic brain injury sustained the injury while not mounted.

Unfortunately, there are no current estimates of equestrian helmet use in the USA. The latest survey conducted in 1991 estimated that 43% of riders wore helmets at least some of the time.³¹ Identified barriers to helmet use (for example, low risk perception, lack of comfort and style) apply to both equestrian and bicycle helmets^{31 32}; promotion strategies identified for bicycle helmets may also be successful in promoting helmets for horse related activities.^{33 34}

Previous recommendations emphasise wearing appropriate riding attire. Sturdy boots with a heel should be worn to prevent the feet from slipping through the stirrup.^{3 5 6 24 27 35–38} Gloves of non-skid material may also be worn.^{5 35 39} Loose fitting clothes should be avoided and hair should be tied back to avoid entanglement with branches and other obstacles.^{3 6 27 36}

Other safety equipment has been suggested, although the protective effects have not been proven. Safety stirrups that release when a certain amount of pressure is applied may prevent a rider from being dragged. Though recommended by some experts,^{9 37} others question whether they are effective.^{5 35 36} In this study, more than 350 people were injured each year when a foot was caught in a stirrup. Additionally, body protector vests may protect the spinous processes and ribs from kicks and falls.³⁶ While mandatory for certain events in Britain,²⁵ the effectiveness of such vests has not been evaluated.⁵ An ASTM standard for these vests has been established (ASTM F1937).

Individuals should be in the proper physical and mental condition to ride or work around horses.³⁵ Riding requires balance, agility, mental acuity, and a reasonable level of physical fitness.^{5 40} Alcohol should not be consumed when riding or working with horses.⁴⁰ Previous studies have found that of those tested, 17% of horse related hospital admissions¹² and 33% of deaths³⁹ involved a detectable blood alcohol level. In this study, less than 1% of unweighted cases (34)

were reported to involve alcohol use. However, alcohol use was probably underreported because the information was not routinely collected in NEISS-AIP.

Education by trained instructors may help prevent horse related injuries.^{5 6 17 24 27 30 40} Horses are a prey species whose actions can be better understood and predicted when the animal's instincts are considered. For example, horses can be spooked when exposed to new experiences or perceived threats (for example, a person walking into a horse's blind spot).³⁸ Additionally, experts recommend instruction in proper falling techniques.^{5 24 27 36 40}

Aside from protective equipment, appropriate clothing, and training, other safety measures should be considered when preparing to ride. One should ensure that the horse is in good health and appropriately matched to the rider's abilities.^{3 5 30 37 40} Additionally, inspect all tack to ensure that it is correctly applied.^{3 5 6 27 40} In this study, an estimated 550 people were injured each year when the saddle slipped or broke. Riders and others working with horses should avoid wrapping the reins, lead, or rope around their hands.^{37 38} An estimated 2000 people in this study were injured annually when their hands or fingers were caught in the horse's tack.

Riding organisations and stables can influence proper horse riding and handling by instituting regulations or guidelines regarding helmet use, appropriate attire, rider education, and supervision to create an atmosphere where safe practices are routine. Previous researchers suggest that children and inexperienced riders should be adequately supervised,^{5 37} and children under six should not be allowed to ride independently.⁶ In addition, riding environments can be modified to reduce the risk of injury (for example, energy absorbing riding surfaces⁵). Finally, previous researchers recommend having medical care available at organised events,^{5 41 42} along with having an emergency plan for daily operations including first aid training for personnel and the availability of emergency supplies.⁴³

Riders, equestrian organisations, and health care providers have opportunities to prevent horse related injuries by counselling those involved in these activities. Stressing injury prevention to persons who have experienced an injury may be beneficial because reinjury rates are reportedly high, with 25% to 37% of injured persons having had a previous injury.^{9 10 23 28} Because of the frequency of concussions during horse related activities and the concern regarding repeated concussions, the use of return-to-play guidelines similar to those used in contact sports is relevant.^{24 44}

What is already known on this topic

- Previous studies suggest that horse-related injuries can be severe and are more frequent in females, particularly those ages 10-14 years

What this study adds

- Over 100 000 people with horse related injuries are treated in American emergency departments annually. Using a national sample, this study characterises these injuries overall, and when mounted or not mounted
- Horse related injuries can be severe as evidenced by higher percentages of hospital admissions, fractures, and traumatic brain injuries when compared with other recreation related injuries

Conclusions

This study shows that horse related injuries are a serious issue, particularly for young females. The hospital admission rate and the percentage of people with potentially severe diagnoses underscores the need for prevention efforts. Prevention programmes should target helmet use as well as education and training about horse behaviour, and safe horse handling and riding. Additional research is needed to evaluate the effectiveness of specific interventions to reduce the number and severity of horse related injuries.

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Authors' affiliations

K E Thomas, J L Annett, Office of Statistics and Programming, National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, Atlanta, Georgia, USA

J Gilchrist, Division of Unintentional Injury Prevention, National Center for Injury Prevention and Control

D M Bixby-Hammett, American Medical Equestrian Association/Safe Riders Foundation, Albuquerque, New Mexico, USA

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