

# Fatal and non-fatal farm injuries to children and adolescents in the United States, 1990-3

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## Abstract

**Objective**—Examine the current magnitude of the injury problem to children and adolescents on farms, and to compare these data to that from 1978-83.

**Data sources**—US National Center for Health Statistics Mortality Multiple Cause of Death Tapes for the years 1991-3, and the US Consumer Product Safety Commission National Electronic Injury Surveillance System for data on emergency department visits for 1990-3.

**Subjects**—Children and adolescents 19 years and younger injured on farms.

**Results**—There were an average of 104 deaths per year due to injuries occurring on farms. The rate of 8.0 deaths per 100 000 child farm residents is 39% lower than in 1979-81. More of the deaths occurred in hospital than previously. There were an average of 22 288 emergency department treated injuries per year. The rate of 1717 injuries per 100 000 child farm residents is 10.7% higher than 1979-83. Males were injured more frequently than females. Tractors accounted for 20.9% of all injuries, followed by horses (8.4%), all terrain vehicles and minibikes (8.0%), and farm wagons (7.7%).

**Conclusions**—Farm injuries continue to be a major problem to children living on farms. While improved medical care may have contributed to the reduction in mortality, the continued high rate of injuries warrants study of a variety of intervention strategies to reduce the injury toll. There is also a need for ongoing injury surveillance to provide accurate data on the farm injury problem.

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Agriculture is one of the most dangerous occupations in the United States,<sup>1</sup> and unlike other industries, children and adolescents make up a substantial portion of the agricultural workforce. In addition, by virtue of the fact that children and adolescents live on farms, they are constantly exposed to the hazards of farm equipment, regardless of whether or not they are working. This is qualitatively different from other industries in which children have little, if any, exposure to occupational hazards.

In recent years, there has been greater attention to the problem of agriculture related injuries and illnesses to children living and

working on farms. A National Committee for Childhood Agricultural Injury Prevention (NCCAIP) was formed and issued 13 recommendations to prevent farm injuries to children in the form of a national action plan.<sup>2</sup> The Maternal and Child Health Bureau has established a Rural Injury Prevention Resource Center with a major focus on farm injuries. Grassroots groups, such as Farm Safety 4 Just Kids, have been formed to increase public awareness of the magnitude of the problem, conduct public education, and lobby for legislation and regulation.<sup>3</sup>

In spite of this, there have been relatively few studies of the incidence of farm injuries nationally. This study was undertaken to examine the current magnitude of the injury problem to children and adolescents on farms, and to compare these data with those analyzed previously.<sup>4</sup>

## Methods

### DATA SOURCES

The data sources used for the analyses were as follows:

(1) National Center for Health Statistics (NCHS) Mortality Multiple Cause of Death Tapes. The most recent tapes available were for the years 1991, 1992, and 1993. These tapes are based on information received by the NCHS from all states and the District of Columbia. The cause of death was listed by the *International Classification of Diseases*, adapted-revision 9 (ICDA-9) codes. The data include all fatalities to children and adolescents 19 years of age or younger with external cause of death codes of E850 to E929 that occurred on a farm, including farm homes. These only included non-transport fatalities, because transport fatalities cannot be separated as to place of injury. This same data source was used previously to calculate fatality rates for 1979-81.<sup>4</sup>

(2) National Electronic Injury Surveillance System (NEISS) of the Consumer Product Safety Commission (CPSC). NEISS is a surveillance system of consumer product related injuries treated in hospital emergency departments located in the United States. The surveillance system is a statistically representative sample of emergency rooms, and thus allows estimates of non-motor vehicle related injuries involving consumer products. Tapes on injuries involving farm products to individuals 19 years of age or less during the years 1990-3 were analyzed. Data were not analyzed for the period after 1993 because of changes in data collection methods and scope of the NEISS sample. This same data source was used previously to estimate non-fatal injury rates for 1979-83.<sup>4</sup> The NEISS data

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indicate morbidity due to farm related products occurring to these individuals, irrespective of location, with the exception of animal and all terrain vehicle (ATV) injuries, which were analyzed for farm locations only. This was done to make the study comparable with the 1985 report.

The denominators for the rate calculations were the number of children and adolescents 19 years of age and younger reported to be living on farms in the 1991 census.<sup>5</sup>

**Results**

**NCHS DEATH CERTIFICATE DATA**

An estimated 1 298 000 children and adolescents 19 years of age or younger were living on farms in 1991. There were an average of 104 deaths per year due to injuries occurring on farms to individuals in this age group, a rate of 8.0 deaths per 100 000 population per year (table 1). Males had 5.6-fold higher rates of death than females, although this varied by a ratio of 3.7 in children under the age of 5 to 9.9 in adolescents 15–19 years old.

This represents a 39% reduction in the rate of fatal injuries to children and adolescents on the farm compared with the rate of 13.2 per 100 000 in 1979–81. The rate declined in males and females equally; rates declined least for children under the age of 5 (29%) and most for children 10–14 years (47%).

Nearly one half of children died in the hospital and an additional 13.8% were pronounced dead on arrival (table 1). Out-of-hospital deaths accounted for 38.6% of fatalities, although this varied from 16.7% of young children to 55.4% of teens 15–19 years. The place of death was unknown in only 1.6%.

These statistics are substantially different from a decade earlier in which only 15% of children and adolescents died in the hospital and one half died out of hospital. It indicates that, in all likelihood, emergency medical services in rural areas have improved substantially.

Deaths were most common in the Midwest (41.8%) and the South (35.3%) and least common in the Northeast (7.7%) and the West (15.1%).

*Table 1 Fatal farm injuries to children and adolescents in the United States, 1991–3, NCHS data, 0–19 years, average annual deaths*

	Age (years)				
	<5	5–9	10–14	15–19	Total
Annual No of deaths					
Male	21.0	17.7	20.0	31.0	89.7
Female	5.0	3.3	3.0	2.7	14.0
Total	26.0	21.0	23.0	33.7	103.7
Annual rate per 100 000 farm resident children					
Male	11.9	10.5	11.9	17.2	13.0
Female	3.2	2.2	2.0	1.8	2.3
Total	7.8	6.6	7.3	10.2	8.0
Place of death (%)					
Inpatient	30.8	20.6	7.2	14.9	18.3
Outpatient/ED	37.2	27.0	29.0	19.8	27.7
DOA	15.4	17.5	17.4	7.9	13.8
Out of hospital	16.7	30.2	46.4	55.4	38.6
Unknown	0	4.8	0	2.0	1.6

DOA=dead on arrival; ED=emergency department.

The external cause of death, as documented in the E codes, is shown in table 2. Farm machinery was involved in one third of the deaths, with the highest proportion among children 5–9 years. Drowning accounted for one fourth of the deaths overall, and one third of those to the youngest children. One in seven died from firearms or explosives; among teens, firearms and explosives accounted for fully one quarter of all deaths. The remainder of deaths were caused by a wide variety of mechanisms.

The most common injury resulting in death was to the head or brain, accounting for nearly two thirds of the total (table 3). Other common causes of fatal injury were to the chest or abdomen. Neck injuries were uncommon. Only 2% died from burns.

**NEISS EMERGENCY DEPARTMENT DATA**

The data from NEISS for the most part represent non-fatal, morbidity data. There were an estimated 89 153 injuries treated in an emergency department for the years 1990–3 which involved farm related products or animals on farms as defined above. The mean number of emergency department treated injuries was 22 288 per year, which is 5% lower than the estimated annual number reported for the period 1979–83. However, because of a smaller child and adolescent farm population in the latter period, the rate of farm injuries was actually 10.7% higher, 1717 per 100 000 compared with 1551 per 100 000 during the earlier time period.

As expected, rates of injuries varied with age and gender as shown in table 4. Males had 2.4-

*Table 2 Fatal farm injuries to children and adolescents in the United States, 1991–3, NCHS data, 0–19 years, cause of death by age (%)*

Cause	Age (years)				Total
	<5	5–9	10–14	15–19	
Machinery	35.9	46.0	34.8	24.8	34.1
Drowning	32.1	23.8	11.6	26.7	24.1
Suffocation	1.3	0	7.3	1.0	2.3
Falls	6.4	3.2	5.8	3.0	4.5
Firearms/explosives	3.9	4.8	21.7	25.7	14.8
Electrical	1.3	1.6	4.3	1.0	1.9
Other	19.2	17.5	14.5	17.8	18.0

*Table 3 Fatal farm injuries to children and adolescents in the United States, 1991–3, NCHS data, 0–19 years, parts of body injured*

Body part	%
Head	40.2
Brain	24.1
Neck	1.9
Face	7.4
Trunk	26.0
Upper extremity	1.6
Lower extremity	4.2

*Table 4 National estimates of annual farm injuries in the United States, 1990–3, 0–19 years, rates per 100 000 resident farm children*

Age (years)	Male	Female	Total
<5	1214	660	953
5–9	1884	1107	1518
10–14	2923	1239	2135
15–19	3399	944	2279
All ages	2360	983	1717

fold greater rates than females, with the greatest difference in the adolescent years, when males had 3.6-fold higher rates. Children 10 and older had substantially higher rates than did the younger age groups.

Lacerations and punctures were the most common injuries, followed by contusions, abrasions, and hematomas (table 5). One in five injuries was a fracture of a dislocation with children 10–14 years having a rate nearly twice that of any other age group.

Approximately one third of the injuries were to the upper extremities and another 30.8% were to the lower extremities (table 6). Young children were more likely to have injuries to the head or face, while older adolescents had injuries primarily to the extremities.

The majority of individuals (89.8%) were treated in the emergency department and released. Approximately 4% were transferred to another facility, and 5.6% were admitted. Children under the age of 5 and those 10–14 years were more likely to be admitted than were children in other age groups (7.7% and 7.5%, respectively). Overall, 0.3% of children died in the emergency department.

There was a wide variety of products involved in farm injuries (table 7). Tractors accounted for one in five injuries overall, but one in three injuries to children under the age of 5. Farm wagons, tillage equipment, and

other farm machinery were also frequent causes of injuries. Horseback riding on farms accounted for 8.4% of injuries and riding motorized vehicles such as ATVs, minibikes, and trail bikes accounted for another 8%. There was a wide variety of products in the other category; none of these products singly accounted for more than 2% of injuries.

NEISS classifies injury severity based on type of injury, body part involved and requirement for admission. Two thirds of the injuries were of low severity. However, younger children were less likely to have injuries in the lowest severity category (51.4%) than any other age group, especially when compared with those 10–19 years (72.2%). The proportion of children with severe injuries was highest for tillage equipment (13.9%), and silo loaders (13.8%), followed by combines and hay processing equipment (12.2%), and forklifts (11.1%).

## Discussion

Rates of death from farm injuries appear to have declined substantially over the last decade. The rate in 1990–3 was 39% lower than the rate in 1979–81. Fatal farm injuries found in smaller population based studies range from 2.3 to 30.9 per 100 000 residents.<sup>6</sup> There are probably multiple reasons for this decline, including better emergency medical service care, better trauma care, and increased prevention. The fact that now nearly one half of children who die from farm injuries die in the hospital compared with only 15% a decade ago indicates that emergency medical services have substantially improved. More injury victims are being transported to hospitals faster, allowing them to be resuscitated from their injuries during the first 'golden' hour, with a resulting improvement in outcome. Regionalized trauma care may have also contributed to the decline in mortality. Other studies have shown a substantial effect of regionalized systems in both urban and rural areas.<sup>7,8</sup>

Prevention efforts may have also contributed to this decline. One third of the fatal injuries were due to machinery; other studies indicate that the most common cause of farm machine related deaths are due to tractors.<sup>9</sup> Rollover protective structures are effective in preventing these deaths,<sup>10</sup> and there have been major efforts in recent years to promote their use.

The decline in deaths of children from farm related injuries is also consistent with the decline in unintentional injuries from other causes. During the 14 year period 1978–91, unintentional injuries to children and adolescents in the United States declined by 30%.<sup>11</sup> This decline is, as with farm injuries, likely to be due to a combination of better emergency medical service and trauma care, as well as the effects of prevention programs such as car seats and smoke detectors. The decline in drowning deaths of children and adolescents that have occurred, both on the farm and elsewhere, is due at least in part to better emergency medical service care. In addition, some of the decline in fatal injuries may be due to decreases in

Table 5 National estimates of annual farm injuries by type of injury in the United States, 1990–3, 0–19 years, rates per 100 000 resident farm children (%)

Type	Age (years)				
	<5	5–9	10–14	15–19	Total
Lacerations/punctures	378 (40.4)	574 (36.9)	801 (37.6)	829 (36.4)	644 (37.6)
Dislocations/fractures	118 (12.6)	282 (18.6)	449 (21.1)	291 (12.8)	283 (19.5)
Contusions/abrasions/hematomas	182 (19.4)	351 (23.2)	474 (22.2)	589 (25.9)	398 (23.3)
Crush	17 (1.8)	27 (1.8)	24 (1.1)	33 (1.5)	25 (1.5)
Strains/sprains	3 (0.3)	65 (4.3)	161 (7.6)	227 (10.0)	114 (6.7)
Avulsions/amputations	11 (1.2)	45 (3.0)	27 (1.2)	76 (5.0)	49 (2.9)
Burns	51 (5.5)	45 (3.0)	43 (1.4)	59 (2.6)	39 (3.0)
Concussions	8 (0.9)	8 (0.5)	37 (1.8)	9 (0.4)	15 (0.9)
Other	185 (19.4)	121 (8.0)	119 (5.6)	166 (7.3)	150 (8.7)

Table 6 National estimates of annual farm injuries by body part and age group in the United States, 1990–3 (%)

Body part	Age (years)				
	<5	5–9	10–14	15–19	Total
Head	17.4	12.0	5.2	5.9	8.7
Neck	0	1.8	0.9	1.9	1.3
Face	29.4	15.7	15.0	5.9	8.7
Trunk	5.7	7.8	7.9	5.6	6.8
Upper extremity	28.7	28.8	29.1	36.3	31.4
Lower extremity	9.3	28.2	39.4	33.9	30.8
Other	9.5	5.7	2.5	3.5	4.5

Table 7 Proportion of farm injuries by product in each age group in the United States, 1990–3 (%)

Product	Age (years)				
	<5	5–9	10–14	15–19	Total
Tractor	33.4	20.8	15.9	20.2	20.9
Tillage equipment	9.1	5.9	3.2	7.7	6.2
Combines/threshers/hay processors	2.6	6.6	2.5	6.3	4.7
Elevators/conveyers	2.3	0.6	0.9	1.6	1.3
Farm wagons	5.4	10.9	8.8	5.7	7.7
Forklifts	3.3	2.9	2.4	1.3	2.3
Fertilizers	9.6	2.7	0.5	0.4	2.2
Silo loaders	1.3	2.6	1.8	1.4	1.7
Horseback riding	3.2	9.4	10.7	7.9	8.4
ATV/trail bikes/minibikes	0.9	5.9	12.0	8.8	8.0
Other	28.9	31.8	41.3	38.8	36.6
Total	100.0	100.0	100.0	100.0	100.0

exposure to risk. In contrast, the proportion of deaths due to guns is higher in this time period than that reported previously and, in all probability, reflects continued exposure to guns around the home and farm.

In contrast, there has been a 10% increase in the incidence of non-fatal farm injuries as reported in NEISS. The rate of child and adolescent farm injuries found using the NEISS data is similar to that of other recent studies. Stueland *et al* conducted a population based surveillance of farm injuries occurring to children and adolescents under 18 years of age in Wisconsin.<sup>12</sup> Their rate of farm injuries was 1827 per 100 000, very similar to our rate of 1717 per 100 000. Pickett *et al* found a rate of self reported injuries to children on farms in Ontario of 2000 per 100 000 per year,<sup>13</sup> again close to our rate using NEISS data, but higher because the Ontario data include all injuries on farms, not just those related to farm products.

The occurrence of these injuries varies substantially with age. The high number of injuries in preschool aged children, combined with greater severity, is of concern. These children are injured as innocent bystanders because the place where they live is also the site of a dangerous workplace. Thus, their exposure to the risks of the workplace is high, without their direct participation in farm work. In addition, some of these injuries occur when the children are taken along with adults or older siblings on tractors, or while working around other machinery. This may reflect a lack of other child care options, but may also reflect the desire to 'treat' the child to a ride on a tractor or other farm equipment. Similar injury consequences are seen when children are taken on riding lawn mowers, making this the most common cause of amputation injuries to toddlers in a recent study.<sup>14</sup>

The high rate of injuries to the 10–14 year age group is likely work related. The exposure to farm work in this younger age group is lower than that for older adolescents. Thus, the rate of injuries in 10–14 year olds indicates greater risk due to inexperience working with farm equipment. It may also indicate physical immaturity, in terms of size and weight, to safely operate farm equipment.

Injuries to children and adolescents are more severe than those occurring in other areas of child labor. Heyer *et al* found that in Washington state, farm workers accounted for 7% of worker's compensation claims, but among workers age 13 and under accounted for 50% of all severe injury claims and 48% of all disabling injury claims.<sup>15</sup>

The problem of ATVs, trail bikes, and minibikes is well known.<sup>16</sup> These motorized vehicles are used around the farm for both work and recreation. The speeds attained and the lack of safeguards make them dangerous. The American Academy of Pediatrics has strongly endorsed their removal from the market. In 1988, the ATV industry arrived at an agreement with the CPSC that stopped the sale of new three wheeled ATVs, implemented a nationwide riders' training program, and developed voluntary standards to make ATVs

safer. There appeared to be a 7% reduction in ATV related injuries and a 9% reduction in fatalities over the 1988–90 time period associated with these regulations.<sup>17</sup> Nevertheless, some injuries continue to occur.

Injuries on farms occur to children in other parts of the world, and the patterns in industrialized countries are similar to those in the United States. Tractors were responsible for one fourth of farm related deaths to children in the UK.<sup>18</sup> Tractors and farm machines caused the majority of severe and fatal injuries in a case series from France.<sup>19</sup> Reports from Manitoba<sup>20</sup> and New South Wales<sup>21</sup> indicate that animals are a common source of injuries, particularly among young girls. In less industrialized countries such as India, a larger portion of farm injuries to children involve hand tools.<sup>22</sup> As in the United States, ongoing surveillance systems to provide accurate population based data on child farm injuries are rare.

### Limitations

There are a number of limitations that must be addressed. The denominator for these calculations includes only children and adolescents living on farms. It is estimated that there are more than one half million migrant workers under age 21 or children of migrant workers traveling with their parents.<sup>23</sup> Unfortunately, there are no accurate data on the total number of children and adolescents who either live or work on farms. Thus, exclusion of these individuals potentially overestimates the rate of injuries. At least one report found that 95% of the injuries occurred to children from the immediate farm family.<sup>24</sup> Other studies estimate that one third to one half of injuries on the farm are not to residents.<sup>25</sup>

I have not attempted to determine which injuries occurred during farm work, and those that occurred while simply being exposed to the hazards on farms. Thus, the rates should not be construed to indicate child labor related trauma. On the other hand some injuries, such as motor vehicle crashes due to farm work, were excluded because of the impossibility of separating out vehicular crashes on farm roads and those on other roads. This is an important limitation since motor vehicle crashes are an important source of occupational injuries and, for migrant farm workers, may be the leading cause.

The NEISS data are based on a representative sample of hospital emergency departments in the United States. However, the sample does not necessarily reflect hospitals located in rural areas. This may be particularly true for pediatric injuries, in that the NEISS hospitals specializing in pediatric care are primarily located in urban areas.

The fatality data, while complete, may not accurately record the place of occurrence of death. Other deaths to farm children may have also been missed if the place of occurrence was listed differently. The data include only fatal injuries or those treated in the emergency department. There are few American data on

injuries treated in physicians' offices. Pickett *et al* estimated that approximately 68% of farm injuries receive medical care and only 28% receive care in the emergency department.<sup>13</sup> Thus, the data presented here represent only a portion of the actual farm injury problem.

### Implications for prevention

Prevention of farm injuries to children and adolescents is possible with a multifaceted approach such as that put forward by the NCCAIP. This proposed national action plan calls for: the establishment of a national surveillance system to detect and track injury rates; to establish a national database on agricultural injuries; guidelines for children's and adolescents' work in agriculture; uniform standards to protect young workers from agricultural hazards, with appropriate enforcement of regulations; the development and evaluation of intervention programs to educate parents, owners, operators, and youth themselves on safe farm practices; and adequate support from the public and private sector. As with other injury problems, farm related injuries to children and adolescents should be viewed as preventable and not accepted as the cost of a hazardous environment.

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### Soft landing

A boy aged 3 who toppled from a first floor window at his home in Leicester fell safely on to the family dog, which was dozing on the patio. Michael suffered only scratches and a bumped head while Duke, a mongrel, walked away unhurt (*The Times*, 25 June 1997).

*Editor's note:* at least the television news coverage of this story noted that the parents thought that they should now fit locks on the window. For non-British readers, I should point out that the first floor is the one above the ground floor, so the fall would have been from about 3 metres.