

**Fatal and Non-fatal Falls in United States Agriculture Production to
Youth Less than 20 Years Old**

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Abstract

Falls are one of the many dangers present in agriculture production. However, few studies have looked specifically at this hazard for youth populations who may have unique exposures and susceptibilities. Fatal agricultural work injuries to youth resulting from falls were examined using data from the U.S. Bureau of Labor Statistics, Census of Fatal Occupational Injuries (CFOI). CFOI collects data on occupational injury deaths throughout the United States. Non-fatal falls, both work- and non-work-related, were examined using data from the Childhood Agricultural Injury Survey (CAIS). The CAIS, conducted by the U.S. Department of Agriculture for NIOSH, collected information on all non-fatal injuries to youth on farms for the calendar year of 1998. For the purposes of this research, the term fall includes injuries resulting from falls from heights, falls on the same level, or a fall from a vehicle or machine.

From 1992-1999, CFOI identified 36 fatalities resulting from falls occurring to youth less than 20 years of age, the majority among males. Over three-quarters (81%) of the fatalities resulted from the youth falling from a vehicle or machine. In 64% of these cases the youth fell from and was struck by the vehicle or its trailing implement. CAIS identified an estimated 10,733 fall-related injuries to youth less than 20 years of age. The mean age was 9, with over three-quarters of the injuries occurring to males. Approximately 37% of the injuries were incurred while the youth was performing work or chores on the farm. Eighty-five percent of fall-related injuries occurred to youth living on the farm. Twenty-six percent of the injuries resulted from falling from a vehicle or machine.

This paper will utilize national data to examine falls resulting in death or injury to youth on farms. Data on the circumstances of these injuries, demographics, and injury rates will be presented. This examination will also provide a discussion of intervention strategies which may reduce the number of youth fall-related deaths and injuries on farms.

Introduction

Falls are the leading cause of all nonfatal injury, accounting for one out of five injuries and one-third of all hospitalized injuries (Rice et al. 1989). For fatal fall injuries, only highway injury causes more fatalities from unintentional injury throughout the world (Waller 1985). Even though tractors and other farming machinery have received the most attention in agricultural safety research, falls are an important contributor to both nonfatal and fatal injuries on farms.

For nonfatal injuries, falls have been identified as the most commonly cited mechanism of farm-related injury (Nordstrom et al. 1995). It has been estimated that one out of every five farmwork injuries occurred as the result of a fall (NSC 1982, Myers 2001). Between 14 and 32% of general farm injuries are associated with falls, with 11-19% of these being machinery-related and 21-36% associated with animal-related injuries (Nordstrom et al. 1995).

Additionally, Nordstrom et al. (1995) found an average annual incidence rate of farm-

related fall injuries for the six-year period of 1986-1991 in a Central Wisconsin study to be 7.0 per 1,000 farm residents. This study also discovered that fall-related injuries were more than twice as common in males. The most common diagnoses for the fall-related injuries were strains and sprains, contusions, and fractures. The lower and upper extremities were the most commonly injured body part. The most common site for a fall was the barn and hay loft, with most of the injuries occurring during the summer months (Nordstrom et al. 1995).

Youth appear to be at considerable risk for fall-related injuries. Children less than 16 years of age incurred 30% of fall-related injuries in the Central Wisconsin study (Nordstrom et al. 1995). Further, a two year study of agricultural trauma found that falls are responsible for nearly half of the injuries to children under the age of six (Stueland et al. 1991).

With respect to fatal injuries, the agriculture, forestry and fishing industry has one of the highest rates of fall-related fatalities by industry division (.99 deaths/100,000 workers), only construction (3.89/100,000 workers) and mining (1.69/100,000 workers) have a higher rate (NIOSH 2000). A study of work-related fatalities in the agricultural production and services sectors identified 359 fall-related deaths for the 10-year period of 1980-89 for workers of all ages (Myers and Hard 1995). For the years 1982 to 1996, a study of youth less than 20 identified 69 fall-related deaths, 80% of which occurred to males (Adekoya and Pratt 2001).

Because the farm location exists as both a residence and a place of work, it is often difficult to distinguish the work-relatedness of injuries. However, an examination of on-farm fatalities to youth aged 16 to 19 found an estimated 43% of fatal falls to these youth appeared to be work-related (Myers and Adekoya 2001).

Although there has been substantial research on occupational falls, it generally has been focused towards roofers or other construction activities. There has been very little literature on falls in agriculture, and what does exist is generally state-specific or focused on one geographic area of the country. A goal of this research is to illustrate at the national level the magnitude of the fall-related injury problem for youth less than 20 years of age associated with occupational and non-occupational farm exposures.

Methods

Data on nonfatal injuries were obtained from the 1998 Childhood Agricultural Injury Survey (CAIS) which was conducted for NIOSH by the United States Department of Agriculture (Myers and Hendricks 2001). CAIS, stratified based on the 4 major Bureau of Census defined geographic regions, was a telephone survey of 26,000 farm households across the United States. Data were collected for on-farm injuries occurring during 1998 to youth less than 20 years of age.

For the CAIS, an injury was defined as any event occurring on the farm operation that required at least four hours of restricted activity or required the individual to seek professional medical attention. Information was collected for both work and non-work injuries occurring to youth who were either living on, visiting, or directly hired to work on the farm. A work-related injury was defined as any injury that occurred while

performing activities that had a direct impact on the farming operation as a business, regardless of whether the activity was performed for pay. Demographic information was also collected for members of the farm household and for any youth hired to work on the farm. As a note, no information was collected for contract workers.

For all reported injuries, common injury information, such as nature of injury, body part, and a narrative description of the injury were collected. Source and event were coded per the Occupational Injury and Illness Classification scheme (OIICS) (BLS 1992). Injury incidence rates were calculated as the estimated number of injuries, divided by the estimated number of youth obtained from CAIS. The rates are in terms of 100 youth potentially exposed. Since demographic data were available only for household youth and hired workers, estimates of injury rates were calculated excluding any injuries occurring to visitors on the farm. Estimates for both the injury and demographic data were obtained using the unbiased estimators for a stratified simple random sample (Cochran 1977).

On-farm fall related injuries were subset from the data by selecting respondents who answered positively to the question asking if a fall was involved in the injury or if the injury event was coded as a fall from the narrative. This included falls to the same level, falls to a lower level, jumps to a lower level, and falls from machinery. Those respondents who reported that a fall was involved were asked to provide more detailed information, such as surface condition, for the reported fall-related injury. Cases were weighted based on the total number of farms responding by stratum and the number of farms reported in the 1997 Census of Agriculture for each region.

Data on fatal occupational injuries were obtained from the Census of Fatal Occupational Injuries (CFOI). CFOI was developed by the Bureau of Labor Statistics (BLS) for surveillance of occupational fatalities in the United States. The fatality data covers all industries and occupations, for all ages. To be included in the database, cases must meet the following criteria: 1) the decedent was employed at the time of the event, and 2) engaged in a legal work activity or present at the site of the incident as a requirement of his or her job (Toscano and Windau 1997). CFOI data are compiled using a multi-source methodology, and generally cases are only included in the database if two sources indicate a work relationship. Nature of injury, body part injured, source, and event were coded using OIICS. To better meet the research needs of NIOSH, BLS provides NIOSH with a more detailed research file than generally released. This file includes more detailed data, such as specific age. The New York City Department of Health did not release this more detailed data, therefore, data from New York City are excluded from this research file.

For this analysis, fatalities in the agricultural production sectors were selected by Standard Industrial Classification Codes (SIC codes 0100 to 0299) for youth less than 20 years of age for the years 1992-1999. Fall-related fatalities were selected based on an event code which indicated that the fatality was the result of a fall to the same level, a fall to a lower level, a jump to a lower level (OIICS event codes 1000-1900), or a fall from a vehicle or machine, which includes tractors, automobiles, agricultural machinery, and recreation vehicles, such as bicycles, motorcycles, and ATVs (OIICS event codes 4231 and 4232). Narrative data were used to code additional information on the circumstances

of the fatality.

Fatality rates were calculated using employment data for youth, 15-19, derived from the Current Population Survey (CPS) micro data files for the years 1992 through 1999. CPS is a monthly survey of US households selected from a probability sample representative of the civilian noninstitutionalized population (BLS 2001). From these data, fatality rates were calculated as the number of deaths divided by actual hours worked per week, which are presented per 100,000 full-time equivalents (FTE). The number of FTEs is calculated based on 2,000 hours of employment per year. Previous research has shown that for youth populations, injury rates based on actual hours worked provide a more accurate estimate of risk than rates based on the number of employed workers because of the part-time and sporadic nature of their work (Ruser 1998). Note that the CPS does not include the collection of employment data for persons 14 years of age and under, therefore, fatality rates were calculated only for youth age 15-19 years.

Results

Non-fatal

During 1998, the CAIS data estimated 32,808 (95% confidence interval 28,416 to 37,200) non-fatal injuries to youth that occurred on farms. Of these on-farm injuries, 10,733 (32.7%) were from falls. A fall injury rate of .53/100 youth on farms was calculated for household and hired youth. For those fall injuries where sex was reported, seventy-six percent (6,654) occurred to males, and 24% to females. Sex was not reported in approximately 18% of cases. An estimated 9,142 (85%) of the fall injuries occurred to youth who were living on the farm, and 603 injuries occurred to hired workers and visitors to the farm.

The majority (5,635) of the fall-related injuries were considered minor, with less than 1% of the injuries rated as life threatening by the respondents. A large proportion (88%) of the fall injuries required professional medical attention. Medical attention was most often sought in an emergency department (61%) or a doctor's office (34%). Hospitalization was required for an estimated 2,604 cases, with a median stay of 1 day (range 1 to 60).

The distribution of fall-related farm injuries by age group is shown in Table 1. Over one-half (5,610) of the injuries occurred to youth under 10, 3,257 injuries involved those age 10-14, and 1,646 to youth 15-19. The mean age for fall-related injuries was 9 years. Thirty-seven percent of the injuries occurred while the youth was performing work on the farm, with the remaining 6,711 injuries resulting from non-work activities.

Table 1 also shows that youth, both working and non-working, were most frequently injured by falls to a lower level (27%), and falls from a vehicle (26%), which included such things as tractors, ATVs, and motorcycles. Youth in the youngest age group (<5) most frequently experience falls to a lower level, followed by falls to the same level. As age increases, so does the proportion of youth injured by falls from vehicles. For those youth who sustained injuries requiring hospitalization, falls from vehicles resulted in an average of 9 days in the hospital compared to falls to the same or a lower level which averaged a 2-day hospital stay.

Table 1. Estimated non-fatal fall injuries¹ on farms to youth less than 20 by age group and injury event.

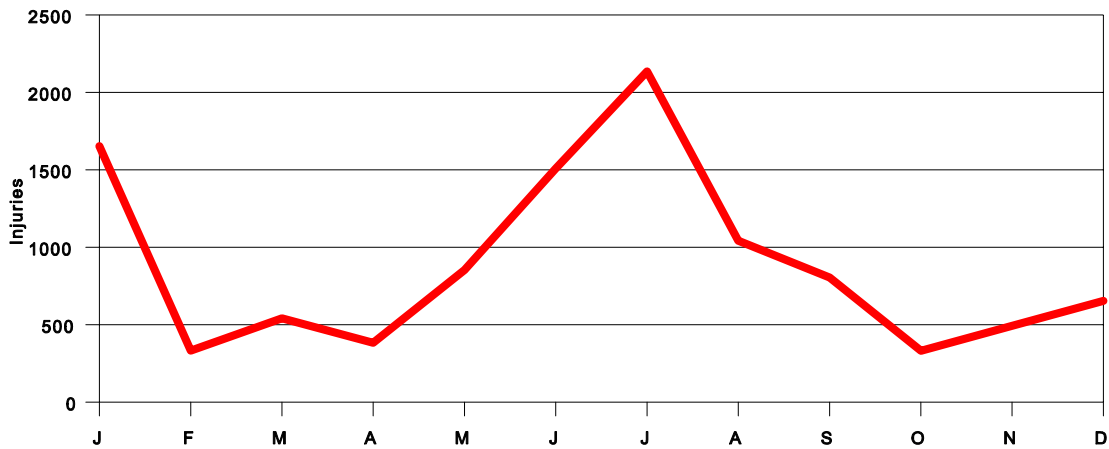
Injury Event	< 5	5-9	10-14	15-19	Unknown	Total
Fall to lower level	899	915	532	473	110	2929
Fall from vehicle	146	676	1741	256	0	2819
Fall to same level	509	457	457	150	0	1573
Fall, unspecified	239	150	40	398	0	827
Other fall	1250	369	487	369	110	2585
Total	3043	2567	3257	1646	220	10733

Source: ¹Childhood Agricultural Injury Survey, 1998.

Of those fall injuries incurred while performing work, over 80% of the youth were being supervised by another worker when the injury occurred. More than one-third (1,418) of the injured youth did not have experience in the task they were performing at the time of the injury, with 38% (1,514) of the youth having more than one year experience at the task they were performing. The majority of the injured youth (66%) worked less than 10 hours per week on the farm, with 13% reporting working more than 40 hours per week. Those youth injured while working most often fell from tractors (41%), ATVs (32%), motorcycles (18%), and trucks (9%).

Youth were most commonly injured in the field or pasture (51%), followed by barns/outbuildings (23%), and in the farm or house yard (23%). The types of on-farm fall related injuries that most frequently occurred were fractures (23%), scrapes and abrasions (21%), and lacerations (20%). The body parts most frequently injured were the head and skull (23%), the leg (18%), and arm (15%). For those falls that resulted in hospitalization, injuries to the head/skull necessitated an average stay of 5.9 days, followed by injuries to the leg and internal injuries with an average stay of 4 and 3.3 days, respectively.

There was a seasonal trend for the non-fatal fall-related injuries occurring on farms (Figure 1). Fifty-two percent of the injuries occurred between the months of May and August, with June and July accounting for over one-third (34%) of all injuries. There was also a second peak with 15% of the injuries occurring in January.



Source: Childhood Agricultural Injury Survey, 1998.

Figure 1. Estimated non-fatal fall-related injuries to youth less than 20 occurring on farms by month.

Fatalities

For the time period 1992 through 1999, CFOI identified 588 fatal work-related fall injuries that occurred in the agricultural production industry, with an age range from 5 to 90 years. The fall fatality rate for agricultural production workers age 15 and older was 3.3/100,000 workers. Ninety-six percent of the fatalities occurred to males. Seventy-two percent of fatalities occurred in crop production with the remaining deaths occurring in livestock production. The majority of fall-related fatalities (64%) resulted from a fall from a tractor or other moving vehicle.

Of these 588 fatalities, 36 (6%) occurred to a youth under the age of 20. Ninety-seven percent of these deaths were to males. The distribution of fatalities by age is shown in Table 2. Fifteen of the fatalities occurred to youth between the ages of 15-19, with approximately 20% of the deaths occurring to youth less than 10. The mean age was 13.8 years. The fatality rate for youth age 15-19 was 1.45 deaths/100,000 FTE.

Table 2. Fatal fall injuries on farms to youth less than 20 by age group.

Age Group	Fatalities, 1992-1999 ¹
< 10	7
10-14	14
15-19	15

¹Census of Fatal Occupational Injuries, 1992-1999

The majority of the deaths (75%) occurred in crop production (SIC 01), and 25% in livestock production (SIC 02). Twenty-one (58%) of the fatalities occurred during the summer months (June-August), and the majority of the decedents (32) were classified as farm workers.

The majority (81%) of the deaths resulted from a fall from a vehicle, with 64% of the decedents being struck by the vehicle or its trailing implement. A large number (19) of these falls from a vehicle occurred while the youth was a passenger either on the tractor, or its trailing implement, with several of the youth (5) reportedly riding either on the hitch or fender of the tractor. Six of the fatalities occurred while the youth was either operating or a passenger on a horse-drawn implement. The remaining 19% of fatalities were due either to a fall on the same level or a fall to a lower level.

Discussion

After decades of research into agricultural safety, agriculture remains one of the most hazardous industries in the U.S. Although tractors and other machinery have received the most attention in agricultural research, this paper demonstrates that falls are a substantial contributor to on-farm non-fatal and fatal injuries. Further, it is evident that tractors, machinery, and other vehicles such as ATVs play a large role in the circumstances surrounding many of these fall-related injuries.

The patterns of fatal and non-fatal fall-related injuries on farms shown by this analysis are consistent with that of previous research. 1) Males incur the most injuries, 2) a large number of injuries result in fractures and contusions, 3) the extremities are one of the most commonly injured body parts, and 4) the pasture/field and barn are common places for falls to occur (Nordstrom et al. 1995).

Other findings in this research show that injuries occurring to the head result in longer hospitalizations. An almost identical proportion of non-fatal injuries occurred as a result of a fall to a lower level and a fall from a vehicle. As expected, the more serious, and often fatal injuries usually resulted from a fall from a vehicle, such as a tractor. These falls often resulted in the youth being run over either by the tractor itself or a trailing implement.

The work status of the non-fatally injured youth was associated with the type of

vehicle the youth usually fell from, although there was some overlap by vehicles that are often used for both work and recreation. For youth who were injured while working, tractors were fallen off of the most frequently followed by ATVs, motorcycles, and trucks. For those youth who were not working, they most frequently fell from bicycles, motorcycles, and ATVs.

The majority of the injuries (85%) were to youth who lived on the farm. Additionally, many of the injuries (6,711) which occurred were to youth who were not performing work or chores, and over half of the injuries were to youth who were less than 10 years old. These children on the farm need special consideration when planning strategies for injury prevention for youth on farms.

There have been many recommended strategies for keeping children safe on farms. Most of these strategies fall into one of several categories: the need to separate children from injury hazards, the need for adult supervision, and the need for an adult to assess safety risks and eliminate hazards (Adekoya and Pratt 2001). The goal of providing a safe environment where youth on farms can “grow, play, learn, and rest in protective environments that are free of agricultural hazards” is a new area of research that has gained the attention of the National Children’s Center for Rural and Agricultural Health and Safety (Lee et al. 2002)

Youth could be separated from areas where injury hazards are present by providing fenced in play areas for young children which should be away from work areas, and by providing physical barriers, such as a locked shed, which may prevent children from playing on or around farm machinery. Constant supervision, although difficult, is a must when children are around hazards, such as farm machinery, or while playing at heights. Adults can also help to reduce some hazards that youth encounter while on the farm by ensuring that youth observe standard safety practices. For example, ensure that youth permitted to drive tractors wear their seatbelt if the tractor is equipped with a rollover protective structures (ROPS). Such measures could help to prevent or minimize the seriousness of many injuries.

The seasonal trend for fall injuries, which is very similar for both fatal and non-fatal injuries, also is not unusual. Youth are more likely injured during the summer months. Not only is this a time period where there is a lot of activity on the farm, but it is also a time when youth are most available for work or are on the farm because they are out of school.

Although tractors are recognized as a major hazard on the farm, the number of fatalities resulting from animal-drawn agricultural machinery should help to emphasize that work in agriculture is inherently dangerous by itself. The addition of mechanized machinery and motorized vehicles, such as tractors, only increase the number of hazards.

The results of this paper highlight the dangers of extra riders on tractors. Over half of the youth fall fatalities occurred while the youth was a passenger on a tractor or its trailing implement. Tractors are not designed as passenger vehicles. Extra riders on farm tractors are placing themselves at risk of falling from the tractor or falling into the path of a trailing implement. Extra riders on tractors may also distract the tractor operator from the considerable task of driving the tractor. Adults ensuring that there are no extra riders on tractors may help reduce the number of fatal and non-fatal fall injuries on farms.

Conclusions

Being aware of the fall hazards that exist on the farm and implementing some simple solutions may help prevent an injury. Fall prevention around the farm could include simple measures, such as providing adequate lighting and hand rails for commonly used walking surfaces, or more advanced measures such as placing energy-attenuating surfaces (Baker et al. 1992) in barns and hay lofts where falls often occur.

Youth on farms, work status notwithstanding, are exposed to many different types of fall hazards. Many of the vehicle-related falls occur to working and non-working youth due to the evolving nature of the types of machinery used for farm work. ATVs and motorcycles are commonly used for both work and recreation on farms. Falls occurring in farm buildings, such as barns, also present hazards for youth regardless of their work status. Although much work is performed in these areas, they are also a common place of play for farm youth.

Extra riders on tractors and implements resulted in 19 of the deaths in this analysis. Distributing this information to the youth who work on, live on, or visit farms and the adults who supervise them is essential. Prohibiting extra riders on tractors and prohibiting youth to ride on hitches or implements could greatly reduce the number of youth fall-related fatalities on farms.

Further research into the areas of fall protection and effective methods of disseminating safety information, such as the dangers of passengers on tractors, is needed. Furthermore, research into prevention strategies should take into consideration the common circumstances of both agricultural and childhood injury. The hazards and risks presented to children on farms are constantly changing, just as their level of physical and mental development constantly changes. Parents, employers, educators and researchers face a formidable challenge in identifying risk factors for youth on farms and finding ways to effectively minimize their impact through engineering controls and dissemination of safety information.

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