

On-Farm Falls Among Youth Less Than 20 Years Old in the U.S.

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ABSTRACT. *This article examines the magnitude and characteristics of fall-related injuries on U.S. farms for youth less than 20 years old for work and non-work exposures at a national level. To examine the problem, data from the Childhood Agricultural Injury Survey (CAIS) and Census of Fatal Occupational Injuries (CFOI) were used. Findings indicate that falls are an important contributor to on-farm injuries, with youth appearing to be at considerable risk. Thus, a reduction of the exposure of youth to fall-related hazards on farms is needed. Strategies such as providing safe play areas for young children and continuing efforts to prevent extra riders on farm equipment will help in reducing these hazardous fall exposures.*

Keywords. *Agricultural falls, Fatal work-related falls, Youth.*

In the U.S., falls are the most common cause of nonfatal injury and among the most common causes of injury deaths. Further, falls are the leading cause of nonfatal injury visits to hospital emergency departments (ED), accounting for approximately eight million visits to EDs annually (Institute of Medicine, 1999). In 2000, there were an estimated 2.8 million unintentional fall-related injuries to youth less than 20 years presenting to hospital EDs, resulting in a fall injury rate of 3,467/100,000 youth (CDC, 2000). For fatal fall injuries, only highway injury causes more fatalities from unintentional injury throughout the world (Waller, 1985). In 2000, 180 deaths to youth less than 20 years resulted from unintentional falls for a fatality rate of 0.23/100,000 youth (CDC, 2000). While some attention has been given to the general understanding and prevention of these fatal and nonfatal falls, focused attention to falls occurring specifically on farms is limited.

Previous studies have identified falls as the most commonly cited mechanism of nonfatal farm-related injury (Nordstrom et al., 1995). It has been estimated that one out of every five work-related farm injuries occurred as the result of a fall (NSC, 1982; Myers, 2001). A study by Nordstrom et al. (1995) found an average annual incidence rate of farm-related nonfatal fall injuries for the six-year period of 1986-1991 to be 7.0 per 1,000 farm residents in central Wisconsin.

For the years 1980-1994, the agriculture, forestry, and fishing industry had one of the highest rates of work-related fall-related fatalities by industry division (0.99 deaths/100,000 workers). Only construction (3.89/100,000 workers) and mining (1.69/100,000 workers) have higher fatality rates for falls (NIOSH, 2000). A study of work-related fatalities in the agricultural production and services sectors identified

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359 fall-related deaths for the 10-year period of 1980-89 for workers of all ages (Myers and Hard, 1995).

Previous studies have also shown that youth on farms appear to be at considerable risk for both fatal and nonfatal fall-related injuries. For example, 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). For the years 1982 to 1996, a study of farm-related deaths for youth less than 20 years of age in the U.S. identified 69 fall-related deaths (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, particularly for youth. However, an examination of on-farm fatalities to youth age 16 to 19 found an estimated 43% of fatal falls to youth to be work-related (Myers and Adekoya, 2001).

Although there has been substantial research on work-related falls, it generally has been focused towards roofers or other construction activities (NIOSH, 2000; Suruda et al., 1995). The limited literature on falls in agriculture is generally state-specific or focused on one geographic area of the country. A goal of this research is to provide descriptive data at the national level on the frequency and characteristics of fall-related injuries for youth less than 20 years of age associated with both work and non-work farm exposures.

Methods

Nonfatal Injuries

Data on nonfatal injuries were obtained from the 1998 Childhood Agricultural Injury Survey (CAIS), which was conducted for the National Institute for Occupational Safety and Health (NIOSH) by the USDA (Myers and Hendricks, 2001). The CAIS, stratified by the four major Bureau of Census defined geographic regions, was a telephone survey of 26,000 farm households across the U.S. Data were collected for all on-farm injuries occurring during 1998 to youth less than 20 years of age. Data collection occurred from the last week of January 1999 to the second week in March 1999. The targeted respondent for the survey was the female head of household; however, the male head of household was substituted if the female was unavailable. If the youth was 16 years of age or older and available, the injured youth was interviewed during the injury portion of the survey.

For the CAIS, an injury was defined as any event occurring on the farm operation that resulted in 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 (excluding contract laborers, who are defined as workers who are hired by and work for a contractor). A work-related injury was defined as any injury that occurred while the youth was performing activities that had a direct impact on the farming operation as a business, regardless of whether the activity was performed for pay. For an injury to be considered work-related, the youth must have been performing work; just being present where work was being conducted would not qualify as work-related.

Demographic information was collected for members of the farm household and for any youth hired to work on the farm. Household youth were defined as all youth who resided on the farm. Hired farm workers were defined as youth who were hired directly

by the farm operators, excluding contract laborers, to work on the farm but were not household members.

For all reported injuries, common injury information, such as nature of injury, body part injured, and a narrative description of the injury, were collected. Source and event were coded by the authors per the Occupational Injury and Illness Classification System (OIICS) (BLS, 1992). Injury rates were calculated as the estimated number of injuries divided by the estimated number of youth obtained from the CAIS. The rates are expressed in terms of 1,000 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). Since responses to the survey were on a per farm basis, sampling weights were calculated based on the number of farms responding to the survey within each stratum. The total number of farms within each stratum was derived from the 1997 Census of Agriculture. The national estimates for a specific injury or youth population variable was calculated as the sum of all stratum estimates for that specific variable.

On-farm fall-related injuries were selected from the data if respondents answered positively that 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 vehicles and machinery (OIICS event codes 1000-1900, 4231, and 4232). Fall 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.

Although falls from vehicles and machinery are not always considered when thinking about falls, they were included in this analysis for several reasons. First, the CAIS instrument included a section that asked questions specific to fall injuries. Those respondents who reported that a fall was involved were asked to provide more detailed information for the reported fall-related injury. These questions included falls from vehicles and machinery as valid fall events. Therefore, when selecting cases by OIICS code, event codes 4231 and 4232, which fall under transportation, were included for consistency. Further, falls from vehicles and machinery are an important issue with nonfatal injuries. For example, a youth may be injured by a tractor rollover; however, the initial fall from the tractor was the primary cause of injury.

Falls from horses were excluded from this analysis due to the design of the survey. Respondents who were injured as a result of a fall from a horse were asked a separate set of questions, which were not included in the falls section.

Fatal Work-Related Injuries

Data on fatal work-related injuries were obtained from the Census of Fatal Occupational Injuries (CFOI). CFOI was developed by the Bureau of Labor Statistics (BLS) for surveillance of work-related fatalities in the U.S. The fatality data cover all industries, occupations, and 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) the decedent was 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). The CFOI data include fatalities to contract workers, which were excluded from the nonfatal data. However, due to an inability to reliably identify these cases, they were left in the data.

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 provided NIOSH with a detailed research file that includes variables such as specific age. The New York City Department of Health declined to release these more detailed data; therefore, data from New York City are excluded.

For this analysis, fatalities in the agricultural production sectors were selected by the Standard Industrial Classification Codes (U.S. OMB, 1987) for agricultural production in crops and livestock (SIC codes 01 to 02) for youth less than 20 years of age for the years 1992-1999. As was the case with the nonfatal falls, fall-related fatalities were selected based on an event code that indicated if the fatality was the result of a fall to the same level, a fall to a lower level, a jump to a lower level, or a fall from a vehicle or machinery, which includes tractors, automobiles, agricultural machinery, and recreation vehicles, such as bicycles, motorcycles, and all terrain vehicles (ATVs). Falls from machinery and vehicles were included in this analysis, and falls from horses were excluded for consistency with the definition used in the nonfatal analysis.

Fatality rates were calculated using employment data for youth age 15-19, which were derived from the Current Population Survey (CPS) micro data files for the years 1992-1999. CPS is a monthly survey, conducted by BLS, of U.S. 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 average hours worked per year, which are presented per 100,000 full-time equivalent (FTE) workers as shown in the following equation:

$$\text{Fatality rate} = \frac{\text{Number of deaths}}{\text{Number of FTEs}} \times 100,000 \quad (1)$$

The number of FTEs is calculated based on 2,000 hours of employment per year. Previous research has shown that for youth populations, who tend to have part-time and sporadic work patterns, injury rates based on actual hours worked provide a more accurate estimate of risk than rates based on the number of employed workers (Ruser, 1998). 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

Nonfatal Fall Injuries

During 1998, the CAIS data estimated that 32,808 (95% confidence interval (CI) 28,416 to 37,200) nonfatal injuries to youth occurred on farms. Of these on-farm injuries, 10,733 (95% CI 8,406 to 13,059, 32.7%) were from falls. A fall injury rate of 5.3/1,000 youth on farms was calculated for the combined group of household and hired youth. An estimated 51% of fall injuries occurred on livestock farms, with 44% occurring in crop production. In 5% of the cases, farm type was not reported. In the 8,737 fall-related injury cases where sex was reported, 76% (6,654, 95% CI 5,884 to 7,424) occurred to males, and 24% (2,082, 95% CI 1,312 to 2,852) occurred to females.

An estimated 9,142 (95% CI 8,432 to 9,851) of the fall injuries occurred to youth who were living on the farm, with an injury rate of 7.2/1,000 household youth. For hired workers and visitors, an estimated 603 (95% CI 144 to 1,062) fall injuries occurred, with hired workers having an injury rate of 0.2/1,000 hired youth. An injury rate could not be calculated for visitors due to a lack of denominator data.

Table 1. Estimated number of nonfatal fall injuries on U.S. farms to youth less than 20 years by age group and injury event (source: Childhood Agricultural Injury Survey, 1998).

Injury Event	<10 (SE) ^[a]	10-14 (SE)	15-19 (SE)	Unknown	Total (SE)
Fall to lower level	1814 (376)	532 (203)	473 (208)	110	2929 (444)
Fall from vehicle	822 (275)	1741 (371)	256 (131)	0	2819 (445)
Fall to same level	966 (299)	457 (185)	150 (113)	0	1573 (356)
Fall, unspecified	389 (189)	-- ^[b]	398 (205)	-- ^[b]	827 (277)
Other fall	1619 (375)	-- ^[b]	369 (188)	-- ^[b]	2585 (449)
Total	5610 (505)	3257 (457)	1646 (367)	220	10733

[a] SE = standard error.

[b] Estimate is not reportable or is suppressed because of a non-reportable cell.

The majority (5,635, 95% CI 4,649 to 6,621) of the fall-related injuries were considered minor, with less than 1% of the injuries reported 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 (95% CI 1,753 to 3,455) cases, with a median stay of 1 day (range 1 to 60 days).

The distribution of fall-related on-farm injuries by age group is shown in table 1. Over one-half of the injuries occurred to youth under 10 years of age, 30% of injuries involved those age 10-14, and 15% involved youth 15-19. The mean age for fall-related injuries was 9.2 years.

Table 1 also shows that youth were most frequently injured by falls to a lower level (27%) and falls from a vehicle (26%), which included tractors, ATVs, and motorcycles or machinery. In approximately 8% of the fall incidents, the type of fall was unspecified, and in 2% of the cases, the age of the youth was not reported. Youth in the youngest age group (<5) most frequently experienced falls to a lower level, followed by falls to the same level. The proportion of youth injured by falls from vehicles or machinery increases with age. For those youth who sustained injuries requiring hospitalization, falls from vehicles or machinery resulted in an average of 9 days (median = 2) in the hospital, compared with falls to the same or a lower level, which averaged a 2-day (median = 1) hospital stay.

Youth were most commonly injured in the field or pasture (51%), followed by barns/outbuildings (23%), and in the 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 required an average stay of 5.9 days, followed by injuries to the leg and internal injuries with average stays of 4 and 3.3 days, respectively. There were no discernable differences in type of injury, age, or work status by type of farm or body part injured.

There was a seasonal trend for the nonfatal fall-related injuries occurring on farms. 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.

Nonfatal Falls—Work-Related

An estimated 4,022 (95% CI 3,046 to 4,998) of nonfatal fall injuries occurred to youth who were performing work or chores on the farm, with 3,873 (95% CI 2,905 to 4,841) of these injuries occurring to household youth. The mean age for nonfatal

Table 2. Estimated number of nonfatal work-related fall injuries on U.S. farms to youth less than 20 years of age by injury event (source: Childhood Agricultural Injury Survey, 1998).

Injury Event	Nonfatal Work -Related Injuries (SE) ^[a]	% of Total
Fall to a lower level	928 (293)	23.1
Fall from vehicle/machinery	685 (244)	17.0
Fall to same level	316 (161)	7.9
Fall, unspecified	2093 (417)	52.0
Total	4022 (498)	100

[a] SE = standard error.

work-related fall injuries was 9.9 years, with males incurring 92% of the injuries. An estimated 52% of the work-related fall injuries occurred on livestock operations, and 42% occurred in crop production.

Of those work-related fall injuries, over 80% of the youth reported being supervised by another worker when the injury occurred. More than one-third (1,418, 95% CI 709 to 2,127) of the injured youth did not have experience in the task they were performing at the time of the injury, while 38% (1,514, 95% CI 818 to 2,210) reported having more than one year of experience at the task. The majority of the injured youth (66%) worked less than 10 hours per week on the farm, with 13% reportedly working more than 40 hours per week.

As shown in table 2, falls to a lower level were responsible for 23% of the work-related injuries, followed by falls from a vehicle (17%). An estimated 65% of the falls to a lower level were from structural elements, such as roofs and barn lofts. For the 685 working youth who fell from a vehicle, most of the youth fell from tractors (55%) and ATVs (29%), followed by motorcycles (16%).

Nonfatal Falls—Non-Work-Related

An estimated 6,711 (95% CI 5,735 to 7,687) of the fall injuries were not work-related, with 71% (4,047, 95% CI 3,341 to 4,753) of these injuries occurring to household youth. The mean age for non-work-related fall injuries was 8.7 years. Males incurred 70% of the injuries. An estimated 51% of the non-work-related fall injuries occurred on livestock operations, compared to an estimated 46% on crop operations. As shown in table 3, falls from a vehicle accounted for 32% of the non-work-related injuries, followed by falls to a lower level (30%) and falls to the same level (19%).

For the non-work-related injuries, the most frequent falls from vehicles and machinery were from bicycles (28%), ATVs (19%), and motorcycles (18%). Non-working youth commonly fell to a lower level from such things as trees and swing sets.

Table 3. Estimated number of nonfatal non-work-related fall injuries on U.S. farms to youth less than 20 years of age by injury event (source: Childhood Agricultural Injury Survey, 1998).

Injury Event	Non-Work-Related Nonfatal Injuries (SE) ^[a]	% of Total
Fall from vehicle/machinery	2135 (403)	31.8
Fall to lower level	2001 (380)	29.8
Fall to same level	1257 (326)	18.7
Fall, unspecified	1318 (328)	19.6
Total	6711 (498)	100

[a] SE = standard error.

Fatal Fall Injuries—Work-Related

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 less than 9 to more than 88 years. Of these 588 fatalities, 36 (6%) occurred to a youth under the age of 20. Fifteen (42%) of the 36 fatalities occurred to youth between the ages of 15-19, 14 (39%) occurred to youth ages 10-14, and 7 (20%) occurred to youth less than 10 years of age. The mean age was 13.8 years. The fatality rate for youth age 15-19 was 1.46 deaths/100,000 FTE.

The majority of the 36 youth deaths (75%) occurred in crop production (SIC 01), with the remaining 25% occurring in livestock production (SIC 02). Fifty-eight percent (21) of the fatalities occurred during the summer months (June to August). The majority of the decedents (89%) were classified as farm workers.

A fall from a vehicle was the predominate event (81%), 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 on its trailing implement, with five of the youth reportedly riding either on the hitch or fender of the tractor. Six of the fatalities occurred while the youth was either operating or riding as 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, the focus has mainly been on injuries resulting from overturns or caught-ins (Hard et al., 1999; Myers et al., 1998). This article demonstrates that falls are a substantial contributor to on-farm nonfatal and fatal injuries to youth, for both work-related and non-work-related injuries. Further, when looking at tractors, machinery, and other vehicles such as ATVs in the context of falls, it is evident that these vehicles play a large role in the circumstances surrounding many of these fall-related injuries.

The patterns of fatal and nonfatal 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 the most commonly injured body parts, and (4) the pasture/field and barn are common places for falls to occur (Nordstrom et al., 1995).

In order to put fall injury rates into context, the general injury rate for household and hired youth on farms is 13.3/1,000 youth (Myers and Hendricks, 2001). The nonfatal fall injury rate for the same population is 5.3/1,000 youth, which accounts for a large proportion of the general injury rate. Further, the fall injury rate exceeds that of other rates, such as the rate for animal-related injuries to household and hired youth on farms, which is 3.2/1,000 youth (Hendricks and Adekoya, 2001). When looking at only those youth who live on the farm, the general injury rate is 18.7/1,000 youth (Myers and Hendricks, 2001). The nonfatal fall injury rate for household youth is 7.2/1000 youth, which again is a large proportion of the general injury rate. To compare the on-farm fall-related injury rate to that of the general population, the nonfatal fall injury rate based on ED reports is 34.7/1,000 youth (CDC, 2000), which is substantially higher than the 5.3/1,000 youth found here. However, it is important to note that the rate for the general population may include these on-farm cases. Furthermore, the farm rate only includes household and hired youth, which might explain some of the difference.

For fatal falls, it is difficult to compare the on-farm and general population rate due to differences in the age of youth used in the denominator, and because the fatality rate in this study is for occupational fatalities only.

Other findings in this research show a similar proportion of nonfatal injuries that 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 occurred after a fall from a vehicle, such as a tractor. These falls often resulted in the youth being run over either by the vehicle itself or by a trailing implement, such as a baler or wagon. As would be expected, these injuries often resulted in longer hospitalizations.

A large proportion of youth who were injured while working reported being supervised at the time of the injury. However, there is no information on the level of supervision or the age of the supervisor, only that a supervisor was in the area. Further, the number of youth injured while performing an unfamiliar task combined with the high number of youth reporting working less than 10 hours per week on the farm during the time they were injured indicates that inexperience may be an important element in youth on-farm work-related injuries.

The work status of the youth who were not fatally injured was associated with the type of vehicle from which the youth fell, although there was some overlap of vehicles that are commonly used for both work and recreational purposes. Youth who were injured while working most often fell from tractors, followed by ATVs, motorcycles, and trucks. Non-working youth most frequently fell from bicycles, motorcycles, and ATVs.

The majority of the nonfatal injuries (85%) were to youth who lived on the farm. Additionally, 63% of all injuries occurred to youth who were not performing work or chores at the time of the injury, and over half of the injuries were to youth who were less than 10 years old. Although these non-work-related injuries often involved falls from trees or swings, other large contributors included ATVs, tractors, and other farm equipment. Therefore, when planning strategies for injury prevention for youth on farms, researchers should give special consideration to how to protect the young non-working youth from the hazards that exist on the farm.

There have been many recommended strategies for keeping children safe on farms, although few have been rigorously evaluated. 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 part of an ongoing prevention effort at 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 play areas for young children, which should be away from work areas, and by providing physical barriers, such as a locked shed or barn, which may prevent children from playing on or around farm machinery. Almost one-quarter of the nonfatal falls were in barns or outbuildings. Providing passive safety barriers, such as railings for open haylofts and limiting access to these areas, would also limit the exposure to fall hazards. Constant supervision, even if difficult, is a must when children are around hazards, such as farm machinery, or while playing or working at heights. Adults can also help to reduce some of the hazards that youth encounter while on the farm by ensuring that youth observe standard safety practices. For example, youth permitted to drive tractors should only drive those equipped with a rollover protective structure (ROPS), and they should always wear a seatbelt. 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 nonfatal injuries, also is not unusual. Youth are more likely to be injured during the summer months. This is a time when there is a lot of activity on the farm, and it is also a time when youth are most available for work or are on the farm because school is in recess. Another peak in injuries was seen during the month of January. A review of the narrative data determined this winter peak to be a result of increased slips and falls due to snow and ice.

The results of this article highlight the dangers of extra riders on tractors. Over half of the fall-related fatalities occurred while the youth was a passenger on a tractor or on its trailed implement. Tractors are not designed as passenger vehicles. Extra riders on farm tractors place 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 operating the tractor. Adults who ensure that there are no extra riders permitted on tractors will help reduce the number of fatal and nonfatal fall injuries on farms.

Limitations

A substantial limitation to this research is the lack of available data on fatal non-work-related falls on farms. It is estimated that over half of the fall-related deaths on farms to youth age 16-19 are not work-related in nature (Myers and Adekoya, 2001), and it may be inferred that non-work-related fall deaths to youth less than 16 would equal this proportion if not surpass it. Data collection of all on-farm deaths to youth is currently underway by NIOSH in an attempt to fill this gap.

Although the recall period for nonfatal injuries was at most 15 months, and information was requested for only the most serious injuries, the potential for recall bias exists. A study on the effect of recall bias found a 32% decrease in injury reports for surveys based on a 12-month recall period (Landen and Hendricks, 1995). However, injuries that resulted in lost workdays (more severe) had a lower rate of under-reporting (22.5%) than injuries that did not result in lost work days (44.6%). Further, a study of recall for nonfatal injuries for children and adolescents found that although recall bias exists to some degree regardless of severity, the effects of recall bias are significantly lower for severe injuries (Harel et al., 1994). This study collected information on more severe injuries that required at least four hours of restricted activity or required medical attention. Therefore, the number of injuries reported should be considered a conservative estimate.

Youth farm workers hired by a contractor, although an important part of the work force, were excluded for the nonfatal data in this study. This exclusion was made based on the belief that contract laborers would be more likely to report injuries to the contractor and not to the farm operator.

An additional limitation may be the way a fall was operationalized for this analysis. As stated in the methods, for the purpose of this research, a fall included falls to a lower level, falls to the same level, jumps to a lower level, and falls from vehicles and machinery. Further, falls from horses were excluded. As previously stated, this definition of falls was necessary due to the questionnaire design and for consistency in analysis. Using this definition limits the ability to compare these results to the results of other fall analyses with differing fall definitions.

Future research in this area could be improved by taking measures to increase the response rate for some variables. In this study, there were an estimated 2,000 cases in which the sex of the injured youth was not reported. Additional data on the

circumstances surrounding the fall injury would also be useful in developing appropriate fall prevention strategies.

Conclusions

Being aware of the fall hazards that exist on the farm and implementing some simple solutions may help prevent injury. Fall prevention around the farm could include simple measures, such as providing railings around open loft areas, or more advanced measures, such as placing energy-attenuating surfaces (Baker et al., 1992) in barns and haylofts 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. For example, 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 these buildings were designed for operational purposes, they are also a common place of play for farm youth.

Extra riders on tractors and implements have resulted in many deaths. 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 from riding on hitches or implements could greatly reduce the number of youth fall-related fatalities on farms.

Additional protection could be provided for youth hired to work on farms if the age requirements in the child labor laws for agriculture were made consistent with those in other industries. However, it is important to note that the federal exemption for children working on operations owned and operated by their parents is also present in most other industries, with the exception of mining and manufacturing (DOL, 2001). Therefore, these laws would have an impact on the hazard exposure of hired youth but would do little to increase the safety of youth living on the farm. Further, even though many child safety and public health advocates support public policy approaches for addressing injury prevention issues, this is not a popular approach in many farming communities (Lee et al., 2002).

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 production agriculture and childhood injury. Research to evaluate the prevention strategies mentioned above and in other studies is needed.

The hazards and risks for children on farms are constantly changing, just as their level of physical and mental development constantly changes. Parents, employers, educators, and researchers should make it a priority to identify risk factors for youth on farms and to finding ways to effectively minimize their impact through engineering controls and dissemination of safety information.

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