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REVIEWS, CASE HISTORIES, AND RESEARCH

Fatal Work-Related Injuries in the Agricultural Production and Services Sectors Among Youth in the United States, 1992-96

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ABSTRACT. We used data from the U.S. Bureau of Labor Statistics' Census of Fatal Occupational Injuries to describe fatal agricultural work injuries among youth less than 20 years of age from 1992-1996. There were 188 deaths, 23% of which were tractor-related. Eighty-three deaths were reported among individuals engaged in family businesses. The fatality rate for 15- to 19-year-olds was 12.2 deaths per 100,000 full-time equivalents. Youth fatality rates were comparable to those of adult workers up until the age group of 45-54 years. Non-regulatory

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approaches to preventing injuries, especially in family businesses, are important given the current form of U.S. child labor laws.

KEYWORDS. Agriculture, child labor, occupational injuries, adolescent

Farms are unique because they frequently serve as both a place of work and residence. Children and adolescents are exposed to agricultural hazards while living, working, or visiting on farms. Childhood farm injuries have been recognized as a public health problem.[1-2] In the United States, an estimated 262,000 youths 16-19 years of age were employed in the agriculture, forestry and fishing industry division in 1996, accounting for 7.6% of working youths in this age group.[3] Employment data are not routinely collected or published for youth less than 15 years of age, though youth surveys and injury data demonstrate that they work and are injured, especially in agricultural settings.[4-18] Previous analyses demonstrate that the agriculture industry accounts for a substantial number of work-related fatalities of youth.[8,19-21] For the years 1992-1995, 22% of work-related deaths of youth less than 20 years of age were in the agriculture, forestry and fishing division.[8]

The United States Bureau of Labor Statistics (BLS) has reported on youth work-related fatalities, including some breakdowns for the agriculture, forestry and fishing division, using a relatively new work-related fatality surveillance system, the Census of Fatal Occupational Injuries (CFOI).[8] A comprehensive analysis of fatalities occurring in the agricultural production and services sectors (excluding fatalities in the forestry and fishing sectors) has not been conducted. This study analyzes fatal occupational injuries to youth less than 20 years of age in the agricultural production and services sectors for the years 1992-1996. These data can be used to develop and target interventions specifically aimed at reducing the occurrence of youth work-related fatalities and injuries associated with agricultural production and services.

METHODS

CFOI was developed by BLS to monitor and characterize occupational fatalities in the United States. CFOI data cover all industries, occupations, and types of events leading to fatalities. There is no age restriction on the database. Case subjects in the database meet the following criteria: (1) the decedent was employed at the time of the event (working for pay, compensation, or profit), and (2) engaged in a legal work activity or present at the site of the incident as a requirement of his or her job.[22] CFOI data are derived from a Federal-State cooperative system using death certificates, state and federal workers' compensation reports, motor vehicle fatality reports, coroner or medical examiner reports, related fatality reports from the Occupational Safety and Health Administration, Mine Safety and Health Administration reports, Employment Standards Administration reports and other sources.[22] State cooperators verify all fatal occupational injuries and obtain descriptive information on the circumstances surrounding each event. With a few exceptions, fatalities are included in the database only if two sources indicate a work relationship.[22] The Occupational Injury and Illness Classification Structure (OIICS) is used to code nature of injury, body part injured, the event leading to the injury, and the source of the injury.[23] Industry is coded according to the Standard Industrial Classification (SIC) System.[24]

For this analysis, fatalities in the agricultural production (livestock and crops) and services sectors were selected (SIC codes 0100 to 0799) for youth less than 20 years of age from a research file provided by BLS to the National Institute for Occupational Safety and Health for the years 1992-1996. Examples of industries included in the agricultural services sector are farm labor and management services, soil preparation services, crop services, and veterinary services. All youth less than 20 years of age are grouped together in the research data file. BLS provided, by request, tabulations for more refined age groupings: < 12 years, 12-13 years, 14-15 years, 16-17 years, and 18-19 years.

Fatality rates were calculated using employment data derived from the Current Population Survey (CPS) micro data files for the years 1992 through 1996. CPS is a monthly survey of US households selected from a probability sample representative of the civilian noninstitutionalized population.[25] Data collected by the CPS include demographic characteristics of employed civilians, as well as information

on what primary jobs workers hold and the number of hours worked by employed persons. In addition, unpaid family members are counted as being employed if they work for the family business. Self-employed individuals are also included in the CPS sample. Rates were not calculated for youth 14 years of age and younger because the CPS does not collect employment data for these age groups. Rates were calculated for older workers (age groups beginning at 20 years of age) for comparison purposes.

CPS data were used to derive monthly estimates of the hours worked by youth 15 years of age and older who were employed in agricultural production and services (1990 Bureau of Census industry codes 011-030, which correspond to SIC codes 0100-0799). These monthly estimates were annualized and summed over calendar years to provide estimates of total employed hours. These annual employed hours were converted to Full-Time Equivalents (FTE), using the Bureau of Labor Statistics definition (FTE = 2000 hours of work per calendar year).[26] Rates are presented per 100,000 FTE. This method is recommended for calculation of work-related injury rates for youth specifically, and especially when rates are to be contrasted with those of older workers.[26-27] Hours of work, which typically are lower for youth than adults, are a rough measure of exposure. Failure to control for fewer hours worked by youth results in an underestimate of risk.

RESULTS

There were 188 work-related deaths to youth less than 20 years of age from 1992 through 1996 in the agricultural production and services sectors in the United States. Crude fatality rates per 100,000 FTE for 15- to 19-year-olds were: 16.9 in 1992, 10.8 in 1993, 9.1 in 1994, 12.6 in 1995, and 11.6 in 1996. The summary rate for the five-year period was 12.2 deaths per 100,000 FTE. There were seasonal variations in fatalities. Sixty-two percent of the fatalities to youth less than 20 years of age were reported between May and August, with June and July accounting for 42%. Among fatally injured youth working in crop and livestock production, there was a second peak in October.

Individuals working for pay accounted for 51.1% of the fatalities, individuals engaged in a family business accounted for 44.1% of the fatalities, and 3.7% of the fatalities were among the self-employed. The employment status of the remaining 1.1% was unknown (Table 1).

TABLE 1. Descriptive Characteristics of Fatal Work-Related Injuries Among Youths < 20 Years of Age, United States, 1992-1996

	Total	Crops Total	Livestock Total	Services Total
	188 (%)	N = 98	N = 58	N = 32
Employment Status				
Family Business	83 (44.1)	50	33	0
Wage/Salary	96 (51.1)	44	25	27
Self Employment & Unknown	9 (4.8)	4	0	5
Age Distribution				
<12 years	26 (13.8)	19	7	0
12-13 years	27 (14.4)	15	12	0
14-15 years	32 (17.0)	16	13	3
16-17 years	46 (24.5)	22	13	11
18-19 years	57 (30.3)	26	13	18
Event[1]				
Transportation	93 (49.5)	62	23	8
Contact with Objects	50 (26.6)	24	20	6
Exp/Harmful/Substances	23 (12.2)	5	5	13
Assault/Violent Acts/Other	22 (11.7)	7	10	5
Source[3]				
Vehicle/Machinery	126 (67)	78	36	12
Persons/Plant/Animal/Mineral	19 (10.1)	6	7	6
Other Sources	19 (10.1)	5	6	8
Other	24 (12.8)	9	9	6
Region				
Midwest	86 (45.7)	54	25	7
South	42 (22.3)	19	9	14
Northeast	31 (16.5)	11	16	4
West	29 (15.5)	14	8	7
Part				
Head	59 (31.4)	36	14	9
Mult. Body Parts	47 (25.0)	27	15	5
Body Systems	39 (20.7)	15	10	14
Other	43 (22.9)	20	19	4

[1] Categories based on the Occupational Injury and Illness Classification Structure (OIICS) Event or Exposure Divisions. Transportation includes events involving transportation vehicles, powered industrial vehicles or powered mobile industrial equipment, regardless of where the event occurred. Contact with Objects and Equipment includes injuries produced by contact between the injured person and the source of the injury, except when contact was due to falls, transportation events, fires, explosions, assaults or violent acts. Exposure to Harmful Substances, Environments includes contact or exposure to: electric current; caustic, noxious, or allergenic substances; and oxygen deficient environments. Assaults and Violent Acts includes assaults by persons and animals. To comply with BLS requirements that prohibit presentation of data in cells with three or fewer cases, events from diverse Divisions were combined with data from the Assaults and Violent Acts Division. These include Falls, Fires and Explosions, and other events not listed or elsewhere classifiable.

[2] Categories based on the Occupational Injury and Illness Classification Structure (OICCS) Source of Injury or Illness Divisions. Vehicle and Machinery Divisions were combined in Table 1 to comply with the BLS reporting requirements which prohibit presentation of data in cells with fewer than three cases. Vehicles include equipment that serves the purpose of transporting people and carrying or transferring goods, such as automobiles, power-driven aircraft, forklifts, all-terrain vehicles, pickup trucks, and dump trucks. Machinery includes equipment that performs specific functions or processes under power, including plowing machinery, harvesting and threshing machinery, and loaders. Persons, Plants, Animals and Minerals include living organisms, such as persons and animals. Other Sources includes ammunition and explosive devices, atmospheric and environmental conditions, and other sources not elsewhere classified. The Other category includes sources classified by the OIICS structure, but not presented here because of small numbers. These include Chemical and Chemical Products; Containers; Parts and Materials, Structures and Surfaces; Tools, Instruments and Equipment.

Crop production accounted for 52% of the deaths, livestock production for 31%, and services for 17%. Sixty percent of fatalities that occurred in family businesses were in crop production; 40% were in livestock production. Crop production had the highest fatality rate among 15- to 19-year olds with a rate of 20.8 deaths per 100,000 FTE. The rates for livestock production and services were 8.2 and 10.1 per 100,000 FTE, respectively (Table 2).

The number of deaths increased with age (Table 1). Crop production accounted for the most fatalities across all age groups, but accounted for a greater proportion of deaths among youth < 12 years of age (73% of the deaths). Among the deaths to youth less than 16 years of age in crop and livestock production, 64 were in family businesses. Youths 15-17 years of age had slightly higher rates than 18- to 19-year olds (Table 2). Rates per 100,000 FTE for youth are comparable to those of adults up to the age group of 45-54 years. Similar patterns are seen when rates are calculated by agricultural sector.

Males comprised the majority (96.3%) of the fatalities. Fifty-three percent of fatally injured males were working in crop production, 29% in livestock production, and 18% in services. Five of the seven fatali-

TABLE 2. Frequencies and Rates per 100,000 Full-Time Equivalents, of Fatal Work-Related Agricultural Injuries by Age Group and Agricultural Sector, United States, 1992-1996

	Crop		Livestock		Services		Total Deaths	
	Deaths	Rate*	Deaths	Rate	Deaths	Rate		Rate
15-19 years	54	20.8	32	8.2	31	10.1	117	12.2
15-17 years	28	21.8	19	9.4	13	11.5	60	13.5
18-19 years	26	19.8	13	6.9	18	9.2	57	11.0
20-24 years	73	18.5	46	10.0	77	10.7	196	12.4
25-34 years	200	18.3	96	6.4	206	12.9	502	11.7
35-44 years	282	23.4	125	6.8	190	15.0	597	13.9
45-54 years	266	29.6	116	8.2	134	20.0	516	17.3
55-64 years	353	50.9	161	14.5	95	35.7	609	29.4
65 years +	678	154.9	264	35.4	52	60.4	994	78.3
Total	1906	38.2	840	11.3	785	16.0	3,531	20.3

There were three cases with unknown or unspecified age group.
*Rate = Deaths per 100,000 FTE

ties of females were in livestock production. Whites (not Hispanic) accounted for the majority (83.2%) of the fatalities. Fifty-four percent of the fatally injured whites were working in crop production, 34% in livestock production, and 12% in services. Twenty-eight fatalities were to youth of Hispanic origin, 4 fatalities were of Black youth, and 8 fatalities were to youth of other or unknown race. Fifty-seven percent of the fatally injured Hispanic youth were working in crop production.

An injury to the head was most common, followed by injury to multiple body parts (Table 1). Head injuries accounted for over one-third of the fatal injuries to youth working in crop production. Injury to body systems, a classification used to code when the functioning of an entire body system has been affected without specific injury to any other part of the body, accounted for 43.8% of the deaths of youth working in agricultural services.

Transportation events accounted for one-half of the fatalities, and represented 3 out of 5 fatalities to youth in crop production (Table 1). Transportation events include vehicles such as cars and trucks as well as industrial machinery such as tractors and forklifts. Transportation events include collisions, loss of control, and falls from vehicles and machinery. Off road non-collision events, such as vehicle and machinery overturns and falls from vehicles and machinery, were the leading transportation-related event accounting for 43 deaths, 72% in crop production, 23% in livestock production, and 5% in agricultural services. There were 28 public roadway fatalities. On public roadways, jackknives and overturns were the leading transportation-related event accounting for 20 fatalities; 85% in crop and livestock production and 15% in agricultural services.

The leading sources of fatal injuries were vehicles which accounted for 82 fatalities (43.6%), followed by machinery with 44 fatalities (23.4%). Tractors, which are classified as a vehicle in the CFOI, were the major contributor to vehicle-related fatalities, accounting for 23% of all fatalities. Tractor-related fatalities accounted for 30% of fatalities in crop production, 19% in livestock production, and 6% in agricultural services. Among the 43 tractor-related cases in this study, 33 decedents were operating tractors, 5 were passengers on a tractor, and 5 were involved in other activities. Twenty-two deaths were also attributed to trucks such as pickups, dump trucks, semi trucks, and delivery trucks; 55% in crop production, 18% in livestock production,

and 27% in agricultural services. Of the 22 truck related fatalities, 8 decedents were operating trucks, 8 were passengers, and 6 were involved in other activities. Machinery-related fatalities included: plowing, planting and fertilizing machinery (9); harvesting and threshing machinery (8); and, loaders (6).

Forty-six percent of all fatalities were in the Midwest, followed by 22.3% in the South (Table 1). The fatality rates were comparable across the four regions, with rates from 11.5 per 100,000 FTE in the South and Northeast, to rates of 12.6 and 12.8 in the West and Midwest respectively (Table 3). Crop production accounted for the most deaths in every region except for the Northeast, where livestock production predominated, followed closely by crop production (Table 1). The South was unique in that deaths attributed to agricultural services outnumbered those from the other regions. While the aggregated rates (crop production, livestock production, and agricultural services) were fairly similar across the four regions, rates by sectors were quite different (Table 3). The highest rate was found for Midwest crop production, with 35 deaths per 100,000 FTE. The next highest rates were for

TABLE 3. Frequencies and Rates per 100,000 Full-Time Equivalents, of Fatal Work-Related Agricultural Injuries Among Youth 15-19 Years of Age, by Agricultural Sector, United States, 1992-1996

	Total		Crop		Livestock		Services	
	Deaths	Rate*	Deaths	Rate	Deaths	Rate	Deaths	Rate
Midwest	47	12.8	26	35.0	15	6.7	5	8.0
South	35	11.5	15	16.2	6	6.7	14	11.4
Northeast	12	11.5	-	9.6	6	13.2	4	10.5
West	23	12.6	11	15.1	5	13.2	7	9.6
Total	117	12.2	54	20.8	32	8.2	31	10.1

-indicate no data or less than 3 work fatalities.

Midwest Region States: North Dakota, South Dakota, Minnesota, Wisconsin, Michigan, Ohio, Indiana, Illinois, Missouri, Kansas, Nebraska, and Iowa.

South Region States: Virginia, West Virginia, Kentucky, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Arkansas, Delaware, Maryland, District of Columbia, Oklahoma, and Tennessee.

Northeast Region State: Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, Pennsylvania, and New Jersey.

West Region States: Washington, Montana, Wyoming, Idaho, Oregon, Colorado, Utah, Nevada, California, Arizona, New Mexico, Hawaii, and Alaska.

*Rate = Deaths per 100,000 FTE

crop production in the South and West, 16.2 and 15.1 deaths per 100,000 FTE, respectively, livestock production in the Northeast and West, with rates of 13.2 deaths per 100,000 FTE each, and agricultural services in the South and Northeast, with rates of 11.4 and 10.5 deaths per 100,000 FTE, respectively.

DISCUSSION

Many findings from these analyses are consistent with previous research on youth work-related fatalities: the predominance of males; the substantial contribution of family businesses to agricultural deaths among younger youth; the finding that tractors contribute to more deaths than any other type of vehicle or machinery; and, that youth fatality rates are comparable to those of young and middle-aged adults.[8,19-21,27] This study builds upon previous research by: providing age-, sector-, and region-specific fatality rates for agricultural production and services; identifying crop production as having both high numbers and rates of fatal injuries for youth; and, demonstrating regional differences in patterns and risk of fatal injury.

Rates of youth agricultural work-related fatalities are cause for concern. The rate of 12.2 deaths per 100,000 FTE is 2.4 times greater than the overall work-related fatality rate for the United States across all ages and industries combined in 1992-1993 (5.1/100,000 FTE).[26] The rate for crop production of 20.8 deaths per 100,000 FTE is within the range of the top 3 industries with the highest rates of fatal injury.[26]

The regulatory authority on farms of the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) and Wage and Hour Division (WHD) are diluted compared to other industries. OSHA, which sets safety and health standards for U.S. workplaces, is prohibited from investigating farms with fewer than 11 employees. WHD has responsibility for federal child labor laws which regulate the types of work that youth less than 18 years of age can perform. There are different sets of child labor laws for agricultural and nonagricultural industries. In agriculture, youth who are less than 16 years of age are prohibited from doing work declared hazardous by the Secretary of Labor, when working on farms not operated by their parent or guardian, whereas the corresponding age in nonagricultural industries is 18 years.[28-29] Children 14 and 15 years of age employed on farms operated by someone other than a parent or guardian are

permitted to do hazardous duties such as operating tractors and farm machinery, but only after completing specific training courses for such equipment. Children employed on a farm by their parents or guardians however, are exempt from all child labor laws, regardless of how dangerous the work might be.[28] There is no such exemption in non-agricultural industries.[29] It was not possible to identify the numbers of deaths among youth less than 16 that involved work declared hazardous by the Secretary of Labor. There have been efforts to extend OSHA's jurisdiction on farms[30] and to make child labor laws in agriculture comparable with nonagricultural industries, e.g., raising the minimum age for hazardous work to 18 years of age and removing the exemption for family businesses.[31-32] It is assumed that such changes would lead to fewer agricultural work-related deaths among youth.

While there have been as of yet unsuccessful efforts in the United States to extend the regulatory authority onto farms, the current status of minimal regulations must be recognized and nonregulatory approaches pursued. Voluntary guidelines were recently developed, through a consensus process, to help parents and employers in assigning tasks to youth based on matching the abilities of youth at various developmental levels and job requirements of specific tasks.[33] While the development of these guidelines is an important step, there is a need to conduct an independent review to determine the scientific basis for specific guidelines.[34] It must also be recognized that there may be economic and psychosocial pressures on family farms which will complicate the adoption of these guidelines. The use of these guidelines by farmers and the effectiveness of these guidelines in preventing deaths and injuries will also need to be evaluated.

There are also efforts underway to educate youth themselves, including tractor safety classes, vocational agricultural education, and programs which use youth peer leaders to teach other youth.[7,35] It is critical that these efforts be evaluated to ensure that limited resources, time and money, are being applied most effectively.[1,2]

Pediatricians, adolescent medicine physicians, and family practitioners could contribute to efforts to educate parents and older adolescents about farm hazards and prevention messages along the lines of the American Academy of Pediatrics' Injury Prevention Program (TIPP).[36] This approach has been evaluated and found to be extremely cost effective in preventing childhood injuries,[37] though not necessarily widely used.

Tractors account for more agricultural work-related deaths of youth than any other machinery.[a] This finding is not unique to youth, but is also true for adults where tractors are the leading cause of machinery-related death in the United States.[38] Tractors are a very hazardous machine, posing risks for: rollovers to operators and passengers; and runovers of operators or passengers who fall off of the tractor, or bystanders who are working in close proximity to tractors. [39] Hazards are also introduced by power take-off shafts and implements towed behind tractors. The appropriateness of youth less than 16 or 18 years of age operating tractors has been questioned.[2,32,40] Research coupling youth development and human factors disciplines are needed to provide empirical data to address the question as to the age or development level at which youth can be expected to have the physical and cognitive capacity to safely operate tractors within a reasonable margin. The use of engineering controls to decrease hazards associated with tractors also needs to be aggressively pursued. Rollover protective structures, when used in conjunction with seatbelts, have been shown to be very effective in reducing fatalities.[39,41] Since 1985, tractor manufacturers in the United States pledged to sell only tractors with roll over protective structures. Unfortunately, it is estimated that over 2.7 million tractors in use, most manufactured before 1985, have not been retrofitted.[42] The costs of retrofitting older machines are not inconsequential.[42]

The region specific data in this study demonstrate that the number and rates of youth agricultural work-related deaths varied across different regions of the country. This information can be used to target injury prevention efforts. For example, the high numbers and rates for crop production in the Midwest argue for concentrated efforts focusing on this sector and associated hazards, with a secondary emphasis on livestock production which had a substantial number of deaths.

There are several limitations to this research which should be noted. Although CFOI is expected to do a better job of identifying work-related deaths than previous work-related fatal injury surveillance systems because of the use of multiple data sources, sensitivity and data quality studies have not been conducted. The identification of work-relatedness for youth can be unclear when a child lives on the farm. It is not known if there is variability between states, which are the data collection units, in identification of agricultural work-related deaths of youth, specifically, or work-related deaths in general.

Another limitation of this study was imposed by the grouping of youth less than 20 years of age in the research data file provided by BLS. This age grouping is one mechanism which allows BLS to be able to provide a research file to outside researchers without jeopardizing confidentiality agreements with state agencies. While BLS was very responsive to providing special tabulations, it was unreasonable to request extensive age tabulations which may or may not have provided important age-specific information. Additionally, there were some research questions which could not be answered by age-specific tabulations, for example, the number of fatalities to youth less than 16 or 18 years of age which involved work declared hazardous by the Secretary of Labor. Such an assessment would require the use of narrative information in conjunction with coded data, and would require an individual year of age with each record.

Finally, because of the nature of the CFOI data, only those deaths which involve a work relationship are included. Deaths to children who were not working, but exposed to hazards in their living environment or when they visited a farm or accompanied their parents to work are not included in the database. The extent to which work contributes to childhood agricultural injury deaths overall, and by age, is not known, but an important question for focusing research and prevention efforts.

NOTE

a. Tractors are classified as vehicles within the CFOI data base. However, tractors are defined as machinery under the ICD-9 E-Code structure.

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