Farm Injuries in Ohio, 2003-2006: A Report from the Emergency Medical Services Prehospital Database

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ABSTRACT. *Agriculture has among the highest numbers and rates of fatal and non-fatal traumatic injuries in the U.S. Surveillance is an integral part of injury prevention. However, traditional sources of surveillance data are incomplete and inaccurate in describing agricultural injuries. The goals of this research are to describe acute, traumatic farm injuries in Ohio utilizing the Ohio EMS prehospital (ambulance run) database, and to explore the database's utility in agricultural injury surveillance. Ohio mandates reporting of responses to every call for emergency medical services (EMS) in the state. A dataset containing every transported injury case from 2003-2006 was obtained. A descriptive analysis of farm injuries was conducted and compared to existing surveillance sources. Of the total transported injuries, 15% (1714 injured individuals) came from farms. "Falls" were the most common cause of injury in all age groups except ages 15-24, in which "off-road vehicles" were most common. Other leading causes include "ridden animal," "machinery," and "caused by animal." These results are similar to other data sources. Strengths of EMS databases include mandatory reporting, low expense, and lack of need for employer or worker reporting. They may be used to look at injury severity, quality of acute care, resource allocation, and to assess the need for specialized training of EMS personnel. Limitations are lack of specificity for work-related agricultural injuries and variation in definitions of data elements. EMS prehospital databases are an important source of data for agricultural injury surveillance.*

Keywords. *Agricultural injuries, EMS surveillance, Farm injuries, Injury surveillance, Occupational surveillance, Prehospital surveillance.*

Agriculture has ranked in the top two economic sectors for numbers and rates of fatal and non-fatal traumatic injury in the U.S. for decades (NIOSH, 2004a). Certain populations, especially children, the elderly, and migrant and seasonal farm workers, are particularly vulnerable to injuries in farm settings (Rivara, 1997; NCCAIP, 1996; Gelberg et al., 1999; McCurdy et al., 2003). There is a national consensus and targeted funding attached to prevention of injuries in agriculture (Castillo et al., 1998).

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Surveillance is the systematic collection and analysis of health data for planning, implementing, and evaluating public health programs, with the timely dissemination of these data to those who need to know (Langmuir, 1963). Surveillance is an integral part of injury prevention, allowing for identification and characterization of injuries, specifically numbers, rates, mechanisms, causes, health outcomes, healthcare service needs, and associated social, psychological, and economic costs. Surveillance aids in prioritizing interventions and evaluating the outcomes of those interventions.

Surveillance for non-fatal agricultural injuries is limited by many factors. First, many systems are based on employer reporting, and small businesses, which have a relatively high rate of injuries (NIOSH, 1999), are more likely to underreport (Rosenman et al., 2006). Second, agriculture is poorly covered by the data collection and enforcement agencies that typically collect occupational injury data: OSHA does not receive reports from workplaces with under 11 employees and is not heavily involved in enforcement of agricultural health and safety rules, the USEPA does not collect health outcomes data in agriculture despite its responsibility for prevention of pesticide poisoning, and the USDA has only recently begun to collaborate with NIOSH on agricultural health and safety surveillance. Third, there is a significant amount of hired labor on farms (USDA-NASS, 2002a), much of which is low-paid, unskilled, and foreign-born; these workers have a higher number and rate of workplace injuries overall, and are less likely to be captured in the usual occupational injury databases (Friedman and Forst, 2008). Finally, data systems that capture injuries that occur on farms frequently misclassify occupational injuries, sometimes designating non-farm work as agricultural and, conversely, assuming that injuries that take place on family farms occurred at home, rather than at work. Injuries of farm children are commonly misclassified in this way (Murphy et al., 1993).

The usual data reporting systems for occupational illness and injury, e.g., the BLS Survey of Occupational Illnesses and Injuries and workers' compensation systems, have been shown to be limited in their ability to capture cases (Rosenman, 2006; Ruser, 2008). There is a call for greater use of state-based health outcomes databases to fill in the gaps (Thomsen et al., 2007). The greatest advantage of health-based data repositories is that they do not rely on employers or workers to report but instead capture records when individuals obtain healthcare for their injuries, according to existing statutes (Azaroff, 2002; Friedman and Forst, 2007).

Many states in the U.S. have laws mandating the reporting of injury cases that are transported by ambulance to the hospital, and all 56 states and territories have signed a memorandum of understanding recognizing the need for uniform emergency medical services (EMS) data collection at the national level (NAEMSD, 2003). EMS prehospital run data have the potential of providing surveillance information on agricultural injuries. The goals of this research are to describe acute, traumatic farm injuries in Ohio utilizing the Ohio EMS database, and to explore the database's utility in agricultural injury surveillance.

Methods

The Ohio Revised Code §4765.06 of 1992 mandates the establishment of an EMS incident reporting system to collect information on the delivery of emergency medical services in the state (Law Writer, 2008). Every ground or air response for emergency medical assistance by a public or private EMS organization must be reported by the final transporting agency to a data repository that is maintained by the Ohio Department of Public Safety (ODPS).

The information that is reported to the EMS incident reporting system (EMSIRS) is collected by the emergency medical technicians (EMTs) on the responding ambulance. It includes incident demographics (date, time, and place of the incident), patient demographics (age, sex, and race), assessment of the patient's condition, medical procedures performed, medications administered, and the disposition of the incident, i.e., whether and where the patient was transported (ODPS, 2003). This information is recorded in a "run report" at the time of the incident, and a copy of that report is generally left at the receiving hospital to assure continuity of care. Upon returning to the station, responders enter the information from the report into a database for periodic transmission to EMSIRS. The frequency of data transmission depends on the EMS agency's annual run volume; agencies that make 10,000 runs or more per year transmit monthly, while agencies with lower volumes transmit on a quarterly basis.

Transmission of EMSIRS data is done via the internet using a secure file transfer protocol (FTP) process to ensure data privacy. When the records are received by ODPS, they are immediately checked by the EMSIRS computers for completeness and errors. Any record that is incomplete or contains errors is not accepted into the database. Examples of errors would be non-sequential times (i.e., arrived at scene before receiving the call), dates of birth resulting in a negative patient age, or male patients with a history of childbirth or in labor. At the end of the error-checking process, the person transmitting the file receives an error report indicating which records in the file contain errors and what those errors are. The records with errors are corrected and resubmitted. Internal quality assurance activities show that Ohio's EMSIRS database captures no less than 87% of all EMS encounters in the state.

Approximately one million responses occur every year, of which around 15% are injured people actually transported to a healthcare facility. ODPS makes a dataset available to researchers that protects patient confidentiality (ODPS, 2008).

A dataset of every injury that was transported by ambulance in Ohio from 2003 to 2006 was requested. Data elements requested include demographics (age, gender, and race/ethnicity); month, year, and county of injury; incident site (home/residence, farm, mine or quarry, industrial place and premises, place for recreation, street or highway, public/commercial building, residential institution, educational institution, other specified, other unspecified, or unknown); time the EMS unit was notified; chief complaint; mechanism of injury; primary injury description; protective devices used; and vital status assessment variables. Treatment procedures in the field also are recorded but were not requested for this research. All cases of "farm" as the site of injury were extracted. The designation of the site as a farm is determined by the responding EMTs. The EMSIRS defines a farm as including "a place of agriculture or land under cultivation," but excluding residential buildings such as farm houses is based on ICD-9-CM place of injury codes (E code 849.1). A descriptive analysis was conducted using Microsoft Excel.

Denominator data for rate calculation was obtained from the USDA National Agricultural Statistics Service (NASS) for the last available year, which is 2002. Upon request for this project, NASS provided a dataset based on a weighted sample of a household survey that queries the number of family members living on the farm (unpublished); from the NASS website we obtained the number of farm laborers employed in Ohio, by county (USDA-NASS,2002b). We added these two values together for each county and then multiplied that sum by four to establish an estimate of the at-risk population between 2003 and 2006.

Results

There was a total of 3,741,680 ambulance calls in Ohio from 2003 to 2006, of which 577,987 cases (15%) were injured persons who were picked up and transported by ambulance to the hospital; 2,738,566 cases (73%) were illness-related transports, and the remaining 425,127 cases (11%) were not transported to the hospital. Included among the ambulance calls are 103 deaths that were documented by EMTs but were not transported; 65 of the 103 deaths were due to injury. Of the 65 deaths at the scene due to injury, 16 cases (25%) were due to machinery, 10 (15%) were “struck by” or “caught between,” 10 (15%) were airplane crashes, and 9 (14%) were motor vehicle crashes, with 2/3 of those from off-road vehicles. Six individuals were believed to have died by suicide. The machinery-related deaths were most common in individuals over 65; there was one child (<18) in this group, and in four cases the age was missing.

There were 1714 individuals who were non-fatally injured on farms and transported by EMS to the hospital. The average age of farm-injured individuals was 39.5, the median was 31 years, and the recorded range was 1 to 102 years of age. Table 1 lists the gender and race/ethnicity of the farm-injured cases, the EMS-transported cases throughout the state, and the general population of Ohio in 2006 (U.S. Census, 2000).. The proportion of injured males transported from farms was higher than the proportion from other locations. Males and white non-Hispanics are more highly represented in the group transported from farms than they are in the general population of Ohio.

Table 1. Demographics of injured individuals transported by ambulance from farms, of injured individuals transported from all locations, and of the general population of Ohio, 2003-2006.

		Transported from Ohio Farms	Transported from All Locations	Ohio Population
Total cases		1714	577,987	11,353,140
Gender	Male	1016 (59%)	271,873 (47%)	49.1%
	Female	686 (40%)	297,635 (51%)	50.9%
Race/ethnicity	White, non-Hispanic	1459 (85%)	401,386 (69%)	82.9%
	Black, non-Hispanic	28 (2%)	59,326 (10%)	12%
	White, Hispanic	20 (1%)	6577 (1%)	2%
	Black, Hispanic	2 (0.2%)	721 (0.12%)	
	American Indian/Alaskan	1 (0.06%)	338 (0.06%)	0.2%
	Asian/Pacific islander	1 (0.06%)	1664 (0.28%)	1.5%
	Other	203 (11.8%)	107,975 (18.7%)	1.4%

Fifty-one of the cases did not have “county” specified and so were eliminated from calculations of rate by county. Figures 1 and 2 show the distribution of the remaining 1663 injuries by county and the injury rates per 10,000 farming population (using the NASS data) in the counties. The majority of injury events were concentrated in 23 counties. Of these, 18 counties had incidence rates of more than 30 injuries per 10,000 farm population. Five counties had the highest rates and the highest numbers of injuries: Licking, Medina, Butler, Huron, and Montgomery. By and large, the numbers and rates of injuries were similar by county; three exceptions were Holmes, which had a high number but a low rate, and Jefferson and Summit, which had relatively low numbers but high rates. Most injuries occurred during the summer season, with the highest numbers in July (fig. 3). Afternoon was the most common period of injury during the day (table 2).

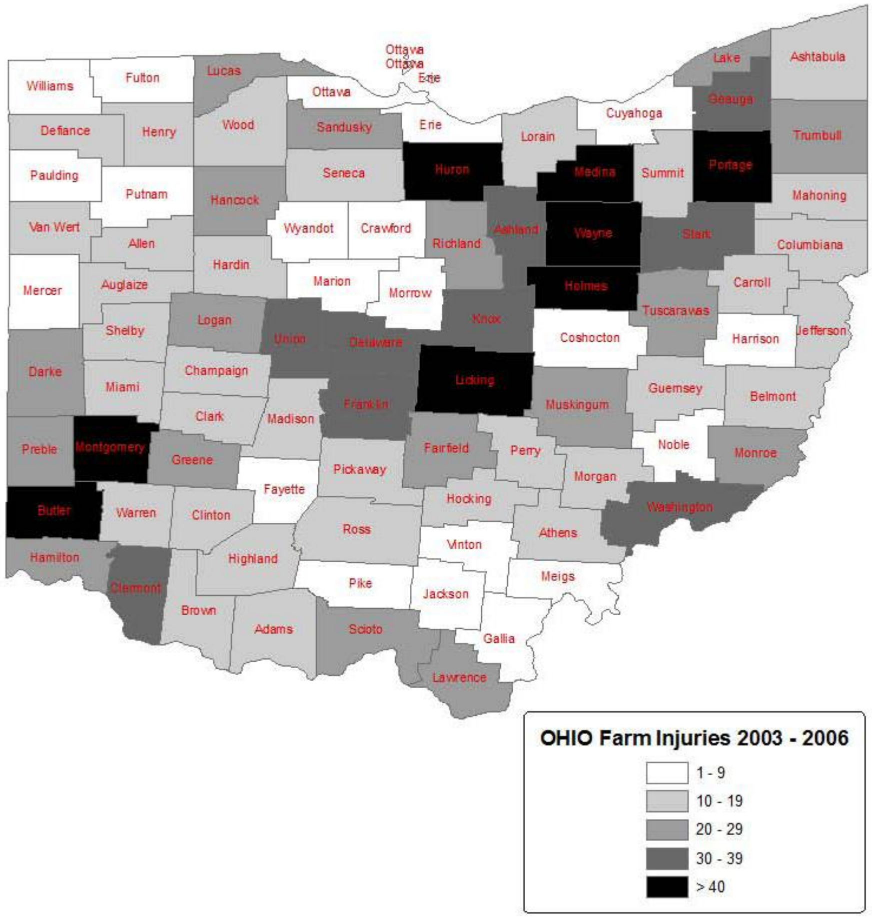

Figure 1. Number of farm injuries transported by ambulance in Ohio, 2003-2006.

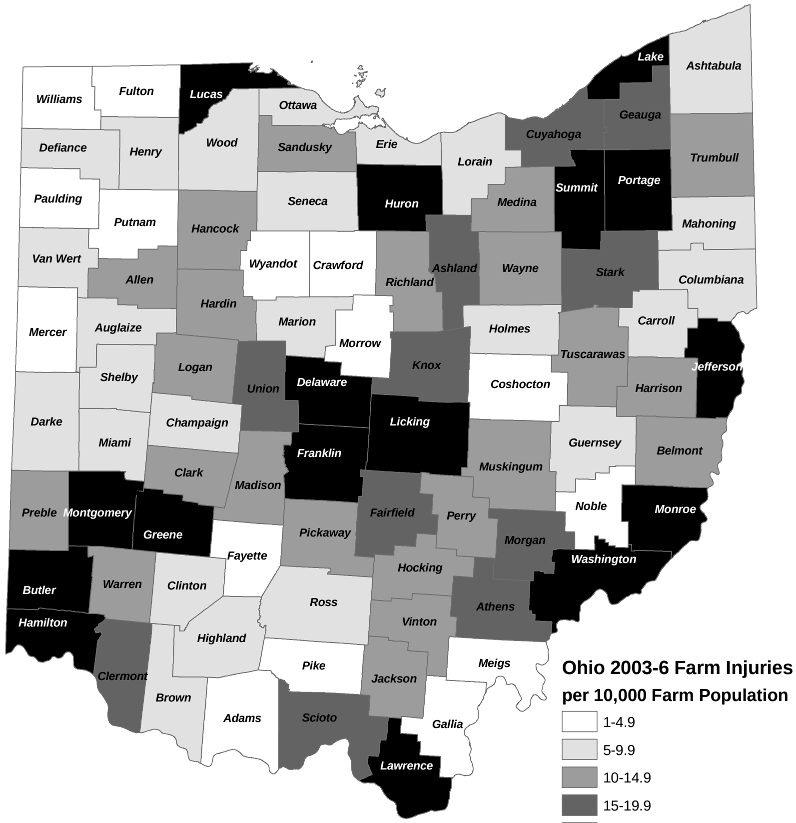

Figure 2. Rate of farm injuries transported by ambulance in Ohio, 2003-2006.

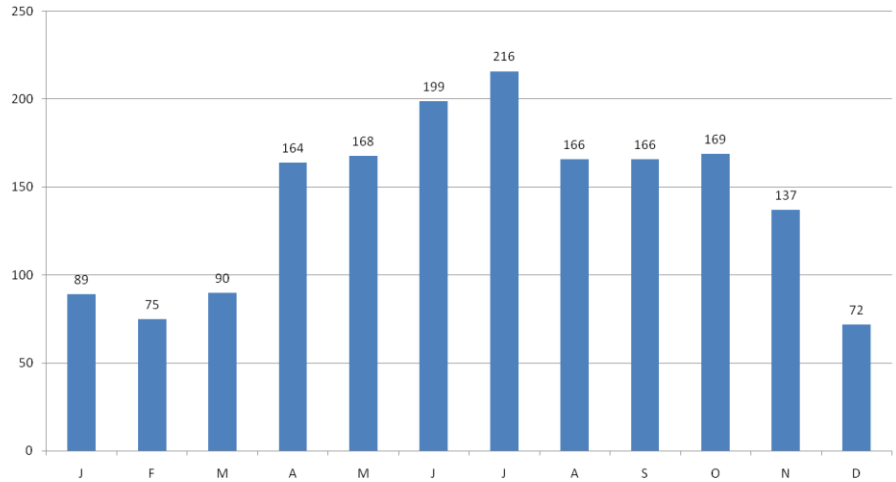

Figure 3. Farm injuries in Ohio transported by ambulance, 2003-2006, by month.

Table 2. Farm injuries in Ohio transported by ambulance, 2003-2006, by time of day.

Hour	No.	%
00-600	55	3
600-1159	316	18
1200-1759	772	45
1800-2399	467	27
Unknown	105	6

Table 3 shows the five leading causes of non-fatal injury overall and by age group. Falls are by far the leading cause of injury requiring EMS transport, followed by ridden animal, off-road vehicle, injury caused by animal, and machinery. These five leading causes change places across the age groups. Notable is the number-one rank of off-road vehicle injuries among teens. Machinery-related injuries rise in rank as age increases; people >65 rarely get injured riding animals. The next most frequent causes, overall, are motor vehicle crash (N = 55, 3.2% of total), struck by falling object (N = 56, 3.3%), struck by person (N = 48, 2.8%), and caught between (N = 29, 1.7%). Remaining causes are numerous, but each occurred in only one or a few cases.

Table 3. Five leading causes of farm injuries transported by EMS in Ohio, overall, and by age category, 2003-2006. [Note that the colors will not be distinguishable in print]

Rank	Total by Cause[a]	Age Groups						
		0-14	15-24	25-34	35-44	45-54	55-64	>65
1	**Fall 546, 32%**	**Fall 65, 35%**	*Off-road vehicle 75, 24%*	**Fall 46, 23%**	**Fall 76, 32%**	**Fall 80, 32%**	**Fall 59, 39%**	**Fall 122, 53%**
2	Ridden animal 243, 14%	*Off-road vehicle 32, 17%*	**Fall 59, 19%**	*Off-road vehicle 33, 17%*	Ridden animal 38, 16%	Ridden animal 47, 19%	***Machinery*** 18, 12%	***Machinery*** 37, 16%
3	*Off-road vehicle 216, 13%*	Ridden animal 31, 16%	Ridden animal 50, 16%	Ridden animal 28, 14%	Caused by animal 27, 12%	***Machinery*** 20, 8%	Ridden animal 16, 11%	*Off-road vehicle* 14, 6%

4	Caused by animal 156, 9%	Caused by animal 15, 8%	Caused by animal 39, 12%	***Machinery*** 21, 11%	***Machinery*** 21, 9%	*Off-road vehicle 20, 8%*	Caused by animal 13, 9%	Caused by animal 12, 5%
5	***Machinery*** 147, 8.5%	***Machinery*** 10, 5%	***Machinery*** 13, 4%	Caused by animal 18, 9%	*Off-road vehicle 20, 9%*	Caused by animal 18, 7%	*Off-road vehicle* 9, 6%	Struck by 9, 4%
Injury total[b]	1714	188	317	197	234	250	151	231

[a] Total by cause = total injuries resulting from each of the five leading causes, and each cause as a percentage of the total in the column..

[b] Injury total = total injuries resulting from all causes, for the entire population and by age group. (columns only display the five leading causes; those ranked above 5 are not displayed, but bring the sum to the total listed in the bottom row of each column) .

Table 4 shows external causes of injury to children. The age groups are chosen to reflect guidelines for different age groups: the ages at which children may be employed legally in agriculture (age 12), the age at which a driver's license can be obtained (age 16), the ages considered "children" in the Child Agricultural Injury Survey (<20) (NIOSH, 2007), and the NIH designation of adults as "children" (ages 18 to 20). Off-road vehicles are the leading cause of injury among children ages 15 to 20, and they appear as the second leading cause in the 6-11 age group.

Table 4. Five leading causes of childhood farm injuries transported by EMS, Ohio 2003-2006.

Rank	Age Groups				
	0-5	6-11	12-15	16-17	18-20
1	**Fall** 8,27%	**Fall** 26, 34%	**Fall** 36, 33%	*Off-road vehicle* 19, 27%	*Off-road vehicle* 28, 27%
2	Struck by 5, 17%	*Off-road vehicle* 14, 18%	Ridden animal 25, 23%	**Fall** 16, 23%	**Fall** 19, 19%
3	***Machinery*** 4, 13%	Ridden animal 11, 14%	*Off-road vehicle* 21, 19%	**Motor vehicle crash** 7, 10%	Ridden animal 15, 15%
4	Ridden animal 4,13%	Caused by animal 7, 9%	Caused by animal 7, 6%	Ridden animal 7,10%	Caused by animal 8, 8%
5	Caused by animal 3, 10%	Struck by 4, 5%	***Machinery*** 4, 4%	Caused by animal 7,10%	Firearm 6, 6%
Total	30	76	109	71	102

Discussion

EMS prehospital (ambulance) data give a glimpse of farm injuries that is not seen in other datasets. First, these cases mainly represent severe, non-fatal injuries, as distinct from fatalities, less serious injuries, and illnesses. Although there were 65 individuals pronounced dead at the scene, the vital status of those who were transported and the deaths that did not lead to an EMS call are unknown. Surveillance systems that better capture fatal agricultural injuries are the BLS Census of Fatal Occupational Injuries (BLS, 2003-2006) and, in the past, NIOSH's National Traumatic Occupational Fatalities system (NIOSH, 2004b). There are also newspaper clipping surveillance projects (Baullinger et al., 2001) in many states that have been implemented to better count fatalities and non-fatal injuries on farms (University of Iowa, 2008; University of Illinois Extension, 2007). The types and distribution of non-fatal injuries seen in the EMS database are similar to those seen from other surveillance sources. In the NIOSH Childhood Agricultural Injury Survey, a telephone survey of farm households, the major causes of injuries among youth on farms in the U.S. were falls, off-road vehicles, and being struck by objects (Myers and Hendriks, 2001). A 1991 survey of 113 dairy and beef farmers in Ontario found the three leading causes of injuries to be falls, animals, and machinery (Brison and Pickett, 1991). The NIOSH Traumatic Injury Surveillance of Farmers (1993-1995) showed livestock, machinery, falls, and use of hand tools to be the leading causes of injury (Myers, 1997). A descriptive analysis from the Canadian Agricultural Injury Surveillance Program of people experiencing an agricultural injury that required hospitalization showed machinery, falls from heights, animal-related injuries, and “struck by” to be the major causes (Pickett et al., 2001). Ohio is one of the few states that do not participate in the BLS Survey of Occupational Injuries and Illnesses (SOII), and the BLS SOII does not capture small businesses, a major category of farms. Therefore, it is impossible to compare EMS prehospital data to this valuable information source. The leading non-fatal injuries as determined by telephone surveys, hospitalizations, and ambulance runs are remarkably similar. It is likely that the proportion of specific farming operations has an influence on the exact ranking of causes of severe, non-fatal injuries.

NIOSH has used data from four sources, including the BLS Survey of Occupational Illnesses and Injuries (ongoing), the NIOSH Traumatic Injury Surveillance of Farmers (1993-1995), the NIOSH Childhood Agricultural Injury Survey (1998), and the Minority Farm Operator Childhood Agricultural Injury Study (2000) (NIOSH, 2004b; NIOSH 2004c). These surveys show that the number of agricultural injuries has stayed relatively constant from the 1980s to 2001, while the rates of agricultural injuries appear to be coming down but remain around 50% higher than overall non-fatal injuries in the private sector. Ohio had some of the highest rates of non-fatal agricultural injury in 1993-1995, and the rates were somewhat higher for crop farms than for livestock farms. Machinery and livestock were the greatest sources of non-fatal injury, and household youth were injured on farms at almost six times the rate of hired youth (NIOSH, 2004d).

Although not among the most common causes, horseback riding features prominently in the CDC/NCIPC/NEISS, as it does in the Ohio EMS database. Between 2003 and 2006, around 73,000 horseback riding injuries presented to U.S. emergency departments (CDC, 2008). In that study, girls were more frequently injured than boys (CDC, 1990), similar to the Ohio EMS data. In 1987 and 1988, the greatest number of horseback riding injuries occurred in ages 25 to 44, although the highest rates were for ages 5 to 24 (CDC, 1990). Fifty percent of these injuries occurred in farm settings, although they are generally unrelated to farm work.

Off-road vehicle injuries among youth on farms also feature prominently in the Ohio EMS datasets. While these injuries may include tractors, they are more likely to describe all-terrain vehicles (ATVs), which may be unrelated to farm work. According to data from 1981 to 2006, Ohio ranks 13th in the nation for injuries related to ATV use (CPSC, 2007). There are an estimated 40,000 emergency room visits across the U.S. yearly, and one-third of these are for children under 16 years of age.

A major limitation to the use of EMS data for work-related agricultural injuries is that injuries that are picked up on farms are not necessarily related to farm work. First, all events that occur on farms may not be related to the agriculture sector. For example, a fall from construction of a barn is not related to agricultural work. Second, certain activities, such as farm chores, are not always considered “work” and thus may not be recorded as occupational. Not only do farm families fail to make the distinction, but healthcare practitioners (e.g., EMS providers) also may not recognize farm injuries as work-related. Third, defining a case as “work-related’ in the agricultural setting is complicated by the fact that “work” and “home” may be the same place. For example, if a farmer is injured and then enters his house to call EMS, the place of the incident may be recorded as “home” rather than “farm.” Finally, and most importantly, there is no data field for work-relatedness in this database. Agricultural injury surveillance is complicated by the difficulty in establishing case definitions that are uniform (Murphy et al., 1993).

A second limitation is that databases that are designed for purposes other than agricultural injury surveillance are unlikely to have identical descriptors for certain variable types. For example, EMS “mechanisms of injury” are not directly comparable to the ICD-9 external cause of injury (E) codes that are used in emergency room, trauma center, or hospital discharge databases. Mechanisms of injury are limited in number (there are 36 choices) and are general in scope, whereas there are more than 200 E codes to choose from, and they can be further split into more detailed descriptors. Does the mechanism “ridden animal” in the EMS data get recorded as “fall from one level to another “(E884), “other injuries caused by animals” (E906), or a different code? Aside from the lack of 1:1 correlation and the inexactness of the codes themselves, hospital coding personnel tend to have much more training than EMS personnel, and hospital coding is done for billing purposes, whereas EMS codes are unrelated to cost.

A third limitation of the EMS prehospital database is that it lacks data elements related to exposure conditions. A “fall from height” could be related to work on a ladder, a silo, a building, or some other structure. If the goal of surveillance is prevention, then appropriate intervention cannot easily be surmised from the “mechanism of injury.” In addition, the lack of designation of hired farm worker versus owner or family member prevents utilizing this dataset to better understand injuries that occur to more vulnerable populations working in agriculture (Villarejo and Baron, 1999).

Finally, the EMS prehospital database could have misclassified entries for the data fields for place as “farm,” or for any of the data elements. Although there are quality control procedures for missing and nonsensical entries, there is no follow-back to determine the accuracy of data entry in the first place. This is true for many health outcomes databases.

Denominator data for farm populations are limited. In this study, NASS could only provide data from 2002, forcing an extrapolation of the underlying population during the years of the study (2003-2006). Hired farm labor is a crude estimate of this portion of the at-risk population, since these workers may be seasonal rather than at-risk for an entire calendar year. In addition, the number of hired farm workers is obtained by survey, and there are disincentives for farm owners to report. County population estimates from the U.S. Census Bureau could be used if one were considering overall resource allocation for EMS transport in a state.

Despite these limitations, this data source has many strengths. Because there is a statute requiring reporting, it is likely to be complete for the injuries that are addressed by EMS responders, unlike systems in which reporting is voluntary. In addition, this database does not rely on employer or worker reporting, so typical disincentives to report are not at play here; this is a strength of data arising from healthcare facilities. This database captures more serious injuries than those that may be detected through surveys, allowing consideration of interventions for injuries that might be of a higher priority for prevention. Finally, because the data repository is passive in receiving case records, it is much less expensive to maintain than active systems.

EMS prehospital databases may be used to look at types of injuries, severity of injuries, and factors related to acute care in the field. It is possible to allocate resources in the state by looking at the numbers and types of injuries that occur on farms and other specified settings. For farm injuries, it is possible to determine EMT training needs based on the types of injuries that EMTs care for, e.g., they may need to learn specific machinery extrication techniques, or how to care for animal-related injuries.

National efforts are underway to establish a nationwide data repository for EMS prehospital data (NEMSIS, 2009), and Ohio data managers are avidly involved in this effort. Harmonization and expansion of the data elements (to include work-relatedness and associated tasks), descriptors of pre- and intra-event exposure circumstances, uniformity in classification schemes among the 50 states and six territories, and built-in quality control mechanisms will improve the usefulness of this surveillance data in describing work-related agricultural injuries. In addition, linkage of this database with others that contain information on work-related agricultural injuries could expand its usefulness.

Conclusion

EMS prehospital (ambulance) data provide a snapshot of more severe, farm-related injuries; results are similar to those seen in other databases. Results from analysis of this database can be used to target interventions and to allocate resources. Involvement of epidemiologists in agricultural health and safety in the effort to establish and utilize the NEMSIS national repository and to conduct record linkage across different databases could greatly expand the usefulness of state-based EMS data repositories.

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