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# Agricultural Youth Injuries: A Review of 2015-2017 Cases from U.S. News Media Reports

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**ABSTRACT**

**Background**: The hazardous nature of the agricultural environment, reflected in the numerous injuries and deaths to children who live, work and play on farms, coupled with the lack of a comprehensive national surveillance system in the United States, highlights the need for making the best use of publicly available youth agricultural injury data.

**Objective**: The purpose of this study was to describe a 3-year collection of youth agricultural injuries using the publicly available injury and fatality data from AgInjuryNews.org and present recommendations for future injury prevention strategies.

**Methods**: Data were obtained from AgInjuryNews.org, a web-based collection of U.S. news reports of agricultural injuries. We analyzed cases from 2015 to 2017 for youth aged 0–17. We classified injuries as occupational and non-occupational related, based on the Farm and Agricultural Injury Classification (FAIC) code. Each case was also coded for source and event using the Occupational Injury and Illness Classification System (OIICS).

**Results**: Of the 348 injury reports reviewed, 51% were fatal, and about one-third of the victims were 6 years old or younger. Most injuries were non-occupational, and the most frequent injury sources were vehicles (includes tractors and all-terrain vehicles) and machinery. Youth operators, extra riders, roadway operations, and unsupervised youth playing near or in a worksite were four key contributing factors associated with vehicle and machinery related injuries.

**Conclusions**: This study reaffirms that youth agricultural-related injuries and fatalities are still a persistent problem in the United States. The hypothesis generating AgInjuryNews system can provide more current data than traditional surveillance datasets as a tool for understanding the sources of youth agricultural injuries, monitoring injury trends, and informing policy efforts and prevention strategies. Future studies should continue to explore and evaluate the comprehensiveness of this system's data and the impact of its dissemination, as well as similar rural health informatics solutions for integration into sustainable interventions that can be customized and delivered domestically and abroad.

**KEYWORDS**
Youth; child; AgInjuryNews.org; agriculture; safety; fatalities; injuries; news report; media; trauma

## Introduction

The more than two million U.S. farms, ranches, and other agricultural operations are major economic engines for their local communities, and as a whole, provide a backbone for international trade and commerce. Yet, agriculture continues to be the most dangerous occupational sector in the United States.[1] On average, one in 25 farm family youth (4.2%, ages 6–17 years) have a disability.[2] The environmental and occupational hazards within this sector are numerous. Among working youth (<18 years-of-age), injuries and fatalities are responsible for an estimated cost to society of $1 billion and $420 million per year (2005), respectively.[3,4] At least 25.9 million youth lived on, worked on, or visited farms in 2012, and these youth suffered nearly 14,000 farm injuries.[5] Furthermore, youth working in agriculture are seven times more likely to die at work than their non-farm counterparts, and a child dies in an agricultural-related injury event approximately every 3 days.[6–8]

From 1998 to 2012, the National Institute for Occupational Safety and Health (NIOSH) reported a steady decline in the rate of non-fatal childhood agricultural injuries, but 2014 data show a leveling of this trend.[9] Over the same time period, the prevalence of child labor reported by farmworkers also declined, though there has been no measurable decline in the

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number of childhood agricultural deaths.[10,11] Costs associated with farm injuries (inclusive of both adults and children) have been estimated to be in the millions, with the largest proportion of costs associated with fatalities.[12]

The injury data collected and compiled in the Childhood Agricultural Injury Survey (CAIS) included data on demographics, causes of injuries, and types of injuries for non-fatal injuries. These data will no longer be available, as this survey was discontinued in 2015.[13] Other existing U.S. public health data systems have been explored to determine their utility with respect to informing youth agricultural injury surveillance and primary prevention.[14] The conclusion was that existing public health data systems can supply information on anatomical injuries, medical care, and treatment; however, they provide little information on the circumstances surrounding the injury, which limits their utility for injury surveillance and prevention initiatives.[14]

Previous studies have shown that publicly available reports, such as news media, can provide valuable and relatively inexpensive data and more nuanced information on recent childhood agricultural injuries, their causes, and their consequences.[15–18] The AgInjuryNews.org interactive web-based system includes a diversity of cases, such as news reports of working youth injuries and fatalities, as well as non-working bystanders, visitors, and guests (in the case of agritourism operations). AgInjuryNews.org and most of its dataset are publicly available and free to use. The system's methods, development, and functions are further described in another paper.[19] It has been used by national youth-based associations such as the National Children's Center for Rural and Agricultural Health and Safety, the Progressive Agriculture Foundation, the Child Agricultural Safety Network, and Concerned Families for ATV Safety to help keep their members informed about injury incidents, provide information for presentations and publications, and provide information on injury trends (useful for media releases).[19]

The purpose of this study was to describe a three-year collection of youth (ages 0–17) agricultural injuries using the publicly available injury and fatality data from AgInjuryNews.org and to present several key injury prevention recommendations. This paper was not written to describe how AgInjuryNews.org contributes to a national surveillance system or to address representativeness of these types of reports. In the absence of federal survey-based surveillance of youth injuries, we acknowledge the gaps between systematic data collection and news media reports. We hope to extend comparisons with other datasets in future, separate work.

## Methods

Data were obtained from AgInjuryNews.org, a web-based collection of U.S. agricultural injury and fatality reports maintained by the National Farm Medicine Center, Marshfield Clinic Research Institute.[19,20] The study population was youth injured as a result of an activity related to agriculture in the United States, with 3 years of youth injury data selected for review: 2015–2017.

The age of the victim was obtained from the news reports and classified as 0–6, 7–9, 10–12, 13–15, and 16–17 years. When the victim's exact age was not specified in the available report, those reports were coded as "unknown age", including reports that used terms like "adolescent", "teen", or "youth". Injury severity was classified as fatal or non-fatal. Non-fatal injuries ranged from minor to severe. Data were sorted based on victim name, location of incident, and date of the incident. This resulted in 17 duplicate cases, which were removed from the analysis.

The cases in AgInjuryNews.org were collected, entered, and coded by a trained primary data entry specialist, and more than 10% were reviewed by a trained second coder (the first author). Additionally, all cases were reviewed and coded according to the Farm and Agricultural Injury Classification (FAIC) code and the Occupational Injury and Illness Classification System (OIICS) by a trained third coder (the second author), specifically for this study. Interrater reliability was not calculated. Discrepancies in coding were resolved through team consensus. FAIC was used to classify farm- and agriculturally related fatalities and injuries consistently and accurately as either occupational or non-occupational from a production agriculture (farming or ranching) perspective (American Society of Agricultural and Biological Engineers – ASAE S575.1).[21] The current

FAIC code categories used in this study are shown in Table 1. FAIC code categories were assigned as occupational (FAIC-1 through FAIC-4) and non-occupational (FAIC-5 through FAIC-9) fatalities. In some cases, the information in the report text was not detailed enough to assign an FAIC code. For example, several cases did not contain enough information to determine if the injured person was actually working at the time of the incident. Forestry and fishing related occupational youth injuries were also excluded from the analysis. The authors used an unpublished protocol for the coding FAIC of youth injuries.

The Occupational Injury and Illness Classification System (OIICS), version 2.01, was used to code the cases based on the injury source and event type.[22] Report summaries and text were used to find injury source and event types. The injury source code is designed to capture "the object, substance, element, or bodily motion that directly produced the injury". The event or exposure is defined as the manner in which the injury or illness was produced or inflicted by the primary source and, when applicable, by the secondary source.[22] In some cases, there was not enough reported information available to accurately assign a code.

In this study, we used the following definitions. Example cases are described as well:

- "unsupervised" for a child who was not watched over at the time of the event: case examples include "1-year-old boy who was playing with his siblings died after accidentally falling into a small pond at a farm house", "2-year-old child found his way to a makeshift stock tank used for watering sheep and fell into the tank, and his father found him a short time later".
- "bystander" for a victim who was not working but injured as a result of workplace activities:[23] case examples include "4-year-old boy's father was backing up a grain wagon, and unknowingly ran over him, who was behind it", "2-year-old boy on a farm was struck by a pickup truck driven by his father", "6-year-old boy was flown to a hospital after his neck was crushed between the frame and bed of a dump truck that was being operated by the boy's father".
- "extra rider" for a child who was carried on farm vehicle/equipment, tractor, all-terrain vehicles/utility task vehicles (ATV/UTV), or horse and buggy as well as a child who was sitting on someone's lap at the time of incident.

The Statistical Package for the Social Sciences (SPSS) for Windows (IBM SPSS Version 24) was used to analyze data. Univariate statistics (i.e., frequency distributions) were used to describe the characteristics of youth injuries. The relationships among variables (incident year, victim's age, victim's gender, FAIC, OIICS source, OIICS event type) for fatal and non-fatal injuries were determined by Chi-square ($\chi^2$) tests.

## Results

A total of 255 incidents involving 348 youth injuries that occurred from January 1, 2015 through December 31, 2017 were retrieved from the AgInjuryNews.org database. Table 2 provides a distribution of injuries and fatalities by various demographic characteristics, FAIC codes, OIICS source, and event categories. Contingency table analyses were used to compare the injury severity, and more than half of these injuries (51%) were fatal.

A disproportionate number of youth were 6 years old or younger and were more likely to have fatal injuries than victims in other age groups (Table 2). Most victims were male, who had a significantly higher fatality rate than female victims. Injuries

**Table 1.** Current FAIC code categories and titles.

| Code | Title |
|---|---|
| FAIC-1 | Farm Production Work (Crop Production, Animal Production) |
| FAIC-2 | Forestry and Logging |
| FAIC-3 | Fishing, Hunting & Trapping |
| FAIC-4 | Agricultural and Forestry Support Activities |
| FAIC-5 | Farm Hazard Exposure, outside services |
| FAIC-6 | Farm Hazard Exposure, Nonworkers: equipment, tools, objects and products |
| FAIC-7 | Farm Hazard Exposure, Nonworkers: structures and landscape |
| FAIC-8 | Farm Hazard Exposure, Nonworkers: animals |
| FAIC-9 | Farm Hazard Exposure: Roadway collision |

**Table 2.** Characteristics of injured victims ($n$ = 348), FAIC and OIICS codes, and injury severity between January 1, 2015 and December 31, 2017.

| Characteristics | Total ($n$ = 348) | Fatal ($n$ = 178) | Non-fatal ($n$ = 170) | $\chi^2$ |
|---|---|---|---|---|
| **Year** | | | | |
| 2015 | 125 (35.9%) | 63 (50.4%) | 62 (49.6%) | $\chi^2$= 4.330, df = 2, $p$ = 0.115 |
| 2016 | 113 (32.5%) | 66 (58.4%) | 47 (41.6%) | |
| 2017 | 110 (31.6%) | 49 (44.5%) | 61 (55.5%) | |
| **Age (valid *n* = 328)** | | | | |
| 0–6 years | 105 (32.0%) | 69 (65.7%) | 36 (34.3%) | $\chi^2$= 11.043, df = 4, $p$ = 0.026 |
| 7–9 years | 76 (23.2%) | 37 (48.7%) | 39 (51.3%) | |
| 10–12 years | 55 (16.8%) | 25 (45.5%) | 30 (54.5%) | |
| 13–15 years | 51 (15.5%) | 29 (56.9%) | 22 (43.1%) | |
| 16–17 years | 41 (12.5%) | 17 (41.5%) | 24 (58.5%) | |
| Missing age* ($n$ = 20, 1 fatal, 19 non-fatal) | | | | |
| **Gender (valid *n* = 292)** | | | | |
| Male | 210 (71.9%) | 129 (61.4%) | 81 (38.6%) | $\chi^2$= 7.371, df = 1, $p$ = 0.007 |
| Female | 82 (28.1%) | 36 (43.9%) | 46 (56.1%) | |
| Missing gender* ($n$ = 56, 13 fatal, 43 non-fatal) | | | | |
| **FAIC code (valid *n* = 280)** | | | | |
| Occupational | 58 (20.7%) | 30 (51.7%) | 28 (48.3%) | $\chi^2$= 0.012, df = 1, $p$ = 0.911 |
| Non-occupational | 222 (79.3%) | 113 (50.9%) | 109 (49.1%) | |
| Undeterminable FAIC* ($n$ = 68, 35 fatal, 33 non-fatal) | | | | |
| **OIICS-Injury source (valid *n* = 345)** | | | | |
| Vehicles | 241 (69.9%) | 114 (47.3%) | 127 (52.7%) | $\chi^2$= 12.206, df = 4, $p$ = 0.016 |
| Machinery | 41 (11.9%) | 25 (61.0%) | 16 (39.0%) | |
| Persons, plants, animals | 25 (7.2%) | 10 (40.0%) | 15 (60.0%) | |
| Others | 20 (5.8%) | 14 (70.0%) | 6 (30.0%) | |
| Structures and surfaces | 18 (5.2%) | 14 (77.8%) | 4 (22.2%) | |
| Unclassifiable Injury source* ($n$ = 3, 1 fatal, 2 non-fatal) | | | | |
| **OIICS-Injury event type (valid *n* = 342)** | | | | |
| Transportation | 253 (74.0%) | 124 (49.0%) | 129 (51.0%) | $\chi^2$= 13.789, df = 4, $p$ = 0.008 |
| Contact with objects and equipment | 33 (9.6%) | 16 (48.5%) | 17 (51.5%) | |
| Violence and injuries by persons or animals | 19 (5.6%) | 9 (47.4%) | 10 (52.6%) | |
| Exposure to harmful substances | 23 (6.7%) | 20 (87.0%) | 3 (13.0%) | |
| Others | 14 (4.1%) | 5 (35.7%) | 9 (64.3%) | |
| Unclassifiable injury event type* ($n$ = 6, 4 fatal, 2 non-fatal). | | | | |

FAIC, Farm and Agricultural Injury Classification; OIICS, Occupational Injury and Illness Classification System.
*Missing and undeterminable/unclassifiable cases not included in the percentages or in chi-square analysis.
Column percentages are shown for "total". Row percentages are shown for fatal/non-fatal.

were also classified as occupational and non-occupational based on FAIC code (Table 2). In 68 cases, FAIC coding was not possible because of a lack of information in news reports. Occupational and non-occupational injuries resulted in similar injury severities.

The most frequent primary injury source was vehicles, which includes tractors and ATV/UTVs. The proportions of fatal and non-fatal injuries were significantly different for different injury sources, with machinery and structures/surfaces related injuries resulting in proportionally more fatalities than the other injury source categories (Table 2). Other injury sources included chemicals, containers, parts and materials, and other sources.

Transportation-related incidents were the most common event type of injury, followed by contact with objects and equipment. In terms of injury severity, the proportion of fatalities resulting from exposure to harmful substances was significantly higher than those associated with other event types. "Exposure to harmful substances" category included drownings, suffocation, carbon monoxide, and electrocution.

## FAIC codes

Injuries were analyzed by occupational status, age, gender, and change in prevalence of occupational injuries over the study years (Table 3). There were 68 injuries where the FAIC could not be determined, which are shown for each variable in Table 2, but were not included in the Chi-square analyses.

The occupational and non-occupational injuries among youth varied significantly over the study years (Table 3). In 2015, the proportion of occupational injuries was higher than those that occurred

**Table 3.** Characteristics of occupational and non-occupational injuries ($n$ = 348).

| Variables | Undeterminable* | Occupational | Non-occupational | $\chi^2$ |
|---|---|---|---|---|
| **Year** | | | | |
| 2015 | 32 | 28 (30.1%) | 65 (69.9%) | $\chi^2$= 7.814, df = 2, $p$ = 0.02 |
| 2016 | 17 | 17 (17.7%) | 79 (82.3%) | |
| 2017 | 19 | 13 (14.3%) | 78 (85.7%) | |
| **Gender** | | | | |
| Male | 35 | 46 (26.3%) | 129 (73.7%) | $\chi^2$= 2.619, df = 1, $p$ = 0.106 |
| Female | 25 | 9 (15.8%) | 48 (84.2%) | |
| **Age categories** | | | | |
| 0–6 | 12 | 5 (5.4%) | 88 (94.6%) | $\chi^2$= 29.409, df = 4, $p$ < 0.0001 |
| 7–9 | 21 | 13 (23.6%) | 42 (76.4%) | |
| 10–12 | 10 | 10 (22.2%) | 35 (77.8%) | |
| 13–15 | 12 | 11 (28.2%) | 28 (71.8%) | |
| 16–17 | 7 | 16 (47.1%) | 18 (52.9%) | |

*Undeterminable variables not included in chi-square analysis.

in 2016 and 2017. Males had more occupational injuries than females. Of the males, 26% (46/175 with known FAIC) were involved in the occupational activity, whereas 16% of the females (9/57 with known FAIC) were involved in the occupational activity. The relationship between age categories and whether the injuries were occupational was also examined, and the proportion of occupational injuries was higher for the older youth. However, five of the victims aged 0–6 years had occupational injuries, meaning they were working at the time of the incident. One such preventable worksite case in Wisconsin included parental supervision, as a 3-year-old victim was run over by a skid steer operated by his 5-year-old sibling while picking field stones with the mother and other siblings.[17,24]

All of the occupational related fatalities and injuries were associated with the occupation of farming (FAIC-1). Non-occupational injuries mostly occurred as a result of exposure to farm equipment, tools, product hazards, and roadway traffic, followed by farm structures and landscapes incidents, and non-occupational animal-related incidents. Common incidents in the product hazards category involved extra riders on the tractor, extra rider in the bucket of the skid steer or on an ATV/UTV, and bystander and unsupervised children in the working area.

## Source and event categories

### Vehicle-related injuries

A total of 241 youth victims were fatally or non-fatally injured caused by a vehicle (Table 4). Vehicle sources in these incidents were ATV/UTVs, tractors, motorized highway vehicles, and other vehicles (non-powered, animal powered vehicles/carts, etc.).

A total of 113 victims sustained injuries via ATV/UTV related incidents, and about half of these injuries were fatal. Almost two-thirds of ATV/UTV injuries occurred as non-roadway incidents (Table 4). Of the ATV-related injuries, one-third were as roadway incidents. Of all ATV/UTV victims, 49 were driving the ATV/UTV, while 52 were passengers. Other victims were bystanders, such as unsupervised youth playing/working on/near a running ATV/UTV without a driver.

Tractor related incidents were associated with 65 injuries, and 25 of these happened on roadways (Table 4). Tractor related incidents resulting in fatal and non-fatal injuries to youth occurred most commonly to extra riders, followed by tractor drivers, youth passengers in other vehicles, and other vehicle drivers.

Highway vehicles were associated with 49 incidents. The vehicles were multi-purpose highway vehicles, passenger vehicles, and trucks. These injury cases include farm hazards on roadways such as farm tractors on roadways and farm animal-related roadway incidents, as well as bystander incidents on farms. Other vehicles such as animal-powered vehicles, non-powered carts, and wagons were associated with 14 injury incidents (Table 4).

### Machinery-related injuries

Almost half of the machine-related cases involved agricultural and garden machinery (Table 4). Skid steer incidents resulted in 14 fatalities, with one youth skid steer operator fatally injured, while the rest of the victims were unsupervised bystanders or extra riders, including children on the lap of the

**Table 4.** Source and descriptions of the event for vehicle-related injuries ($N$ = 241).

| Event | Fatal ($n$) | Non-fatal ($n$) |
|---|---|---|
| **Source: ATV/UTV ($n$ = 113, 47%)** | | |
| **Secondary sources: tractors, agricultural machinery, ground surface irregularity** | | |
| Roadway incidents ($n$ = 38) | driver (9) | driver (6) |
| | extra rider (6) | extra rider (15) |
| | unknown (1) | unknown (1) |
| Non-roadway incidents ($n$ = 75) | driver (21) | driver (13) |
| | extra rider (10) | extra rider (21) |
| | unsupervised (3) | - |
| | bystander (1) | - |
| | unknown (3) | unknown (3) |
| **Source: Tractors, PTOs ($n$ = 65, 27%)** | | |
| **Secondary sources: horse and buggies, highway vehicles, agricultural machinery** | | |
| Pedestrian vehicular incidents ($n$ = 12) | bystander (5) | bystander (5) |
| | unsupervised (2) | - |
| Caught in/compressed by equipment ($n$ = 6) | driver (1) | working (1) |
| | extra rider (1) | bystander (1) |
| | - | unknown (2) |
| Roadway incidents ($n$ = 25) | driver (1) | driver (3) |
| | extra rider (3) | other vehicle driver (1) |
| | - | extra rider (10) |
| | - | other vehicle passenger (7) |
| Non-roadway incidents ($n$ = 22) | driver (2) | driver (3) |
| | extra rider (11) | extra rider (5) |
| | unknown (1) | - |
| **Source: Highway vehicles, motorized ($n$ = 49, 20%) – passenger vehicles** | | |
| **Secondary sources: animals, horse and buggies, wagon, tractors, pickup truck** | | |
| Pedestrian vehicular incidents ($n$ = 3) | bystander (3) | - |
| Caught in/compressed by equipment ($n$ = 1) | bystander (1) | - |
| Roadway incidents ($n$ = 35) | driver (3) | driver (1) |
| | other vehicle driver (1) | other vehicle driver (3) |
| | passenger (9) | passenger (12) |
| | extra rider (1) | extra rider (5) |
| Non-roadway incidents ($n$ = 6) | bystander (3) | - |
| | other vehicle driver (1) | other vehicle driver (1) |
| | pedestrian (1) | - |
| Struck by object or equipment ($n$ = 4) | bystander (1) | bystander (2) |
| | - | driver (1) |
| **Other vehicles – ($n$ = 14, 6%) – Animal-powered vehicles, non-powered carts, wagons** | | |
| **Secondary sources: animals, highway vehicles, off-road vehicles** | | |
| Pedestrian vehicular incidents ($n$ = 1) | bystander (1) | - |
| Roadway incidents ($n$ = 5) | - | driver (1) |
| | extra rider (3) | extra rider (1) |
| Non-roadway incidents ($n$ = 4) | bystander (1) | driver (1) |
| | extra rider (1) | extra rider (1) |
| Struck, caught, or crushed in collapsing equipment ($n$ = 2) | unsupervised (1) | unsupervised (1) |
| Struck against object or equipment ($n$ = 1) | driver (1) | - |
| Caught in or compressed by equipment or objects ($n$ = 1) | unknown (1) | - |

operator or in the bucket of the skid steer. Most of the skid steer victims were 6 years of age and under. The remainder of the machinery related incidents were caused by augers and resulted in four non-fatal injuries (Table 5).

### *Persons-, plants-, animals-, and minerals-related injury incidents*

Within this category, 10 fatal and 15 non-fatal injuries were identified. Most of these injuries were caused by the animals, with five of those resulting in fatalities. Most animal-related injuries were caused by horses and cows or bulls. Another six injuries were linked to animal waste (*Escherichia* coli), with two resulting in fatalities. Two injuries were intentional self-harm (fire-arm related) and one injury was physical assault.

### *Structures- and surfaces-related injury incidents*

Injury incidents in this category included farm ponds, manure pits, and silos. Of the victims in this source category, 11 of them drowned in farm ponds and one of them drowned in a manure pit. The victims in this category were mostly aged 0–6 years.

**Table 5.** Machinery-related injuries ($n$ = 41).

| Event | Fatal | Non-fatal |
|---|---|---|
| **Agricultural and garden machinery ($n$ = 20, 49%)** | | |
| Caught in or compressed by equipment ($n$ = 5) | - | unsupervised (1) |
| | worker (2) | worker (1) |
| | bystander (1) | - |
| Fall from collapsing equipment ($n$ = 4) | extra rider (1) | extra rider (3) |
| Non-roadway incidents ($n$ = 2) | driver (2) | - |
| Roadway incidents ($n$ = 3) | other vehicle driver (1) | other vehicle passenger (2) |
| Struck by object or equipment ($n$ = 2) | unknown (1) | unsupervised (1) |
| Struck, caught, or crushed in collapsing structure, equipment, or material ($n$ = 1) | - | unsupervised (1) |
| Nonclassifiable ($n$ = 3) | extra rider (2) | - |
| | worker (1) | - |
| **Skid steer ($n$ = 17, 41%)** | | |
| Pedestrian vehicular incidents ($n$ = 8) | bystander (8) | - |
| Roadway incidents ($n$ = 2) | extra rider (1) | bystander (1) |
| Non-roadway incidents ($n$ = 5) | driver (1) | - |
| | extra rider (3) | extra rider (1) |
| Falls to lower level ($n$ = 1) | - | unsupervised (1) |
| Struck by object or equipment (1) | bystander (1) | - |
| **Conveyors – screw, auger ($n$ = 4, 10%)** | | |
| Caught in or compressed by equipment ($n$ = 3) | - | worker (3) |
| Nonclassifiable ($n$ = 1) | - | worker (1) |

### *Other sources related injury incidents*

Other injury sources were classified as fires, trailers, tanks and bins, power lines, carbon monoxide, tires, and ice. Almost three-quarters of these were fatalities.

## Discussion

This study reinforces youth agricultural-related injuries and fatalities as a problem in the United States. Moreover, AgInjuryNews.org and its data provide an important tool for understanding demographics, causes of injuries, and underlying causal factors of youth injuries. This type of information provides insights for assessing costs and other consequences of injuries and fatalities of children and adults alike, and for determining appropriate strategies to minimize risk and prevent injuries.

Of the 348 injuries reviewed, about one-third occurred to victims 6 years old or younger. Consistent with prior studies, a disproportionately high number of victims were male and 6 years old or younger.[25,26] Also consistent with past studies, our data revealed that unsupervised children, especially youth ages 0–6 years, playing near vehicles, machinery, animals, or farm structures face increased risk of injury.[26–28]

The most common injury sources were vehicles, where ATV/UTV accounted for almost half of the vehicle-related injuries. Although ATV/UTVs are designed for off-road use, one-third of the ATV injuries occurred as roadway incidents. Laws and local ordinances for "on-road" ATV/UTV use vary drastically and include such restrictions as (1) when ATV/UTVs can be used on the road, (2) who must wear a helmet, and (3) when passengers are permitted. More information on state-specific laws can be found in a study by Williams et al. (2014), which noted that state laws prohibiting on-road use have many exceptions, and it is not clear how well these laws are understood by ATV/UTV operators or law enforcement officials.[29] For example, state law in Pennsylvania prohibits the operation of general use ATV/UTVs on public roads except to cross the public road perpendicular to the roadway.[30] Exempt from this law is an ATV/UTV used exclusively for agricultural purposes, but if an ATV/UTV is used for both general (i.e., recreational) and agricultural uses, it is not exempt from the state regulation. ATV/UTV regulations such as this are often difficult to understand and remember. The occurrence of ATV/UTV injury incidents on public roads, paved and unpaved is common.[31–33] Locally administered educational campaigns for law enforcement and for farm and rural ATV/UTV operators may help reduce these types of incidents.

Youth operating tractors, roadway usage, extra riders, and unsupervised children playing nearby

were the four most common contributing factors associated with tractor injury incidents. Farm youth often operate tractors and perform work that is beyond their physical and cognitive abilities to carry out safely, and also operate or ride along in tractors with cabs, some of which were crushed flat in rollovers[34] In the United States, under the Fair Labor Standards Act, youth 14 and 15 years-of -age can legally operate tractors over 20 PTO horsepower for hire if they have completed a tractor and machinery certification training course.[35] However, there are no legal age restrictions for youth working for their parents on a family owned farm.[36] In our study, there were five youth victims aged 12-years-old or younger.

These study findings and up-to-date AgInjuryNews.org data can be used to justify prevention measures that may lead to a reduction of injuries. Given the high number of youth injuries and fatalities, program implementation strategies should be devised that target farm families with young children. Likewise, engineering research and solutions are needed to increase the visibility of children living on farms, especially when they are working or otherwise present around operating tractors, skid steers, or other machinery.

Finally, and perhaps most importantly, attention should be given, and significant investment made to keep young children out of the worksite. The data presented herein, along with past research, has shown an increased vulnerability for young children in agricultural work environments. Yet, parents continue to place children in hazardous situations, and parental attitudes toward farm safety have changed little in recent decades.[37–43] Nationally representative farmworker survey data following workers in crop agriculture indicate that child labor remains substantial.[11] Agriculture continues to be one of the least regulated industries in terms of worker and bystander safety and in terms of child labor law, and significant changes are unlikely to be seen in the near future. In lieu of any confidence in passing new legislation, health and safety professionals and researchers should further test evidence-based interventions such as safe play areas,[44] offsite child care,[45,46] and Next Generation Youth Work Guidelines[47-50] with new or beginning agriculturalists, specifically targeting millennial parents. It is through these efforts that we may have the greatest impact in successfully protecting and preserving this vulnerable population of next-generation farmers and ranchers – today's youth.

The AgInjuryNews.org system's novel pipeline approach for collecting and disseminating a steady flow of stories that humanize traditional injury data has the potential to more effectively reach and impact influencers within the Socio-Ecological Model.[51] Furthermore, these data provide contextual information missing from other data sources which can be used to determine appropriate prevention strategies. Finally, these data provide support for continued attention toward keeping young children out of the worksite, which may be essential for impacting youth health and safety in the industry.

## Limitations

Our study has several limitations. We only analyzed data from a single repository of news reports – AgInjuryNews.org. That dataset and the program's collection efforts have limitations, including that an undeterminable number of incidents are not captured through standard collection efforts.[10] Moreover, 68 cases could not be coded by FAIC due to insufficient details. Although we could not determine the FAIC code for those 68 cases, of the cases that could be coded, 21% were occupational. This finding falls between the Goldcamp et al.[6] study of 13% occupational and the Gorucu et al.[26] study of 30%. One possible explanation for the lower percentage of fatalities in the Goldcamp et al.[6] study may be because their data source (Census of Fatal Occupational Injury) was only death certificates with the location of death on a farm, and they did not use FAIC. Our study may have a lower percentage of occupational cases than the Gorucu et al. study because the AgInjuryNews.org database uses only publicly available reports such as news media, and does not manually follow-up on potential cases for multiple sources or additional details as the Gorucu et al.[26] study did. Additionally, this study's data included non-fatal injuries, while the two aforementioned did not.

At times, there are limitations with the original reporting and subsequent challenges with injury coding, a topic of a separate paper.[52] Interrater reliability was not assessed as part of this study, though this is now being systematically monitored. Further, it can be difficult to determine whether an ATV/UTV injury

incident is occupational or non-occupational because ATV/UTVs are used for both recreation and work, sometimes on the same trip. These types of incidents are often difficult to determine agricultural relatedness due to insufficiently reported details and inconclusive evidence from available geolocations data since most ATV/UTV-related injuries occur in rural areas, which are often surrounded by farmland.

Finally, news media reports are inherently inconsistent and likely to only cover newsworthy injuries. However, newsworthiness may also correlate positively with injury severity, suggesting that the most traumatic and severe injuries and fatalities are those that will be reported via news media or other public outlets such as GoFundMe, Facebook, and obituaries. These injury cases may also be valuable to health and safety stakeholders since the associated causal factors are likely those on which we should spend the most effort to prevent.

## Conclusions

This study describes traumatic youth injuries in agricultural environments available in AgInjuryNews.org. The data presented herein highlight and reconfirm previous literature describing demographics and injury variables extrapolated from news media reports. Furthermore, we demonstrate that the growing AgInjuryNews.org database is hypothesis generating, compatible with the other agricultural injury databases, and can supply up-to-date information more readily than other traditional sources such as death certificates, state surveys, or other investigative reports.

## Implications for future studies

In addition to an upcoming expansion to international data collection, we anticipate that AgInjuryNews.org will continue to expand in scope as a data delivery platform, sending customizable reports of injuries directly to stakeholders' email accounts or mobile phones.[53] Future work can further compare AgInjuryNews.org data to other databases both in terms of the reporting of youth injuries and fatalities but also those pertaining to other demographics (e.g., by age, gender, race/ethnicity, and others) in order to better understand any systematic differences across data sources. Attention to the geography of reporting will also be of interest.

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## Author contributions

All authors participated in the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; drafting the work and revising it critically for important intellectual content; final approval of the version to be submitted/published; and all agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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