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BRIEF REPORT

Non-Fatal Work-Related Farm Injuries Occurring to Michigan Adults and Youths

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ABSTRACT

Farming is one of the top industries in Michigan and has the highest fatality rate. National sources of non-fatal farm injuries underestimate the burden, especially among children. In this paper, we provide a more accurate estimate of non-fatal farm injuries in Michigan by using an ongoing multi-source surveillance system. Michigan's farm-injury surveillance system includes abstractions of hospital-based medical records, poison control center calls, ambulance runs, and workers' compensation claims for individuals with a farm-related injury. For this analysis, injury onset occurred in 2015 to 2021 and included all injuries regardless of age or occupation. We identified 4,306 injuries in adults and 336 injuries in youth. For those 0–13 years of age all but two were family members. For those 14–15 and 16–17 years of age, 19% and 45%, respectively were hired hands. For adults, 51% were owner/operators, 43% were hired hands, and 5% were family members. For all ages, the most frequent injury source was cattle. Lacerations/cuts/punctures were the most common type of injury for those < 14 years of age while for older individuals it was contusions/bruises. The plurality of injuries occurred in the summer months. Children working on a farm are in unique situation and tracking injuries and identifying injury sources provide necessary information to protect their health and well-being. Michigan's farm-injury surveillance system will continue to provide a comprehensive count of work-related injuries among Michigan's farming population. The information is used to direct public health intervention both at the individual and population level.

KEYWORDS

Agriculture; surveillance; farm injury; youth; work-related

Introduction

Farming is one of the top three industries in Michigan. It also has the highest fatality rate of any industry sector both nationally and in Michigan.[1] The national data on nonfatal work-related farm injuries is less robust, unlike fatality data which uses multiple sources, the non-fatal work-related farm injury data compiled by the Bureau of Labor Statistics (BLS) Survey of Occupational Injuries and Illness (SOII) only uses employer reports. The BLS statistic only includes hired laborers. In Michigan only 25% of farms use hired labor.[2] Further, while the BLS/SOII is not restricted by age, results for children under the age of 15 are typically not published. In fact, for Michigan between 2015 and 2020, none of the BLS estimates for those ≤17 years of age meet BLS guidelines for publication.[3] It is estimated that the BLS data for non-fatal farm injuries misses 77% of injuries and illnesses.[4,5] National estimates on children injured on the farm are available from other sources[6,7] but detailed information on the types of injures specific to Michigan have not been published. The aim of this paper is to present non-fatal work-related injuries for adults and youth in agriculture in Michigan. This is an update of our prior publication of work-related farm injuries for the years 2015 and 2016.[8]

Methods

In 2015, Michigan added surveillance of farm injuries to their previously well-established multi-source non-fatal work-related injury surveillance system.[8] As part of Michigan state regulations for traumatic injury reporting requirements, all 134 acute care hospitals, including Veterans' Administration hospitals are required to report work-related injuries. Medical

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records (i.e., hospital discharge summaries, Emergency Department (ED) and hospital-based outpatient clinic records) with personal identifiers are received, reviewed, and abstracted for the following conditions defined using the International Classification of Disease 9th/10th edition, Clinical Modification (ICD-9-CM [2015 only], ICD-10-CM): farm injuries, skull fractures, amputations, crushing injuries, and burns (Table 1) (short descriptions of the conditions are shown in supplementary Table S1). In 2017 and 2019, respectively, data from Michigan Poison Control Center (PCC) and ambulance runs started being included in the surveillance system. If the PCC call or ambulance run led to either a hospitalization or emergency department visit the medical records for the injury were requested. To identify additional cases or additional information for known cases, the data were matched with the Michigan Workers' Disability Compensation Agency lost time claim data (i.e., ≥7 consecutive days away from work) based on first name, last name, date of birth, and date of injury or hospital admission date.

Farm-related injuries with onset in 2015 through 2021 were included. We defined a farm-related injury as an individual with one of the ICD codes listed in Table 1, for whom the review of the history/physical, discharge summary, or notes in the medical record indicated their injury occurred from an agricultural activity on a farm. Injured children who were performing regular daily light work on a farm (i.e., chores) were included. Injuries related to activities around the home were not included, even if those activities occurred on a farm. We excluded the 39 injuries identified that resulted in a death. We grouped individuals age ≥18 years of age as adults and ≤17 years of age as youth. Youth cases were further split into age-groups based on the Agricultural Youth Work Guidelines (AYWG).[9] Occupation type was defined as owner/operator, hired hand (includes migrant workers), family member, and other (e.g., helping neighbor, volunteer). We were not able to determine if family members were paid or unpaid.

To account for farm owner operators and family members/unpaid workers, denominator data were obtained from 2012 Census of Agriculture in Michigan and 2017 Census of Agriculture in Michigan.[10,11] Per year, 217,552 farm workers (80,304 farm owner operators 53,797 family members/unpaid workers, and 83,451 hired farm laborers) for 2015–2016 and 212,746 farm workers (77,475 hired farm laborers 80,432 farm owner operators, and 54,839 family members/unpaid workers) for 2017–2021. Hired farm laborers included paid family members and workers in agricultural production (e.g., bookkeepers office workers maintenance workers).

Data were analyzed using RStudio R2023.03.0 with R version 4.2.3. Display quotations of over 40 words, or as needed.

Table 1. International classification of disease, clinical modification (ICD CM) codes used to identify non-fatal work-related farm injuries.

Surveillance Category	ICD-10-CM*	ICD-9-CM*
Farm Injuries	T60 (Toxic effect of pesticides, excluding self-harm: T60.0X2-4X2, T60.8X2, T60.92), T65.0 (Toxic effect of cyanides), T65.1 (Toxic effect of strychnine and its salts), V80 (transportation accidents involving animal rider/animal-drawn vehicle), V84 (transportation accidents involving agricultural vehicle), Y92.7 (farm as place of injury), W55.2–4 (contact with cow, hoofstock, or pig), W30 (contact with agricultural machine)	989.0–1 (Toxic effect of hydrocyanic acid and cyanides/strychnine and salts), E827.0–9 (Animal-drawn vehicle accident), E849.1 (Farm accidents), E906.8 (Other specified injury cause by animal), E919.0 (Accidents cause by agricultural machines)
Skull Fractures**	S02	800.0–9, 801.0–9, 802.0–9, 803.0–9, 804.0–9
Amputations**	S48, S58, S68, S78, S88, S98	885.0–1, 886.0–1, 887.0–7, 895.0–1, 896.0–3, and 897.0–7
Crushing Injuries**	S07, S17, S28, S38, S47, S57, S67, S77, S87, S97	925.1–2, 926.0–9, 927.0–9, 928.0–9, 929.0–9
Burns**	T20, T21, T22, T23, T24, T25, T26, T27, T28, T30.0, T30.4, T31, T32	940.0–9, 941.0–5, 942.0–5, 943.0–5, 944.0–5, 945.0–5, 946.0–5, 947.0–9, 949.0–5, 948.0–9

*ICD-9-CM used in for the first three quarters of 2015 and ICD-10-CM used for the fourth quarter of 2015 and 2016 through 2021.
**Only includes injuries that occurred on a farm or had a North American Industry Classification System (NAICS) 3-digit code of 111, 112, 115.

Results

A total of 4,642 injuries (4,306 adults; 336 children) with an incidence rate of 3.1 per 1,000 farm workers occurred during the study time-period. The number of injuries decreased over time (Figure 1). There were 137 individuals who suffered multiple injury events (2 events = 124 adults and 3 children; 3 events = 10 adults). Demographic information associated with each injury are provided in Table 2. The age range of injured individuals was 4 years to 98 years. Regardless of age, the majority of injured individuals were male, with the difference in distribution being smaller among the younger individuals (age ≤15 = 59% male) than the older individuals (age ≥60 = 83%). Among youth with known occupation, 82 individuals 0–13 years of age were family members and 2 worked on a neighbor's farm, while 19% (n = 11/59) and 45% (n = 50/112) of those aged 14–15 and 16–17, respectively, worked as hired hands and the rest (age 14–15: n = 48, age 16–17: n = 59) were family members. Among the 3,014 adults with known occupation, the distribution was 51% (= 1,591/3,115) owner/operators, 5% (= 146/3,115) family members, 43% (= 1,341/3,115) hired hands (including 72 migrant workers), and 1.2% (= 37/3,115) other workers.

Injury characteristics stratified by age group are provided in Table 3. Among all age groups, cattle associated injuries occurred most frequently followed by tractor associated injuries for those ≤17 years of age and other machine associate injuries for adults (Table 3). The most common injury for children ≤13 years of age was a laceration/cut/puncture followed by a contusion/bruise while the reverse was observed for those 14 to 59 years of age, contusion/bruise followed by a laceration/cut/puncture (Table 3). Fractures were the most common injury among those ≥60 years (supplementary Table S2). The highest proportion of injuries occurred on dairy farms for those 16 to 59 years of age (43% = 805/1860) and livestock farms for younger (54% = 34/62) and older (26% = 121/392) individuals (Table 3, supplementary Table S2). For 49% (= 2,289/4642) of injuries, the medical record did not contain any specification of the type of farm. For all age groups, most injuries were treated in the ED (Table 3). Although the proportion of hospitalizations, and presumably more severe injuries, increased with age. Non-skull fractures were the most common reason for an inpatient hospitalization (adults: 27% = 138/504; children: 32% = 7/22) with lower extremity injuries accounting for the majority (54% = 75/138) of fractures in adults and upper extremity injuries in children (71% = 5/7). All injuries occurred more frequently in the summer season (Table 3) defined as June – August; the highest number of injuries occurring in June and July for children aged ≤ 13 and adults, while for those aged 14–17, it was July and August.

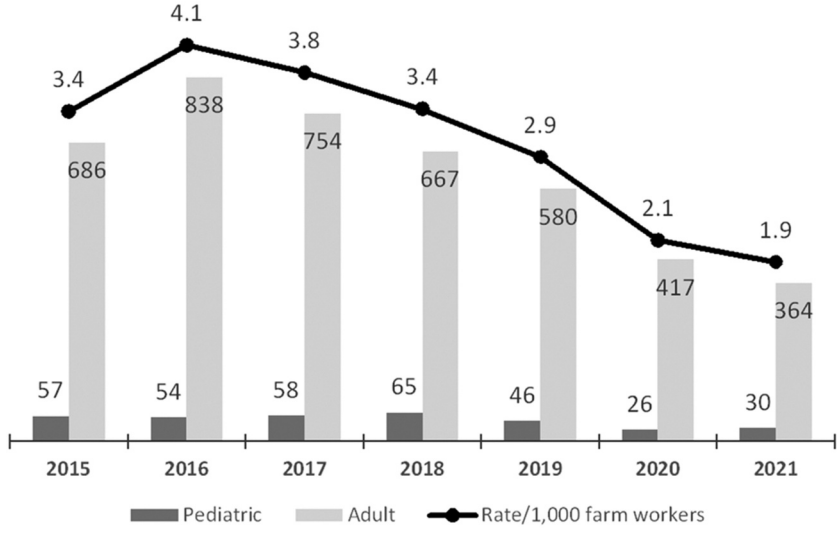

Figure 1. Non -fatal work-related farm injury counts stratified by age group and rates by year, Michigan (2015–2021). The rate per 1,000 includes all injuries. The denominator is from the 2012 census of agriculture in Michigan (2015/2016) and the 2017 census of agriculture in Michigan (2017–2021).[10,11] The denominator includes all farm workers; hired farm laborers, farm owner operators, and family members/unpaid workers.

Table 2. Demographic characteristics of individuals with a non-fatal work-related farm injury stratified by sex, Michigan (2015–2021).

Characteristic	Female	Male	Total
Total	1162 (25%)	3480 (75%)	4642 (100%)
Race			
White	540 (92.3%)	1549 (89.6%)	2089 (90.3%)
Black	8 (1.4%)	20 (1.2%)	28 (1.2%)
Asian	3 (0.5%)	2 (0.1%)	5 (0.2%)
Other	34 (5.8%)	157 (9.1%)	191 (8.3%)
Missing*	577 (49.7%)	1752 (50.3%)	2329 (50.2%)
Ethnicity			
Non-Hispanic	275 (77.9%)	730 (66.9%)	1005 (69.6%)
Hispanic	78 (22.1%)	361 (33.1%)	439 (30.4%)
Missing*	809 (69.6%)	2389 (68.6%)	3198 (68.9%)
Occupation			
Owner	378 (44%)	1214 (48.3%)	1592 (47.2%)
Family	126 (14.7%)	209 (8.3%)	335 (9.9%)
Hired Hand	345 (40.2%)	1058 (42.1%)	1403 (41.6%)
Other	10 (1.2%)	30 (1.2%)	40 (1.2%)
Missing*	303 (26.1%)	969 (27.8%)	1272 (27.4%)
Age Group (years)			
<6	5 (0.4%)	6 (0.2%)	11 (0.2%)
7–9	8 (0.7%)	14 (0.4%)	22 (0.5%)
10–11	6 (0.5%)	13 (0.4%)	19 (0.4%)
12–13	19 (1.6%)	27 (0.8%)	46 (1%)
14–15	34 (2.9%)	45 (1.3%)	79 (1.7%)
16–17	59 (5.1%)	100 (2.9%)	159 (3.4%)
18–19	70 (6%)	141 (4.1%)	211 (4.5%)
20–29	238 (20.5%)	712 (20.5%)	950 (20.5%)
30–39	230 (19.8%)	557 (16%)	787 (17%)
40–49	161 (13.9%)	481 (13.8%)	642 (13.8%)
50–59	156 (13.4%)	525 (15.1%)	681 (14.7%)
60–69	108 (9.3%)	461 (13.2%)	569 (12.3%)
70–79	53 (4.6%)	264 (7.6%)	317 (6.8%)
80–89	14 (1.2%)	122 (3.5%)	136 (2.9%)
90+	1 (0.1%)	12 (0.3%)	13 (0.3%)

*The denominator for percent of missing values are the total number of individuals within sex category and are not included in variable column percentages.

Table 3. Summary characteristics of non-fatal work-related farm injuries stratified by age group, Michigan 2015–2021.

	0–13 years	14–15 years	16–17 years	Adults	Total
Injury Source					
Cattle	28 (29.5%)	37 (46.8%)	63 (40.9%)	1224 (29.6%)	1352 (30.3%)
Other Machine	7 (7.4%)	6 (7.6%)	12 (7.8%)	455 (11%)	480 (10.8%)
Tractor	11 (11.6%)	8 (10.1%)	11 (7.1%)	351 (8.5%)	381 (8.5%)
Fall From Height	5 (5.3%)	8 (10.1%)	8 (5.2%)	347 (8.4%)	368 (8.3%)
Fall Ground Level	4 (4.2%)	3 (3.8%)	4 (2.6%)	342 (8.3%)	353 (7.9%)
Livestock*	9 (9.5%)	5 (6.3%)	11 (7.1%)	217 (5.3%)	242 (5.4%)
Tool	10 (10.5%)	4 (5.1%)	3 (1.9%)	173 (4.2%)	190 (4.3%)
Horse	4 (4.2%)	1 (1.3%)	5 (3.2%)	129 (3.1%)	139 (3.1%)
Chemical	0 (0%)	0 (0%)	6 (3.9%)	133 (3.2%)	139 (3.1%)
Struck by Falling Object	3 (3.2%)	2 (2.5%)	1 (0.6%)	29 (0.7%)	35 (0.8%)
Nail	2 (2.1%)	0 (0%)	0 (0%)	31 (0.8%)	33 (0.7%)
Insect	0 (0%)	0 (0%)	2 (1.3%)	27 (0.7%)	29 (0.7%)
Poultry	0 (0%)	0 (0%)	0 (0%)	11 (0.3%)	11 (0.2%)
Other†	12 (12.6%)	5 (6.3%)	28 (18.2%)	662 (16%)	707 (15.9%)
Missing‡	3 (3.1%)	0 (0%)	5 (3.1%)	175 (4.1%)	183 (3.9%)
Nature of Injury					
Contusion	17 (18.1%)	18 (23.7%)	40 (25.8%)	860 (21.5%)	935 (21.7%)
Laceration/Cut/Puncture	24 (25.5%)	14 (18.4%)	26 (16.8%)	582 (14.6%)	646 (15%)
Fracture	15 (16%)	8 (10.5%)	9 (5.8%)	459 (11.5%)	491 (11.4%)
Sprain/Strain	9 (9.6%)	9 (11.8%)	15 (9.7%)	364 (9.1%)	397 (9.2%)
Crush	6 (6.4%)	3 (3.9%)	15 (9.7%)	343 (8.6%)	367 (8.5%)
Head Injury (no fracture)	5 (5.3%)	2 (2.6%)	6 (3.9%)	156 (3.9%)	169 (3.9%)
Skull Fracture	3 (3.2%)	2 (2.6%)	5 (3.2%)	145 (3.6%)	155 (3.6%)

(*Continued*)

Table 3. (Continued).

	0–13 years	14–15 years	16–17 years	Adults	Total
Burn	0 (0%)	1 (1.3%)	6 (3.9%)	147 (3.7%)	154 (3.6%)
Amputation	0 (0%)	2 (2.6%)	1 (0.6%)	142 (3.6%)	145 (3.4%)
Abrasion	5 (5.3%)	1 (1.3%)	2 (1.3%)	89 (2.2%)	97 (2.2%)
Concussion	1 (1.1%)	4 (5.3%)	5 (3.2%)	57 (1.4%)	67 (1.6%)
Animal Bite	0 (0%)	0 (0%)	5 (3.2%)	53 (1.3%)	58 (1.3%)
Dislocation	1 (1.1%)	1 (1.3%)	0 (0%)	39 (1.0%)	41 (0.9%)
Other†	8 (8.5%)	11 (14.5%)	20 (12.9%)	555 (13.9%)	594 (13.8%)
Missing‡	4 (4.1%)	3 (3.8%)	4 (2.5%)	315 (7.3%)	326 (7.0%)
Body Part					
Upper Extremity	33 (34%)	32 (40.5%)	59 (38.3%)	1578 (37.7%)	1702 (37.7%)
Lower Extremity	31 (32%)	25 (31.6%)	42 (27.3%)	1033 (24.7%)	1131 (25%)
Back	4 (4.1%)	1 (1.3%)	8 (5.2%)	340 (8.1%)	353 (7.8%)
Chest/abdomen	3 (3.1%)	5 (6.3%)	8 (5.2%)	265 (6.3%)	281 (6.2%)
Head	5 (5.2%)	2 (2.5%)	6 (3.9%)	166 (4%)	179 (4%)
Vision	4 (4.1%)	0 (0%)	2 (1.3%)	120 (2.9%)	126 (2.8%)
Respiratory¶	0 (0%)	0 (0%)	1 (0.6%)	21 (0.5%)	22 (0.5%)
Hearing	0 (0%)	2 (2.5%)	0 (0%)	2 (0%)	4 (0.1%)
Other	17 (17.5%)	12 (15.2%)	28 (18.2%)	664 (15.9%)	721 (16.0%)
Missing‡	1 (1%)	0 (0%)	5 (3.1%)	117 (2.7%)	123 (2.6%)
Farm Type					
Dairy	7 (23.3%)	6 (18.8%)	30 (47.6%)	853 (38.3%)	896 (38.1%)
Livestock**	19 (63.3%)	15 (46.9%)	19 (30.2%)	525 (23.6%)	578 (24.6%)
Grain	0 (0%)	5 (15.6%)	2 (3.2%)	189 (8.5%)	196 (8.3%)
Fruit	1 (3.3%)	1 (3.1%)	5 (7.9%)	168 (7.5%)	175 (7.4%)
Vegetable	0 (0%)	4 (12.5%)	1 (1.6%)	145 (6.5%)	150 (6.4%)
Poultry	0 (0%)	0 (0%)	1 (1.6%)	73 (3.3%)	74 (3.1%)
Other†	3 (10%)	1 (3.1%)	5 (7.9%)	275 (12.3%)	284 (12.1%)
Missing‡	68 (69.4%)	47 (59.5%)	96 (60.4%)	2078 (48.3%)	2289 (49.3%)
Seasonality††					
Spring	13 (13.3%)	18 (22.8%)	31 (19.5%)	1046 (24.3%)	1108 (23.9%)
Summer	44 (44.9%)	41 (51.9%)	77 (48.4%)	1353 (31.4%)	1515 (32.6%)
Fall	29 (29.6%)	12 (15.2%)	29 (18.2%)	1117 (25.9%)	1187 (25.6%)
Winter	12 (12.2%)	8 (10.1%)	22 (13.8%)	790 (18.3%)	832 (17.9%)
Visit Type					
ED	90 (91.8%)	68 (86.1%)	145 (91.2%)	3567 (83.1%)	3870 (83.6%)
Inpatient	7 (7.1%)	6 (7.6%)	9 (5.7%)	504 (11.7%)	526 (11.4%)
Outpatient	1 (1%)	5 (6.3%)	3 (1.9%)	154 (3.6%)	163 (3.5%)
Other†	0 (0%)	0 (0%)	2 (1.3%)	68 (1.6%)	70 (1.5%)
Missing‡	0 (0%)	0 (0%)	0 (0%)	13 (0.3%)	13 (0.3%)

*Sheep, goats, pigs/hogs, donkeys, mules, llamas, alpacas … etc.

†Examples of *Injury Source = Other* include bite by rat, injured baling hay/shoveling manure, injured on gate or other stationary object, lifting heavy objects, fire, repetitive motion. Examples of *Nature of Injury = Other* included anaphylaxis, hyperthermia/hypothermia, carbon monoxide/pesticide poisoning, Examples of *Nature of Injury = Other* included anaphylaxis, hyperthermia/hypothermia, carbon monoxide/pesticide poisoning. Example of *Farm Type = Other* include NAICS = 111998 (all other miscellaneous crop farming), NAICS = 115113 (crop harvesting, primarily by machine), NAICS = 111422 (Floriculture Production), NACIS = 111419 (Other Food Crops Grown Under Cover), Christmas tree farms, and Cannabis farming. Examples of *Visit Type = Other* include poison control center reports, surgery centers, urgent care locations, emergency department overnight observation but not hospitalized.

‡The denominator for percent of missing values is the total number of individuals within sex category and are not included in variable column percentages. ¶An inhalation injury to the lung such as shortness of breath or bronchitis from dust, fire, diesel fuel, or pesticide.

**Farms where the main activity is animal production excluding dairy farms and poultry farms.

††Spring = March, April, May; Summer = June, July, August; Fall = September, October, November; Winter = December, January, February.

Discussion

Michigan's multi-source non-fatal injury surveillance system provides a comprehensive count of work-related injuries among Michigan's farming population that is used to direct public health intervention. The system captures injuries regardless of farm employment size or if the injured individual was paid or unpaid. This analysis presents follow-up data from the initial report of 2015 and 2016 data from our ongoing farm injury surveillance system.[8] The number of work-related farm injuries has shown a consistent decline since 2017 (Figure 1). The distribution of farm injuries across the presented data elements were similar to our prior analysis. Cattle-associated

injuries remained the most common injury source, followed by non-tractor machines. However, tractors moved from the fifth position to replace fall from height as the third most common injury source. Contusions/bruises continued to be the most common injury type while lacerations/cuts/punctures switched places with fractures to be the second most common injury type. Fractures remained the most common reason for an inpatient hospitalization.

This is the first Michigan paper to provide information on work-related injury characteristics for children in farming, filling a previously identified gap for pediatric surveillance data.[12] Among children, we observed an increasing number of injuries in older youths, likely reflecting the additional job duties children were given as they grew older. For instance, the AYWG recommends that children younger than 10 years of age wait until they are older to work with livestock.[9] Cattle related injuries among youth in Michigan were largest for the 16- to 17-year age-group and we only observed three children under the age of 10 injured in this manner. Two recent studies using trauma registry data have also reported animal injuries as the most common source.[13,14] while one reported tractors/vehicles first then animal associated injuries.[15] As with our hospitalizations, fractures.[13,14] and upper extremities injuries.[15] were the most common.

Michigan's non-fatal work-related farm injury surveillance system has several limitations. The system doesn't capture injuries where the patient sought care at non-hospital associated facilities such as a primary care office, urgent care facility, or migrant health clinic. The system is, in part, dependent on external cause of injury codes, which are not required for billing purposes and their usage varies by hospital. Data availability in the medical records also varies resulting in some elements (e.g., race/ethnicity) having large amounts of missing data. When the amount of missing data are greater than 10% (i.e., race/ethnicity, occupation, and farm type), the results should be interpreted with caution as there may be bias in the information included in the medical records. Also lack of specificity on farm type in the medical records many times does not provide sufficient detail to direct interventions (e.g., dairy vs beef cattle). The system does not capture pediatric injuries among those not actively involved in farm work (e.g., playing or recreation). Two prior national studies have reported that work-related injuries only comprise 13% to 34% of pediatric non-fatal injuries occurring on a farm.[6,7] Horse-related injuries are not included since we found it was too labor intensive to review all the medical records associated with ICD-10-CM code W55.1 (contact with a horse) since the vast majority of these injuries were from recreational use of a horse. Due to these limitations the numbers presented here should be considered an underestimate of all non-fatal work-related farm injuries but rather an estimate of severe non-fatal work-related farm injuries (i.e., required a hospital/ED visit).

The results of Michigan's farm-injury surveillance system include personal identifiers and provide a valuable source for both population level (e.g., education materials) and individual level interventions. Two examples of educational material written and disseminated are hazard alerts on safe animal handling.[16] and farm-related machine entanglement.[17] Examples of individual level interventions are the 204 letters sent to farmers who suffered disabling injuries informing them of Michigan State University Extension's United States Department of Agriculture (USDA) funded AgrAbility program, which provides assistive technology to farmers with disabilities. Michigan's Occupational Safety and Health Association (MIOSHA) has completed eight enforcement inspections from referrals of injuries identified in the surveillance system. We will continue to conduct surveillance in Michigan of non-fatal work-related injuries occurring on farms.

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Disclosure statement

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References

1. U.S. Department of Labor, Bureau of Labor Statistics. Fatal injury rates by state of incident and industry, all ownerships, 2021. https://www.bls.gov/iif/state-data/fatal-injury-rates-by-state-and-industry-2021.htm. Published December 16, 2022. Accessed July 26, 2023.
2. U.S. Department of Agriculture, National Agricultural Statistics Service. 2017. Census of agriculture, state profile: Michigan. https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/Michigan/cp99026.pdf. Accessed July 23, 2023.
3. Occupational Injuries/Illnesses and Fatal Injuries Profiles [Internet]. *Washington DC: United States Department Of Labor, Bureau Of Labor Statistics*. https://data.bls.gov/gqt/ProfileState. Accessed July 24, 2023.
4. Leigh JP, Du J, McCurdy SA. An estimate of the U.S. government's undercount of nonfatal occupational injuries and illnesses in agriculture. *Ann Epidemiol*. 2014;24(4):254–259. doi:10.1016/j.annepidem.2014.01.006.
5. Picciotto I, Beatty T, Hill AE. Estimating the nonfatal injury undercount in agriculture from 2004 to 2019. *J Agric Saf Health*. 2022;28(3):161–202. doi:10.13031/jash.15039.
6. Hendricks KJ, Hendricks SA, Layne LA. A national overview of youth and injury trends on U.S. Farms, 2001-2014. *J Agric Saf Health*. 2021;27(3):121–134. doi:10.13031/jash.14473.
7. Weichelt BP, Gorucu S, Burke RR, Salzwedel MA, Murphy DJ, Lee BC. Agricultural youth injuries: an updated review of cases from U.S. news media reports, 2016–2021. *Front Public Health*. 2022;10(10):1045858. doi:10.3389/fpubh.2022.1045858.
8. Kica J, Rosenman KD. Multisource surveillance for non-fatal work-related agricultural injuries. *J Agromed*. 2020;25(1):86–95. doi:10.1080/1059924X.2019.1606746.
9. National Children's Center for Rural and Agricultural Health and Safety (NCCRAHS). *Agricultural Youth Work Guidelines*. https://cultivatesafety.org/safety-guidelines-search/?category=familyyouth. Accessed July 23, 2023.
10. U.S. Department of Agriculture, National Agricultural Statistics Service. 2012 Census of agriculture, volume 1 chapter 1: state level data, Michigan. *Table 68. Summary By North American Industry Classification System: 2012*. https://agcensus.library.cornell.edu/wp-content/uploads/2012-Michigan-st26_1_068_068.pdf. Accessed July 20, 2023.
11. United State Department of Agriculture, National Agricultural Statistics Service. 2017. Census of agriculture, volume 1 chapter 1: state level data, Michigan. *Table 75. Summary By North American Industry Classification System: 2017*. https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_1_State_Level/Michigan/. Accessed July 20, 2023.
12. Lee BC, Salzwedel MA. Safeguarding youth from agricultural injury and illness: the United States' experience. *Front Public Health*. 2023;11(11):1048576. doi:10.3389/fpubh.2023.1048576.
13. Rathje C, Venegas A, Helmer SD, et al. Pediatric farm injuries: morbidity and mortality. *Kans J Med*. 2017;10(4):92–95. PMCID: PMC5733402. doi:10.17161/kjm.v10i4.8670.
14. Gilblom EA, Johnson AB, Sahr S, et al. Children and youth agricultural injuries: a retrospective analysis of pediatric trauma admissions in North Dakota. *Heliyon*. 2023;9(6):e16626. doi:10.1016/j.heliyon.2023.e16626.
15. Gorucu S, Michael J, Chege K. Nonfatal agricultural injuries treated in emergency departments: 2015-2019. *J Agromed*. 2022;27(1):41–50. doi:10.1080/1059924X.2021.1913271.
16. Michigan State University (MSU), Division of Occupational and Environmental Medicine. Hazard alert: safe animal handling to prevent farm-related injuries and deaths. https://oem.msu.edu/images/Alerts/AnimalHazardAlert.pdf. Published August 2017. Accessed July 23, 2023.
17. Michigan State University (MSU), Division of Occupational and Environmental Medicine. *Hazard Alert: Farm-Related Machinery Entanglements In Michigan*. https://oem.msu.edu/images/Alerts/RotatingMachineryHazardAlert.pdf. Published August 2017; Accessed July 23, 2023.