

Fatal Agricultural Injuries in Pennsylvania, 2015-2017: A Comparative Analysis of Two Systems' Data Collection Methods and Datasets



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ABSTRACT. *The purpose of this study was to assess and compare 2015-2017 Pennsylvania agricultural fatal injury data and methods from two separate sources: the Pennsylvania Farm Fatality (PA-FF) dataset and the national AgInjuryNews (AIN) dataset. Between January 1, 2015, and December 31, 2017, a total of 104 agricultural fatalities were identified in Pennsylvania across both systems. Differences between the two systems included coding, such as victim age and demographics, as well as inclusion criteria, such as the time between the incident and victim death. Of the 104 agricultural fatalities, 73% were identified through the PA-FF dataset, and 53% were identified through the AIN dataset. AIN included a higher proportion of female victims and roadway incidents, whereas PA-FF included a significantly higher proportion of the identified Anabaptist cases ($\chi^2 = 22.329$, $df = 2$, $p < 0.001$). Although PA-FF may have an advantage by including death certificates, this study revealed that PA-FF alone missed mortality data and certain risk factors, such as roadway fatalities related to farm equipment. When comparing two datasets, the inclusion criteria should be considered. Supplemental surveillance programs such as these would benefit from a periodic review between two or more datasets to ensure that agricultural fatalities are captured more accurately.*

Keywords. *Agriculture, Fatality, Injury surveillance.*

Injury surveillance in the public health field is generally defined as an ongoing, systematic collection and interpretation of injury data (Holder et al., 2001). Such efforts provide evidence for the allocation of resources to support prevention efforts by assisting health and safety professionals with effectively planning and delivering relevant programs to specific targeted populations. Injury surveillance data can be collected in a number of ways, including interviews, surveys, patient health records, death certificates,

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and agency reports, such as traffic accidents and insurance claims, including workers' compensation (Pinzke et al., 2018; Bonauto et al., 2003; Pate and Merryweather, 2012; Patel et al., 2017; Kim et al., 2018; VanWormer et al., 2017; Forst and Erskine, 2009; Scott et al., 2015, 2017; Denning and Jennissen, 2018; Carnedas et al., 2018; Rautianien et al., 2005, 2009). Each method of data collection can provide information and insights needed for targeted intervention.

Currently, there is no active, national level, systematic injury surveillance program for farm and agriculture-related injuries of adults or children (Marlenga et al., 2018). The National Institute of Occupational Safety and Health (NIOSH) discontinued its periodic agricultural injury surveys in 2015 (NIOSH, 2018). The decision to discontinue was linked to the declining size of the U.S. agricultural workforce, the number of work-related injuries in recent years, limited federal funding, and the lack of a national injury surveillance program at the time (NIOSH, 2018; Murphy and Lee, 2018). However, the agriculture, forestry, and fishing (AgFF) sector remains the most hazardous industry sector in the U.S. based on fatal occupational injury rates. According to the U.S. Census of Fatal Occupational Injuries (CFOI), the 2016 rate of fatal injuries was highest for the AgFF sector, at 23.2 fatal injuries per 100 000 full-time equivalent (FTE) workers (BLS, 2018a). From 2015 through 2017, the CFOI data for Pennsylvania's AgFF sector included 48 fatalities (11, 17, and 20 fatalities in 2015, 2016, and 2017, respectively) (BLS, 2018b). Even with national surveillance efforts such as CFOI, Leigh et al. (2014) documented that agricultural injury cases are likely underreported, leaving significant gaps in agricultural injury surveillance data.

Regional and state-based programs have been initiated to help supplement injury surveillance gaps by tracking media reports such as Google Alerts and subscription-based media crawler services (Wickman, 2015; Field, 2015; Weichelt and Gorucu, 2018; Riedel and Field, 2013; Ehlers and Field, 2017; Marlenga et al., 2017). These surveillance efforts allow researchers to develop a more complete picture of safety issues in agriculture, particularly for special populations such as youth and Anabaptist (Plain Sect). In January 2015, the National Farm Medicine Center (NFMC) in Marshfield, Wisconsin, began development of AgInjuryNews, a national collection of news reports on agricultural injuries (<https://aginjurynews.org>; Weichelt et al., 2018). AgInjuryNews provides injury data, search tools, and filters for directing users to original sources of publicly available news on injuries and fatalities, including print media articles, obituaries, social media, and similar electronic news sources (Weichelt et al., 2018). In Pennsylvania, statewide farm and agriculture-related fatal injury data have been collected by Penn State's Agricultural Safety and Health Program since 1980 using a print and electronic news clipping service and through collection of death certificates through the state's Office of Vital Statistics. Fatal injuries in agriculture continue to be a significant concern, as the database contains records on more than 500 fatal injury cases in Pennsylvania for the years 2000 through 2017.

Differences between state, local, and national efforts, such as coding methods and definitions of terms, may complicate the comparison of data regarding the magnitude, representativeness, and distribution of agricultural injuries (Murphy et al., 2018). While many state programs have made efforts in injury surveillance, these efforts have struggled for recognition as a critical component of agricultural safety and health programming. This study is a collaborative project between Penn State and the National Farm Medicine Center to assess and compare the 2015-2017 Pennsylvania agricultural fatal injury data and methods from two data collection systems: (1) the Pennsylvania Farm Fatality (PA-FF) dataset and (2) the national AgInjuryNews (AIN) dataset.

Methods

Pennsylvania Farm Fatality Dataset

Data sources for the PA-FF dataset include death certificates from the Pennsylvania Department of Health's Office of Vital Statistics, police and coroner reports, a newspaper and media clipping service, and reports of farm-related injury incidents by county agricultural and extension educators and rural volunteer emergency medical service (EMS) providers. Similar to the methods used by the Bureau of Labor Statistics, multiple sources of information are used to clarify and confirm details of injury cases before entering each case into the database. Penn State's Institutional Review Board (IRB) and the Pennsylvania Department of Health approved the procedures used for collecting and storing injury data.

National AgInjuryNews Dataset

Designed for public use, the AIN dataset is available through a web-based system that provides interactive searches of publicly available injury data, most often derived from news media, obituaries, social media (e.g., Facebook and GoFundMe), and police reports. At the time of this writing the AIN dataset had nearly 4,000 agriculture-related injury reports spread across 36 years, 54% of which were from 2015-2018 (AgInjuryNews, 2018). Thus, we chose to analyze both systems' most complete datasets (i.e., from 2015-2017). The Marshfield Clinic Research Institute's IRB approved the AIN methods for collection and storage of injury data. To keep the search terms relevant with advances in technology in the agriculture industry, the AIN data collection team periodically reviews and revises the AgFF-related definitions and inclusion criteria with input from a 15-member national steering committee (Weichelt et al., 2018).

Features of the two data collection systems are shown in table 1. Major differences be-

Table 1. Characteristics of the two data systems, 2015-2017.

Feature		PA-FF	AIN
Data sources	Google Alerts	X	X
	Media clipping subscription service	X	X
	Colleague submissions	X	X
	Social media (e.g., Facebook, GoFundMe)	-	X
	Death certificates	X	-
	Police and coroner reports	X	-
	County agricultural and Extension educators	X	-
	Rural volunteer emergency medical services	X	-
Coding scheme	Occupational Injury and Illness Classification System (OIICS)	X	X
	Farm and Agricultural Injury Classification (FAIC)	X	Partly
Victim variables	Age	Continuous	Categorical
	Gender	X	X
	Religious sect (Anabaptist or not)	X	Partly
	Agent of injury	X	X
Incident variables	Location	X	X
	Incident date	X	X
	Publication date	X	X
	Date of death (if applicable)	X	X
Injury severity	Fatal	X	X
	Non-fatal	-	X
Inclusion criteria	Death occurred less than 30 days after the incident	X	-
	No time limit between incident and death	-	X
	Multiple sources required to verify	X	-

tween the two datasets were in their data sources, victim variables, injury severity, and inclusion criteria.

Data Matching Procedures

We used fatality data from the PA-FF dataset for 2015 through 2017. For the study years 2015-2017, the AIN data for Pennsylvania were searched and exported, and only fatal cases were included. Fatalities from the PA-FF data were matched iteratively with the AIN Pennsylvania fatalities using a spreadsheet. To make the victim ages comparable, the PA-FF victims' specific ages were converted to the age categories used for the AIN cases (i.e., 0-6, 7-9, 10-12, 13-15, 16-17, and 18 years and older). Date of incident, county of incident, age category, and description of incident were used to identify matching cases.

Results and Discussions

For the years 2015-2017, a total of 104 agricultural fatalities were identified in Pennsylvania. The numbers of fatalities by study year for matched cases, PA-FF only, and AIN only are shown in table 2. Of the 104 fatalities, 73% were identified through PA-FF, and 53% were identified through AIN. The agreement in reporting between PA-FF and AIN was only 26%, meaning that only 26% of all known agricultural fatalities were identified in both data sources. There were 49 cases in PA-FF that were not recorded in the AIN dataset, and 28 fatality cases in AIN were not recorded in the PA-FF dataset.

Table 3 shows results of the descriptive statistical analysis of selected variables. The gender and categorical age variables for matched cases were identical between the two datasets. However, examination of the demographic information revealed considerable differences between the two datasets. A larger proportion of victims age 18 and older was captured by PA-FF than by AIN (61% vs. 20%). AIN used a single age group category for victims age 18 years and older; therefore, we could not make more detailed age group comparisons between datasets. Victims age 65 and older are identified in PA-FF, and there were 27 fatalities in this age group during the study years (data not shown in table 3). Reporting between the data sources also differed by gender. A larger proportion of female victims was captured by AIN than by PA-FF (65% vs. to 18%).

There were 19 Anabaptist victims identified by the PA-FF and AIN datasets combined. The PA-FF dataset identified 18 victims as Anabaptist, while AIN contained 15 of the 19 victims but only coded two of them as Anabaptist. The PA-FF dataset uses multiple sources of information to determine if victims have an association with an Anabaptist sect. Indications of this association include statements in newspaper, media, and investigative reports, place of burial, and follow-up contact with local extension educators. There was only one Anabaptist fatality in AIN that was not captured by PA-FF.

The distribution of the fatalities by source shows that the cases identified by both datasets were dominated by off-road and industrial vehicles, which includes farm tractors and all-terrain vehicles. OIICS injury sources at the two-digit level (major division) for the

Table 2. Agreement between PA-FF and AIN datasets, 2015-2017.^[a]

Year	Matched	PA-FF Only	AIN Only	Total
2015	8 (27.6%)	19 (65.5%)	2 (6.9%)	29
2016	9 (23.1%)	18 (46.2%)	12 (30.8%)	39
2017	10 (27.8%)	12 (33.3%)	14 (38.9%)	36
Total	27 (26.0%)	49 (47.1%)	28 (26.9%)	104

^[a] $\chi^2 = 10.192$, $df = 4$, $p = 0.037$.

Table 3. Comparison of Pennsylvania farm fatalities, 2015-2017.

Variable	Matched (n = 27)	PA-FF Only (n = 49)	AIN Only (n = 28)	Total (n = 104)
Gender ($\chi^2 = 15.062$, df = 2, p < 0.001)				
Male	24 (27.6%)	46 (52.9%)	17 (61%)	87 (83.7%)
Female	3 (17.6%)	3 (17.6%)	11 (64.7%)	17 (16.3%)
Age ($\chi^2 = 30.078$, df = 12, p = 0.003)				
0-6	8 (50.0%)	2 (12.5%)	6 (37.5%)	16 (15.7%)
7-9	2 (50.0%)	-	2 (50.0%)	4 (3.9%)
10-12	-	1 (33.3%)	2 (66.7%)	3 (2.9%)
13-15	1 (50.0%)	-	1 (50.0%)	2 (2.0%)
16-17	1 (100%)	-	-	1 (1.0%)
18 and older	15 (19.7%)	46 (60.5%)	15 (19.7%)	76 (74.5%)
Missing age ^[a]	-	-	2	2
Religion ($\chi^2 = 22.329$, df = 2, p < 0.001) ^[b]				
	PA-FF	AIN		
Anabaptist	13 (68.4%)	1	5 (26.3%)	19 (27.7%)
Non-Anabaptist	14 (16.5%)	26	44 (51.8%)	85 (81.7%)
Injury source (OIICS)				
Containers	-	-	1 (100%)	1 (1.0%)
Agricultural and garden machinery	4 (50.0%)	4	3 (37.5%)	8 (7.7%)
Construction, logging, mining machinery	3 (42.9%)	2	4 (57.1%)	7 (6.7%)
Material and personnel handling machinery	-	-	1 (100%)	1 (1.0%)
Vehicle and mobile equipment parts	2 (100%)	2	-	2 (1.9%)
Animals	1 (20.0%)	1	4 (80.0%)	5 (4.8%)
Animal and plant byproducts	1 (100%)	1	-	1 (1.0%)
Person other than injured or ill worker	-	-	1 (50.0%)	1 (50.0%)
Plants, trees, and vegetation, not processed	-	-	5 (62.5%)	3 (37.5%)
Structures and surfaces, unspecified	-	-	1 (100%)	1 (1.0%)
Confined spaces	-	-	1 (50.0%)	1 (50.0%)
Structures other than buildings	-	-	1 (100%)	1 (1.0%)
Geographical structures	-	-	1 (50.0%)	1 (50.0%)
Highway vehicles, motorized	1 (10.0%)	2	5 (50.0%)	4 (40.0%)
Animal- and human-powered vehicles	2 (66.7%)	2	1 (33.3%)	3 (2.9%)
Off-road and industrial vehicles, powered	12 (29.3%)	12	19 (46.3%)	10 (24.4%)
Environmental and elemental conditions	1 (11.1%)	1	1 (11.1%)	7 (77.8%)
Event/exposure type (OIICS)				
Animal and insect-related incidents	1 (20.0%)	4 (80.0%)	-	5 (4.8%)
Pedestrian vehicular incident	4 (66.7%)	2 (33.3%)	-	6 (5.8%)
Roadway incidents, motorized vehicle	2 (18.2%)	3 (27.3%)	6 (54.5%)	11 (10.6%)
Nonroadway incidents, motorized vehicles	12 (31.6%)	19 (50.0%)	7 (18.4%)	38 (36.5%)
Fires	1 (11.1%)	1 (11.1%)	7 (77.8%)	9 (8.7%)
Explosions	2 (100%)	-	-	2 (1.9%)
Falls to lower level	-	5 (71.4%)	2 (28.6%)	7 (6.7%)
Struck by object or equipment	4 (22.2%)	11 (61.1%)	3 (16.7%)	18 (17.3%)
Caught in or compressed by equipment or objects	-	1 (50.0%)	1 (50.0%)	2 (1.9%)
Struck, caught, or crushed in collapsing structure, equipment, or material	1 (33.3%)	1 (33.3%)	1 (33.3%)	3 (2.9%)
Rubbed, abraded, or jarred by vibration	-	1 (100%)	-	1 (1.0%)
Nonclassifiable	-	1 (50.0%)	1 (50.0%)	2 (1.9%)

^[a] Missing variables were not included in percentages and chi-squared calculations.

^[b] Only matched incidents from PA-FF were used to calculate the percentages and chi-squared values.

matched cases were identical for the PA-FF and AIN datasets except for one case. One source classified under “Construction, logging, and mining machinery” was coded as “Highway vehicles, motorized”. For this specific case, PA-FF had an additional data source indicating that the vehicle involved in the incident was a skid steer, which is classified

under “construction, logging, and mining machinery” by OIICS source category.

All matched cases from the PA-FF and AIN datasets were identical for the event/exposure type. The distribution of the event/exposure types were mainly non-roadway transportation incidents for both datasets. AIN captured a higher number of roadway fatalities involving farm vehicles and fire-related fatalities, while PA-FF captured a higher number of animal-related incidents, non-roadway transportation incidents, falls, and incidents in which the victim was struck by an object or equipment (table 3).

Conclusions and Implications for the Future

This study has demonstrated that collaboratively matching different databases can provide more accurate and complete information on agricultural fatalities than is available through either individual database. This study also highlights some gaps in the collection methods of both systems. Further research is needed, including an expanded analysis of individual cases and specific search criteria and terminologies.

There were differences between the inclusion criteria of the PA-FF and AIN datasets. PA-FF excludes fatalities related to farm house fires, farm equipment incidents in welding shops, tractor-related incidents not involving agricultural purposes, and cases in which more than 30 days elapsed between the incident and the time of death.

Furthermore, PA-FF excludes incidents that occurred away from the agricultural operation, e.g., a farm machinery technician injured while performing repairs in an off-site workshop, rather than on the farm. After assessing multiple sources of information, this case was determined to be unrelated to AgFF and thus was not included in the PA-FF dataset. Normally, the AIN would also exclude this case; however, in coding it from only one report, the AIN team opted to include it until more details were identified to overturn the initial decision. Similarly, we identified several roadway incidents involving farm equipment that were captured by AIN but not by PA-FF.

The larger proportion of adult victims and the larger proportion of cases involving Anabaptist or Plain Sect recorded by PA-FF may be explained in part by manual follow-ups and submissions from colleagues and Extension offices, while AIN relies more heavily on traditional media reports. Likewise, the larger proportion of female and youth victims recorded by AIN may be explained in part by the newsworthiness of cases involving victims from these two populations.

Victim ages in PA-FF are recorded as a continuous variable, while AIN records age data as a categorical variable, with only one category for victims age 18 years and older. More than one-third of the agricultural fatalities in Pennsylvania were in the 65 and older age group (34%), and this age group could only be identified in PA-FF (Gorucu et al., 2015). The 2018 redesign of the AIN system includes victim age as a continuous variable, as well as search and filter functions.

This study also highlighted PA-FF’s case validation approach, in which the PA-FF team reviews multiple reports from different sources prior to entering a case into the database. Although time-consuming and costly, this process likely yields improved data quality. To improve the reliability and quality of the national dataset, the AIN team will likely explore options for multiple report collection, including collaborative multi-site data reviews, in the future.

Finally, combining these two datasets provided a more robust and valid recording of Pennsylvania fatalities, i.e., 104 total fatalities from 2015 through 2017. The PA-FF data

collection efforts, including a multi-source approach developed through decades of relationships built across the state, may be a model for success at the state level. These methods, combined with informatics-based approaches leveraging emerging information technology (e.g., Google Alerts, paid media subscription services, and social media data mining) can build a more complete dataset to guide injury prevention efforts. Future national collection strategies should consider including state and regional data as it becomes available from collaborative state and regional sources.

Limitations

Several limitations must be acknowledged. The different inclusion criteria used by AIN and PA-FF precluded some cases from inclusion in both datasets. Both datasets rely on several data sources, including news media. Due to its national scope, AIN relies more heavily on digital media and conducts limited follow-ups of individual cases. This study was conducted for agricultural fatalities in Pennsylvania; other states' agricultural fatality datasets can be compared to the AIN dataset to generalize the results and suggestions.

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