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Comparison of agricultural injuries reported in the media and census of fatal occupational injuries

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ABSTRACT

The Bureau of Labor Statistics (BLS) publishes annual statistics on occupational injuries and fatalities in the United States. The BLS fatality data include all agricultural workers while the non-fatal injury data only cover hired employees on large farms. In 2012, the Central States Center for Agricultural Safety and Health (CS-CASH) began collecting regional media monitoring data of agricultural injury incidents to augment national statistics. The aims of this report were: a) to compare CS-CASH injury and fatality data collected via print and online sources to data reported in previous studies, and b) to compare fatality data from media monitoring to BLS Census of Fatal Occupational Injuries (CFOI) data. CS-CASH media monitoring data were collected from a news clipping service and an internet detection and notification system. These data covered years 2012–2017 in seven Midwestern states (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota). CS-CASH occupational fatality data were compared with aggregate CFOI data for the region during 2012–2015. Media monitoring captured 1048 injury cases; 586 (56%) were non-fatal and 462 (44%) were fatal. The numbers of occupational fatality cases from media monitoring and CFOI were nearly identical (280 vs. 282, respectively), and the distributions by type of injury were similar. Findings suggest that media monitoring can capture equal numbers of fatalities compared to CFOI. Non-fatal injuries, not captured by national surveillance systems, can be collected and tracked using print and electronic media. Risk factors, identified in media sources, such as gender, age, time, and source of the incident are consistent with previously reported data. Media monitoring can provide timely access to detailed information on individual cases, which is important for detecting unique and emerging hazards, designing interventions and for setting policy and guiding national strategies.

KEYWORDS

Fatality; CS-CASH monitoring database; CFOI; Agricultural injuries; Midwestern states

Introduction

The agriculture, forestry and fishing occupational sector is among the most hazardous in the United States (US). Unlike in many other occupations, the fatality rate in agriculture has not declined in the past two decades, remaining persistently over 20 fatalities per 100,000 workers each year.[1] Agricultural workers also rank amongst the highest occupations for non-fatal injuries.[2,3] Common sources of injury include livestock, agricultural machinery, vehicles (tractors, trucks, and all-terrain vehicles), grain bins, silos, confined spaces, manure pits, and ladders.[4] Beyond physical and mental distress, these incidents can have a major economic impact on the family and the farm operation, including uncovered medical expenses, lost work time and reduced productivity. Fatalities and injuries in agricultural workers constitute a significant public health challenge.

Beginning in 2012, the Central States Center for Agricultural Safety and Health (CS-CASH), a NIOSH-funded agricultural safety and health center based at the University of Nebraska Medical Center (UNMC), created a database to track agricultural injury and fatality cases reported in the media. Cases were obtained from the internet and print media sources. Similar media monitoring systems have been utilized elsewhere to augment injury data collection.[5] As the media is transforming from print to electronic formats, it is not well understood how this transition affects reporting of agricultural injuries. Local newspaper

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reporters are often the primary source for identifying farm injury incidents. Cases may be reported in printed papers, online news, or both.

The aims of this report were to analyze 6 years of agricultural injury and fatality data (2012–2017) collected via two media sources a) to summarize information on incidents in a seven-state region in the Midwest, b) to compare data collected via news clipping service and internet media sources to previously reported risk factors, and c) to determine whether the number and types of fatalities collected from the media over a 4-year period (2012–2015) were comparable to those reported by the BLS CFOI system.

Methods

Data collection

Injury and fatality case data were obtained from two sources: news clipping service and internet detection and notification system. Both systems used keywords to identify reports of agricultural injuries and fatalities in the CS-CASH region (IA, KS, MN, MO, NE, ND and SD). Within this region, there are approximately 1700 daily newspapers, non-daily papers, magazines, and trade journals. CS-CASH contracted with an agricultural safety expert to select, extract, and code incidents from a news clipping service (Newz Group, Columbia, MO). These data were primarily from print media sources. CS-CASH staff entered the identified cases into a database on a monthly basis. Electronic media reports were obtained by CS-CASH staff using an internet content detection and notification service (Google Alerts). The service sends emails to a user when it finds new results that match the user's search terms. An extensive list of search terms (n = 1040 combinations), matching those used in the print media source, was employed in the Google Alert system. Examples include "agricultural accident", "farm death", "ranch accident", "tractor overturn", and "grain bin death". Links to articles received from the Google Alert system were screened for relevance. Incidents were extracted, coded, and compiled into the CS-CASH media monitoring database. Entering the same case twice from the two systems was avoided by manual searches by date and location of the incident and name of the victim. Injuries or fatalities involving children were included if the incident occurred in a work setting, even if the child was not actively working. Incidents occurring during leisure activities, such as hunting, were excluded. The following data were entered into the database: title of article, publication name, retrieval method, publication date, publication location, number of injured/deceased people involved in the incident, age of victim, gender of victim, race of victim, primary occupation of victim, type of incident (fatality or non-fatality), incident geographic location, incident location on farm, victim's role in incident (working, playing, etc.), date of incident, type of injury, type of injury event, type of work being performed during incident, object that caused incident, and body parts that were affected. Additionally, a short summary of the article was written for each case for further details. All incidents occurring in the Center's seven-state region between January 2012 through June 2017 were selected for analysis. Aggregate data for the seven-state region were requested from CFOI for the years 2012–2015. Media data compared to CFOI included only occupational fatalities, excluding all fatalities involving children who were not employed at the time of death.

Statistical analysis

All variables in CS-CASH data were treated as categorical. The primary variables of interest were the injury outcomes of fatal vs. non-fatal injury. Univariate analysis (chi-square test) was used to identify factors associated with the outcomes. We also evaluated associations of non-fatal versus fatal injury with gender, age, sources of injury, place of injury, activity during injury, time of the day of injury, and season. Place of injury was re-categorized into "Farm" or "Road" (including on- and off-farm road) incident. Place of injury was tested in a secondary analysis for association with gender, age group, and season. The third analysis compared fatal occupational injuries in CS-CASH media monitoring (print and electronic combined) during 2012–2015 to occupational fatalities captured by CFOI during the same time in the same seven-state region using a two-sample z proportion test for injury types. Data were analyzed using SAS 9.4.

Results

Between January 2012 and June 30, 2017, print and electronic media monitoring systems identified 1046 agricultural injury incidents in the CS-CASH seven-state region; 584 (56%) were non-fatal and 462 (44%) were fatal. Characteristics of non-fatal and fatal incidents from both surveillance systems combined are shown in Table 1. Gender was significantly associated with the incident being non-fatal vs. fatal (p = 0.0004), while males had a higher proportion of both fatal and non-fatal incidents. Half of the non-fatal (50%) and fatal (49%) incidents occurred in the afternoon, and a greater proportion of fatal incidents (31% vs. 22%) happened in the evening (p = 0.003). Most non-fatal injuries (61%) occurred on the road/off-farm, while the fatalities were more evenly distributed between farm building, field/pasture, road/off-farm, and other places. Non-fatal injuries were fairly evenly distributed between the seven work activity categories, while fieldwork was clearly the most common activity resulting in fatalities.

The age distribution of fatal and non-fatal incidents is shown in Figure 1. The number of non-fatal incidents was particularly high among the 0–10 years-of-age category, while the fatal injuries were most frequent in the oldest age categories.

The numbers of fatal and non-fatal incidents by source are shown in Figure 2. Tractor was clearly the most frequent source for both fatal and non-fatal incidents, followed by trucks, machinery, and other sources. ATV was a significant source of fatalities as well.

Table 2 shows the distribution of on-farm vs. roadway injuries (fatal and non-fatal combined) by season, gender, and media source. Media monitoring captured a total of 718 injuries where the location could be differentiated between farm and road. Of these incidents, 51% (368) occurred on the farm and 49% on the road (off-farm). The highest proportion (37%) of farm injuries occurred in the summer, while the highest proportions of road injuries occurred in the fall (37%). A higher proportion of injuries to females occurred on the road (23%) vs. farm (9%).

To examine the effectiveness of the print and electronic media surveillance in reporting agricultural fatalities, data from the media systems were compared with CFOI data for the years 2012–2015, using only occupational fatalities. Figure 3 illustrates the numbers of fatalities captured by CFOI, fatalities captured by CS-CASH media monitoring, and non-fatal incidents captured by CS-CASH media monitoring during the years 2012–2015. CFOI and CS-CASH media monitoring showed almost identical numbers of fatalities; 282 and 280, respectively. In addition, CS-CASH monitoring database captured twice as many non-fatal cases as CFOI did fatal cases during the same time in the seven Midwestern states, demonstrating the impact of injuries in this workforce.

Table 1. Characteristics of non-fatal and fatal agricultural injuries in CS-CASH media monitoring database from a seven-state region[a] (January 2012–June 30, 2017).

	Non-fatal		Fatal		
	N	%	*N*	%	(*P*-value)[d]
Media source					
Print Media and Google Alerts Total	584	56	462	44	
Gender					
Female	88	16	39	8	0.0004
Male	468	84	423	92	
Missing	28		0		
Total	556		462		
Time of the day injury occurred					
Morning	128	28	72	20	0.0027
Afternoon	223	50	172	49	
Evening	99	22	110	31	
Missing	134		108		
Total	450		354		
Place injury occurred					
Farm building	83	19	56	20	<0.0001
Field/Pasture	61	14	99	34	
Road/off farm	265	61	85	30	
Other[b]	23	6	46	16	
Missing	152		176		
Total	432		286		
Activities during injury					
Farmstead maintenance	31	16	43	18	0.0002
Fieldwork	33	17	76	32	
Livestock handling	17	9	21	9	
Machinery services and repair	24	12	28	12	
Storing/handling of harvested crops	29	15	35	15	
Driving or riding	32	16	14	6	
Other[c]	34	17	22	9	
Missing	384		223		
Total	200		239		

[a]Central States Center for Agricultural Safety and Health (CS-CASH) region includes: Iowa, Kansas. Missouri, Minnesota, Nebraska, North Dakota, and South Dakota.
[b]Other: pond, manure pit, ditch, railway crossing and silage pile.
[c]Other: bystander, washing walls in chicken barn, crop dusting plane, working in manure pit and passenger in truck.
[d]Chi square analysis.

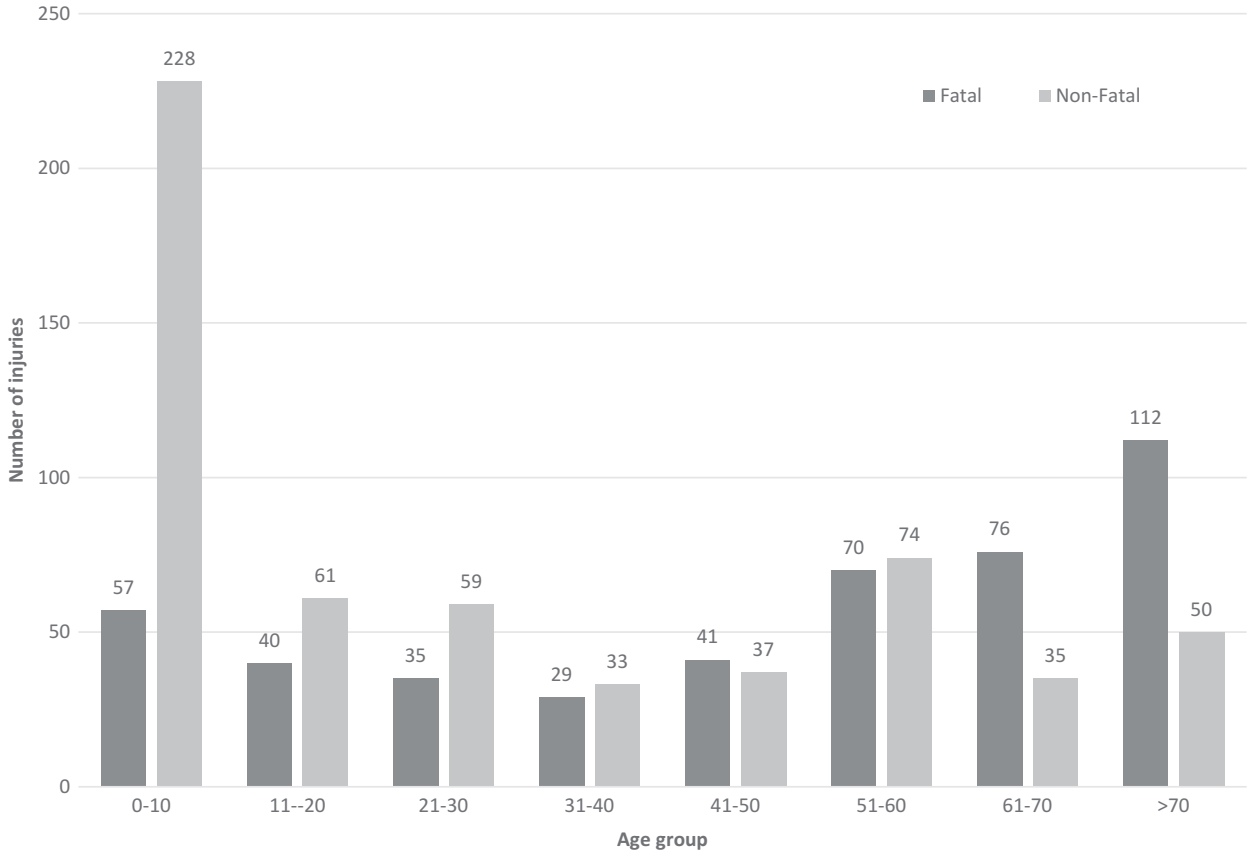

Figure 1. CS-CASH media monitoring fatal and non-fatal agricultural injuries by age in a seven-state region.

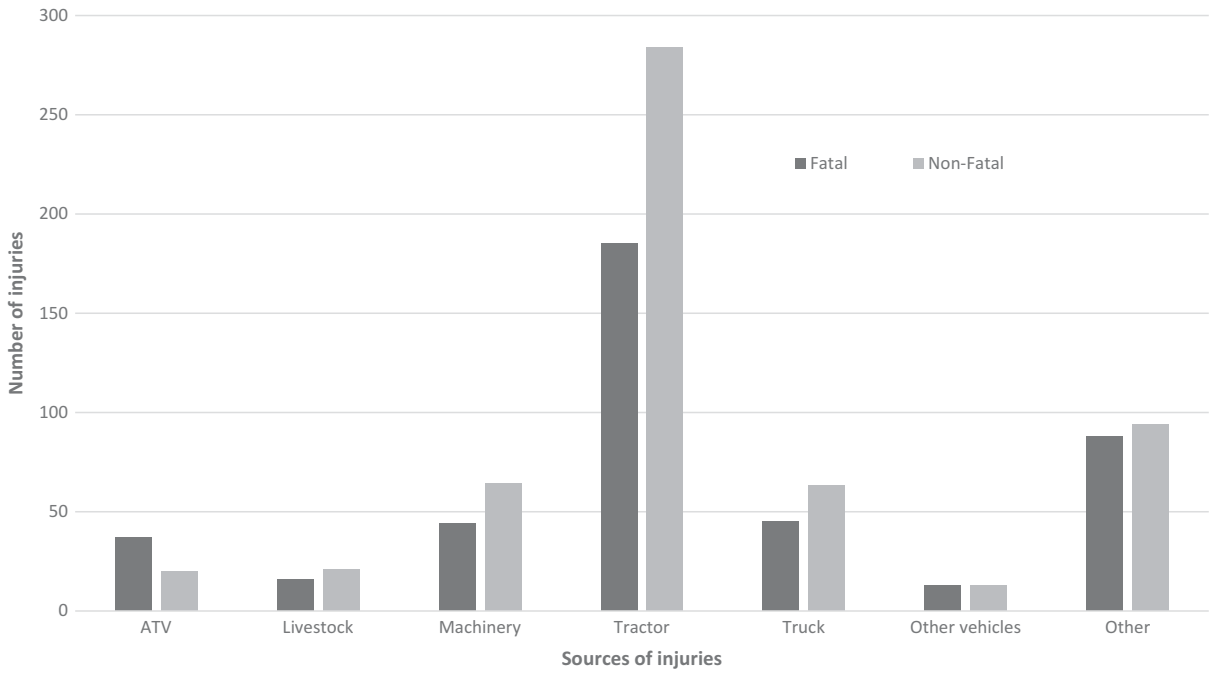

Figure 2. CS-CASH media monitoring fatal and non-fatal agricultural injuries by source in a seven-state region. (Note: Other includes grain bin, wagon, snowmobile, power washing barn, and fertilizer cart).

Table 3 shows the distribution of fatal injuries by selected types of injury events (fall, contact/caught, and struck by/against) for CS-CASH media monitoring data and CFOI data. The

Table 2. Characteristics of on-farm and roadway injuries[a] in a seven-state region in CS-CASH media monitoring database.

	On-farm injuries		Roadway injuries		
Factors	*N*	%	*N*	%	(*P*-value)[b]
Season					
Winter	48	13	38	10	<0.0001
Spring	115	31	60	18	
Summer	118	37	121	35	
Fall	87	24	131	37	
Total	368		350		
Gender					
Female	31	9	75	23	<0.0001
Male	322	31	260	77	
Total	353		335		

a: Includes both non-fatal and fatal injuries.
b: Chi square analysis.

proportions of fatalities captured by media monitoring and CFOI did not differ significantly.

Discussion

To understand the current hazards facing agricultural workers, and to effectively address and propose best practices to mitigate the risks, it is necessary to know the causes and circumstances surrounding injuries and fatalities. Efforts have been made to address surveillance of agricultural injuries and fatalities. National surveillance systems, supported by the National Institute for Occupational Safety and Health (NIOSH), collected injury and fatality data on children and self-employed farmers in agriculture,[6] but these national surveillance efforts have been discontinued.[7] A few of the 11 NIOSH Agriculture, Forestry and Fishing (AFF) Safety and Health Centers have injury surveillance projects that survey agricultural producers in specific regions. The Bureau of Labor Statistics (BLS) Injuries, Illnesses, and Fatalities (IIF) program provides information on agricultural work-related

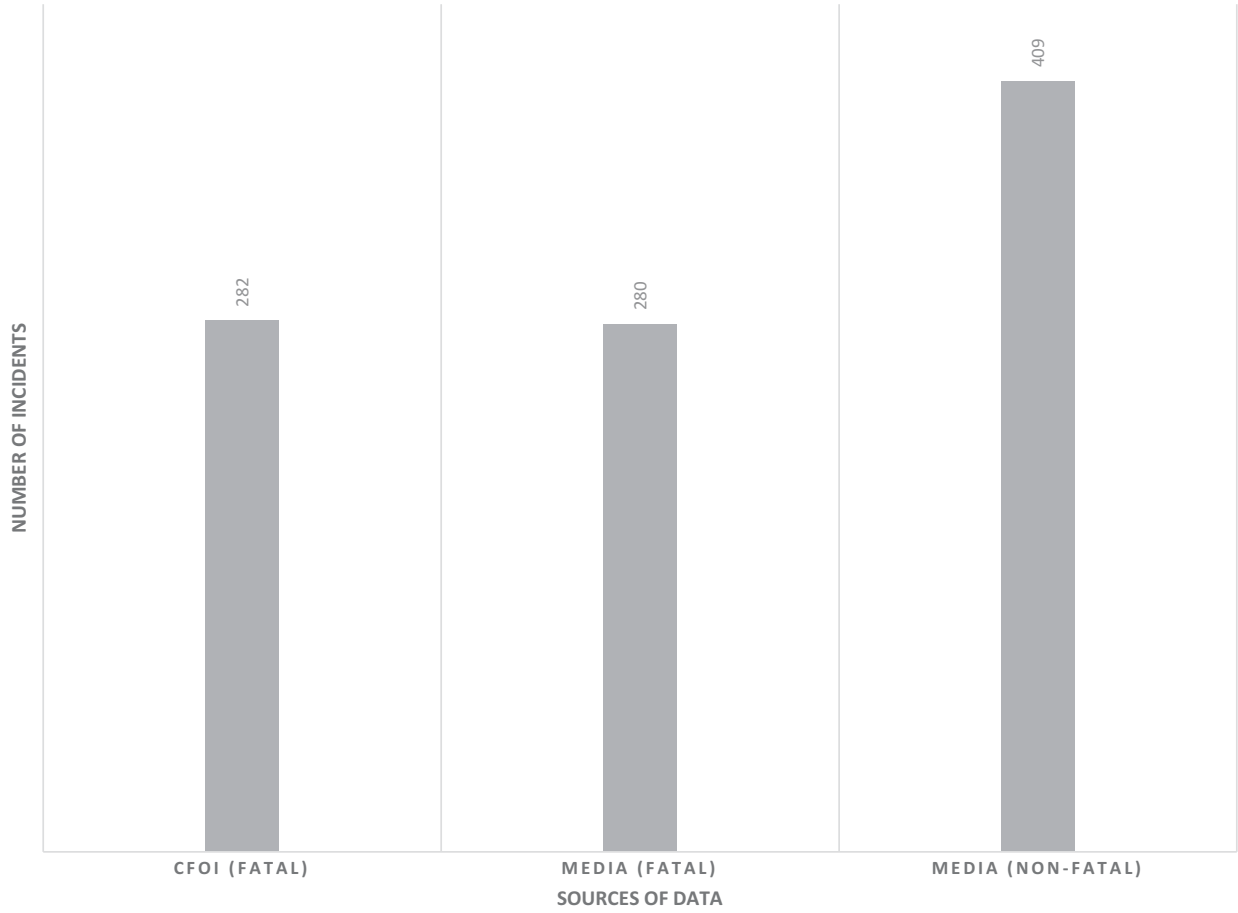

Figure 3. Count of fatal and non-fatal agricultural injury incidents by data source for seven US Midwestern states[1] (2012–2015) [CFOI Data – source of the data is U.S. Department of Labor, Bureau of Labor Statistics. Census of Fatal Occupational Injuries, September 29, 2017.].

Table 3. Count of fatal injury incidents by type of event and data source in seven Midwestern states[a] (2012–2015).

	Media		CFOI		
Type of injury	N	%	N	%	(*P*-value)[b]
Fall	41	15	27	10	0.073
Contact and caught	118	42	138	49	0.0957
Struck	121	43	117	41	0.631

a: Central States Center for Agricultural Safety and Health (CS-CASH) media monitoring region for injury incidents includes: Iowa, Kansas. Missouri, Minnesota, Nebraska, North Dakota, and South Dakota.
b: Two sample z proportion test.

injuries, illnesses, and fatalities. These data are collected through the Survey of Occupational Injuries and Illnesses (SOII) and the Census of Fatal Occupational Injuries (CFOI).[1,2] While CFOI reports fatalities for all workers, including self-employed farmers and ranchers, SOII excludes injuries to farmers, ranchers and hired workers on farms with 10 or fewer employees. Data from CFOI and SOII consist of counts and rates of killed or injured workers, listed by industry and occupation categories, as well as some distributions of demographic and injury characteristics data. Detailed reports can be requested, for instance for the incidence of injuries by state, or region, as was done for the current study.

Although these data are useful for understanding the magnitude of the problem and how agriculture ranks against other sectors, they provide few details needed to understand and address specific hazards, which is critical for prevention. As SOII does not report injuries in self-employed and small operations (<11 employees), agricultural injuries are clearly under-reported in official statistics.[8–10] Hence, researchers and safety professionals must utilize alternative means for collecting information on injuries and fatalities, such as print media and internet reports. Media reports in many cases provide detailed information that can be useful in recognizing emerging issues, tailoring programs to address specific hazards, providing information to government officials regarding fatality and injury numbers in their region, and creating a narrative to convey safety and health information to the agricultural community.

The Central States Center for Agricultural Safety and Health (CS-CASH) has a surveillance program that includes annual injury surveys to farmers and ranchers (n = 7000 surveys), investigations of existing heath record databases, and conducting media monitoring to gain a comprehensive picture of injuries and fatalities in the Center's region. This report utilized data from CS-CASH media monitoring database for the years 2012–2017.

In terms of the cost associated with print and electronic media monitoring, there is a substantial cost associated with contracting the news clipping service and hiring the expert to enter the reports into the database. Although not as costly, the electronic media alerts (Google Alerts) are free to access, but the cost of hiring an agricultural safety expert to enter data can be significant, as this is a labor-intensive endeavor.

CS-CASH media monitoring captures non-fatal injuries slightly more than fatal cases. While these non-fatal injury incidents provide valuable information for prevention, they represent only the tip of the iceberg of all non-fatal injuries in agriculture. Only incidents that are for some reason "newsworthy" get reported on a given day in a given news outlet. The ratio of fatal vs. non-fatal agricultural injuries is approximately 1 to 500, and about 1 out of 5 injuries is serious, leading to over one-month of lost time.[11] This illustrates the importance of employing alternative methods of injury surveillance.

A significant majority of both non-fatal and fatal injuries captured by media monitoring involved males. This is consistent with national statistics.[3,12–14] Jadhav et al. pooled results from 10 articles and found that males have 1.68 times greater odds to have an agricultural injury compared to females.[15] Females were more likely to be involved in road-related (vs. on-farm) incidents. While no data could be found on the distribution of working hours, females in the Midwest may be more likely to be involved in transportation of personnel or supplies, administrative responsibilities duties, and purchasing of farm materials, which require road travel. Half of the injuries and fatalities occurred in the afternoon. This is consistent with previous studies.[16,17] This may be partly due to increased work activities on the farm in the afternoon.

It was notable that 31% of the fatalities occurred in the evening, compared to 22% of non-fatal injuries reported happening in the evening.[18] Many of the evening fatalities that were previously reported involved tractor crashes. Although our data did not report that fatalities occurring in the evening were due to tractor or agricultural vehicle crashes, driving or riding was reported as a frequent source of fatalities. More than half of the non-fatal injuries happened on the road/off-farm, while fatalities were more evenly distributed between farm building, field/pasture, road/off-farm, similar to findings of Raina et al.[19]

Fatalities were most frequent in the oldest age categories of greater than 70 years, while the 0–10-year-old age group had by far the most non-fatal injuries. An increased risk of fatal and non-fatal injuries in children less than 10 years-of-age has been documented by surveillance conducted as part of the Childhood Agricultural Injury Survey.[20] The large number of non-fatal injuries among young children in these data could also be in part due to data sharing with the National Children's Center for Rural and Agricultural Health and Safety. This organization provided information on cases that they located in the media and via Google Alerts. Also, incidents involving children could be seen by the media as "news worthy" and as a result reported more frequently than similar accidents involving an adult on the farm.

Tractors were the leading cause of non-fatal and fatal injuries in our data. This is consistent with previous studies.[3,21–24]

Results indicate that media monitoring using print and electronic media can effectively capture fatal occupational incidents as the counts of fatalities were nearly identical between CS-CASH media monitoring and the official CFOI system. Although it was not possible to compare case-by-case information to determine if the two systems report the same cases, the distributions of types of injuries had no statistically significant differences. Media monitoring-based surveillance can, therefore, provide fairly reliable counts of fatalities, as well as more detailed information on the characteristics of the fatality cases. Additionally, media sources can provide data for injury root cause analysis and identify opportunities for prevention. CFOI does not provide case-level data for prevention, as public release of identifiable CFOI cases is restricted due to the Confidential Information Protection and Statistical Efficiency Act.

Overall, results from the current study suggest that active monitoring using a press clipping service and electronic media detect both fatal and non-fatal injuries that are "newsworthy" in larger media markets. It can be speculated that rural newspapers may report incidents that are of interest to readers of local papers; these outlets may not have an online presence.

Limitations

There is great variability in media reports regarding description of incident circumstances, and therefore, key variables such as time of the day, place where the incident occurred, and activities during the incident could not be determined and coded. As a result, interpretations of the distribution of injury events related to these variables may be biased.

The identification of non-fatal injuries is likely impacted by publication bias. As stated, there were a large proportion of non-fatal injuries reported in children less than 10 years-of-age; likely these were viewed as newsworthy reports, presenting a bias in the recording and comparison of non-fatal injuries.

Duplicate reports from print and electronic media were removed from the database, and data from each source were combined in the incident report. Records were not kept of the duplicate reports; therefore, comparisons between these sources could not be made.

The comparison between CFOI and the CS-CASH media monitoring data could not be done on case-by-case basis. It is expected that CFOI is a more accurate source for occupational fatalities, as CFOI uses two or more sources for verification. CS-CASH data may include cases that would not meet the CFOI criteria for occupational fatality.

Conclusion

While CFOI is the "gold standard" for occupational fatality counts and rates, the actual rate of non-fatal injuries cannot be determined by government databases due to inadequate surveillance.

Available data are inadequate to set well-informed national strategies, policies, and targets for agricultural safety. Media monitoring might prove useful in providing a strengthened surveillance system for detection of serious non-fatal injuries to both hired agricultural workers and self-employed farmers and ranchers.

This research indicates that media reports can capture the majority of fatality cases and add value by providing more detailed case information that is valuable for prevention. In addition to fatalities, electronic and print reports provide information on serious non-fatal injuries. Media reports create a rich source of case-based information that can be used in crafting prevention strategies and messages.

Disclosure statement

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References

1. BLS (Bureau of Labor Statistics, U.S. Department of Labor). Number of fatal work injuries by employee status, 2003–17. https://www.bls.gov/iif/oshwc/cfoi/cfch0016.pdf. Accessed December 26, 2018
2. BLS (Bureau of Labor Statistics, U.S. Department of Labor). 2017 Survey of occupational injuries & illnesses charts package. November 8, 2018. https://www.bls.gov/iif/osch0062.pdf Accessed December 27, 2018
3. Missikpode C, Peek-Asa C, Young T, Swanton A, Leinenkugel K, Torner J. Trends in non-fatal agricultural injuries requiring trauma care. *Inj Epidemiol*. 2015;2(1):1. doi:10.1186/s40621-015-0062-3.
4. OSHA (United States Department of Labor Occupational Safety & Health Administration). Agricultural operations. Retrieved from https://www.osha.gov/dsg/topics/agriculturaloperations/hazards_controls.html#3.Accessed December 26, 2018
5. Herde E, Lower T. Farm related injuries reported in the Australian print media. 2011. http://sydney.edu.au/medicine/aghealth/uploaded/Research%20Reports/farm_related_injuries_reported_in_the_australian_print_media_2010.pdf. Accessed August 4, 2016
6. Frank AL, McKnight R, Kirkhorn SR, Gunderson P. Issues of agricultural safety and health. *Annu Rev Public Health*. 2004;25:225–245. doi:10.1146/annurev.publhealth.25.101802.123007.
7. Patel K, Watanabe-Galloway S, Gofin R, Haynatzki G, Rautiainen R. Non-fatal agricultural injury surveillance in the United States: a review of national-level survey-based systems. *Am J Ind Med*. 2017;60:599–620. doi:10.1002/ajim.22720.
8. Leigh JP, Du J, McCurdy SA. An estimate of the US 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.
9. Hayden GJ, Gerberich SG, Maldonado G. Fatal farm injuries: a five-year study utilizing a unique surveillance approach to investigate the concordance of reporting between two data sources. *J Occup Environ Med*. 1995;37:571–577.
10. Spieler EA, Wagner GR. Counting matters: implications of undercounting in the BLS survey of occupational injuries and illnesses. *Am J Ind Med*. 2014;57(10):1077–1084. doi:10.1002/ajim.22382.
11. Rautiainen RH, Ledolter J, Donham KJ, Ohsfeldt RL, Zwerling C. Risk factors for serious injury in Finnish agriculture. *Am J Ind Med*. 2009;52(5):419–428. doi:10.1002/ajim.20688.
12. Viscusi WK. *Estimating the Value of a Statistical Life Using Census of Fatal Occupational Injuries (CFOI) Data*. 2013.
13. Jennissen CA, Harland KK, Wetjen K, Hoogerwerf P, O'Donnell L, Denning GM. All-terrain vehicle safety knowledge, riding behaviors and crash experience of farm progress show attendees. *J Safety Res*. 2017;60:71–78. doi:10.1016/j.jsr.2016.12.001.
14. Karttunen JP, Rautiainen RH. Occupational injury and disease incidence and risk factors in Finnish agriculture based on 5-year insurance records. *J Agromedicine*. 2013;18(1):50–64. doi:10.1080/1059924X.2012.742029.
15. Jadhav R, Achutan C, Haynatzki G, Rajaram S, Rautiainen R. Risk factors for agricultural injury: a systematic review and meta-analysis. *J Agromedicine*. 2015;20(4):434–449. doi:10.1080/1059924X.2015.1075450.
16. Richardson D, Loomis D, Wolf SH, Gregory E. Fatal agricultural injuries in North Carolina by race and occupation, 1977–1991. *Am J Ind Med*. 1997;31:452–458.
17. Holle RL. *Lightning-Caused Deaths and Injuries Related to Agriculture. In Preprints of the 33rd International Conference on Lightning Protection*. Estoril; September 2016. 25–30.
18. Nogalski A, Lubek T, Sompor J, Karski J. Agriculture and forestry work-related injuries among farmers admitted to an emergency department. *Ann Agric Environ Med*. 2007;14:253–258.

19. Raina P, Sohel N, Oremus M, et al. Assessing global risk factors for non-fatal injuries from road traffic accidents and falls in adults aged 35–70 years in 17 countries: a cross-sectional analysis of the prospective urban rural epidemiological (PURE) study. *Inj Prev*. 2016;22(2):92–98. doi:10.1136/injuryprev-2014-041476.
20. NIOSH (The National Institute of Occupational Safety and Health). Childhood Agricultural Injury Survey (CAIS). https://www.cdc.gov/niosh/topics/childag/cais/default.html. Accessed February 2, 2019.
21. Caffaro F, Lundqvist P, Cremasco MM, et al. Falls from tractors in older age: risky behaviors in a group of swedish and italian farmers over 65. In: *Congress of the International Ergonomics Association*. Cham: Springer; August 2018:78–86.
22. Rondelli V, Casazza C, Martelli R. Tractor rollover fatalities, analyzing accident scenario. *J Safety Res*. 2018;67:99–106. doi:10.1016/j.jsr.2018.09.015.
23. Erkol Z, Buken B, Hekimoglu Y, Erkol H, Ince H, Erzengin OU. Analysis of tractor-related deaths. *J Agromedicine*. 2013;18(2):87–97. doi:10.1080/1059924X.2013.767737.
24. Storm JF, LePrevost CE, Tutor-Marcom R, Cope WG. Adapting certified safe farm to North Carolina agriculture: an implementation study. *J Agromedicine*. 2016;21(3):269–283. doi:10.1080/1059924X.2016.1180273.