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Coding agricultural injury: Factors affecting coder agreement

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ABSTRACT

Objectives: To determine coders' agreement level for the Occupational Injury and Illness Classification System (OIICS) source of injury and injury event codes, and the Farm and Agricultural Injury Classification (FAIC) code in the AgInjuryNews.org and to determine the effects of supplemental information and follow-up discussion in final code assignments. *Methods:* Two independent researchers initially coded 1304 injury cases from AgInjurynews.org using the OIICS and the FAIC coding schemes. Code agreement levels for injury source, event, and FAIC and the effect of supplemental information and follow-up discussions on final coding was assessed. *Results:* Coders' agreement levels were almost perfect for OIICS source and event categories at the 3-digit level, with lower agreement at the 4-digit level. By using supplemental information and follow-up discussion, coders improved the coding accuracy by an average 20% for FAIC. Supplemental information and follow-up discussions had helped finalize the disagreed codes 55% of the time for OIICS source coding assignments and 40% of time for OIICS event coding assignments for most detailed 4-digit levels. Five key themes emerged regarding accurate and consistent coding of the agricultural injuries: inclusion/exclusion based on industry classification system; inconsistent/discrepant reports; incomplete/nonspecific reports; effects of supplemental information on coding; and differing interpretations of code selection rules. *Practical applications:* Quantifying the level of agreement for agricultural injuries will lead to a better understanding of coding discrepancies and may uncover areas for improvement to coding scheme itself. High level of initial and final agreement with FAIC and OIICS codes suggest that these coding schemes are user-friendly and amenable to widespread use.

1. Introduction

Accurate coding of occupational and non-occupational injury events is an ongoing international concern among many researchers. Just a few examples include Finch et al. (2014) examining the background of coders when using the Orchard Sports Injury Classification System (OSICS-10) for sports medicine diagnoses, Jacinto, Santos, Soares and Silva (2016) questioning the reliability of coding work accidents in Portugal, Schmitz and Forst (2016) researching the intercoder reliability in the United States of NIOSH's Industry and Occupation Computerized Coding System (NIOCCS), and Wuellner and Bonauto (2014) exploring injury classification agreement in linked Bureau of Labor Statistics (BLS) annual Survey of Occupational Injuries and Illnesses (SOII) to Washington State workers' compensation(WC) data.

Accurate coding of agricultural injuries is also an important topic for agricultural safety and health professionals. Recent studies of coding and classification issues surrounding agriculture advocate for the joint use of the Farm and Agricultural Injury Classification (FAIC) and Occupational Injury and Illness Classification System (OIICS) codes (Murphy, Gorucu, & Weichelt, 2019; Scott, Bell, & Hirabayashi, 2017). Agricultural surveillance data are used to monitor occupational injury and illness, identify hazards and risk, and develop workplace interventions. Accurate coding of injuries is critical for understanding the circumstances of injury and developing effective prevention strategies. Using standardized coding systems allows for the categorization of qualitative information to standardized categories, and enables the collection, storage, and analysis of comparable data (Murphy et al., 2019).

The purposes of this study were: (a) to determine coders' agreement level for the Occupational Injury and Illness Classification System (OIICS) source of Injury and Injury Event codes, and the Farm and Agricultural Injury Classification (FAIC) code in the AgInjuryNews database; (b) to determine the effects of additional infor-

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mation and follow-up discussion in final code assignments; (c) to identify factors that affect agreement among coders; and (d) to promote wider use of standardized coding systems, such as FAIC and OIICS, with agricultural injury data.

2. Methods

Injury data were exported from AgInjuryNews.org (AIN), a national collection of agricultural injury reports maintained by the National Farm Medicine Center since 2015 (Weichelt, Salzwedel, Heiberger, & Lee, 2018). AIN was redesigned and enhanced in 2018 to enable the collection of two coding schemes for each injury: The Occupational Injury and Illness Classification System (OIICS), version 2.01 and the Farm and Agricultural Injury Classification codes (FAIC) (Weichelt, Heimonen, & Gorucu, 2019). Each injury case in AIN was coded for FAIC and OIICS nature, body part, injury source, secondary injury source, and event/exposure categories.

A total of 1,304 agricultural injury cases were coded following these steps (Table 1). As described in the Results section, not all cases required all five steps.

The outcome from supplemental sources and steering committee member consultation was represented by the single variable "Supplemental Information" with two categories: "0" indicating that neither additional sources were searched/found, nor steering committee member opinion was sought, and "1" being additional sources were found and/or steering committee member opinion was sought. Supplemental information was used for 275 of the 1304 cases (21%).

2.1. FAIC codes

The FAIC code was designed to facilitate consistent and accurate classification of farm- and agriculture-related fatalities and injuries and is a systematic scheme of separating farm production work cases from non-farm production work (American Society of Agricultural and Biological Engineers (ASABE), 2007). Importantly, FAIC codes are based on the North American Industrial classification (NAICS) system Table 2 (Murphy et al., 2019). FAIC-10 is not part of the FAIC coding and is assigned to cases when there was not enough information to assign a more specific code even though coders are confident that the case falls within the FAIC coding structure.

Table 1
Coding steps.

Step 1	Coder 1 entered and coded the cases based on an initial report(s), then sent the initial report(s) to coder 2
Step 2	Coder 2 independently blind coded the same cases based on the initial report(s) used by coder 1
Step 3	Coder 2 then searched for additional information when the initial data source seemed ambiguous or lacked details of the incident. These additional information sources included post-incident news and TV reports, police reports, and OSHA reports
Step 4	Coder 1 and Coder 2 convened for a weekly telephone meeting to review cases previously coded. During the meetings, Coder 2 shared any supplemental information with coder 1 to come to a final agreement about the code for any cases where there was initial disagreement between the two coders, or a possible change based on new information
Step 5	In some cases, when there was a lack of supplemental information or supplemental reports still lacked clarity for coding purposes, an AIN National Steering Committee member (second and last author) was consulted to help make a final decision on the codes to be assigned

Table 2
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
FAIC-10*	Undeterminable

*The FAIC-10: Undeterminable category will be part of the standard which is currently undergoing revision to ASAE S575.2.

2.2. OIICS codes

The OIICS was developed by the U.S. Department of Labor's (USDOL) Bureau of Labor Statistics (BLS) and has been the primary tool for characterizing U.S. occupational injuries since 1992. The coding scheme is used by the US DOL for its Census of Fatal Occupational Injuries (CFOI) and Survey of Occupational Injuries and Illnesses (SOII), by the American National Standards Institute (ANSI) as the basis for the ANSI Z16.2-1995 American National Standard for Information Management for Occupational Safety and Health, and by NIOSH to characterize nonfatal occupational injuries and illnesses treated in emergency departments (Occupational Injury and Illness Classification Manual, 2012). The OIICS codes employ a hierarchical structure with up to four digits used to describe each aspect of the case. The first digit designates the division that represents general categories of case characteristics. The second digit designates the major group, and, in certain prescribed instances, a third and sometimes fourth digit are used to designate the group and subgroup, respectively.

2.3. Data analysis

Code agreement levels between coders 1 and 2 and finalized codes were assessed for FAIC and OIICS's injury source, event categories. There are several coefficients for assessing the coders agreement with consensus on the most appropriate coefficient to use (Jacinto et al., 2016). Three measures to estimate the coders agreement level were calculated by using SPSS version 26 and Microsoft Excel:

- **Percent agreement (% agreement):** the proportion of units with matching codes on which two coders agree (Hayes & Krippendorff, 2007). Since it does not consider the agreement that can occur due to chance, it may overestimate reliability. This makes it possibly the weakest measure, while still being very commonly used for estimating agreement (Jacinto et al., 2016).
- **Cohen's Kappa (κ):** most commonly used statistic for assessing nominal agreement between two raters. Kappa has value 1 if there is perfect agreement between the raters, and value 0 if the observed agreement is equal to agreement expected by chance. Kappa scores were interpreted using Viera and Garrett's conventions: < 0 as less than chance, 0.01–0.20 as slight, 0.21–0.40 as fair, 0.41–0.60 as moderate, 0.61–0.80 as substantial, and 0.81–0.99 as almost perfect level of agreement (Viera & Garrett, 2005).
- **Krippendorff's alpha (K-alpha):** Estimates the reliability for more than two coders simultaneously overcomes many of the weaknesses associated with other agreement measures

(Amendola, Jarvik, & Leo, 2016). We calculated K-alpha values by using the macro KALPHA© "add-in" for SPSS available in the public domain. We have adopted the Landis and Koch approach for interpreting these results such as K-alpha slight (0.00–0.20), fair (0.21–0.40), moderate (0.41–0.60), substantial (0.61–0.80), and almost perfect (0.81–1.00) (Landis & Koch, 1977).

3. Results

3.1. FAIC codes

Coders 1 and 2 provided the same initial FAIC codes for 1,161 of the 1,304 cases (89%). This level of agreement, based on Kappa and K-alpha scores, is considered 'almost perfect' (Kappa = 0.85, K-alpha = 0.82) by the coding agreement literature (Landis & Koch, 1977; Viera & Garrett, 2005).

Agreement percentage varied with the FAIC categories. FAIC-2: Forestry and logging and FAIC-9 Farm hazard exposure: Roadway collision averaged 97% agreement, respectively, between Coders 1 and 2. These were followed by FAIC-3 Fishing, hunting, & trapping and FAIC-1: Farm production work at 94% and 92%, respectively. Agreement between coders 1 and 2 was the lowest for FAIC-5: Farm hazard exposure, outside services categories (75%).

Finalized FAIC codes reflect the information obtained from the supplemental data and follow-up discussion between the coders. After finalizing the codes, the codes were compared to the initial coding by Coder 1 and Coder 2 (Table 3). When we exclude the FAIC-8 since it has only one injury case, the most disagreed FAIC categories were FAIC-4 and FAIC-5. Accurate coding of FAIC-4 and FAIC-5 depends on the detailed information given by the reports. If the initial report(s) does not have the detailed information, it is difficult to make the initial accurate code assignments for these categories.

The number of FAIC-10: Undeterminable injury cases were 205 and 221 for Coders 1 and 2, respectively. After using the supplemental information, some of these cases were classified into the other FAIC categories. This left 172 undeterminable cases meaning that 13% of the total injury cases were not classified into a more specific FAIC category.

Disagreed cases were further examined in Table 4. There were 258 cases (146 cases, coder 1; 112 cases coder 2) where either coder 1 or coder 2 assigned a different initial FAIC code than what was agreed as the final code after supplemental information was used in the decision-making, a 20% improvement (258/1304 cases) in FAIC code accuracy.

Supplemental information affected different FAIC categories at various levels. For example, when we look at the FAIC-4 category which is for injuries to agricultural and forestry support persons, the additional information from the supplemental data affected the decision on final coding by 87% for Coder 1 and 100% for Coder 2.

3.2. OIICS source and event

Coding agreement for injury source and event/exposure categories varied by level of coding detail (number of digits), with the portion of injuries in agreement decreasing as coding detail increased (Table 5). The two coders provided exactly the same four-digit OIICS source and event codes for 57% (n = 743) and 69% (n = 900) of the 1,304 recorded injuries, respectively. As shown in the Table 4, the Kappa and K-alpha scores for 1-digit to 3-digits levels were varied between 0.78 to 0.94 which are indicators of 'substantial' and 'almost perfect' agreements.

Overall, when we look at the division level (1 digit) of the OIICS source categories, the coders agreement was highest for 'vehicles' (98%) followed by 'persons, plants, animals, and minerals' (94%), and 'machinery' (85%). The lowest agreements were occurred on 'tools, instruments, and equipment' (40%), 'other sources' (60%), and 'parts and materials' (67%).

For OIICS event categories, overall, the coders agreement was highest for 'violence or other injuries by persons or animals' (100%) followed by 'transportation incidents' (98%), and 'fires and explosions' (97%) at division level (1 digit). The agreement was lowest for 'falls, slips, and trips' (74%).

Table 6 and Table 7 show the disagreement levels for OIICS source and event categories by initial coding by coders 1 and 2. All division level categories and the most disagreed (based on number) categories at 2-and 3-digit levels are shown in the tables. On average for OIICS source categories coders 1 and 2 disagreed with finalized codes in 128, 212, 347, and 712 injury cases for 1-digit, 2-, 3-, and 4-digits source categories, respectively. For OIICS event categories the numbers of disagreements on average were 107, 202, 307, 524 for 1-digit, 2-, 3-, and 4-digits event categories, respectively.

The effects of supplemental information and follow-up discussions on final coding were also calculated for OIICS Source and Event categories. By dividing number of disagreements over total number of injury cases, it was determined that supplemental information and follow-up discussions improved accuracy by 55% (712/1,304) and 40% (524/1,304), respectively,

Table 3
Finalized FAIC codes versus initial coding by coders.

Finalized FAIC codes (n = 1,304)	Coder 1				Coder 2			
	Agreeing (n = 1,158)		Disagreeing (n = 146)		Agreeing (n = 1,192)		Disagreeing (n = 112)	
	n	%	n	%	nn	%	n	%
FAIC-1 (619, 100%)	578	93%	41	7%	564	91%	55	9%
FAIC-2 (29, 100%)	28	97%	1	3%	28	97%	1	3%
FAIC-3 (17, 100%)	17	100%	-	-	15	88%	2	12%
FAIC-4 (35, 100%)	20	57%	15	43%	29	83%	6	17%
FAIC-5 (16, 100%)	8	50%	8	50%	12	75%	4	25%
FAIC-6 (134, 100%)	103	77%	31	23%	120	90%	14	10%
FAIC-7 (24, 100%)	21	88%	3	12%	18	75%	6	25%
FAIC-8 (1, 100%)	-	-	1	100%	-	-	1	100%
FAIC-9 (257, 100%)	245	95%	12	5%	251	98%	6	2%
FAIC-10 (172, 100%)	138	80%	34	20%	155	90%	17	10%

Table 4
Examination of disagreed cases.

Coder 1 Disagreeing cases (n = 146)	Change based on		Coder 2 Disagreeing cases (n = 112)	Change based on	
	Supplemental data (n = 70, 48%)	Follow-up Discussion (n = 76, 52%)		Supplemental data (n = 72, 64%)	Follow-up Discussion (n = 40, 36%)
FAIC-1 (n = 41)	30	11	FAIC-1 (n = 55)	38	17
FAIC-2 (n = 1)	–	1	FAIC-2 (n = 1)	–	1
FAIC-3 (n = 0)	–	0	FAIC-3 (n = 2)	1	1
FAIC-4 (n = 15)	13	2	FAIC-4 (n = 6)	6	–
FAIC-5 (n = 8)	6	2	FAIC-5 (n = 4)	4	–
FAIC-6 (n = 31)	4	27	FAIC-6 (n = 14)	9	5
FAIC-7 (n = 3)	1	2	FAIC-7 (n = 6)	3	3
FAIC-8 (n = 1)	–	1	FAIC-8 (n = 1)	–	1
FAIC-9 (n = 12)	4	8	FAIC-9 (n = 6)	3	3
FAIC-10 (n = 34)	12	22	FAIC-10 (n = 17)	8	9

Table 5
Agreement levels for OIICS source code.

	Statistics		
OIICS - Source	% agreement	Kappa	K-alpha
1 digit (Division)	93%	0.88	0.86
2 digits (Major group)	89%	0.86	0.84
3 digits (Group)	81%	0.78	0.82
4 digits (Subgroup)	57%	0.55	0.79
OIICS – Event/Exposure			
1 digit (Division)	96%	0.92	0.94
2 digits (Major group)	90%	0.87	0.94
3 digits (Group)	83%	0.81	0.88
4 digits (Subgroup)	69%	0.68	0.73

Table 6
Disagreement levels for finalized OIICS-source codes versus initial codes by coders.

Finalized codes	Coder 1 Disagreement$n$ (%)	Coder 2 Disagreement n (%)
1: Chemicals and chemical products (n = 29)	–	–
2: Containers, furniture and fixtures (n = 13)	3 (23%)	3 (23%)
3: Machinery (n = 175)	21 (12%)	21 (12%)
31: Agricultural and garden machinery	18 (18%)	20 (20%)
311: Harvesting and threshing machinery	7 (18%)	5 (13%)
32: Construction, logging, and mining machinery	12 (23%)	9 (17%)
322: Loaders	8 (22%)	4 (11%)
4: Parts and materials (n = 13)	2 (15%)	2 (15%)
5: Persons, plants, animals/minerals (n = 115)	10 (9%)	7 (6%)
57: Person—other than injured or ill worker	6 (35%)	–
58: Plants, trees, vegetation—not processed	4 (8%)	6 (13%)
6: Structures and surfaces (n = 59)	11 (19%)	5 (8%)
7: Tools, instruments, and equipment (n = 6)	4 (67%)	–
8: Vehicles (n = 856)	19 (2%)	12 (1%)
84: Highway vehicles, motorized	12 (3%)	17 (5%)
841: Passenger vehicles	18 (7%)	73 (28%)
86: Off-road and industrial vehicles—powered	33 (7%)	16 (3%)
863: Tractors, PTOs	34 (10%)	9 (3%)
9: Other sources (n = 15)	1 (7%)	3 (20%)
9999: Nonclassifiable (n = 23)	1 (4%)	4 (17%)

for the most detailed levels of OIICS source and event categories.

3.3. Examining coding agreement factors

Accurate and consistent coding of agricultural injury has been discussed previously (Murphy et al., 2019). In this study, the process of coding the 1,304 cases included detailed note taking about why there was disagreement in initial coding cases between coders 1 and 2, and why decisions were made for the final code assigned. These notes included important points about original and supplemental sources, discussion between coders 1 and 2, and discussion with national steering committee members.

Five themes emerged regarding accurate and consistent coding of the agricultural injuries obtained from AgInjuryNews.org reports: (1) inclusion/exclusion based on industry classification system; (2) inconsistent/discrepant reports; (3) incomplete/non-specific reports; (4) effects of supplemental information on coding; and (5) differing interpretations of code selection rules (primary/secondary injury sources). These themes are explained with some case examples.

3.3.1. Inclusion/exclusion based on North American industry Classification System (NAICS)

Coders are limited with the information given by the news report. In some cases, additional search was needed. In the case shown in Box 1, the news narrative established that the victim was working for a grain company but does not indicate if the grain company was an agricultural enterprise, a grain storage company, or a wholesaler. After searching for more information for the company, we found out it was classified as "grain merchant wholesaler – NAICS 42 (wholesale trade)" which is not part of Agriculture, Forestry, Fishing, and Hunting industry (NAICS 11). So, this case is excluded from the AIN system.

Box 1 *"A 58-year-old man is dead after an elevator bin accident at [company name] Grain in [location], according to the County Sheriff's Office.*

Authorities responded to a call of man trapped in a grain bin shortly after 3 p.m. Wednesday. A news release from the sheriff's office said a man from rural [location] was working inside the bin when he became submerged in corn. Sheriff [name] said rescue workers lost contact with the man as they attempted to save him by releasing grain from the bin. After about an hour of searching, the man was pulled from the bin and was pronounced dead at the scene, according to the news release." (KWCH, 2018)

3.3.2. Inconsistent/discrepant reports

In some cases, the terminology used in the news report was not specific enough. In these cases, additional data sources should

Table 7
Disagreement levels for finalized OIICS-event/exposure codes versus initial codes by coders.

Finalized event/exposure codes	Coder 1 Disagreement *n* (%)	Coder 2 Disagreement *n* (%)
1: Violence and other injuries by persons or animals (*n* = 45)	3 (7%)	2 (4%)
2: Transportation incidents (*n* = 821)	11 (1%)	19 (2%)
23: Animal/non-motorized vehicle transportation incidents	9 (32%)	4 (14%)
231: Animal transportation incident	2 (8%)	8 (31%)
24: Pedestrian vehicular incident	4 (7%)	9 (16%)
244: Pedestrian struck by vehicle in nonroadway area	9 (19%)	4 (9%)
26: Roadway incidents involving motorized land vehicle	8 (2%)	9 (2%)
261: Roadway collision with other vehicle	14 (4%)	9 (3%)
27: Nonroadway incidents involving motorized land vehicles	19 (6%)	12 (4%)
273: Nonroadway noncollision incident	13 (5%)	20 (7%)
3: Fires and explosions (*n* = 37)	1 (3%)	1 (3%)
4: Falls, slips, trips (*n* = 36)	3 (8%)	11 (31%)
43: Falls to lower level	10 (33%)	4 (13%)
433: Other fall to lower level	3 (18%)	5 (29%)
5: Exposure to harmful substances and equipment (*n* = 62)	–	2 (3%)
6: Contact with objects and equipment (*n* = 262)	18 (7%)	29 (11%)
62: Struck by object or equipment	25 (21%)	9 (7%)
621: Struck by powered vehicle—nontransport	7 (10%)	11 (16%)
64: Caught in or compressed by equipment or objects	30 (27%)	9 (8%)
641: Caught in running equipment or machinery	7 (10%)	11 (16%)
65: Struck, caught, or crushed in collapsing structure, equipment, or material	5 (24%)	4 (19%)
656: Engulfment in other collapsing material	2 (20%)	2 (20%)
7: Overexertion and bodily reaction (*n* = 1)	1 (100%)	–
9999: Nonclassifiable (*n* = 40)	2 (5%)	4 (10%)

be searched to help with accurate coding. In the example case in Box 2 case, two different news reports established two different scenarios for the same incident. This proved problematic with OIICS event codes as OIICS code terminology often is not descriptive of modern production agriculture (Murphy et al., 2019). In the first report, the victim was pinned under the manure spreader (Event code 6230: Struck by falling object or equipment, unspecified) while in the second report the victim was caught in the spreader (Event code 6410: Caught in running equipment or machinery, unspecified). No other information could be found that identified if the victim was pinned under the machine or caught in it. Instead of choosing one event over another, coders used the 2-digit event code '60: Contact with objects and equipment, unspecified' as the final code. Even though this is a broader, less specific code, it was the most accurate code that could be assigned with confidence.

Box 2 Case 2 ***Report 1:*** *"An 83-year-old man was pinned underneath a manure spreader in [location] County Thursday afternoon. The man was still trapped under the manure spreader upon arrival, the sheriff's department said. First responders were able to free the man from the spreader and get him to a landing zone for the Life Link III helicopter."* (Wisconsin State Farmer Staff, 2018)

Report 2: *"Police have identified an 83-year-old man caught in a manure spreader in [location] County Thursday afternoon. The victim was caught in the spreader just after 1:30 p.m. Thursday on his farm in the [location], according to a press release from the Sheriff's Department. The victim was still trapped when deputies and first responders arrived, the sheriff's department said. First responders were able to free him from the spreader and get him to a landing zone for the Life Link III helicopter."* (Tetzlaff, 2018)

3.3.3. Incomplete/nonspecific reports

A lack of specificity in news reporting was a major barrier to coding in some cases. The FAIC could not be determined (FAIC-10: Undeterminable) in 13% of the cases (*n* = 172). For OIICS source and event/exposure coding, non-classifiable cases were 2% (*n* = 23) and 3% (*n* = 40) of the cases, respectively.

Case 1 in Box 3 illustrates an example for FAIC-10. In this case, the narrative does not establish that whether this was agriculturally related, or if the location was a farm or ranch. Additional information sources were searched but none of the additional articles found were detailed enough for FAIC assignment other than FAIC-10.

In Case 2 in Box 3, the news narrative does not identify the source involved or what type of event occurred. In this case, other than the text stating this injury occurred as a result of farm accident, only FAIC-10 could be assigned.

Box 3 Case 1 *"A man was pinned under a tractor at [location] County Road. [Location] Fire and [location] Rescue were dispatched at mutual aid to help extricate the man and transport him to the hospital. County Sheriff's Office was also on the scene."* (Boster, 2017)

Box 3 Case 2 *"Farm Accident Sends Farmer's Daughter to Hospital.*

An unfortunate farm accident on [date], sent [name]'s daughter, [name], to the Children's Hospital of [location]. The [name]'s have a dairy farm in [location] and [name] is a familiar face in the show ring either leading or judging." (Dairy Agenda Today Staff, 2018)

3.3.4. Effects of supplemental information on coding

In this study, supplemental information (additional data sources and/or third opinion) was used in 275 cases (21% of 1,304). The two cases in Box 4 illustrate how supplemental information can be used to enhance the accuracy of agricultural injury coding.

In the first case, based on the initial report, the case was viewed as a single vehicle roadway incident by both coders 1 and 2, with the 'tractor' as the source of injury and 'roadway non-collision' as the event. Thus, there were no disagreement between the coders. However, after finding additional information (see Report 2), the both coders finalized their coding by using 'other vehicle' as the source and to 'roadway collision with other vehicle' as the event.

In second case in Box 4, the victim was working for a vineyard company. From the narrative, both coders used FAIC-1: Farm production work (crop production, animal production) as the FAIC code. Coder 2 then searched for supplemental information and found the OSHA report. The OSHA report indicated that the worker was employed by a farm labor contractor company(OSHA, 2018). For this reason, both coders finalized their coding by using FAIC-4: Agricultural and forestry support activities.

Box 4 Case 1 ***Report 1***: *"A [location] man is dead of injuries suffered in an accident last Thursday. Sheriff [name] says 79-year-old victim was thrown from the tractor he was driving on [roadway]. [Victim] passed away from his injuries in a hospital Tuesday evening."* (Bay Cities Staff, 2018)

Report 2: *"A 79-year-old [victim] died Tuesday after being thrown from his tractor in a two-vehicle accident Thursday, Sheriff [name] said. [Victim] was on [name] Road in the town of [location], when the tractor he was driving, pulling a trailer, was struck by another vehicle. [Victim] had serious injuries and later died at the hospital."* (Daily News Staff, 2018)

Box 4 Case 2 *"A man was killed after being trapped between a trailer and a pickup truck as he attempted to load a forklift onto the trailer while working in a [company name] vineyard early Thursday afternoon. The decedent has been identified as 60-year-old [victim's name]. At about 11:40 a.m., the [location] Highway Patrol, along with [location] County Fire, responded to a report of a possible fatality involving a white pickup truck and a trailer carrying a forklift. Upon arrival, first responders found the victim trapped between a pickup truck and a trailer. He was pronounced dead on arrival.*

According to officials, the victim was trying to load a forklift onto the trailer when the trailer began to slide and jackknifed. [Victim] was fatally injured when he attempted to exit the vehicle and became trapped. In addition to the county Coroner's Office, Cal/OSHA was contacted, since the incident was workplace related." (Jacobson, 2017)

3.3.5. Differing interpretations of code selection rules (primary/secondary injury sources)

In some cases, the coders interpreted the selection rules differently and a third opinion was sought.

In case 1 illustrated in Box 5, a construction company employee was fatally injured while he was laying tile in a farm field. Coder 1 used FAIC-1 and Coder 2 used FAIC-5, so a National Steering Committee member, an expert in the field was contacted as a third opinion. After having the expert opinion, the incident was coded FAIC-5: Farm hazard exposure, outside services.

In case 2 in Box 5, an automobile struck the farm vehicle on roadway. Both coders used the same codes for FAIC and OIICS event categories. However, they disagreed on the source/secondary source. Coder 1 listed the other vehicle as a source, and the farm tractor as a secondary source while Coder 2 flipped the source and secondary source. Two National Steering Committee experts were contacted and provided their coding. After discussion among the four coders, majority rules applied and 'other vehicle' was listed as a source and 'farm tractor' was listed as a secondary source.

Box 5 Case 1 *"A man tiling a field in central Minnesota died on Friday morning in a workplace accident. The construction company employee was installing drainage tile in the field near [location] when the accident was reported just before noon. The 31-year-old was pronounced dead at the scene by emergency responders. It's believed he may have been pinned between some heavy equipment."* (Uren, 2018)

Box 5 Case 2 *"A person driving a farm tractor is in critical condition after his tractor was struck Monday night on [road name] near [location]. Around 9:45 p.m., an automobile driven by [victim 1], 20, collided with a farm tractor driven by [victim 2], 25. Police say the farm tractor did not have any lights on. The driver of the automobile complained of facial pain but was otherwise in good condition. Both vehicles were totaled in the crash."* (FOX 55 Staff, 2019)

4. Discussion

This study identified the level of coder agreement in the assignment of FAIC and OIICS' injury Source and Event/Exposure. Overall, we found substantial and almost perfect agreement in FAIC and in hierarchical OIICS source and event/exposure to the three-digit level. The levels of agreement were found to vary depending on the category which the code belonged. This study found similar levels of agreement in OIICS' Source and Event/Exposure categories to those found by Scott (Scott, 2016). In a study by Yoder and Murphy, coders agreement for FAIC for 40 fatal test cases were evaluated and the coders on average agreed 75% of the time with the researchers' code (Yoder & Murphy, 2000). In their study, agreement among the coders were not evaluated.

Agricultural injuries require accurate injury classification for identifying injury patterns for prevention efforts. The accuracy of coding depends on the quality of information available of the injury events. In applying FAIC and OIICS selection rules to agricultural injury cases, our study highlighted some key themes that emerged regarding accurate and consistent coding of the agricultural injuries. These themes are inclusion/exclusion based on industry classification system; inconsistent/discrepant reports; incomplete/nonspecific reports; effects of supplemental information on coding; and differing interpretations of code selection rules (primary/secondary injury sources).

The most disagreed categories were FAIC-4 and FAIC-5. This is likely the result of media reports lacking specific information. Supplemental information sources such as obituaries were helpful in assigning FAIC-5 since victim's primary occupation or hobbies are often stated. OSHA reports were valuable in assigning FAIC 4 and 5 because the NAICS classification is always available in OSHA reports.

Supplemental data and follow-up discussion over the cases help to improve accurate coding by 20% for FAIC, and by 55% and 40%, respectively, for the 4-digit level of OIICS source and event categories. Even with supplemental information however, we could

not assign the proper FAIC, or OIICS source, and event codes for 172, 22, and 40 injury cases, respectively.

A revised version of the FAIC (S575.2) is expected to be published by the American Society of Agricultural & Biological Engineers (ASABE) in early 2020. Major improvements to S575.2 include the addition of FAIC-10 Undetermined as a category, a written coding protocol, an FAIC Decision-Tree, and example cases applying the FAIC. All these enhancements will make it easier for other coders to accurately use the FAIC.

When assigning OIICS source or event categories, coders found that the instructions from the OIICS manual need more clarifications with increased number of examples. Often in the given examples, the logic behind the selection is not given and this made the coding assignments open to interpretation. The OIICS' major revision is initiated in Spring 2017 and the updated version will include new and emerging conditions as well as a new coding structure to capture other case characteristics such as worker activity (Register, 2017). The improvement and clarification of the order of precedence and rules of selection will make the codings more user friendly and easy to use. It is possible that coding OIICS to the third level only is enough for sufficiently understanding the source of injury. We did not find any literature that examined the level of source and event/exposure coding relative to injury prevention. This would be an excellent future research project.

The strength of this study is the large number of injuries coded covering a diverse range of agricultural events from intentional workplace violence incidents to a wide variety of normal work-related incidents. The OIICS methodology of this study can be applicable for not only AgFF related injury news articles but also other industries and occupations related injuries on news media.

There are certain limitations to this study. While it is common to employ up to 6 coders (Olsen, 2013), we used only two coders for the majority of cases because of financial constraints. However, a third opinion was sought when discrepancies occurred. Weekly discussion of the codes can be interpreted in different ways. Discussions helped the coders to see unintentional mistakes and consequently to improve overall coding accuracy. However, the weekly discussions may have affected the agreement level since the discussions gave each coder a chance to learn the other coder's coding style. Coders also were limited with the information given by the available sources. In some cases, there were multiple information sources reporting the same case in a similar way and one report with discrepant information. In those cases, we assumed that the most detailed version of the information was accurate. Another limitation is that news media typically do not capture less serious injuries and incidents, thus our codings are more relevant to agriculture related deaths, and traumatic and newsworthy non-fatal injuries.

5. Conclusions

In summary, this study assessed and compared the level of agreement between coders when coding traumatic agricultural incidents. There was a high level of agreement between the coders in FAIC coding, and at the 3-digit level of OIICS source and event categories. Quantifying the level of agreement for agricultural injuries led to a better understanding of coding discrepancies and also uncovered areas for improvement.

Our study emphasizes the importance of using supplemental information, follow-up discussions, and a third opinion in ensuring agricultural injuries are coded accurately. By using supplemental information and weekly discussions between coders, the accuracy of codings were improved significantly.

When coding the agricultural incidents, coders should carefully check the information given by the data source to make sure whether the incident is agriculturally related or not. Multiple data sources should be looked at closely for identifying the injury sources and injury events.

The most important contribution this paper makes to coding of agricultural injury is to show that agricultural injury can be coded by multiple coders with a great deal of accuracy. This in turn increases the value of agricultural injury surveillance because of increased comparisons of injury data across states and regions of the country, improved identification of sources of injury, and a better understanding of the circumstances surrounding the injury event. All of this enhances understanding of possible interventions and we encourage all safety professionals to use FAIC and OIICS coding systems together.

6. Practical applications

- Quantifying the level of agreement for agricultural injuries will lead to a better understanding of coding discrepancies and may uncover areas for improvement to coding scheme itself.
- High level of initial and final agreement with FAIC and OIICS codes suggest that these coding schemes are user-friendly and amenable to widespread use.

7. Authors' contributions

SG, BW, ER, DJM: conception or design of the work; SG, ER: coding the injury cases, SG: statistical analysis, SG, DJM: drafting the work or revising it critically for important intellectual content; SG, BW, ER, DJM: Revising the work critically for important intellectual content; final approval of the version to be published. All authors approve the final manuscript and take public responsibility for it.

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Institution and Ethics approval and informed consent

Collection and storage of injury data on AgInjuryNews was approved by Marshfield Clinic Research Institute's Institutional Review Board (IRB).

Disclosure (Authors)

The authors declare no conflicts of interest.

Disclaimer

None.

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