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Cow-Related Injuries in Wisconsin During 2017–2023

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ABSTRACT

Introduction: The dairy industry—a key industry for the economy—remains a potentially hazardous industry across the nation. The literature on animal-related injuries in the agriculture industry is sparse. This analysis aimed to describe cow-related injuries, the utilization of workers' compensation, and the circumstances of the injuries.

Methods: This mixed methods analysis of agricultural injuries focused on cow-related injuries in hospital discharge and workers' compensation data during 2017–2023. Cases, aged 12 or older, were identified in the hospital discharge data using ICD10-CM codes. Cow-related claim injury narratives and industry and occupation data were extracted from workers' compensation data.

Results: During 2017–2023, cow-related injuries represented 13.1% ($n = 2659$) of agricultural injuries and were the second most predominant cause of work-related agricultural injuries. These injury figures were stable, compared to a downward trend of non-cow-related injuries ($p = 0.01$). Young workers (12–34 years) and Hispanic workers had the highest burden for cow-related injuries. The top five body parts affected by cow injuries were the upper (24%) and lower (23%) extremities, other head, face, and neck (22.1%), chest (15.2%), and traumatic brain injury (5.1%). Workers' compensation was used in 28.5% of cases identified in the hospital discharge data. Animal handling, lack of farm worker safety measures, and equipment safety were identified as factors associated with cow-related injuries.

Conclusion: This analysis identified a surprising number of cow-related injuries, including some life-threatening injuries. It is important to continue to promote safety measures and injury prevention best-practices to ensure worker well-being and farm productivity.

1 | Introduction

Agriculture in general and the dairy industry specifically are major contributors to the nationwide economy (3.5% gross domestic product) [1] and to Wisconsin's economy in particular. In Wisconsin, known as “the Dairy State,” the dairy industry is a major driver of the economy by contributing 6.5% of the state's gross domestic product (14.3% of the state's revenue) and

accounting for approximately 353,000 jobs or 9.5% of the state's workforce [2, 3]. According to the census of agriculture in 2022, in Wisconsin, there were approximately 1.3 million dairy cows distributed across 58,521 farms occupying one-third of the state's landmass, and most farms (95%) are family-owned [3].

The dairy industry has been identified as one of the most hazardous and deadliest industries in both the United States and

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Wisconsin [4–6]. In 2021–2022, in the United States, 21,020 injuries in the dairy industry required days away from work, and the fatal injury rates were five times higher than all US industries [7]. Several causes of fatality were identified, out of which violence by animals was a major contributor [7]. In Wisconsin, the findings were similar, with Agriculture, Forestry, Fishing, and Hunting (North American Industry Classification System [NAICS] code 11) being the deadliest sector with 81.3 deaths per 100,000 full-time equivalent workers. According to the Census of Fatal Occupational Injuries (CFOI), the Cattle Ranching and Farming subsector (NAICS 1121) had the highest fatality rate within the Agriculture, Forestry, Fishing and Hunting sector [8]. Several recent journalistic pieces and US Occupational Safety and Health Administration (OSHA) investigation reports have revealed tragic work-related accidents in farms in Wisconsin, some due to crushing by cows [9–12]. Moreover, there is no significant downward trend in the injury or fatality rates in recent decades [8]. The causes of these injuries and deaths varied and ranged from machinery accidents and death in manure pits to crushing by equipment or cows. Despite these alarming trends, several surveillance systems and reports showed that agricultural injuries are likely under-reported [4, 7, 13, 14].

Several risk factors including but not limited to the paucity of consistent effective safety practices and interventions, long work weeks, fast-paced work, language barriers, and staff turnover, a mostly immigrant workforce, and challenges in accessing healthcare, have contributed to these high injuries and deaths [15]. Dairy farms rely heavily on all categories of immigrants (legal, temporary agricultural guestworkers, and undocumented) who represent at least 68% of their workforce with 78% of these immigrants being Hispanic or Latino [16]. In Wisconsin, the dairy cattle and milk production industry, which represents the near-totality (96.6%) of the cattle ranching and farming industry category, employed a disproportionately high number of Hispanic workers, younger workers (11–14 years), older workers (65–99 years), and workers with less than a high school education [17]. Most of these workers likely have little to no healthcare coverage. A recent estimate showed that only 26% of farmworkers had healthcare coverage through their employers [16].

Farm-owners are not statutorily required to have workers' compensation insurance for their workers unless they have six or more employees—a threshold that most small farms (in Wisconsin and other states) do not meet [18]. This situation often leaves farm workers vulnerable when accidents occur and during their recovery from work-related injuries and illnesses [10, 12, 19]. As mentioned, 95% of Wisconsin dairy farms are family-owned and are most likely considered small farms [3]. Additionally, the lack of consistent industry and occupation information in public health surveillance data makes it hard to track farm or other workplace-specific injuries, regardless of insurer. Despite several initiatives to support farm workers' safety and well-being [20–22], the injury and fatality rates have remained unchanged over the past decade [8].

Despite clear indications of dangers in the US dairy industry, analyses of cow or cattle-related injuries were mostly from Europe and dated, contrasting with the paucity of the literature

on this topic in the United States, where the dairy industry is a key industry. Most of the literature on agricultural injuries in the United States focuses on machinery, such as tractors or other vehicle roll-over risks with very little on animal-specific risks [23–28].

Given the paucity of the literature of animal-specific injuries in the dairy industry that contrasts with the importance of this industry and of its workers' well-being, this study aimed to describe the incidence of cow-related injuries and the injury description in the Wisconsin hospital discharge data as well as patients' use—and type—of healthcare coverage. Finally, this study demonstrates how workers' compensation data can provide narratives related to the circumstances of these injuries as well as the industry and occupation distribution of injured workers.

2 | Methods

2.1 | Study Design

This was a mixed methods analysis focused on cow-related injuries in individuals aged 12 years or older discharged from Wisconsin hospitals during 2017–2023; a 5-year period that included the most recent calendar years' worth of data at the time of the analysis. The lower bound of the age limit was set in accordance with state child labor laws applicable to agricultural work [29]. We used non-cow-related agricultural injuries as a comparison group for the quantitative analysis.

The qualitative section of this analysis was the extraction of free-text injury descriptions from the workers' compensation data to depict different circumstances where workers were injured during interactions with cows. A small number of narratives were selected to illustrate the variety of work situations resulting in cow-related injuries. This is a complement to the quantitative analysis and no formal qualitative data analysis methods were employed.

2.2 | Data Sources

Two data sources were used in this analysis. The first data source was the Wisconsin hospital discharge data, where all Wisconsin hospitals and ambulatory surgery centers are statutorily required to report their patient-level health data according to Wisconsin State Statute 153 [30]. This database also includes patient records from Wisconsin residents who seek care in the neighboring states of Minnesota and Iowa [30]. This dataset does not include outpatient clinic or urgent care information. However, hospital emergency department (ED) visits, inpatient cases, observation-stay cases, and ambulatory surgery cases are included in this dataset and analysis.

The second data source was Wisconsin workers' compensation data, where work-related lost time claim information is reported by insurance carriers to the Wisconsin Department of Workforce Development (DWD). This dataset does not include any medical-only claim information. In these data, we were able

to access individual-level information about the occupation of the worker, the injury description, and the detailed claim information (DCI). The workers' compensation data do not have consistent employer industry code including but not limited to the North American Industry Classification System (NAICS) code. Another source of data, the Unemployment Insurance dataset, includes employer name, federal employer identification number (FEIN), and the NAICS code. To attribute NAICS codes to workers' compensation claims, we linked the workers' compensation data to the unemployment insurance data by the FEIN. The occupation information was coded through the National Institute for Occupational Safety and Health Industry and Occupation Computerized Coding System (NIOCCS) to obtain the standardized occupation code (SOC) coded in the 2017 scheme [31].

Due to differences in individual name structures in both databases, and after a sensitivity analysis between an exact match and a probabilistic match, we decided to proceed with a probabilistic match on sex, date of birth, date of admission against date of injury, and the worker's residence zip code. During the sensitivity analysis, the probabilistic match identified more record matches (98 vs. 63) than the exact matching on full name, date of birth, and sex.

2.3 | Case Definitions

Our definition of agricultural injury is based on existing work that identified ICD-10-CM external codes for agriculture, forestry, and fishing [32]. In our analysis, we excluded any forestry and fishing code. We included initial encounter codes only, which excluded subsequent and sequelae codes. As such, in the hospital discharge data, a cow-related injury was defined as any agricultural record in which external cause of injury was coded as "bitten by cow" (W5521XA), "struck by cow" (W5522XA), or "other contact with cow" (W5529XA). We only retained the initial encounter and thus excluded any subsequent encounter or sequela. The remaining work-related agricultural injury codes were considered non-cow-related injuries (all other agricultural injuries).

In the workers' compensation data, we identified cow-related claims using regular expression (regex) searches in the free-text injury description field where the circumstances of the injury were reported. We identified any claim in which at least one of the following words were mentioned: "cow," "bull(s)," "cattle," "heifer," "calves," and "steer." We also looked for the combination of the following regular expressions "feed" or "birth" and "calf." We excluded confusing words such as "coworker," "pitbull," "steering wheels," "skid-steer," or the regular expression "dozer," "cowo," "cowa." For example, this exclusion criteria removed injury related to bulldozer use or injury by a coworker. We excluded the combination of the regular expression "burn," "irritation," or "shin" because these descriptions are related to non-cow-related human lower extremity injuries. We specifically reviewed claims including calves or steers to eliminate injuries affected the lower leg body part "calves" and machinery injuries involving steering wheels, skid-steers, or anything other word including the root "steer" that is not cow-related. Additionally, we excluded claims in which the DCI

cause of injury was chemicals (code 1); fellow worker, patient, or other person (code 74); hand tool or machine in use (code 76); motor vehicle (code 50); or repetitive motion (code 94). For example, a claim description that fits the latter exclusion was "worker got injured by equipment when processing a cow." The hospital discharge and Worker's Compensation datasets were linked to identify overlap (i.e., injured cases who filed for worker's compensation lost time claims).

2.4 | Denominators and Full-Time Equivalent Estimates

Because cow-related injuries can take place outside of agricultural work settings, such as in veterinary practice or meat processing, we used the entire workforce to calculate rates. To cover our study period, we extracted three sets of 5-year ACS data: 5-year ACS 2017–2021, 5-year ACS 2018–2022, and 5-year ACS 2018–2023 [33]. We computed the FTE by the different demographics for each dataset by using the following formula:
$$FTE = \frac{\text{Number of usual hours worked per week}}{40}$$
. The final FTE by demographics that account for the study period was the mean across the three ACS 5-year periods.

2.5 | Statistical Analyses

The quantitative analysis described injured workers' demographics, their health coverage, and the mechanism, nature, and severity of the injury using Wisconsin hospital discharge data. Throughout this section of the analysis, non-cow-related injuries were used as the reference group for comparison. We examined trends for the two injury types (cow vs. non-cow) over time and assessed the annual percentage change using a chi-squared test for trend in proportion (i.e., Cochran–Armitage trend test). We computed the number of injuries, percentage, rate, 95% confidence interval of the rate, and the prevention index (PI) by demographics (age, sex, race, and ethnicity) for cow-related injuries and non-cow-related injuries. The rate was expressed as number of injuries by 100,000 full-time equivalent estimates (FTEs) across all industries during our study period. To assess the burden of the injuries by demographics, we computed the PI—the average of count and rate rankings—that is a key metric for prioritizing preventions and interventions [34].

After linking the hospital data ICD10-CM codes to the injury matrix and external codes, we determined the number and percentage of injured body parts and the nature of injury by injury type. We compared the injury severity between cow and non-cow injuries by using the new injury severity score (NISS) and determined the distribution of injuries by vital status in the ED and the hospital discharge point. The NISS was computed for hospital cases using the ICD programs for injury categorization R package (ICDPICR) [35]. The NISS is defined as the sum of the squares of the three most severe abbreviated injury scale scores (AIS) for each case [36]. NISS is also known to be the best index for predicting mortality among reliable trauma scores [37]. We computed the median and range of NISS as well as the categories of severity. We used *t*-tests to compare median

injury scores between cow and non-cow-related injuries. Finally, we described the primary payer by injury type.

For workers' compensation lost time claims, we determined the number of cow-related lost time claims, the percentage of paid claims, and the distribution of claims by DCI and detailed occupation. To help illustrate how the most frequent types of cow-related injuries occurred, we extracted a few narratives of the injury description in the workers' compensation data and grouped them by detailed cause of injury.

Throughout this analysis, we used the chi-squared test to determine the strength of association with a significance threshold (p -value) less than 5% for categorical variables. For numerical variables, we used t -tests for comparison with the same significance threshold of less than 5%. When a significant association was detected and whenever relevant, we conducted a post-hoc Fisher's exact test to determine the difference between groups (cow-related injuries vs. non-cow-related injuries). These data were cleaned, visualized, and analyzed in R interfaced with Posit.

3 | Results

During the study period (2017–2023), there were 20,333 agricultural injury cases discharged from Wisconsin's hospitals, out of which 13.1% ($n = 2659$) were attributable to cows. Cow-related injuries were the second most predominant cause of work-related agricultural injuries (Table 1).

The median annual number of injured agricultural workers was 2812, with 395 (14%) for cow-related injuries and 2396 (86%) for non-cow-related injuries. There was a statistically significant difference in the proportion trend of cow and non-cow-related injuries during the study period (Figure 1, chi-squared test for trend in proportion, $p = 0.01$). Cow-related injuries have remained relatively steady during the study

period, whereas non-cow-related injuries have decreased significantly during the study period (Figure 1).

Bivariate analyses showed significant differences between workers who suffered cow-related injuries compared to those who had non-cow-related injuries (Table 2). Young workers (aged 12–34 years) had the highest burden (as measured with the PI) of cow-related injuries (Table 2, PI = 1, 2, and 3). For non-cow-related injuries, teenage and older workers (65+) were at the highest burden (PI = 1 and 2, respectively). Disregarding unknown ethnicities, Hispanic workers had the highest burden of cow-related injuries compared to non-Hispanic workers for non-cow-related injuries (Table 2).

Using external cause of injury classifications, the upper and lower extremities were the most injured body parts during these human and cow encounters. However, traumatic injuries of the head (i.e., traumatic brain injury and other injuries of the head, face, and neck) became the most predominant injuries when combined (Table 3). At a more detailed level of injury description, the most predominant injuries were superficial injury of the thorax ($n = 309$, 6.9%), open wound of the head ($n = 264$, 5.9%), superficial injury of knee and lower leg ($n = 234$, 5.3%), fracture of rib(s), sternum, and thoracic spine ($n = 227$, 5.1%), fracture of skull and facial bones ($n = 225$, 5.1%), superficial injury of head ($n = 215$, 4.8%), intracranial injury ($n = 205$, 4.6%), and other/unspecified injuries of head ($n = 187$, 4.2%) (Table SII).

Superficial and contusion injuries, fractures, and open wounds were the injuries most observed in agricultural workers in both cow-related and non-cow-related cases. However, superficial and contusion injuries, crushing, and other or unspecified injuries occurred significantly more often in cow-related cases than in non-cow-related cases (Table 4). Conversely, fractures, open wounds, and amputation occurred significantly less often in cow-related cases than in non-cow-related cases (Table 4).

TABLE 1 | Top 10 mechanisms of injury of agricultural injuries in the Wisconsin hospital discharge data from 2017 to 2023.

ICD10CM	Mechanism of injury	Count (N = 20,333)
V8659X	Driver of other special all-terrain or other off-road motor vehicle injured in non-traffic accident	3782
W5522X	Struck by cow	2128
W5512X	Struck by horse	1498
V8699X	Unspecified occupant of other special all-terrain or other off-road motor vehicle injured in non-traffic accident	1416
V8669X	Passenger of other special all-terrain or other off-road motor vehicle injured in non-traffic accident	958
W3089X	Contact with other specified agricultural machinery	832
W5529X	Other contact with cow	519
W010XX	Fall on same level from slipping, tripping, and stumbling without subsequent striking against object	516
W540XX	Bitten by dog	503
W5519X	Other contact with horse	480

Note: Bitten by a cow (W5521X) ranked 97 in the full table that is available as Table SI.

Abbreviation: ICD-10-CM, International Classification of Diseases, Tenth Revision, Clinical Modification.

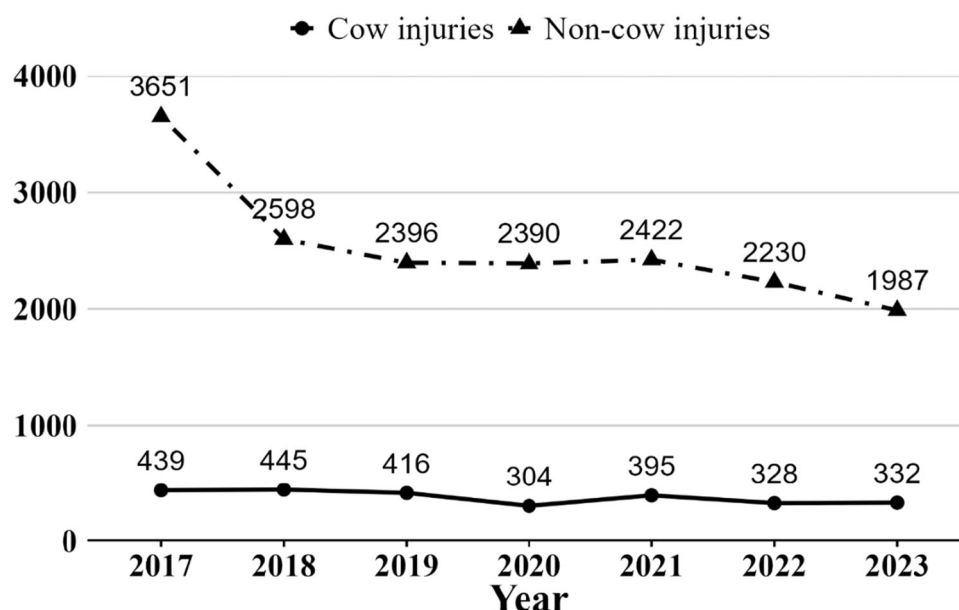


FIGURE 1 | Agricultural workers' injury type by year in the Wisconsin hospital discharge data from 2017 to 2023.

TABLE 2 | Burden (i.e., count, rate, and prevention index) by demographics of cow- and non-cow-related agricultural injuries in the Wisconsin hospital discharge from 2017 to 2023.

	Cow-related injuries (N = 2659)			Non-cow-related injuries (N = 17,674)		
	Count (%)	Rate (95% CI)	PI	Count (%)	Rate (95% CI)	PI
Age						
12–17	235 (8.8%)	964 (841–1087)	3	2252 (12.7%)	9239 (8857–9620)	2
18–24	413 (15.5%)	136 (122–149)	2	2226 (12.6%)	731 (700–761)	5
25–34	482 (18.1%)	79 (72–87)	1	2666 (15.1%)	439 (423–456)	3
35–44	422 (15.9%)	67 (61–74)	4	2436 (13.8%)	389 (373–405)	6
45–54	365 (13.7%)	60 (54–66)	7	2343 (13.3%)	383 (367–398)	7
55–64	410 (15.4%)	74 (67–81)	6	2645 (15.0%)	477 (459–495)	4
65 or more	332 (12.5%)	258 (231–286)	5	3106 (17.6%)	2418 (2333–2503)	1
Sex						
Male	1818 (68.4%)	114 (109–120)	1	10,858 (61.4%)	683 (670–696)	1
Female	841 (31.6%)	60 (62–71)	2	6816 (38.6%)	538 (525–551)	2
Race						
White	2418 (90.9%)	99 (95–103)	1	16,641 (94.2%)	682 (972–692)	1
Non-White	62 (2.3%)	15 (11–19)	2	612 (3.5%)	147 (136–159)	2
Unknown	179 (6.7%)	NA		421 (2.4%)	NA	
Ethnicity						
Non-Hispanic	2047 (77.0%)	77 (73–80)	3	16,574 (93.8%)	621 (612–631)	2
Hispanic	569 (21.4%)	357 (328–387)	1	798 (4.5%)	501 (466–536)	3
Unknown	43 (1.6%)	145 (102–189)	2	302 (1.7%)	1021 (906–1137)	1

Note: Rate is expressed as an injury per 100,000 FTE.

Abbreviations: CI, confidence interval; NA, not applicable or not available; PI, prevention index; %, percentage.

Cow-related injuries tended to be significantly less severe than non-cow-related injuries (median NISS of 4.87 ± 6.8 vs. 5.64 ± 7.94 , $p < 0.001$, respectively) (Table 5). In the ED, there was no statistically significant difference between cow or non-cow-related fatality. Cow-related injuries presenting to the ED

were less likely to result in a hospital admission than non-cow injuries (Table 5).

Patients with cow-related injuries in the Wisconsin hospital discharge data were less likely to report having commercial or

TABLE 3 | Body parts affected by agricultural injuries (cow vs. non-cow) in the Wisconsin hospital discharge from 2017 to 2023.

Body	Cow injuries	Non-cow injuries	p value	Test exact of Fisher
Upper extremity	1071 (24.0%)	10,357 (30.4%)	< 0.001	< 0.001
Lower extremity	1024 (23.0%)	8080 (23.7%)		1
Other head, face, and neck	985 (22.1%)	6038 (17.7%)		< 0.001
Chest (thorax)	677 (15.2%)	3351 (9.8%)		< 0.001
Traumatic brain injury	229 (5.1%)	2084 (6.1%)		< 0.001
Abdomen	199 (4.5%)	923 (2.7%)		< 0.001
Vertebral column	111 (2.5%)	1638 (4.8%)		< 0.001
Pelvis	94 (2.1%)	941 (2.8%)		1
Systemwide	30 (0.7%)	299 (0.9%)		1
Other trunk	7 (0.2%)	23 (0.1%)		1
Spinal cord	4 (0.1%)	52 (0.2%)		1
Missing	24 (0.5%)	299 (0.9%)		

TABLE 4 | Nature of agricultural injuries (cow vs. non-cow) in the Wisconsin hospital discharge from 2017 to 2023.

Nature	Cow injuries	Non-cow injuries	p value	Test exact of Fisher
Superficial and contusion	1616 (36.3%)	8620 (25.3%)	< 0.001	< 0.001
Fracture	1020 (22.9%)	10,030 (29.4%)		< 0.001
Other specified injury	461 (10.3%)	3048 (8.9%)		0.02
Open wound	409 (9.2%)	5848 (17.2%)		< 0.001
Unspecified injury	409 (9.2%)	1928 (5.7%)		< 0.001
Internal organ injury	361 (8.1%)	2880 (8.4%)		1
Crushing	82 (1.8%)	440 (1.3%)		0.03
Dislocation	62 (1.4%)	532 (1.6%)		1
Other effects of external causes	12 (0.3%)	138 (0.4%)		1
Amputation	11 (0.2%)	248 (0.7%)		< 0.001
Blood vessel	5 (0.1%)	66 (0.2%)		1

Note: Those with fewer than five injuries were excluded from the table.

private insurance as a payor for their healthcare coverage than those with non-cow-related injuries (34.9% vs. 46%, respectively). However, there were more workers who claimed workers' compensation insurance for their healthcare among those with cow-related injuries compared to their counterparts with non-cow-related injuries (28.5% vs. 8.4%, respectively, $p < 0.001$) (Table 6).

During the same study period, 786 cow-related lost-work-time workers' compensation claims were reported to DWD, out of which 91.7% ($n = 721$ claims) were paid. The annual median cow-related claims were 117 (range: 82–140). A total of 98 injured cases (3.7%) were found in the workers' compensation claims data for lost time.

Using the DCI cause of injury classification from the worker's compensation data, several causes of injury were identified out of which most workers were struck or injured by cows (47.3%); strained or injured by cows (14%); or had a fall, slip, or trip injury subsequent to an encounter with a cow

(13.5%). The narratives below provide examples of specific circumstances surrounding different causes of cow-related injuries (Table 7).

Cow-related injuries did not exclusively affect farm workers. As shown in Tables SIII and 8, workers across several industries and occupations were injured by cows and their injuries were severe enough to incur lost time during the course of their work. While more than half of all claimants (59.3%) worked in the Dairy Cattle and Milk Production industry, the remaining injured claimants were distributed across several industries associated with the dairy industry including, but not limited to wholesalers, veterinary services, colleges, and many others (Table SIII). Most injured workers (66.5%) were farm workers and their occupation categories included: Farm-workers, Farm, Ranch, and Aquacultural Animals; Farmers, Ranchers, and Other Agricultural Managers; Farmworkers and Laborers, Crop, Nursery, and Greenhouse; Agricultural Workers, All Other; and First-Line Supervisors of Farming, Fishing, and Forestry Workers (Table 8).

TABLE 5 | Injury severity and discharge points of injured (cow vs. non-cow) agricultural injuries (cow vs. non-cow) in the Wisconsin hospital discharge data from 2017 to 2023.

	Cow injuries (N = 2659)	Non-cow injuries (N = 17,674)	p value	Test exact de Fisher
NISS				
Mean (SD)	4.87 (6.80)	5.64 (7.94)	< 0.001	
Median [min, max]	2.00 [0, 66.0]	3.00 [0, 75.0]		
NISS category				
Mild	2144 (80.6%)	13,751 (77.8%)	< 0.001	0.002
Moderate	338 (12.7%)	2302 (13.0%)		0.68
Severe	100 (3.8%)	958 (5.4%)		0.04
Profound	77 (2.9%)	663 (3.8%)		0.002
Death in the ED				
No	2223 (83.6%)	13,941 (78.9%)	0.817	
Yes	1 (0.0%)	12 (0.1%)		
Missing	435 (16.4%)	3721 (21.1%)		
Discharge place				
Emergency department (ED)	2224 (83.6%)	13,953 (78.9%)	< 0.001	< 0.001
Ambulatory surgery	205 (7.7%)	1352 (7.6%)		1
Inpatient	148 (5.6%)	1816 (10.3%)		< 0.001
Observation	82 (3.1%)	553 (3.1%)		1

Abbreviations: ED, emergency department; NISS, new injury severity score; SD, standard deviation.

TABLE 6 | Healthcare payer of agricultural injuries (cow vs. non-cow) in the Wisconsin hospital discharge from 2017 to 2023.

	Cow injuries (N = 2659)	Non-cow injuries (N = 17,674)	p value	Test exact of Fisher
Primary payer			< 0.001	
Commercial or private	928 (34.9%)	8138 (46.0%)		< 0.001
Workers compensation	759 (28.5%)	1485 (8.4%)		< 0.001
Medicaid	332 (12.5%)	2590 (14.7%)		< 0.001
Medicare	296 (11.1%)	3126 (17.7%)		< 0.001
Other	344 (12.9%)	2335 (13.2%)		1

Note: Other includes mostly self-pay and healthcare programs for military and their families or to Veterans Affairs (TRICARE, CHAMPVA).

4 | Discussion

Cows continue to pose a significant occupational hazard for those in the dairy industry. In Wisconsin, during our study period, cow-related injuries were the second most predominant agricultural injury. While the frequency of agricultural injury declined during the study period, cow-related injuries remained flat, making such injuries a growing proportion of all agricultural injuries. The highest burden of cow-related injuries was observed among young workers and Hispanic workers. As with other agricultural injuries, teens (12–17) had the highest rates of cow-related injuries. Notably, teens’ rates of cow-related injuries were higher than the rates of non-cow-related injuries for all other age groups, pointing toward the importance of addressing cow safety in this group. Cow-related injuries impacted several body parts which included the head, brain, and thorax. Along with the body parts affected, superficial

contusions, fractures, internal organ injuries, and crushing were predominant among cow-related injuries. Within the narratives, cow-related injuries are due to, but not limited, animal handling, lack of proper safety measures, and unpredictable animal behaviors. Though cow-related injury occurred in farm settings, these injuries affected several worker types, which demonstrates the structure of modern farms, which are more complex and involve workers from different industries.

The cow-related injury incidence in Wisconsin is exceedingly higher than that of other farms of the same size or more around the world. In Switzerland, Australia, and New Zealand, 94 cases, 1002, and 78 cases of cattle-related injuries were reported, respectively [24, 26–28]. Similarly, the cow-related injury claim incidence in workers’ compensation is also higher than the incidence in Colorado [38]. Though there are differences between injury or claim

TABLE 7 | Example injury narratives by cause of cow-related injuries in the workers' compensation data from 2017 to 2023.

Cause of injury	Count (%)	Circumstances of injuries and worker demographics
Struck or injured by	372 (47.3%)	The employee was moving calf [when the] mother cow hit him in the head. (Male worker, 48 years old) While rounding up 3 heifers to breed, one of them turned and ran over [worker] near a gate and landed on top of him. (Male worker, 61 years old) [Employee] was going to attach milking unit to cow [when the] cow kicked and injured [her] hand and thumb. (Female worker, 50 years old)
Strain or injury by	110 (14.0%)	[The] employee was lifting a cow from sitting to standing and felt a pop [and] sustained an umbilical hernia. (Male worker, missing age)
Fall, slip, or trip injury	106 (13.5%)	The claimant was head-butted by cow slipped and fell on concrete [on her] right knee (patella injury). [She was] struck from [the] back of [the] leg by [the] cow and popped [her] knee cap. (Female worker, 18 years old) [The worker] fell backwards when a cow struck a gate. [He] felt striking [his] head on [the] concrete [and sustained a] traumatic brain injury. (Male worker, 83 years old)
Caught in, under or between	53 (6.7%)	[The worker] was milking cows [when the] cow kicked [her] hand [and her] hand was smashed between [the] cow and [the] wall. (Female worker, 50 years old)
Striking against or stepping on	33 (4.2%)	[The worker] was assisting in cleaning a manure auger [when a] cow knocked [him] into [the] blades of [the] auger. (Male worker, 22 years old)
Cut, puncture, scrape injured by	22 (2.8%)	[The worker] was in [the] giving vaccines cows when another cow bumped into him causing [the injury]. (Male worker, 48 years old)
Miscellaneous causes	8 (1.0%)	Employee was attempting to shoot a cow charging her and slipped accidentally shot left forearm with gun and fractured bones hit her left forearm when gun shot. (Female worker, 42 years old) [Worker] experienced gastric effects due to cryptosporidium from cows. (Female worker, 26 years old)

Note: The cause of injury was missing for 82 (10.4%) workers' compensation claims

TABLE 8 | Worker's compensation cow-related injury claimant's count and percentage by detailed occupation from 2017 to 2023.

SOC	Detailed occupation	Count (%)
45-2093	Farmworkers, farm, ranch, and aquacultural animals	413 (52.5%)
11-9013	Farmers, ranchers, and other agricultural managers	66 (8.4%)
53-7062	Laborers and freight, stock, and material movers, hand	50 (6.4%)
29-1131	Veterinarians	24 (3.1%)
45-2092	Farmworkers and laborers, crop, nursery, and greenhouse	23 (2.9%)
19-4099	Life, physical, and social science technicians, all other	11 (1.4%)
53-3032	Heavy and tractor-trailer truck drivers	10 (1.3%)
45-2099	Agricultural workers, all other	15 (1.9%)
51-3021	Butchers and meat cutters	6 (0.8%)
45-1011	First-line supervisors of farming, fishing, and forestry workers	6 (0.8%)
13-1021	Buyers and purchasing agents, farm products	5 (0.6%)
29-2056	Veterinary technologists and technicians	5 (0.6%)
	Missing	77 (9.8%)

Note: Among the missing occupations at the detail level, there are five agricultural and food science technicians and five sales representatives (SOC: 19-401), wholesale and manufacturing (SOC:41-401) workers at the broad category level. Occupations with fewer than five claimants were suppressed from this table.
Abbreviation: SOC, standard occupation code.

reporting across systems and states, it is important that the Wisconsin dairy industry implement injury prevention best practices and worker well-being strategies to ensure safety in farms.

Although Wisconsin's numbers appeared to be higher than most figures in the literature, these injuries are also likely to be underreported. This analysis focused on hospital cases and did not account for outpatient cases. Also, injuries that are treated

by on-site providers, as described by workers' journalistic accounts, would not be accounted for in this analysis [10, 12]. In Michigan, the same finding of under-reporting from one source was noted through a multisource surveillance system of agricultural injuries [14, 39].

Craniofacial, upper and lower extremity, and thoracic injuries were predominant in both cow-related and non-cow-related injuries, and these anatomical locations were not surprising because almost half of the injuries happened when a cow struck or head-butted the worker, similar to a blunt trauma. The force of kicking combined with the size and strength of the animal suggests that even one kick can result in severe injuries, similar to those observed in our analysis [23]. A similar mechanism of injury was found in various analyses across the world [24, 26–28].

In our analysis, workers' compensation insurance was claimed as the primary payor for 28.5% of cow-related injuries and 8.4% of non-cow-related injuries. According to a study on dairy workers in 2023, many dairy workers were aware of workers' compensation. However, when an injury occurred, medical bills and sometimes lost work time were directly paid out of pocket by the employer [40]. Some workers were reluctant in using workers' compensation because of fear of being deported due to their unauthorized or illegal immigration status. This situation can lead to workers suffering mental and physical abuse, as illustrated in this investigation in 2024 [19].

In most surveillance systems, work-relatedness indicators are usually missing or poorly completed when available, which constitutes a challenge in determining work-related illnesses or injuries. The alternative is the use of workers' compensation as a primary payor as an indicator of work-relatedness. In our analysis, we considered all cow-related injuries as occupationally related because of low probability of recreational human-cow interactions. In our analysis, 28.5% of cow-related injured workers claimed workers' compensation as primary payor. If we were to use workers' compensation, we would have only captured this subject that represents approximately less than half of the cow-injured cases. It is important that health information platforms and healthcare providers consider including clear indicators of work-relatedness, as well as questions about industry and occupation, on their forms.

Our analysis has several strengths and limitations. The first strength is the use of hospital discharge data, where hospitals report ED, ambulatory surgery, and inpatient cases for all Wisconsin residents—even those treated in neighboring states (i.e., Iowa and Minnesota). These data gave us a comprehensive view of severe injuries that warrant emergency department visits and medical admissions.

The second strength is the use of workers' compensation data to supplement the hospital data. Additionally, the workers' compensation dataset provided us both quantitative and qualitative information. The use of narratives illustrates clearly the circumstances of these injuries, which constitute a launching pad for interventions that promote farmers' safety, better animal handling, and farm work policies.

The first limitation of our analysis was the absence of outpatient cases, which limits the evaluation of the scope of the problem. However, outpatient cases are more likely to be mild. As such, our results are likely capturing the most severe cow-related injury cases.

The second limitation is the lack of industry and occupation information in the Wisconsin hospital discharge data and the fact that the available work-relatedness indicators are more likely to undercount work-related injuries, particularly in the agriculture sector. Finally, the third limitation is that the workers' compensation dataset reports only lost time claims. In Wisconsin, workers' compensation data do not include medical claims, outright denied claims by insurance companies, and legitimate claims that do not qualify as lost time (at least days of lost time). This characteristic of workers' compensation data does not allow us to assess the full scope of cow-related claims. Also, because most farms are considered small farms, they are not statutorily required to obtain workers' compensation insurance.

Agricultural injuries, especially cow-related injuries in Wisconsin, which is known as “the Dairy State,” remain a major problem. Teens in agriculture are always at high risk, but the injury rates showed that teens handling cows are a bigger concern than all other agricultural injuries for older age groups. Prevention strategies and interventions to implement better cow handling measures and farm safety protocols focusing on young and Hispanic workers, are more likely to be effective for both workers and employers. Considering the size and strength of cows relative to humans, these injuries were not to be taken lightly because of the immediate and long-term disabling consequences. Although this analysis did not capture the length of recovery and any subsequent disability, there is an indication that some serious injuries, such as traumatic brain injuries, may incur a long recovery or disability period. Based on the injury narratives, better animal-handling training and farm policies could have contributed to a reduction of injuries, while also contributing to a healthier and productive workforce and more productive farms. The farm safety measures must not be limited to farms but expanded to any worker who interacts with cows including but not limited to those at genetics facilities, veterinary workers, livestock transporters, and meat processing workers involved in animal slaughtering operations. This is also a call for better agricultural injury surveillance and more inclusion of industry and occupation information in health and surveillance data.

Author Contributions

All authors contributed to the conceptualization, design of the work, writing, editing, and preparation of the manuscript for publication. Komi Modji and Katherine McCoy were primarily responsible for the conceptualization, design, and data analysis. All authors contributed to the interpretation of findings, drafted the manuscript, and revised it critically for important intellectual content. All authors approved the final version and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Katherine McCoy is the principal investigator of the occupational health surveillance program.

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Ethics Statement

The University of Wisconsin Institutional Review Board (UW-IRB) provided written approval for the Wisconsin Fundamental-Plus Occupational Health Surveillance Program (Submission ID Number: 2013-0331-CR010) under which this study was performed. The UW-IRB determined that this study met the requirements of public health surveillance as defined in the US Department of Health & Human Services regulations for the protection of human subjects (45 CFR 46.102(1)(2)). This analysis did not require informed consent of cases as these were administrative data reported to statewide public health surveillance databases.

Conflicts of Interest

The authors declare no conflicts of interest.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.

Supplementary Table I. Mechanisms of injury of agricultural injuries in the Wisconsin hospital discharge data from 2017–2023. **Supplementary Table II.** Detailed Nature of the cow vs. non-cow injuries among agricultural workers in the Wisconsin hospital discharge from 2017–2023. **Supplementary Table III.** Worker's compensation cow-related injury claimant's count and percentage by detailed industry from 2017–2023.